BIM Reference Book

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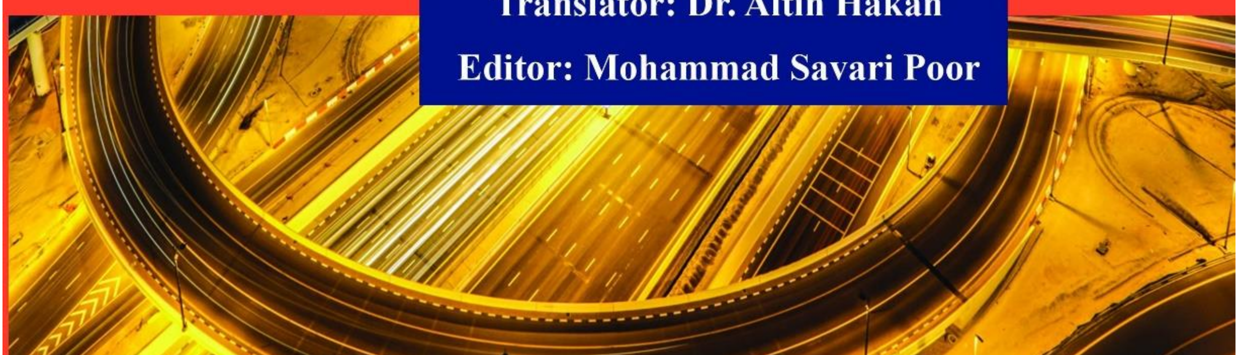
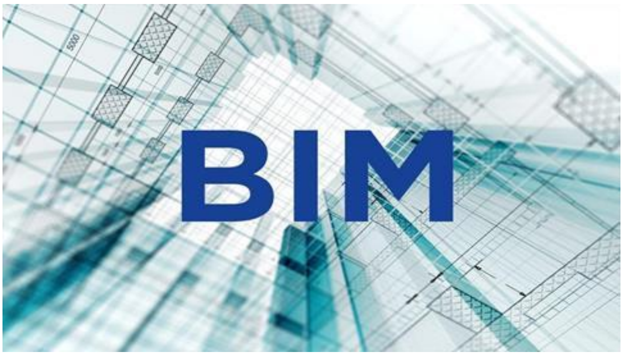


In The Name of God

The Omnipresent, The Omniscient,

And The Omnipotent

BIM Reference Book



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Dedicated to:

Engineering community across universe

Those who thought deeply and built powerfully to make the world a more comfortable and safe place to live.

Engineers who from long ago until now, if they built a wall, it was a shield against the onslaught of calamity, and if they built a bridge, it became a passage to meet the seal.

Those who raised from Mehrab to adytum to become the source of peace of human soul.

sages' men more proud than windbreakers and garlands and bells

Clearer than the water of canals

Nameless pious builders and nameless scientist's pyramids

Acropolis perfect builders and tireless wall builders

And also dedicated to the wisdom of engineering students who we are sure will be the empyrean sun of our future.

The words of the authors

On the way back from the ceremony of receiving the certificate of authenticity of global management from the scientific and educational office of the UNESCO Asian Studies Foundation (OCS), we were completely of the opinion that it is necessary and necessary to use the scientific and practical experiences gained by this group for many years in the way of knowledge production and we let’s play our part in adding a leaf to the thick book of engineering science and among various topics, we chose BIM based on the needs assessment for future generations, according to the progress made in construction science, and that meeting became the basis for implementing BIM in Iran for the first time, and we were proud to establish BIM in Iran.

Now that we have completed the work of writing the first BIM book in Iran, we are proud that we have become the third BIM science producing country in the world after the United States of America and Great Britain and we are now one of the eight countries that have brought this science to the fore in the world arena. And of course this is still one of the results of dawn.

Let the world know that we are determined to be the boundary breakers of knowledge and new horizons in the not-so-distant future.

The goal of our day and night is to throw the machetes and shovels the size of the ancient comrades on the young engineers of our sons and daughters.

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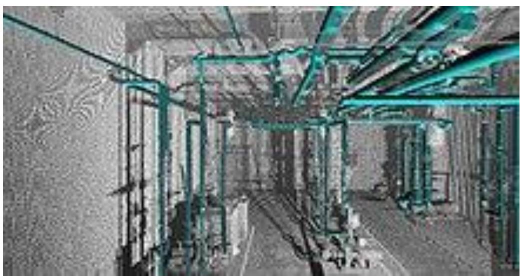
Chapter One

What is BIM?

Building Information Modeling (BIM) is a process supported by various tools, technologies and conventions that involves the production and management of digital representations of the physical and functional characteristics of places. Building Information Models (BIM) are computer files (often but not always in proprietary formats and containing proprietary data) that can be mined, exchanged, or networked to support decision making about built data. BIM software is used by individuals, businesses, and government agencies that plan, design, construct, operate, and maintain a variety of buildings and physical infrastructure.



A building information model of a mechanical room developed from lidar data [1]

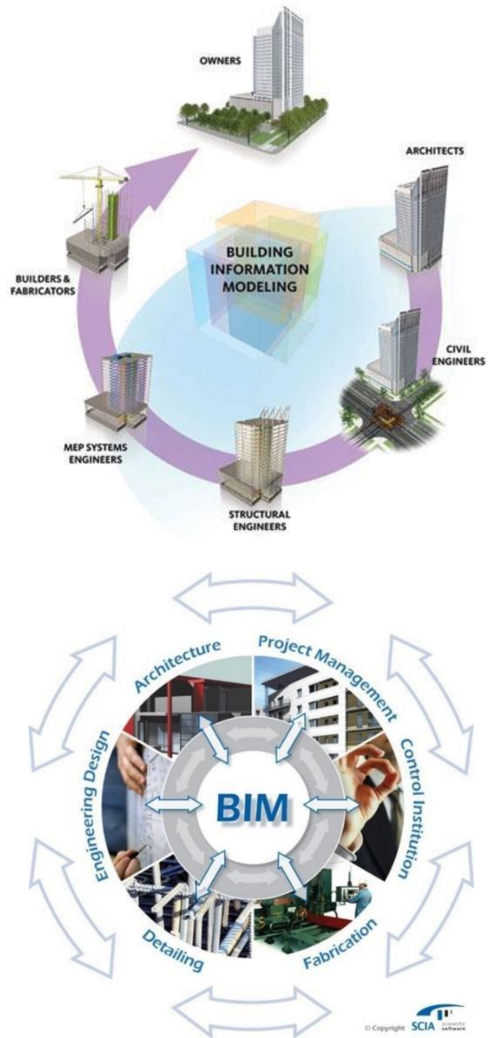
The concept of BIM has been developing since the 1970s, but only became an agreed term in the early 2000s. The development of standards and the adoption of BIM in different countries have progressed at different speeds. Standards developed in the UK since 2007 have formed the basis of the international standard ISO 19650, which Standards launched in January 2019.

1 It is an optical measurement method that uses the characteristics of emitted laser light to determine the specific characteristics of distant objects and the surface of the earth.

BIM technology and its application in the construction industry

Today, BIM (Building Information Modeling) technology is used as a solution in many advanced countries of the world as a new and emerging method to help increase accuracy, understanding and speed in the construction cycle of a building (Life Cycle), including initial studies, design, construction and operation and even demolition of all kinds of buildings and structures, has found a lot of use. Currently, the countries of America, England, Finland, Denmark, Norway, Hong Kong and Singapore have implemented this method in their different private and public sectors. Very large institutions and companies (for example, Autodesk, ...) are implementing and expanding this method in the advanced countries of the world.

In different stages of a project (Life Cycle) which includes preliminary studies, design of different parts (architecture, structure, mechanical and electrical facilities), due to the existence and conflict of different real and legal personalities, different methods and methods of construction, wide and diverse new materials and equipment, this cycle has become more complicated every day, which demands the increasing need for precision and the use of new and precise methods (Figure 1). On the other hand, the strict standards, the requirements for design and implementation of the building in a sustainable and environmentally friendly way (design Green and Sustainable), create this need for each member of the construction team (employer to operator) to be able to have the most visual understanding and the least errors in different stages of work. Another goal of using BIM technology is the correct transfer of information and requests from the project owners to the design team, from the design team to the construction team, and finally from the construction team to the user, so that the initial and final goals of none of the team members are deficient or deviated.



The life cycle of a project and all the factors involved in the BIM process

What is BIM (Building Information Modeling)?

BIM is a digital example of the design and construction process of a building in order to facilitate the exchange of information and concepts, as well as to increase the ability to cooperate and interact between all the people involved in the construction cycle (Life Cycle) of a project, in other words, simulation. All the construction and design process can be done in a virtual environment by the concept of BIM and its related tools; A simulation that makes the entire process in a digital environment verifiable and scrutinized and minimizes the amount and amount of them before any risky and costly mistakes.

Definition of BIM: Building Information Modeling (BIM) is a computer-aided modeling technology that is used to manage and produce building information and processes related to the production, communication and analysis of building information models. (C. Eastman et al. 2011)

Definition of BIM: The American General Contractors Association defines Building Information Modeling as the development and use of a software model to simulate the construction and operation of a building; The resulting model is a building information model, which is an "information-rich", object-oriented, intelligent and parametric digital representation of the building and its views and information can be extracted and analyzed according to the needs of users to produce the information needed to make decisions and improve the project delivery process. (Ernstorm, 2006)

Definition of BIM: Craigie et al. defines BIM as a parametric 3D model that is used to produce plan, section, elevation, perspective, detail, and time-lapse — all components necessary to document a building design and it distinguishes it from the usual two-dimensional drawings, being parametric, interactive and "rich in information". (Krygiel, 2010)

Definition of BIM

The US National BIM Standard notes that there is no unique definition of BIM. however, it defines BIM as a digital representation of the physical and functional characteristics of a building and a shared knowledge resource for reliable decision-making throughout the life of a building (from initial design to demolition). (USA National BIM Standard, 2012)

As we have seen, in fact, there is no standardized and unique definition for BIM, and it has caused researchers, organizations and software companies to have their own definition of BIM, which can cause challenges and confusion in projects. (Abbasnejad & Moud, 2013).

History of BIM

Chuck Eastman

The concept of BIM has been around since the 1970s.

The first software tools developed for building modeling emerged in the late 1970s and early 1980s and included workstation products such as Chuck Eastman's Building Description System and GLIDE, RUCAPS, Sonata, Reflex, and the Gable 4DSeries.

Early applications and the hardware required to run them were expensive, which limited widespread adoption

What became known as BIM products differed from architectural design tools such as AutoCAD by allowing more information (time, cost, builder details, sustainability and maintenance information, ...) to be added to the building model.

Because Graph iSOFT had been developing such solutions longer than its competitors, Laiserin considered its ArchiCAD[1] program to be "one of the most mature BIM solutions on the market" at the time. After its launch in 1987, ArchiCAD is considered by some to be the first BIM implementation because it was the first CAD product on a PC capable of creating 2D and 3D geometry, as well as the first commercial BIM product for PCs.

The term "building model" (meaning BIM as it is used today) first used in the literature in the mid-1980s: in a 1985 paper by Simon Raffel, finally published in 1986, and later in a 1986 paper by Robert

However, the terms "building information model" and "building information modeling" (including the acronym BIM) did not come into common use until about 10 years later. Facilitating the exchange and interoperability of information in a digital format with different terms: by Graphisoft as "virtual building" or "unit building model", Bentley systems were done as "Integrated

1 It is a building information modeling software in Windows.

Project Models" and by Autodesk[1] or Vector works[2] as "Building Information Modeling".

Interoperability and BIM standards

Because some BIM software developers have built proprietary data structures into their software, data and files created by one vendor's applications may not work in another vendor's solutions. To achieve interoperability between applications, neutral, non-proprietary or open standards have been developed to share BIM data between different software applications.

Poor software interoperability has long been considered a barrier to industry efficiency and BIM adoption. In August 2004, a US National Institute of Standards and Technology (NIST) report conservatively estimated that $15.8 billion is lost annually by the US capital facilities industry due to insufficient interoperability resulting from the highly fragmented nature of the industry, paper-based business practices, lack of standardization and inconsistent adoption of technology among stakeholders.

An early BIM standard was the CIMSteel integration standard, CIS/2, a product model and data exchange file format for structural steel project information (CIMsteel: Computer Integrated Manufacturing of Constructional Steelwork). CIS/2 enables seamless and integrated information exchange during the design and construction of steel frame structures.

BIM standard developed in the late 1990s by the University of Leeds and the UK Institute of Steel Construction, with input from Georgia Tech, and BIM standard approved by the American Institute of Steel Construction as its data interchange format for structural steel in 2000.

BIM is often associated with Industrial Foundation Classes (IFC) and aecXML - data structures for representing information - developed by buildingSMART. IFC is recognized by ISO and since 2013 is an official international standard, ISO 16739.

Construction Operations Information Exchange (Cobie) is also related to BIM. Bill Sharq of the US Army Corps of Engineers developed Cobie in 2007, and helps to record equipment lists, product data sheets, warranties, spare parts list and preventive maintenance schedules. This information is used to support the operations, maintenance and management of the data when the data is in service. In December 2011, US-based National Institute of Building Science approving by the US-based National Institute of Building Science as part of the National Building Information Model Standard (NBIMS-US). Cobie embeding

1 It is an American computer company that works in the field of manufacturing and developing 3D software and computer simulation.
2 One of the most powerful design software for architects

in software and may be in various forms including spreadsheet, IFC[1], and ifc XML. In early 2013, Building SMART is working on a lightweight XML format, Cobie Lite, which, Building SMART made available for review in April 2013.

In January 2019, ISO[2] published the first two parts of ISO 19650, which provide a framework for building information modeling based on process standards developed in the UK. British BS and PAS 1192 specifications form the basis for subsequent parts of the ISO 19650 series, with sections on data management (Part 3) and security management (Part 5) published in 2020.

The IEC/ISO 81346 series for reference designation has published 81346-12:2018, also known as RDS-CW (Reference Designation System for Building Works). The use of RDS-CW offers the prospect of integrating BIM with classification systems based on complementary international standards being developed for the power plant sector.

ISO 19650-1:2018 defines BIM as follows

Use a common digital representation of built data to facilitate the design, construction and operation processes to form a reliable basis for decision making.

The US National Building Information Model Standards Project Committee has the following definition:

Building Information Modeling (BIM) is a digital representation of the physical and functional characteristics of a facility. BIM is a shared knowledge source for information about a facility that forms a reliable basis for decision-making throughout its life cycle. It is defined as existing from first conception to destruction.

Traditional building design largely depend on two-dimensional technical drawings (plans, elevations, sections, ...).

Building information modeling expands the three basic spatial dimensions (width, height, and depth), which includes information related to time (so-called BIM-4D), cost (BIM-5D), data management, sustainability, ...; Therefore, BIM covers more than geometry. It also covers the spatial relationships, spatial information, quantities and characteristics of building components (e.g., building details) and enables a wide range of collaborative processes related to build data from initial planning to construction and then throughout its operational life.

1 It is a factor that provides the possibility of maintaining and transferring data and adjusted programs of the BIM model.
2 International Organization for Standardization

BIM authoring tools present a design as a combination of "objects" - vague and undefined, generic or product-specific, solid shapes or voids (such as the shape of a room) that carry their geometry, relationships, and properties. BIM applications allow the extraction of different views from a building model for map generation and other applications. These different views are automatically compatible and based on a single definition of each object instance. BIM software also defines objects parametrically. That is, objects are defined as parameters and relationships to other objects so that if an associated object is modified, the dependent objects are automatically modified. Each model element can have features to automatically select and order them, provide cost estimation as well as track and order materials.

For professionals involved in a project, BIM enables a virtual information model to be shared by the design team of architects, landscape architects, surveyors, civil, structural and building services engineers, ..., the main contractor and subcontractors, and the owner. Each professional adds discipline-specific data to a common model—typically a "federated" model that combines several different discipline models into a single model. Combining models enables visualization of all models in a single environment, better coordination and development of plans, increased collision avoidance and detection, and improved time and cost decision making.

BIM wash:

"BIM wash" or "BIM washing" is a term sometimes used to describe inflated or deceptive claims or offers of BIM services or products.

Use throughout the project life cycle:

The use of BIM goes beyond the planning and design phase of the project and extends throughout the building's life cycle.

The supporting processes of building life cycle management include cost management, construction management, project management, facility operation and building application.

A "common data environment" (CDE) is defined in ISO 19650 as follows:

An agreed upon source of information for any given project or data, for the collection, management and dissemination of any container of information through a managed process.

A CDE workflow describes the processes used, while a CDE solution can provide the underlying technologies. A CDE is used to share data throughout the project or data lifecycle and supports collaboration across the entire project team.

Management of building information models

Building information models cover the entire time period from concept to occupancy. A BIM Manager may be appointed to ensure efficient management of information processes during this period. The BIM Manager is maintained by a client-side design-build team from the pre-design stage onwards to develop and track object-oriented BIM against predicted and measured performance goals and support multi-disciplinary building information models that drive analysis and scheduling. Companies are also considering developing BIM at different levels of detail, because depending on the BIM application, more or less detail is required and there are different modeling efforts associated with producing building information models at different levels.

BIM in construction management

Participants in the construction process are constantly challenged to deliver successful projects despite tight budgets, limited staff, accelerated schedules, and limited or conflicting information. Important disciplines such as architectural, structural and MEP[1] designs must be well coordinated because two things cannot be done in the same place and time. BIM can also help detect collisions and identify the exact location of discrepancies.

The concept of BIM considers the virtual construction of a facility before its actual physical construction, in order to reduce uncertainty, improve safety, solve problems, and simulate and analyze potential impacts. Subcontractors from any trade can enter critical information into the model before construction begins, with opportunities to prefab or assemble some systems off-site.

Waste can minimize on site and products can be deliver just in time instead of stockpiling on site Common values and properties of materials can be easily extracted. The scope of work can be separated and defined. Systems, sets, and sequences can be represented on a scale relative to an entire facility or a group of facilities. BIM also prevents errors by enabling conflict or "collision detection," whereby the computer model visually highlights to the team where parts of the building (e.g. structural framing and building service pipes or ducts) may mistakenly intersect.

BIM in facility operations

BIM can bridge the loss of project management-related information from the design team, construction team, and building owner/operator by allowing each group to add and reference all the information they acquire during their

1 Build active systems

involvement in the BIM model. This can bring benefits to the facility owner or operator.

For example, a building owner may find evidence of a leak in his building. Instead of exploring the physical building, he might refer to the model and see that a faucet is in a suspicious location. He can also include the specific valve size, manufacturer, part number and any other information that has been researched in the past pending sufficient computing power in the model. Such problems were initially addressed by Leite and Akinci when developing a vulnerability representation of facility contents and threats to support the identification of vulnerabilities in building emergencies.

Dynamic information about the building, such as sensor measurements and control signals from building systems, can be incorporated into BIM software to support analysis of building operations and maintenance.

Efforts have been made to create information models for older, pre-existing facilities.

Approaches include reference to key criteria such as a facility condition index (FCI) is either the use of 3D laser scanning surveys and photogrammetry techniques (separately or in combination) or the digitization of traditional building mapping methods using mobile phone technology to record accurate measurements and operational information.

Attempting to model a building built in, say, 1927 requires numerous assumptions about design standards, building codes, construction methods, materials, ..., and is therefore more complex than building a model during design.

One of the challenges of maintaining and properly managing existing facilities is understanding how BIM can be used to support a comprehensive understanding and implementation of building management practices and "cost of ownership" principles that support the full life cycle of a building product.

Green building BIM

BIM in green building, or "green BIM", is a process that can help architecture, engineering and construction firms to improve sustainability in the built environment. It can allow architects and engineers to integrate and analyze environmental issues in their design throughout the data lifecycle.

International developments

Asia

China:

China began its exploration of building information modeling in 2001. The Ministry of Construction announced BIM as a key information technology application in the "Ten New Technologies of the Construction Industry" (by 2010). The Ministry of Science and Technology (MOST) clearly announced BIM technology as a national key research and application project in the 12th five-year science and technology development plan. Therefore, year of 2011 describas "China's first year of BIM".

China has set its actions based on a set of five-year plans; Each of these programs identifies important and necessary initiatives for the development of the country in the social and economic field in its respective time frame. The first program is related to the period between 1953 and 1957. The 11th program implementing between 2006 and 2010. Although China's 12th plan includes several initiatives to balance the country's economy, guide development from urban and coastal areas to rural areas and islands, improve environmental protection, and accelerate the effectiveness of organizational reforms; One of the key initiatives related to construction in this program is the issue of energy-efficient buildings, which serves to realize a higher goal under the title of sustainability in architecture. This issue is very important for China; Because this country has the largest population in the world and its economy is developing rapidly, so it is a serious threat to its limited and finite resources.

Despite not finding specific information about the use of BIM in the recent five-year plan of China, It will be very difficult and even impossible for the construction companies of this country to be able to achieve an acceptable amount of energy efficiency in the building they are designing without resorting to presenting their design by means of computer models in order to carry out accurate analyzes related to the discussion of energy in the building. However, China, by decisively dealing with the issue of waste in the field of energy, as well as imposing limits on energy for buildings, indirectly pushes the construction industry of this country towards the use of advanced technologies in this industry, such as BIM.

Hong Kong:

In 2006, the Hong Kong Housing Authority introduced BIM, and then set the full implementation of BIM in 2014/2015.

The construction industry in Asia Pacific is undergoing major changes and is rapidly automating and streamlining its processes to keep pace with the international business ecosystem. In this sense, Hong Kong is considered as one of the most advanced countries in the region in terms of adopting construction technologies. Hong Kong has played an important role in setting standards for this industry. By using advanced technologies in its projects, this country has shown their effectiveness and efficiency in completing world-class construction projects.

Iran:

Iran Building Information Modeling Association IBIMA established in 2012 by professional engineers from 5 public universities in Iran who intended to share knowledge resources to support construction engineering management decision-making, which unfortunately did not bear fruit.

In 2017, a group of young engineers of the country in the private sector, after obtaining the certificate of global construction manager from the scientific and educational office of the UNESCO OCS organization, thought to take a big step in the country's engineering science and in 2018, with the establishment and launch of the international group of BIM tower builders, they started their official activity in the scientific, educational and executive fields. which, in addition to scientific research and writings in engineering fields and writing the first BIM reference book, played a great role in implementing BIM engineering science in engineering projects and brought BIM to the fore in the country for the first time.

Malaysia:

The implementation of BIM is targeted towards Stage 2BIM by 2020 under the leadership of the Construction Industry Development Board (CIDB Malaysia). According to the Construction Industry Transformation Plan (CITP 2016-2020), it is hoped that greater emphasis on technology adoption during the project life cycle will lead to higher productivity.

Singapore:

The Building and Construction Authority (BCA) has announced that BIM for architectural submission (by 2013), structure and M&E submission (by 2014) and finally for design submission of all projects with a gross area of more than 5000 square meters by BCA Academy is training students in BIM.

BCA[1] (Building and Construction Authority) is an organization in Singapore that is responsible for the management and leadership of the construction industry. Singapore is one of the first countries to consider the strengths of modeling-based design even before the term BIM introducing by BCA. In the early 1990s, this country had defined a project called CORENET, which is actually a system to automatically control the rules and requirements in the plan

1 Building Code of Australia

presented for a building. Of course, it should be mentioned that this control system could only be used for buildings that were presented as a computer model (and not two-dimensional drawings). At that time, this system still in the experimental stage and supposing that BCA use in a few projects as a test before the public release.

Japan:

The Ministry of Lands, Infrastructure and Transport (MLIT) has announced the start of a pilot project on BIM in Government Buildings and Repairs (until 2010). The Japan Institute of Architects (JIA) published the BIM Guidelines (as of 2012) that outlined the agenda and expected impact of BIM for architects. MLIT announced that "BIM will be mandatory for all its public works from FY 2023, except where there are special reasons". Works covered by the WTO[1] Government Procurement Agreement must comply with published ISO[2] standards related to BIM such as the ISO19650 series in accordance with Article 10 (Technical Specifications) of the Agreement.

South Korea:

There were small BIM-related seminars and independent BIM efforts in South Korea even in the 1990s. However, it was not until the late 2000s that the Korean industry paid attention to BIM. The first industry-wide BIM conference held in April 2008 in south korea, and BIM spread rapidly thereafter. Since 2010, the Korean government has gradually increased the scope of mandatory BIM projects. In 2012, McGraw Hill[3] published a detailed report on the status of BIM adoption and implementation in South Korea.

United Arab Emirates:

Dubai Municipality issued a circular (196) in 2014 that mandated the use of BIM for buildings of a certain size, height or type. The one-page directive sparked strong interest in BIM and the market responded to prepare for further guidance and direction. In 2015, the municipality issued another circular (207) entitled "On the expansion of (BIM) practices in buildings and facilities in the Emirate of Dubai", which made BIM mandatory for more projects by reducing the minimum size and height required for projects requiring BIM. This second directive furthered the adoption of BIM with several projects and organizations adopting UK BIM standards as best practice. In 2016, the UAE Quality and Compliance Commission launched a BIM Steering Group to investigate the adoption of BIM across the country.

1 The World Health Organization
2 American publishing company
3 Austrian standards

Europe

Austria:

Austrian standards for digital modeling are summarized in ÖNORM A 6241, published on March 15, 2015; and corrected in the absence of definitions. ÖNORM A 6241-2 (BIM Level 3) contains all BIM Level 3 requirements.

Czech Republic:

The Czech BIM Council, established in May 2011, aims to implement BIM methodologies in Czech construction and design processes, training, standards and legislation.

Estonia:

In Estonia, the Digitaalehituse Klaster formed in 2015 to develop BIM solutions for the entire construction life cycle. The strategic goal of the cluster is to develop an innovative digital construction environment as well as to develop the new VDC[1] product, e-construction grid and portal to increase the international competitiveness and sales of Estonian construction businesses. The cluster is equally funded by the European Structural and Investment Funds through Enterprise Estonia[2] and cluster members with a total budget of EUR 600,000 for the period 2018-2016.

France:

The French arm of buildingSMART[3], called Mediaconstruct (existing since 1989), supports the digital transformation in France. A Digital Building Transfer Scheme - French abbreviation PTNB created in 2013 (from 2015 to 2017 and made mandatory under several ministries). A 2013 survey of European BIM performance ranked France in last place, but with government support, it rose to third place in 2017 with more than 30% of real estate projects completed using BIM.

In France, there are organizations working to further adopt BIM standards to improve the interoperability of software between those active in the construction industry. Such organizations include FBB[4] or the French arm of buildingSMART International, which supports IFCs[5]. On the other hand, software editing companies like Vizelia were early adopters of IFCs and are now taking full advantage of BIM in the new green building business.

1 Virtual design and manufacturing approach
2 It is a national foundation in Estonia that aims to develop the Estonian economy.
3 Digital building
4 folding boxboard
5 Industry Foundation Classes

According to the SmartMarket report from McGraw-Hill Construction, France has the highest adoption rate of BIM among construction professionals surveyed at 38%, although this number is only slightly higher than the rates of Germany and the UK. The report continues that a high percentage of French contractors (72%) use BIM in more than 30% of their projects. The report concluded that French users see the greatest value of BIM in reducing conflicts during construction and improving collective understanding of design goals.

Germany

According to a 2010 SmartMarket report, German contractors as a group use BIM 47% of the time in 30% of their projects. In Germany, architects have the highest acceptance rate among industrial professionals at 77%, followed by engineers at 53% and final contractors at 10%.

The implementation of BIM systems by US Army engineers has also reached Europe. The Army is now using BIM for many of its projects in various mission areas, and the number is still growing. Many German companies in the private sector are using BIM, says Jim Noble, Head of Engineering in the region. The challenge for us is that many architects who use BIM do not have much experience in this field.

Full integration with BIM in construction processes in the European region is expected to take some time, due in large part to the legal process outlined in the agreements signed between the United States and the German government that determine how BIM projects can be conducted in Germany. Our task now is to agree with our partners on some parameters, starting points and interoperability.

Finland:

BIM has been implemented to a higher extent in Finland than in neighboring Scandinavian countries. Also, Finland has mandated the use of BIM in all public sector projects. Recent surveys have shown that architects were the main users of BIM in their projects (approximately 93 percent), and the usage rate of engineers barely reached 60 percent. It should be noted that there is a commitment in the Finnish public sector in the widespread use of BIM. Another evidence of this is the BIM guidelines, which were prepared as a result of the Prolt research and development project and with extensive industrial support. These guidelines are in Finnish and basically cover all product models in construction projects, architectural design projects, modeling projects in construction and product modeling in building services design projects. Although these guidelines describe product modeling in detail, they do not provide sufficient data exchange specifications; Therefore, they provide the possibility of further progress and development in these guidelines.

BIM proponents are also quite active in the Finnish private sector, with a number of companies such as Skansa Oy and Tekes conducting research and development in BIM. Likewise, research organizations and universities, along with the Finnish Contractors Association and government clients, are active in promoting the implementation of BIM in the country's industry.

Denmark:

In 2007, Denmark (like Finland) made the use of BIM mandatory in all public sector projects. The general use of BIM in Denmark is increasing. According to a survey conducted in 2006, approximately 50% of architects and 40% of engineers in Denmark used BIM for some part of their project. One of the leading Danish organizations in this field is bips, which has had a major impact on IT implementation in the Danish manufacturing industry. In addition, the mandatory demands of BIM by Danish government clients have moved the use of BIM to a higher level.

In the public sector, Denmark has at least three government agencies that have started implementing BIM. These agencies include the Real Estate Agency, the Danish University and Real Estate Agency, and the Defense Construction Service. Although public projects in Denmark do not represent a large part of the total real estate area, their impact on the market created by the IFC[1] requirements is significant. There are other government agencies, such as Gentoft Municipality and KLP Ejendommehave, that have approved requirements for digital construction projects in Denmark.

The Danish government has strongly expressed its need to use BIM in government projects. State requirements are called Byggherrekravene. Since January 2007, all architects, designers and contractors involved in public construction projects require to adopt a number of new digital approaches and tools. Based on the digital manufacturing program that Danish Enterprise and Manufacturing Agency initiating it, a set of guidelines for 3D developed. The instructions are related to both setting and fulfilling the requirements in the file and the CAD program based on the BIM database.

Bips is also developing BIM guidelines for the private sector and has adopted the results of the Digital Construction project. It is also promoting new working methods in the Danish construction industry. The Danish Construction and Enterprise Organization is an organization that supports BIM research and development in Denmark as well as other Danish organizations and universities such as Aalborg University. This university focuses on IFC model servers and 3D models.

1 Industry Foundation Classes

America:

Maybe we think that the United States has followed the same path. But it is not like this. While they were among the first countries in the development of BIM in 2005 and created the National BIM Standards of the United States (National BIM Standards of the United States), the development of BIM in different states has not been the same.

Depending on the region, 40-75% of public and private projects use BIM. Some states, like Wisconsin, have applied BIM only to government projects. Even today (2019) when the use of BIM is necessary in large federal (non-state) projects, the use of BIM in many buildings is not affected by this issue. It is known that the number of states and cities located in them and the buildings located in those cities are more than the federal states of America; But there are also smaller government institutions that try to use BIM.

General Services Administration in 2003, U.S. Army Corps of Engineers in 2006, Naval Facilities Engineering Command in 2006 as well as Canada, Australia, New Zealand and many other countries have defined standards in this field, but no regulations have been considered for it.

Ireland:

In November 2017, the Irish Department of Public Expenditure and Reform launched a strategy to increase the use of digital technology in the delivery of key public works projects, which will require the use of BIM over the next four years.

Norway:

In Norway BIM has been increasingly used since 2008. Several large public clients require the use of BIM in Open Formats (IFC) in most or all of their projects. In order to increase the speed and quality of the process, the State Building Organization puts its processes on the basis of BIM in open formats, and all large contractors and some small and medium contractors use BIM. The national development of BIM is centered around the local organization, buildingSMART Norway, which represents 25% of the Norwegian construction industry.

Norway's Graphisoft and Solibri have partnered in response to the growing need for BIM quality assurance and model review in Norway. For this reason, BIM is promoted and used in Norway by various public organizations and contractors, including government client Statsbygg and the Norwegian Builders Association. Norway has also recently provided guidelines for BIM based on the experiences of Statsbygg's HIBO project.

The private sector has also been active in promoting BIM. For example, Selvaag-Bluethink is developing BIM and ICT solutions based on BIM. SINTEF Norway is the leading research organization on BIM. The company is part of Erabuild, a network of national research and development programs focused on sustainable tools to improve the construction and performance of structures. In addition, it is among the first countries to develop the International Framework of Dictionaries (IFD[1]) for the construction industry.

Poland:

BIMKlaster is a non-governmental and non-profit organization founded in 2012 with the aim of promoting the development of BIM in Poland. In September 2016, the Ministry of Infrastructure and Construction launched a series of expert meetings on the application of BIM methodologies in the construction industry.

Portugal:

The Technical Committee for BIM Standardization, CT197-BIM, created in 2015 to promote the adoption and normalization of BIM in Portugal, has created the first strategic document for Construction 4.0 in Portugal, which aims to align the country's industry around a common, integrated vision. ; And it's more ambitious than a simple technology change.

Russia:

The Russian government has adopted a list of regulations that provide a legal framework for the use of building information modeling in construction and encourage the use of BIM in government projects.

Slovakia:

Slovak BIM Association, BIMaS founded in January 2013 as the first Slovak professional organization focused on BIM.

Although there are no legal standards or requirements for presenting projects in BIM, many architects, structural engineers and contractors, as well as a number of investors, are already using BIM. A Slovak implementation strategy developed by BIMaS and supported by the Chamber of Civil Engineers and the Chamber of Architects has not yet been approved by the Slovak authorities due to their low interest in such innovation.

Spain:

A July 2015 meeting at the Spanish Ministry of Infrastructure (Ministerio de Fomento) launched the country's National BIM Strategy, making BIM a mandatory requirement in public sector projects with a possible start date of

1 Internet-facing deployment

2018. Spanish experts created a BIM Commission (ITeC) to adopt BIM in Catalonia.

Swiss:

From 2009 through the Swiss Smart Building initiative, then 2013, awareness of BIM increased among the wider community of engineers and architects due to the open competition for Felix Platter Hospital Basel where a BIM coordinator seek . BIM has also been the topic of events of the Swiss Society of Engineers and Architects, SIA.

England:

In May 2011, the UK government's chief construction adviser, Paul Morrell, called for the adoption of BIM in UK government construction projects. Morrell also told construction professionals to use BIM or be Betamaxed[1].

In June 2011, the UK government published its BIM strategy and announced that it plans to move towards collaborative 3D BIM (with project information and data, documents and data being electronic) in its projects by 2016.

Australia:

In February 2016, Infrastructure Australia recommended: "Governments should mandate the use of Building Information Modeling (BIM) for the design of large-scale complex infrastructure projects. In support of mandatory implementation, the Australian Government should order Australian procurement and construction. The Council works with industry to develop appropriate guidance on the adoption and use of BIM and common standards and protocols to be applied when using BIM.

New Zealand:

In 2015, many Christchurch regeneration projects were assembled in detail on a computer using BIM before workers set foot on site. The New Zealand government launched the BIM Acceleration Committee as part of a productivity partnership aimed at 20% more efficiency in the construction industry by 2020.

Future potential

BIM is a relatively new technology in an industry that typically slows change. However, many early adopters are confident that BIM will play an important role in building documents.

1 It is when a superior product loses compared to an inferior product.

Proponents claim that BIM provides:

Improved visualization
Improved productivity due to easy data retrieval
Increasing the coordination of construction documents
Embedding and linking critical information such as vendors for specific materials, location details and quantities required for estimating and bidding.
Increase the speed of delivery
reduction in costs

BIM also contains most of the data needed to analyze building performance. Building features in BIM can be used to automatically create the input file for building performance simulation and save a significant amount of time and effort. In addition, the automation of this process reduces errors and inconsistencies in the building performance simulation process.

Objectives or dimensions:

Some objectives or applications of BIM may be described as "dimensions". However, there is little consensus on definitions beyond 5D. Some organizations reject this term.

Construction and digital transformations

In 2020, IDC[1] conducted a study on the digital transformation of construction around the world titled "The Future of Connected Construction". This study included more than 800 experts from Europe, America (North and South) and Asia. The most interesting result was that digital transformation was a priority for almost 4 out of 5 construction companies. Specifically, 72 percent of interviewees identified digital transformation as a key priority for developing work processes. Business models and company ecosystems were stated. The study also reported country-by-country results, showing, for example, how important digital transformation is in the construction sector in the UK, where 83% of interviewees prioritized digital transformation. What's more, it's not just a case of aspiration or future goals: 81% of UK professionals said they were actively involved in the digital transformation process.

However, in the case of current projects, it must be said that the use of digital solutions is still on the sidelines. For example, only 1% of respondents claimed to use digital tools in more than 60% of their projects, while more than 70% of businesses use digital solutions in less than 30% of their projects. So it seems that while there are clear benefits to digital advancements and businesses are

1 Internet data center

ready, we're still waiting for what might be called the big leap in digital transformation in construction.

According to IDC, there are 5 digital challenges that companies in this sector will have to deal with in the next few years

The first is to create a common technological roadmap at the company level, in order to determine the amount of digital investment required.

The second is to create a scalable technology architecture, followed by the third to set clear goals to measure development. Finally, the last two challenges are gathering the necessary technical skills and integrating digital best practices into the company.

BIM, the key tool for digital transformation in the construction industry

It is undoubtedly true that if there is one critical tool that can drive digital transformation in the world of construction, it will be the famous tool BIM, which stands for Building Information Modeling. In short, it is a digital representation of a construction that is able to show the physical and functional characteristics of the building as in other phases of the life cycle. BIM is increasingly used in the construction industry around the world and ensures extensive sharing, flexibility and interaction: It should be emphasized that this tool brings together different professionals involved in a project and provides opportunities for them to face around the world.

The whole construction process

BIM can be considered as the virtualization of all the information related to a project, which is very valuable in the design phase as well as the construction phase and later in the maintenance phase.

New professional faces

It is important to note that even more than the spread of digital tools and technologies, digital transformation is and should be the evolution of workers' skills. In recent years, we have seen the emergence of new professionals in the world of construction, such as building physics technology technicians, who seek to improve construction processes and solve application problems. or systemic design engineer, trained to provide modern solutions using innovative systems and sustainable materials; Or again, home automation experts. In some cases, we are facing completely professional faces. While in other cases we are dealing with operators who have previously worked in the sector who have acquired new skills over time. And this will continue in the coming years with professionals specializing in the use of drones or digital mapping tools .....

Innovative materials

Digital transformation in the construction industry also brings the use of more innovative materials that can be used as a result of the new technologies themselves. The use of these new materials means a reduction in maintenance costs or energy requirements per load or a drastic reduction in harmful emissions. Consider, for example, the latest generation of photovoltaic glass that enables more efficient and controllable renewable energy systems, or products that can be made from these innovative materials, such as floors that convert people's footsteps into electrical energy.

Digital technologies and safety

We're not just talking about performance and sustainability: new digital technologies used in the construction sector can have significant safety benefits, as well as reducing the number of accidents and fatalities in the construction industry. With sensors that can be applied to objects or directly to operators, the technology allows for greater control of movement and the opportunity to warn of impending danger and thus stop it. In fact, as a result of new technologies, it is possible to update real-time GPS coordinates, movements and vital signs of people so that we can take immediate and long-term action to improve health and safety.

Internet of things and smart building

finally, On the topic of digital transformation in the construction industry, we should not forget the potential transformations made possible by the Internet of Things, and all that wide range of technologies that enable us to talk about smart buildings and, consequently, smart cities.. By automatically controlling systems and energy consumption, the Internet of Things enables the monitoring of key building parameters at any point in time to increase comfort, health, sustainability and energy savings.

Digital developments in the future

In the coming years, perhaps more than ever before, a technological revolution will transform the construction sector in all its aspects, greatly affecting service, production and supply. With BIM and even more considering the issue of Digital Twin[1], the innovation of tools due to virtual reality simulations and real- time dynamic reality monitoring requires a methodological innovation for the entire sector.

1 A digital twin is a virtual copy of a physical asset.

Freehand drawing, drafting machines or CAD[1] represent innovative tools in graphical representations. In such cases, the evolution of productivity tools has improved and accelerated design, but not much more. With Building Information Modeling (BIM) and even more considering the topic of Digital Twin (DT), the innovation of tools requires a methodological innovation for the entire sector. In the case of BIM and DT, several technologies and topics need to be analyzed, including virtual reality simulation, dynamic real-time monitoring and control, data-driven decisions, ... Several drivers can be identified in the evolution of research and industrial applications. Therefore, there is a need to provide a systematic analysis that can provide a clear and useful background for future research work. Among these drivers, standardization activities and the development of digital platforms for the construction sector represent key points for understanding the ongoing research and development in the digitalization of the construction sector.

In the last two decades, the work of designers has changed drastically, not only in terms of conceptual differences in project representation, but also more and more towards 3D development as a model from which 2D floor plan drawings are derived.

Defining the BIM model and introducing a disruptive process

Once the back-and-forth that accused BIM of destroying the designers' creative process has died down, process integration shows itself. Geometric information alone does not allow the project representation necessary for the BIM process to be complete, and therefore BIM proposes an object-based representation. In the case of construction, this becomes a representational schema modeled around project entities and their interrelationships.

For example, in the definition of a floor object, geometry is only one of the various properties of this building element. A room consisting of floor and wall will contain information such as connected walls and adjacent spaces in addition to geometric data. We are not only talking about the layout of the model, but also about the "building representation" considering the specific domain of information integrated into the objects.

By reshaping the structural principles of object modeling, metrics are introduced to measure the actual application of BIM in manufacturing facilities. As the maturity level of BIM adoption increases, so do the levels. Level 0 represents the initial form of the introduction process. In general, people still work in 2D, with 2D maps enriched with data without common standards. We are in traditional procedures, prodromes of a true BIM and away from object- based architecture. At level 1 standard structures and templates are introduced,

1 It is a technology that studies the use of computer systems to aid creativity, improve analysis, and optimize design.

certainly in the design phase there is a 3D phase enriched with 2D documents with design information. However, the collaborative phase is still far away and the federated models are not yet developed, so the strengths of BIM are not yet utilized. At level 2, we are currently thinking in a fully collaborative environment: all parties use 3D CAD models And collaboration is the way information is exchanged between different parties via common file formats that allow anyone to create a verifiable federated model. So we're in a 3D environment with attachments where the primitive threads are still on separate models that can be assembled. At level 3, sharing and collaboration between disciplines is complete. There is a single design model in an IFC-compliant repository that is referenced in the following lines.

BIM dimension and new professionals:

For the inherent characteristics of models in a BIM environment, they lend themselves to simulation processes even sufficiently complex. We can consider them as the forerunners for

the development of Digital Twins. To account for their natural inclination to complex management of the built environment, a scale of dimensional values, from one to seven, has been devised to describe the characteristics inherent in the workflow. After the second and third dimensions of BIM, the graphic representation of the work in two dimensions, plan function or three dimensions, space function, the fourth dimension of 4 dimensions is introduced to simulate the work or its elements as a function of time.

To manage the whole process, new roles are required and different degrees of expertise are introduced, which keeps the activity focused on managing the model, even if informed. Also, the UNI 11337-7 standard specifies the roles, knowledge and skills associated with professional activities involved in BIM information flow and summarizes the roles envisaged by previous UK standards into the following four roles. The BIM Manager is intended for the overall monitoring and coordination of projects in terms of information. This is the person who defines the BIM guidelines and the way the digitization process affects the organization and the work tools. The BIM coordinator works at the unit order level, in agreement with the senior management of the organization and with the reference of the BIM manager. Generally, he/she follows the elaboration of the model and also communicates with the CDE[1] manager. A BIM specialist should know BIM project implementation software according to his/her disciplinary competence (architecture, structure, factory engineering, road, hydraulic). He must understand and use technical and operational documentation to produce drawings and models (standards and procedures). Under the supervision and coordination of the BIM coordinator or BIM manager of the company or design group, he must model information for

1 Shared information environment

graphical and non-graphical models in order to describe graphical models and related items. objects and their libraries; He must extract data from models, from maps, and from objects. He must modify the models and objects obtained from the coordination between the models and from the revisions of the project. Its intervention is a part of the digital workflow, which is enhanced by the ability to analyze the content of the information specification and the information management plan, which has the full capacity to confirm the information model and validate its compatibility.

Interoperability standards and continuous evolution:

The gradual transition to BIM has created an inevitable expansion of software products related to information modeling, where the model can find a complete expression of the geometry and its related information. However, the coordinated work between different teams, as well as the compulsion to share data in a common environment, imposes solving problems related to communication between software.

Interoperability:

Over the years, the evolution of the data schema has added various degrees of complexity to its hierarchical structure based on the entity-relationship model to provide a data transfer that holds more and more information and subsequent relationships. Currently, the IFC standard can standardize and codify various components of the BIM model: automatic object identification, information about attributes and relationships with other objects, all this to convey the information model while preserving the logic and geometric-documentary information connected to it. However, IFC attempts to encapsulate a field such as the construction sector into a pre-defined logical framework.

Evolution of technical regulations:

The evolution of technology can be traced to the transition from CAD (computer-aided design) software systems dedicated to the construction sector (since the early 1980s) to object-oriented programming systems in the field of AEC (architectural engineering construction), also known as.

Evolution of tools to BIM:

The evolution of legislation (laws, mandatory rules), especially in the European perspective, goes back to the UK government's strategy to restart the construction sector after the systemic crisis of 2007/2008 and the related PAS (2011-2013). They achieved it. BIM government procurement commitment of over £5 million in 2016 in the UK. Voluntary introduction of BIM in the European Procurement Directive 2014: as a result of the transfer of BIM in the contract codes of EU member states (until 2016) and, for example, in Italy, the introduction of mandatory BIM from 2019 to 2025 (complex works greater than or equal to 100 million by 2019; (Each works out to over 1 million euros by 2025).

Key technical specifications and reference practices for BIM:

These constitute, on the one hand, the entry points of the first BIM works and standards (ISO STEP 10303; ISO 16739—IFC), on the other hand, the principle of all voluntary technical regulations in use.

The evolution of the BIM standard in the world

Voluntary technical standards are non-mandatory regulatory references that the market adopts to define the working space – the market – within which all relevant actors recognize common principles that are shared and with which they can act to protect everyone and the market itself. The standardization organization that operates at the international level is the International Organization for Standardization (ISO), and its standards are abbreviated as ISO. The standardization organization that operates at the European level (and some added countries including Great Britain) is CEN, and its standards are abbreviated as EN. CEN is part of ISO. For BIM there is an agreement called the "Vienna Agreement" for which (as of 2017) any ISO standard is automatically converted into a CEN standard (without further adoption). ISO standards in BIM, after 2017, are ISO EN standards. Finally, each state has its own national standards organization (for Italy UNI, for Great Britain BSI, for USA ANSI, ...). They regulate the national laws valid in the particular territory in the national language.

Standard body structure in the world:

Analyzing the three normative levels (National, CEN and ISO), we see that BIM, although not yet widespread and common in the construction sector (compared to CAD), has a large perspective of reference standards that actually allow it to be informed and regulated.

The shape and roles of BIM:

The figures of BIM UNI 11337-7:2017 are:

Shared Data Environment Administrator (CDE Administrator): A Shared Data Environment Administrator (CDE Administrator) is a person who deals with the shared data environment owned by the organization to which it belongs or provided by contract for a specific order by another entity.

Digital Process Manager (BIM Manager):

Digitized Process Manager (BIM Manager) is a figure that is mainly related to the level of the organization, in terms of the digitization of the processes carried out by it, possibly overseeing or overall coordination of the set of orders in progress. Delegated by the top management of the organization, he defines the BIM guidelines and the way the digitization process affects the organization and the work tools.

Order Information Flow Coordinator (BIM Coordinator):

The coordinator of order information flows (BIM coordinator) works at the individual order level, in agreement with the top management of the organization and on the recommendation of the digitized processes manager.

Advanced information management and modeling operator (BIM specialist):

The Advanced Information Modeling and Management Operator (BIM Specialist) usually works within the framework of individual orders and collaborates with a specific organization on a permanent or occasional basis.

An overview of BIM standards cannot be complete without a quick reference to the IFC (Industry Foundation Classes) standard for OpenBIM and OpenBIM. IFC is managed and implemented worldwide by BuildingSmart International and is regulated by the ISO 16739 standard. IFC is both a data model (by defining standard classes and relationships) and an open framework for generating interchange files in a non-proprietary format. Non-specific formats ensure the integrity and readability of data over time, which is very important for example in public procurement.

BIM-based platforms to create process management and research advances towards the digital twin of the entire building process must deal with inefficient information exchange between actors, because data exchange is mainly based on a paper-based transmission system, a variety of classification systems, as well as the use of different criteria and methods and a fixed number of stakeholders. Each stakeholder has a different set of skills, standards, and tools, and therefore communication and information exchange are characterized by a high level of complexity, and knowledge and process management are often time-consuming.

The relevance of BIM in the architecture, engineering, construction and operation (AECO) sector is recognized worldwide. Its implementation benefits the construction project by reducing and avoiding errors, speeding up the process, and improving communication between the actors involved. It integrates multi-disciplinary data to create a digital representation of a data throughout its lifecycle from planning and design to construction and commissioning. BIM-based platforms such as INNOVance and BIMReL help to increase the exchange of information and data during the life cycle of the building.

The first BIM-based platform for the construction sector in Italy is INNOVance. It aims to collect, process and share data and support the stakeholders involved by creating a unique code for the products, services, activities and resources used, a standard data page and a web portal which allows users to use information at every stage of construction.

BIMReL is an interoperable open source BIM library for building products that allows linking all the technical information of products to the BIM objects contained therein. It supports information management throughout the entire life cycle of the building based on information definition and technological needs. The added value lies in the provision of standard datasheets in accordance with UNI 11337-3 13.

With the need to monitor and control data throughout its lifecycle, and with the introduction of the Internet of Things and the spread of artificial intelligence (AI), the birth and growing confirmation of the digital twin has become even more important.

DT can be defined as "a realistic digital representation of data, processes or systems in the built or natural environment" where the data is synchronized from physical to digital, thus it is considered as a technology that enables physical and virtual space to communicate.

DT presents a new approach in the AEC[1] sector: it is not only a visual representation of the building, but the latter can be enhanced with real-time data to detect the situation and by integrating statistical, probabilistic or artificial intelligence models to enable predictive skills. DT can be used for the following applications:

Real-time monitoring, simulation, diagnosis and performance prediction of BIM and DT are still mainly applied in new buildings, even if the increasing attention to renovation calls for their use and benefits.

In fact, since the AEC sector and especially buildings cause serious problems for the environment such as high level of energy consumption and CO2 emissions, more attention has been paid to the renovation phase in recent times.

Therefore, the process of renovation and reuse of buildings should be stimulated. However, improving the quality of renovations, reducing building construction phase time, minimizing the impact on tenants and ensuring that cost/benefit objectives are met are typical obstacles to be faced and overcome.

Digitalization is becoming a tool for the construction sector to improve the renovation process. Digital solutions can be adopted to manage information and

1 Architecture, engineering and construction industry

data in a more organized structure, reducing construction time and waste and increasing productivity and performance.

BIM-based toolbox

BIM-based toolkits have been developed for various areas of renovation such as rapid mapping of existing buildings, building information management, energy simulation of renovation scenarios, rapid construction management, ...

BIM-based tools are connected and can be accessed by a BIM Management System (BIMMS), a platform where all activities of the building process can be managed and interested parties can exchange data from different sources.

The BIM4EEB toolbox is characterized by the following tools, as shown in Figure 15:

BIM management system

BIMplanner is a fast tracking tool for renovation operations.

BIMeaser is a BIM-assisted energy renovation assessment tool.

AUTERAS and BIMcpd are tools for decision support and evaluation of energy renovation.

BIM4Occupants is a human machine interface tool.

Quick Mapping Toolbox is a tool to reduce review time.

The word thousand faces of the building:

A building or mansion is a structure with a roof and walls that are more or less permanently located in a place such as a house or a factory. Buildings come in a variety of sizes, shapes, and functions and have been adapted throughout history for a variety of factors, from available building materials, weather conditions, land prices, land conditions, specific uses, and aesthetic reasons.

Buildings fulfill several social needs - primarily as shelter from the weather, security, living space, privacy, for storing belongings, and for comfortable living and working. The building as a shelter represents the physical division of the human habitat (a place of comfort and safety) and the outside (a place that can sometimes be violent and harmful).

Since the first cave paintings, buildings have become objects or canvases of great artistic expression. In recent years, interest in sustainable planning and building practices has also become an intentional part of the design process for many new buildings and other structures.

Skyscrapers under construction in Kalasatama, Helsinki, Finland (2021)

The word building is both a noun and a verb: the structure itself and the act of building it. As a noun, a building is "a structure that has a roof and walls and stands more or less permanently in one place". "There was a three-story building in the corner"; "It was an impressive building." In the broadest sense, it is a fence or wall of a building. However, the word "structure" is used more than "building" including natural and artificial structures and does not necessarily have walls. It is more likely that the structure will be used for a fence. Sturgis's lexicon consisted in abandoning all ideas of artistic behavior; And its difference with construction is in terms of not including scientific or highly skilled treatment. Building as a verb is the act of making.

The height of the structure in technical use is the height of the highest architectural detail in the building from the street level. Garlands and masts may or may not be included in this height, depending on how they are classified. Garlands and masts used as antennas are generally not included. The definition of a low-rise building versus a high-rise building is a matter of debate, but generally three stories or less is considered low-rise.

History of architecture

There is clear evidence of house building around 18,000 BC. Buildings became common during the Neolithic period.

Types:

Single-family residential buildings are often called houses. Multi-family residential buildings that have more than one residential unit are called duplexes or apartments. Condominium is an apartment that the resident owns instead of renting. Houses may also be built in pairs (semi-detached) on terraces where all but two houses are flanked by other houses. Apartments may be built as round courtyards or as rectangular blocks surrounded by plots of varying sizes. Houses built as single houses may later be divided into apartments or dormitories; They may also be converted to another use such as an office or a shop.

The types of buildings may range from villas to multi-million dollar apartments that can accommodate thousands of people. Increasing residential density in buildings (and shorter distances between buildings) is usually a response to high land prices caused by the desire of many people to live near work or similar attractions. Other common building materials are brick, concrete or a combination of any of these with stone. Residential buildings have different names to use depending on the season.

Historically, many people lived in communal buildings called longhouses, smaller houses called pit houses, and mixed houses with barns, sometimes called barns.

Buildings are defined as substantial, permanent structures, so other forms of habitation such as houseboats, yurts, and motorhomes are homes but not buildings.

Complex

Steel building with aluminum panel frame, in Korea

A group of related (and possibly interconnected) buildings is sometimes referred to as a complex.

- For example, residential complex, educational complex, hospital complex,...
The creation, design, construction and operation of buildings is usually a collective effort of various professional groups. Depending on the size, complexity and purpose of a particular construction project, the project team may include:

A real estate developer who secures project funding.

One or more financial institutions or other investors providing financing

Planning officials and local code surveyor who performs ALTA[1]/ACSM and construction inspections during the project.

1 Border checks

Construction managers who coordinate the efforts of different groups of project participants.

Architects and licensed engineers who provide building design and preparation of construction documents.

Major design engineering disciplines typically include the following specialists: civil services, structures, building mechanics or HVAC (heating ventilation and air conditioning), building electrical services, plumbing and drainage. Other design engineering professionals may also be involved such as fire (prevention), acoustics, facade engineers, building physics, telecommunications, AV (audio visual), BMS (building management systems), automated controls, ... These design engineers also prepare construction documents. It is issued to specialist contractors to get the price of the work and follow up the facilities.

Contractors who provide building services and install building systems such as climate control, electrical, plumbing, decorating, fire protection, security, and telecommunications.

Marketing or leasing agents

Facility managers who are in charge of operating the building. Regardless of size or intended use, all buildings in the United States must comply with zoning laws, building codes, and other regulations such as fire codes, life safety codes, and related standards.

Vehicles like:

Trailers, caravans, ships and passenger aircraft - are considered "buildings" for life safety purposes.

Every building requires a certain amount of internal infrastructure to function, which includes elements such as heating/cooling, electricity and telecommunications, water and sewage, ...

Especially in commercial buildings (such as offices or factories), these can be very complex systems. It takes up a lot of space (sometimes in separate areas or double floors / false ceilings) and a large part of the regular maintenance required.

Transmission systems

People transportation systems inside the building:

Elevator

escalator

Moving sidewalk (horizontal and inclined)

People transportation systems between connected buildings:

Sky V

underground city

Building damage

Buildings may be damaged during building construction or during maintenance.

There are several other reasons behind building damage such as accidents such as storms, explosions, mining subsidence, water withdrawal or weak foundations and landslides. Buildings may also suffer fire and flood damage under certain circumstances. They may also wear out due to lack of proper maintenance or improper modification work.

Building or construction

What is the difference between construction? Construction and building are often used interchangeably. While this is perfectly fine in ordinary English, it can be useful in construction to understand the difference. Technically, their dictionary meanings are synonyms. However, there is a difference in concept and usage in the professional space. Typically, construction refers more broadly to any project in the field. For example, construction might include building a road. While building usually refers to erecting a building such as a house or business.

The same idea can be applied to the product of the process. A team building can be anything from a skyscraper to a parking lot. Conversely, a building is almost always a closed structure with walls and a roof.

Additionally, many engineers use construction to mean the entire project from design to completion. In this framework, the building refers only to the actual construction stage of the structure.

In short, construction is usually a broader term compared to building. Construction tools may include drafting, measuring, and other tools involved in the overall project. While basic construction tools are basically the same as construction tools, more advanced ones may cover a wider range of tasks.

While the differences between building and construction are not clearly stated in their definitions, the common usages in this context are different. Understanding these can help you communicate more clearly.

Any type of structure is man-made. For example, it may be a bridge or a dam. On the contrary, a building is specifically a closed structure with a roof and walls. Again, a building is a more specific term, while a structure is much more general. A much more diverse set of construction tools may be used in creating a structure.

What does building construction mean?

Building construction is the process of building a building. This is more specific than the general term "constructor". The result of building construction is always a building or addition to a building. This may be in a residential or commercial setting. Most construction projects are incremental.

What are the 5 types of building construction?

Types of building construction are based on the fire resistance of the final product. Type I is fire-resistant, Type II is non-combustible, Type III is regular, Type IV is heavy wood, and Type V is wood frame. Lower types require more advanced construction measuring tools and materials to ensure effective resistance.

Types of buildings

There are many ways to define building types. One of the most common classifications classifies a building as residential, commercial, industrial, infrastructure, agricultural, or specialty. This system bases the type of building based on the intended purpose of the final structure. Different methods may be used for each type.

Modern method of construction

Modern construction methods are techniques developed by the construction industry to improve structural integrity, reduce cost, reduce construction time, and ensure greater sustainability.

Many modern construction methods require specialized construction tools. For example, prefabricated flat panel systems require prefabricated parts and heavy equipment for placement.

Industry segmentation

Industrial market segmentation is a plan to categorize industrial and commercial customers to guide strategic and tactical decision making. Government agencies and industry associations use standard classification schemes for statistical surveys. Most businesses create their own segmentation plan to meet their specific needs. Industrial market segmentation is important in sales and marketing and describes the context of segmentation variables as "customer characteristics that are associated with important differences in customer response to marketing efforts."

The goal of any industrial market segmentation plan is to identify the most important differences between current and potential customers that influence their purchasing decisions or buying behavior, while keeping the plan as simple as possible. This allows the industrial marketer to differentiate their prices, programs or solutions for maximum competitive advantage.

While similar to consumer market segmentation, industrial market segmentation is different and more challenging due to greater complexity in purchasing processes, purchasing criteria, and the complexity of industrial products and services themselves. Other additional duties include the role of financing, contracting and ancillary products/services.

Approaches

One recommended approach to segmentation is for a company to decide whether it wants to offer a limited number of products to many segments or many products to a limited number of segments. Some people suggest that businesses that offer multiple product lines to different departments are discouraged, as this can sometimes reduce their focus and over-constrain their resources.

The advantage in trying the above approach is that while it may not always work, it is a force to focus as much as possible. The one-to-many model ensures—in theory—that a business keeps its focus sharp and takes advantage of economies of scale at the end of the supply chain. It "kills many birds with one stone".

For example, we can mention Coca-Cola and some businesses of General Electric. The downside is that the business risks losing business as soon as a weakness in the supply chain or marketing forces it out of the market.

The many-to-one model also has advantages and disadvantages. The problem is that a business spreads its resources too thin to serve only one or a few markets. If the image of the company is damaged in its chosen sector, it can be fatal. However, there are many companies that are dedicated to only one market segment, for example, Flowserve is a US-based supplier of a wide variety of pumps, valves, seals and other components, all dedicated to fluid movement and control.

Among the above models, the most popular is the multi-to-many version. Since companies constantly try to balance their risk in different technologies and markets, there is no choice but to enter new markets with existing products or introduce new products to existing markets or even develop new products and supply them to new markets.

The problem with the many-to-many model is that it can spread a company's resources too thin and soften its focus. One of the reasons for the current financial problems of the world's largest carmaker, General Motors, is that it has tried to be everything to everyone, offering model after model without any clear segmentation, targeting or bundling strategy**.**

Two-stage market segmentation (Wind and Cardozo model)

Yoram Wind and Richard Cardozo (1974) proposed industrial market segmentation based on two broad classifications of macro segmentation and micro segmentation. This model is one of the most common methods used in industrial markets today. It is sometimes extended to more complex models to include multi-phase and 3D and 4D models.

Macro segmentation focuses on the characteristics of the buyer organization [as whole companies or institutions], thus dividing the market by: Company/organization size: One of the most useful and identifiable criteria, it can also be a good rough indicator of a company's potential business. However, it must be combined with other factors to paint a true picture. Geographical location is possible according to the size of the company. This tells a company a lot about its culture and communication requirements. For example, a company may adopt a different offering strategy with an Asian customer than with an American customer. Geographical location is also related to culture, language and business attitudes. For example, companies in the Middle East, Europe, North America, South America and Asia will all have different sets of business standards and communication requirements. The SIC (Standard Industry Classification) code, which originated in the United States, can be a good indicator of program-based segmentation. However, it is only based on relatively standard and basic industries and classification of products or services such as sheet metal manufacturing, spring manufacturing, construction machinery, legal services, cinema, ... under the "Other" category, which will not bring much profit if these form the customer base. Examples include access control equipment, thermal spray coatings, and uninterruptible power supply systems, none of which are classified under SIC. This is another relatively theoretical measure that is not used in real life. As a result of increased competition and globalization in most established industries, companies tend to focus on a small number of markets, know the market well, and establish long- term relationships with customers. It is a common belief that it is cheaper to retain an existing customer than to find a new one. When this happens, purchasing criteria are based more on relationship, trust, technology, and overall cost of purchase, which dilutes the importance of this metric. The decision stage of this criterion is applicable only to newcomers. In the case of long-term relationships, which are usually the goal of most industrial businesses, the qualified supplier is usually aware of the procurement requirement, i.e. always entering the bidding process at the very beginning. Sheth and Sharma are said to have suggested that "with increasing market turbulence, it is clear that companies must move away from transaction-based marketing strategies and move towards relationship-based marketing to increase performance." (Freitag & Clark, 2001) Profit sharing: the economic value of the product to the customer (Hutt & Speh, 2001) which is one of the more useful measures in some industries. Recognizes that customers buy similar products for different reasons and place different values on specific product attributes. (Webster, 1991) For example, the access control industry markets similar products to two different value sets: banks, factories, and airports install them for security reasons, that is, to protect their data. However, sports stadiums, concert halls and the London Underground are installing similar equipment to generate revenue and reduce costs by removing manual ticketing. Institute, (Webster, 2003) For example, banks need designed furniture for their customers, while government offices are satisfied with functional and durable sets. When purchasing office equipment, hospitals require higher hygiene standards than public services. And airport terminals require different degrees of access control and security monitoring than shopping malls.

As institutional buyers reduce procurement costs, they are forced to reduce the number of suppliers with whom they establish long-term relationships. This makes the purchasing organization a very experienced organization by now, and suppliers are usually involved early in the decision-making process. This eliminates the need to apply these two items as segmentation criteria.

Customers' business potential assuming that supply can be guaranteed and prices are acceptable by a particular segment. For example, "Global Accounts" purchase large amounts and are ready to sign long-term contracts. Medium regional customers "Key Accounts" that can be the source of 30% of a company's revenue as long as there is a competitive offer for them. "Direct accounts" are thousands of small businesses that buy primarily on price, but are willing to forego service in the long run.

Purchasing strategies, eg global versus local decision-making structure, decision-making power of purchasing officers versus engineers, or technical specifications. Supply chain location: The customer's business model affects where and how they shop. If he pursues a cost leadership strategy, the company is most likely committed to high-volume production, thus requiring high-volume purchasing. For the supplier, this means firm price pressure and accurate delivery, but relatively long-term business security, for example in commodity markets. But if the company follows the differentiation strategy, it is obliged to offer customized products and services to its customers. This requires high-quality specialty products from the supplier, often purchased in low volume, which largely eliminates intense price competition, emphasizes performance, and requires a relationship-based marketing mix. (Sudarshan, 1998)

On the other hand, micro segmentation requires higher knowledge. While macro segmentation places the business into broad categories and contributes to the overall product strategy, micro segmentation is essential to the implementation of this concept. "Subsegments are homogeneous groups of buyers within macrosegments" (Webster, 2003). Macro segmentation without micro segmentation cannot provide the expected benefits to the organization. Micro segmentation focuses on factors that matter in the day-to-day business. This is where the "rubber hits the road". The most common criteria include the characteristics of decision-making units in each macro-sector (Hutt & Speh, 2001), for example:

Purchase decision criteria (product quality, delivery, technical support, price, continuity of supply). "The marketer may segment the market based on supplier profiles that appear to be preferred by decision makers, eg high quality – fast delivery – premium price versus standard quality – less fast delivery – low price." (Hutt & Speh, 2001) The purchasing strategy, according to Hutt and Speh, is divided into two categories: First, there are companies that contact known suppliers (some have vendor lists) and place an order with the first supplier that meets the purchase criteria. These include mostly OEM public sector buyers. Second, organizations that consider a larger number of familiar and unfamiliar suppliers will solicit bids, review all bids, and order the best bid. Experience has shown that considering this criterion as part of the segmentation principles can be very beneficial, as the supplier can avoid unnecessary costs by not spending time and resources unless it is formally approved on the buyer's vendor list. The structure of the decision-making unit can be one of the most effective criteria. Knowing the decision making process has been shown to make the difference between winning and losing a deal. In this case, the supplier can establish an appropriate relationship with the person/persons who have real decision-making power. For example, according to Hutt and Espe, the medical equipment market can be divided based on the type of institution and the responsibilities of the decision makers. A company that sells protective coatings for human implants will adopt a completely different communication strategy for doctors than for hip joint manufacturers. Perceived importance of the product for the customer's business (e.g. car gearbox, or peripheral equipment, e.g. production tools) Attitude towards the supplier: Buyers' personal characteristics (age, education, job title and decision-making style) play a major role in the formation of customers' purchase attitudes. Is the decision maker cooperative, supportive, neutral, antagonistic, or antagonistic? Industrial power systems are best sold to engineering managers rather than purchasing managers. Industrial coatings are sold almost exclusively to engineers. Matrix and raw materials are typically sold to purchasing managers or even through online auctions.

The above criteria can be very beneficial depending on the type of business. However, their measurement may only be possible in capital-intensive and costly businesses such as corporate banking or the airline business, because of the high costs associated with collecting the desired data. There are serious practical concerns about the cost and difficulty of collecting and using measurements of these fine-grained features (Sudarshan, 1998). The prerequisite for implementing a macro and micro concept on a full scale is the size of the company and the organizational complex. A company must have more than a certain number of customers for a segmentation model to work. Smaller companies do not need a formal segmentation model because they know their customers personally, so they can apply Hunter's n=1 model. Ironically, Webster states that “the strategic implications of microsegmentation lie primarily in advertising strategy. Decisions influenced by micro segments include the selection of sales contact persons, the design of sales presentations, and the selection of advertising media” (Webster 2003). However, advertising should not be viewed in isolation as it cannot facilitate lasting success unless it is supported across all relevant functions such as product, price and location. Just keep in mind that purchase criteria (part of micro segmentation) include factors such as product quality, price, and delivery that are directly related to product, price, and location.

nested approach for segmentation (Bonoma and Shapiro model)

Taking the model of Wind & Cardozo, Bonoma & Shapiro extended this to a multi-step approach in 1984. As it became increasingly difficult to use all the criteria recommended by Wind and Cardozo and later researchers who developed their two-stage theory. Due to the complexity of modern businesses, Bonoma and Shapiro suggest that the same / similar metrics be applied in a multi-process manner to give marketers the flexibility to choose or avoid metrics that are appropriate for their business. They proposed the use of the following five general classification criteria, arranged in a nested hierarchy:

At the level of macro division:

Demographics: industry, company size, customer location

Operational variables: company technology, product/brand usage status, customer capabilities

Purchasing approaches: purchasing performance, power structure, buyer-seller relationships, purchasing policies, purchasing criteria

At the level of micro-division:

Situational factors: order urgency, product application, order size. Buyers' personal characteristics: personality, approach. The idea was for marketers to move from the outer niche to the inner side and use the needed niches. As a result, this model has become one of the most suitable models on the market, competing with the Wind & Cardozo model. One of the problems with the nested approach is that there is no clear distinction between buying approaches, situational factors, and demographics. has good managerial judgment" (Webster, 2003).

Targeting and positioning

One of the most important applications of industrial market segmentation plans is to make decisions for product targeting and positioning.

In order to maximize competitive advantage and the likelihood of success, companies target some segments and downplay or avoid others.There is a fundamental difference in emphasis between target market and audience. The term audience is probably the most used in marketing communications. (Kroft, 1999) Target markets can include end-user companies, procurement managers, company heads, contracting companies and external sales representatives. However, audiences can include people who influence the purchase decision but may not necessarily buy a product themselves, such as design engineers, architects, project managers, and operations managers, as well as those in target markets.

Kraft cites Fristad, Wright, Bush, and Rose (1994) who state that since the purpose of advertising is to persuade, consumers become skeptical of its methods and approaches. However, while this may be entirely true in consumer marketing, the level of trust and reliance on marketing communications by industrial customers is relatively high due to the professional experience and knowledge of the industrial buyer. Some even appreciate advertising because it informs them of products and services available on the market.

Supplier segmentation

In the field of marketing, industry market segmentation usually refers to the demand side of the market, the purpose of which is for companies to segment groups of potential customers with similar wants and desires who may respond to a specific marketing mix. Segmentation on the supply side of the market can also be valuable when companies are working with different potential suppliers.

Parasuraman (1980) suggested a step-by-step procedure for implementing this approach:

Step 1: Identify key characteristics of customer segments

Step 2: Identify the critical characteristics of the supplier

Step 3: Select the relevant variables for supplier segmentation and

Step 4: Identification of supplier sectors.

Kraljic (1983) considered two variables: profit impact and supply risk. The profit impact of a product offering can be defined in terms of volume purchased, percentage of total purchase cost, or impact on product quality or business growth. Supply risk is assessed in terms of availability and number of suppliers, competitive demand, manufacturing or purchasing opportunities, storage risks, and substitution possibilities. Based on these two variables, materials or components can be divided into four supply categories:

(1) non-critical items (supply risk: low; profit impact: low),

(2) leveraged items (supply risk: low; profit impact: high),

(3) bottleneck items (supply risk: high; profit impact: low) and

(4) Strategic items (supply risk: high; profit impact: high). Each category requires a specific sourcing strategy.

Rezaei and Everett (2012) defined the supplier segmentation as follows, considering the two dimensions of "supplier inclination" and "supplier capabilities".

"Supplier segmentation consists of:

Identifying the capabilities and willingness of suppliers by a specific buyer in order to engage the buyer in strategic and effective partnerships with suppliers with respect to a set of evolving business functions and activities in supply chain management.

Manual, inefficient and outdated processes

Many design and construction activities are outdated. Over the past few centuries, businesses such as masonry and carpentry have changed little and will gradually be abandoned due to prefabricated assemblies with the help of robotics. In the same way, drawing contracts are considered remnants of the renaissance period and no longer have a suitable tool to provide project information in the period of great changes.

Drawings must be accompanied by a plethora of additional building specification documents, equipment lists, schedules, operation and maintenance manuals, contracts, supplemental change instructions, and often duplicate or contradict what is shown on the drawings. There must be a better way?

Technological resistance

We've looked at resistance to change in general, and while it often seems like there are specific issues when change involves implementing new technology, the underlying issues are actually very similar. In the Acceptance of Change section, we outline a useful model for the stages individuals go through in deciding whether or not to adopt a particular innovation, and these stages remain valid whether or not the "innovation" is related to technology. There are two key points in this section:

Recognize the change project for what it is and don't be fooled by the red herring of technology. If the project requires someone with experience managing change, make sure you bring those skills and don't be tempted to leave a technical expert with these responsibilities.

Get to know the resistance discourse around the implementation of new technologies. You'll no doubt hear it all for yourself, but the previews are formative, so read on…

It's tempting to ask, "Who are the resisters?" But while relatively small project-specific research can often identify user-related characteristics such as age, gender, ..., as factors influencing people's trust in technology use, the search for individual factors such as those that characterize opponents of a "new" They are very simple. A range of other backgrounds, values and belief systems will inevitably come into play.

Similarly, while the characteristics of the technology itself are important (poorly designed systems and systems with obvious bugs are frowned upon), more interesting are situations where a particular technology is loved by some and hated by others. Marcus (1983) identifies common conditions under which user and system characteristics interact to influence resistance to the introduction of MIS[1] systems:

Systems resist on the basis that they centralize control of events in organizations that otherwise exemplify decentralized structures.

Systems change the balance of power in organizations so that those who lose power resist it. Resistance arises from the interaction between the technical design of a system and the environmental or social conditions in which it is used.

Stories of resistance

The University of Strathclyde considered the above factors when introducing a new system for curriculum management that replaced a diverse set of paper-based processes.

The general perception of academic staff was that this system facilitates greater transparency of the process, which actually empowers academics and supports knowledge sharing and good practice. However, a significant minority found

1 Information management system

that the system favored administrators at the expense of academic freedom. An evaluator's report noted:

"This view appears to be supported by anecdotal observations of academic quality processes in a number of faculties where it was not uncommon for incomplete or substandard curriculum plans to be submitted for faculty review from student contact hours, resource implications, constructive alignment, ... and were handed over to academic quality teams to "sanitize."

The legal process is sometimes messed up at the behest of senior academics. Therefore, the design process in the previous state gave some academics considerable freedom in the curriculum design process, and this freedom no longer exists in the new state."

The conclusion from a number of projects in this sector, particularly at universities such as Strathclyde and Huddersfield, is that taking a very prescriptive approach to technology adoption can be counterproductive and that it is better to facilitate the transition by adopting different approaches.

The University of Strathclyde notes:

The emphasis here is on encouraging the "late majority".

Forcing such users to abandon familiar technologies can be counterproductive, and the use of bridging options is often advocated to provide some choice in adopting the system, at least temporarily."

Although they continue to say:

"Such an approach carries several inherent risks, including the potential for academics to subvert the process."

Overall, the construction industry has so far proceeded conservatively, taking only a few tentative steps in adopting new technologies. Of course, we see some notable exceptions, for example, in the advancement of digital manufacturing processes (CAM, CAD) in metal sectors, wooden structures and other sectors; But these developments are usually limited and do not inspire change in the supply chain.

Reaction or response

So, how can such issues be addressed and what is the role of construction information modeling in this process?

There is no reverse process for separating industrial sectors. Instead, we should accept this specialized separation by establishing communication and sharing information in a networked, flexible and fast way. New processes must be adopted that will remove the old work process and support integrated and digital ways of working; And to change the knowledge and use of technology, a cultural change is needed.

Many of the technologies required for such a digital transformation already exist: cloud computing, mobile devices, digital fabrication technologies, and GPS-controlled site equipment to name a few. We just need to popularize their use.

Can we say that construction information modeling is the digitalization of the construction industry?

Digitalization makes the way things are done integrated, structured and highly flexible. On the one hand, such a specialized industrial process frees us from spectral, cumbersome and centralized processes, and on the other hand, it saves us from the irregularities caused by the separation of departments. Manufacturing information modeling will help us to eliminate many outdated, manual and corrosive work approaches and do these things automatically and mechanically; And it makes technology work in the office, the construction site, and the executive operations and maintenance of the building through the tips of our fingers.

information

BIM is all about sharing and managing information – and there is a wealth of data that can be used to enrich your models.

Just think of all the information that can be used to describe just one object in a system: dimensions, price, material type, brand name, and several other types of data.

Managing expectations

Since BIM is about collaboration with other parties, it depends first of all on the information needed by the construction partners during the different stages of the project. On the one hand, an Excel sheet with a list of components may be sufficient, but a BIM coordinator may need 3D models in IFC format. This means that setting and managing expectations is extremely important.

BIM implementation plan

A starting point for managing expectations is the BIM implementation plan. The plan defines the various roles and responsibilities in the BIM process and defines key deliverables. Having such a plan encourages cooperation and early communication between parties and makes expectations clear.

One of the things that will most likely be discussed in the BIM implementation plan is the desired level of development, level of information or level of detail. These are concepts that can be very helpful when agreeing and setting expectations. However, it's important to know the difference between these three terms to avoid confusion and make sure you don't overload your models unnecessarily.

So what information is needed in your project depends on the requirements and expectations set by your construction partners. These requirements also depend on the type of project:

Example - an electrical system in BIM

When designing an electrical installation in BIM, electrical engineers must consider the possibilities of inspection, maintenance, and expansion, for which parties need proper documentation during the later stages of construction.

For residential buildings, a simple description of the circuit in the form of a list or table is generally sufficient. But for non-residential construction projects, complexity may require a more detailed overview. Local standards may prescribe that, for larger electrical installations, there must be not only floor plan drawings, but also schematics showing the structure and layout of the installation. A block diagram or installation diagram may be required:

1. The block diagram provides an overview of the complete circuit and distribution system and clarifies how the panels are connected. It also shows the total connected power and phase distribution.

2. The installation diagram provides an overview of each distribution panel, including all information about the structure and installation plan. such as connected power in each circuit and type of power, expected consumption based on simultaneity, protection, cable data, phase distribution, type of connection point such as lighting and differentiation between lighting and power circuits and earthing devices.

By knowing which information is needed for your project, you know what data should be in your model. In the case of an electrical system, a building information model makes it easy to generate a block plan or installation diagram from the model. From the BIM model, you can extract data from the floor plan and enrich the application with additional information. This way, the electrical engineer can always provide his partners with the actual data they need – and make sure he's always up to date with the model.

After determining the required information, the design process can begin. However, not all information may be known from the beginning of the project. This information may be clarified as the BIM process progresses. For example, an MEP engineer usually starts by creating a general plan, which he continues to refine and enrich with more specific information. By working this way, duplication of work is avoided and the engineer starts working strong:

Example - a ventilation system in BIM

1. Based on a structural model, the MEP modeler quickly creates space definitions in its model. These space definitions are full of parameters that are required for the design of facilities. In the case of the ventilation system, the desired flow rate will be related to the definition of the space.

2. An advantage of BIM is that if the structural design is adjusted, the space definition changes along with the installation model. However, the definition of space is related to the boundaries of the architectural model. An additional advantage is that the desired flow rate automatically adjusts to the changing dimensions of the space definition.

3. Based on the desired flow rate, the ventilation system can be set up in general. By placing the flow arrows in the rooms, all the requirements of a part of the building can be quickly adjusted. Since the required flow rate is known, it is possible to directly design with appropriate channel dimensions. The advantage of this is that it is immediately clear which and how much space the ventilation system needs.

4. This needed space can then be used in the early stages of design to work more efficiently with, for example, a manufacturer. After all, BIM aims to share knowledge and promote collaboration between parties throughout the construction team.

Additional information

Depending on the purpose of your model, there is additional information that can be added to make other steps in the build process more efficient. For example, consider creator-specific content that is useful for:

Creating BOM[1] (Bill of Material) lists.

Making prefabricated sets

Perform reliable calculations for MEP systems

You can also consider 4D, 5D, or 6D BIM programs. For the next 4 BIMs, the building plan is visualized. 5D-BIM adds cost and materials to the model, so the impact of a decision on design cost can be estimated at an early stage. While 6D-BIM includes maintenance data that is useful for life cycle management.

Whether you need to provide extensive BIM models or a simple drawing, by determining the information needed early on, all parties benefit from the information contained in the model.

1 A list of raw materials to make, manufacture or repair a product

How much information do we need in the BIM model?

Exactly. Given that the term BIM itself refers to object information modeling, it means that the more information we include in the model, the better. After all, this is what we want the model to be as a source of information about the building and structure. How can we do so much BIM? More and more we come across designs based on (non-formal) models. What does this mean in terms of information? Nothing more or less than the information contained in the maps (dimensions, descriptions, texts, ...) can simply disappear. They must be added somewhere. The best place is the model. . The question is: how much of this information should be included in the model? Could there be a situation where this information is simply too much to read and too confusing?

So, consider what the state of the data in the model would be like if:

Pack the model with lots of information

Do not add any information (except those necessary due to the geometry of the objects).

Data in the model

In the BIM world, this is the basis - the 3D model is enriched with information, model attributes include design data, component specifications, ... In addition, the necessary data at the facility management stage (COBIe data) contains information on health and safety. This means that a typical model today may contain the following types of data: A typical BIM model may contain the following data:

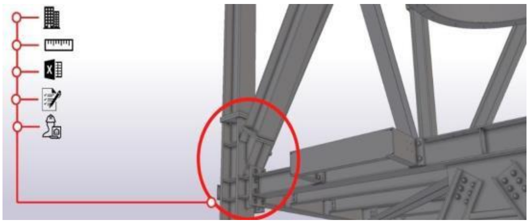
The geometry

Design data

Technical Specifications

COBie data

Health and safety data



Data in the model

This amount of data in the model is now significant. However, this is the initial information that is added to a typical model and we want to include as much information as possible in the model. We want the 3D model to be the source of all design information, have manufacturing (build) information, and really be the only source of truth about the design. Is it right to put all the data we can think of into the model? The list of additional data that seems to be as necessary in the model as those mentioned above are:

Production data

Installation and assembly data

Timing data (4D)

Cost data (5D)

Qualitative data

Inspection data

Order data

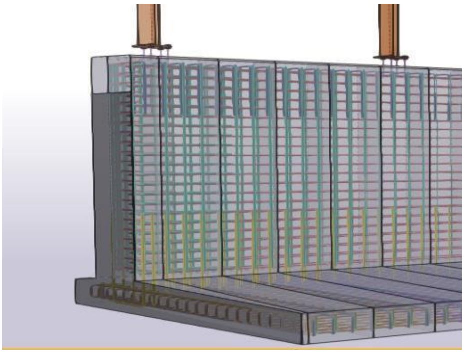
Delivery data to the construction site

Startup data

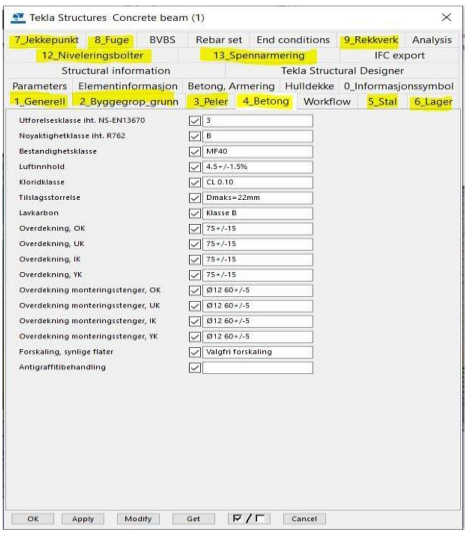
Destruction data

Environmental data

So we have a model full of information, a completely intelligent model, useful for any industry and for any stage of the project. But is such a data-heavy BIM model good or useful? Definitely not! Models collapse under their own weight. Another point is to add all this information to the model. Who does this? Who will manage this data? coordinate? You can use a script or an API (Application Programming Interface) tool that adds all this information automatically, but the data must be prepared and delivered somehow. The model itself, the information sheets are no longer legible and transparent. Just look at the model-based design that contains the information already shown in the drawings. This information is read by scripts from the Excel spreadsheet and assigned as additional element properties...there are a lot of them.



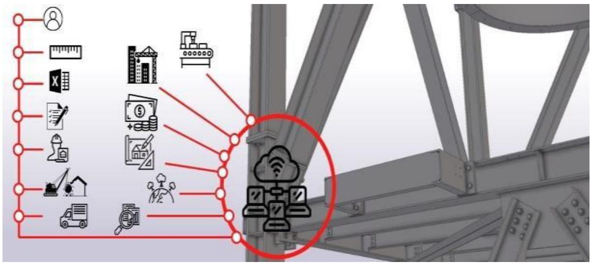
Data in the model



The image above shows the number of additional features (information about objects in the model) for a small retaining wall whose layout is not drawn.

There is no data in the model

Let's move from one extreme to the other. Since it seems impractical to include all the data in the model, consider a pure 3D model. No additional data. The 3D model is not enriched with information, where only the geometry and shape are defined. In that case, the 3D model will be just a more developed form of CAD. What about the data? Let's assume that all the necessary data will be in external systems. Both design data and specifications are linked to the model through microservices and to objects in the model through a global GUID[1].



Data in the model through external systems

Such a solution, despite the old approach and its similarity to the ancient days of CAD, is actually more logical than running the model with a million data. Widespread Internet connectivity (also at the construction site), the development of APIs and many Internet services make such an idea quite reasonable.

Create the right balance

Maybe instead of picking extremes, one can find the golden mean in the amount of data that should be in the model? Part of data assigned to BIM model elements and part of data stored in external services? Instead of adding all the data to the model, we can store some data in external systems and connect those external systems to the model. The question immediately arises: which data should be connected to the model and which are related to external systems? Based on what criteria should the data be distributed in the model and external systems? There is friction between project participants about whose data is more important and should be included in the model. This means elevating one piece of information over another... and yet all information is equally important.

It is very difficult to answer the question of how much data is needed in a BIM model. On the one hand, we see the trend of adding more and more information to objects. Thanks to this, you can, for example, remove maps and render designs based on the model, on the other hand, it may be difficult to use and manage such a large amount of data in the model. Incorporating all the data into the model is difficult to scale. Adding some data to your model means deciding which data is most important, and it may not be possible to combine all of your data at this time. So what will BIM models look like in the future? What direction is the AEC industry going to take in terms of the amount of data in the model? In my opinion, the industry will move towards minimizing the amount of data in the BIM model by using external data storage services that link to the

1 It is a unique number that we give to the objects and interfaces that are created

model, despite the current trend of a lot of information in the model. What do you think about this? How much information do you add to your model?

Information or Data

The terms "data" and "information" are often used interchangeably, but they are not actually the same thing. There are subtle differences between these components and their purpose. Data is defined as individual facts, while information is the organization and interpretation of those facts.

Finally, you can use the two components together to identify and solve problems. Below, take a deeper look at data vs. information and how to apply these elements in a business environment.

What is data?

Data is defined as a collection of individual facts or statistics. (While "data" is technically the singular form of "data," it is not commonly used in everyday language.) Data can be in the form of text, observations, figures, images, numbers, graphs, or symbols. For example, data may include individual prices, weight, address, age, name, temperature, date or distance.

Data is a raw form of knowledge and has no meaning or purpose in itself.

In other words, you must interpret the data to make sense of it. Data can be simple and may even seem useless until it is analyzed, organized, and interpreted.

There are two main types of data:

Quantitative data is presented in numerical form, such as the weight, volume, or cost of an item.

Qualitative data is descriptive, but not numerical, such as a person's name, gender, or eye color.

What is information?

Information is defined as knowledge acquired through study, communication, research or teaching. Basically, the information is the result of analysis and interpretation of data pieces. While data are individual figures, numbers or graphs, perception information is those pieces of knowledge.

For example, a data set could include temperature readings at the same location over several years. Without any additional context, those temperatures have no meaning. However, when you analyze and organize that information, you can determine seasonal temperature patterns or even broader weather trends. Only when data is organized and compiled in a useful way can it provide useful information to others.

Key differences between data vs. information

Data is a collection of facts, while information puts those facts into context.

While data is raw and unorganized, information is organized.

Data points are individual and sometimes unrelated. Information maps this data to provide a big picture of how it all fits together.

Data by itself is meaningless. When analyzed and interpreted, it becomes meaningful information.

Data does not depend on information. However, information depends on data.

Data is usually in the form of graphs, numbers, figures or statistics. Information is usually presented through words, language, thoughts, and ideas. Data is not enough to make a decision, but you can make a decision based on information.

Examples of data versus information

To further explore the differences between data and information, consider these examples of how data can be turned into insight:

In a restaurant, the bill amount of a single customer is given. However, when restaurant owners collect and interpret multiple invoices over a period of time, they can generate valuable information, such as what menu items are most popular and whether prices are sufficient to cover resources, overhead and wages.

A customer response to an individual customer service survey is a data point. But when you collect that customer's responses over time—and in the larger scheme of things, responses from multiple customers over time—you can generate insights about areas for improvement within your customer service team.

The number of likes on a social media post is a single element of data. When these statistics are combined with other social media engagement statistics, such as followers, comments, and shares, a company can understand which social media platforms are performing best and which platforms they should focus on to engage their audience more effectively.

Inventory levels are self-evident. However, when companies analyze and interpret that data over time, they can identify supply chain issues and increase the efficiency of their systems.

Competitor prices are individual data elements, but processing this data can reveal where competitors have an advantage, where there may be gaps in the market, and how a company can outperform its competitors.

How businesses can use data and information?

Why is the distinction between data and information important for businesses? Organizations that prioritize data collection, interpretation, and use of that information can reap significant benefits. When data is used properly (and the information gathered from it) it can make smarter and faster business decisions.

For example, a company may collect data about the performance of its advertisements or content. They can organize and interpret this data to generate a wealth of insights, such as what kind of graphics, wording, and even products appeal most to their customers. They may also be able to develop a more comprehensive understanding of their target audience, which can help them make decisions about future offerings, branding, and communication preferences. The right data can lead to almost unlimited information and insights, all of which are valuable for decision making.

However, there can be several obstacles to creating that kind of data-driven organizational culture. For example, different teams may collect and maintain different sets of information. Without a central database, others in the company cannot interpret or benefit from that data. Furthermore, if no one is constantly monitoring the data, the data may not be of sufficient quality to be interpreted—and as a result, any information derived from that data may be misleading or incorrect.

To create a truly effective data-driven culture, it is critical to maintain information and insights gleaned from data in a centralized resource that is available throughout the organization (such as a knowledge management system), protocols to ensure data quality and develop analytical skills.

Data and information are both critical elements in business decision making. By understanding how these components work together, you can move your business toward a more data-driven and insight-driven culture.

The importance of BIM data management in construction. Why is the BIM database important?

The biggest attraction of BIM as a whole is that it makes construction processes faster, cheaper and easier. All this is due to the large amount of data that each part of the BIM project has. BIM itself is not just 3D modeling, it is much more complex than that.

Since one of the main purposes of building information modeling is basically the transfer of data between different parties in the project, it is not surprising that BIM data generally plays an important role in the overall process. BIM data is what makes BIM projects so information-rich, and this data is also used to determine conflicts and potential problems, among other benefits.

Benefits of BIM database management

However, like BIM itself, you should use BIM data models as much as possible to reap the full benefits at all stages of your projects. Below are some reasons to use BIM data management in the first place:

Improvement in project control through quality improvement and cost avoidance: It is not uncommon for project complexity to increase in proportion to its size. This often leads to additional problems such as incorrect orders of construction materials or even duplicate orders. Accordingly, this problem can be solved by effective supply management, which BIM data management can help with - by monitoring the quantities of building materials, streamlining procurement and delivery schedules.

Easier communication and collaboration with automated dashboards: Stakeholder meetings are an important part of any project, no doubt about it. Most of the communication and collaboration is often done through them. Accordingly, it is also necessary for stakeholders to have supporting materials in the process to make it easier to understand more complex issues. Nowadays, thanks to BIM data-rich projects, it is much easier to distribute said materials in digital format, making it easier to collaborate with different stakeholders.

Leverage data insights that help save time and money: Unfortunately, the construction sector has been struggling with both productivity and efficiency for some time. That is why contractors are always looking for a way to increase these parameters without reducing the overall quality of the project. Fortunately, adding BIM to a project allows builders to significantly or completely eliminate the time spent analyzing BIM data obtained from different designers in different formats. BIM always strives to work in a single format or format that is supported by all the software tools involved.

Easier handling of geometric conflicts: Speaking of different formats, the addition of BIM as a whole and more or less unified BIM data model formats allows designers to find and resolve essentially all geometric conflicts at the same design stage. It is possible to integrate a BIM model with almost any type of data or model, including plumbing, electrical systems, ventilation ducts, ...

Auditing and compliance: Another area where the introduction of BIM data will greatly benefit is auditing and compliance with various standards. For example, digital project models are supposed to adhere to the company's own data standards or one of the globally accepted standards (COBie, Uniclass, ...). To meet compliance requirements, it is not uncommon for BIM consultants to audit the model for exactly this reason. Fortunately, having BIM as a system leads to a much easier audit process overall thanks to data unification, among other benefits.

Transfer Improvements: Having an accurate project model early in the design phase makes it much easier to complete the entire project without conflicts, errors, or delays. Full data compliance and cost reduction are also included in the package so that both parties can benefit from the addition of BIM in the first place.

Use cases of BIM data in design

Another way to see how many benefits the addition of BIM data models provides is to list a few specific use cases of BIM data in the design phase:

Accurate drawings and documentation: Adding BIM as a complete system allows companies to produce much more accurate and consistent drawings and documentation.Including, for example, maps and floor plans - even if the floor plans have already been revised several times, the connections between the various systems have made the schedule automatically calculated and changed each time according to the changes in the floor plans.

Complex Calculations: Speaking of calculations, BIM is incredibly useful in that area as well, automating some of the most difficult calculations and reducing the possibility of human error mid-calculation as much as possible. For example, it is possible for a virtual representation of a fire alarm design to automatically calculate electrical loads for each circuit so that the entire electrical system in the finished form of a building is not overloaded.

Easier presentation of information to people less connected to the design work: The rapid pace of overall technological progress has led to key team members being left with the latest information, on some design phase issues, or more technical things. The addition of BIM allows these people to have a much easier time interacting with the system in general and even benefit from the introduction of BIM data, for example, allowing monitoring of changes to model data.

Two questions to think about before you start interacting with BIM

Integrating BIM is no small feat, and it is to be expected – with the many benefits it can bring. If thoroughly considered before implementation, the transition can be seamless. Two questions are important, particularly from a facility management perspective, but also applicable to BIM data in general:

What will be your BIM format?

The use of data in BIM is done through a specific software provider that shares its data formats with the relevant software, or through one of the globally accepted file formats from standards such as COBie, formats that most software providers can at least work with.

What information is required for facility management?

BIM models often contain a lot of different data about different elements of the project, sometimes as much as a screw. Both the contractor and the owner must understand the importance and impact of BIM data and why it is needed for facility management. Any data available about the project may be useful in unexpected ways that the owner did not think of, so learning about it may be beneficial to the project as a whole.

BIM in itself is a big change for the industry and its recent growth has been exponential. Some people say that we are already past the stage of asking whether BIM should be used, now we are more concerned with how everyone can benefit from the addition of BIM databases.

All in all, the benefits of BIM data are wide and varied, and it's easy to be completely overlooked. But ignoring this list of potential benefits would probably be a huge waste of potential for the vast majority of companies that are still unsure if BIM is worth it. And it's worth it, at all stages of the project, in many ways, the benefits of BIM are enormous, and the potential of BIM data is enormous.

What is manufacturing information modeling?

Today, construction information modeling has found a wide application from design and construction to operation and even the stage of building destruction. This technology helps the project manager and stakeholders to make the right decision at every stage by displaying the building's characteristics digitally. Building Information Modeling All construction management activities, based on contract documents, are dependent on two categories of maps and specifications, in such a way that with the help of maps, the quantity of work is defined and based on technical specifications, its quality is defined (Figure 1).

Figure 1. Construction contract documents

In fact, the performance evaluation criteria of contractors are determined based on these two categories. We already know that in the conventional method of construction management, on the one hand, preliminary drawings and specifications are presented separately and on the other hand, the executive plans of different design groups (architecture, structure, mechanical and electrical facilities) are prepared separately but during the coordination and meetings held; Therefore, the problems of this method are obvious to everyone, and perhaps some of the worst of them are lack of coordination, mistakes, defects in construction information and rework, which ultimately leads to a decrease in the quality of work and waste of time in addition to increasing the cost of construction. One of the most exciting recent developments in the field of construction management is the introduction of building information modeling technology or BIM for short.

In general, BIM adds 3D modeling components with special features to 2D maps and related specifications. That feature is that each member of the design shown in BIM, in addition to having its three-dimensional physical nature, carries with it an array of information related to various construction management activities and tasks. This information is related to the entire life cycle of the project, from the stage of justification studies to conceptual design, first and second stage studies, procurement, construction and installation, start- up, operation period and even its end; Therefore, if we want to summarize BIM in a short sentence, it will be the process of producing and managing building information during its life cycle. In other words, a BIM model is a three- dimensional digital representation of the physical and functional characteristics of a building.

The main difference between the BIM model and a conventional three-dimensional CAD model is the storage of important information of the entire construction process with all its components. This information includes items such as material specifications (weight, volume, length, height, color, size, fire resistance, ...), installation and assembly guide, product warranty service, maintenance and repair requirements, component price information, project costs, ... BIM, in technical terms, is a CAD model that is connected to a database, so that any information related to the project can be stored in it; Therefore, BIM acts as a common source of information between the entire design and construction team. The result of this integration of information is increased coordination, reduction of errors and waste, redundancies, cost reduction and finally increase of work quality.

BIM building blocks

The government mandate to achieve Level 2 BIM in publicly procured projects is getting closer by April 2016.

Organizations involved in the design, construction and operation of a public building are affected by the information requirements inherent in meeting BIM Level 2. For designers, contractors and the contracting supply chain, this means a more systematic and comprehensive approach to building data collection and recording. The government's goal is to provide data data in a structured and identifiable format that can be transferred to a CAFM (Computer Aided Facilities Management) system. COBie (Construction Operations Building Information Exchange) data format is specified.

While designers and contractors have been preparing for COBie for some time, there is one community in construction that has only recently become aware of what Level 2 means to them – building product manufacturers. These manufacturers are the originators of the product data required in COBie and are most motivated to ensure that this data – descriptive, performance, sustainability, ... – is accurately captured in the BIM models. If it is accurate in the BIM model, it will be accurate in COBie.

The Level 2 data required for different types of construction products are now identified through the provision of product data templates that manufacturers can fill in to provide data about their products (product).

How this PDS data is incorporated into a BIM model can be achieved through a number of methods, but most of them are manual and therefore error-prone and time-consuming. The most concise way to incorporate this data is with a geometric representation of the product - a BIM object. All manufacturers are capable of producing a PDS, but only a few have the skills to create geometric representations that work well in popular BIM modeling software. For this reason, most manufacturers look to an external supplier to create their geometric objects.

Using an external supplier to create geometric objects clearly has cost implications for manufacturers. Today, object creation is largely a "craft industry" with a limited number of specialists capable of developing objects. This crafting industry is not scalable, so the large number of items needed will be impossible, either for 2016 or beyond.

And with this hands-on approach, stability is difficult to achieve, and creation costs remain on the higher end. In this situation, with the need for many more objects, but only a limited number of specialists, how can the needs of the construction industry and product manufacturers be met?

BIMobject has been investigating this conundrum for some time and has come to the conclusion that the development of BIM objects should be "industrialized". This process should include all the components of a BIM object - the geometric representation, structured data (eg PDS) and any other unstructured information (eg PDF installation instructions). This is a strategic focus for BIMobject in 2015. Simply put, there are two communities of manufacturers that need to be supported: those that do not have 3D representations of their products and those that have 3D representations generated from CAD mechanical design software. To support the former, BIMobject Mosquito™ introduced in late 2014. A new technology that allows manufacturers to create and maintain in-situ BIM objects that contain 3D visualizations and feature data. Over the course of this year, further releases of this software will expand the range of manufacturing products to which this technology can be applied. An introduction to mosquito can be found on the YouTube channel - key "mosquito biobject" in the search criteria. For those manufacturers who already have digital renderings of their mechanical CAD system, it's actually a case of "watching this space" for future announcements from BIMobject. The goal here is simple: easily and accurately convert what already exists into formats that can be used by various BIM modeling software.

BIMobject® enables the development, maintenance and distribution of BIM objects for building and interior products through its peer-based portal. These objects are available at no cost to architects, designers, specifiers and contractors from the BIMobject portal and are available in native format for a number of modeling tools including ArchiCAD, Revit, SketchUp as well as AutoCAD. Other formats are also available.

BIMobject founded three years ago and has been publicly listed on NASDAQ OMX since January 2014. Winner of the 2013 Global Red Herring Award, which recognizes the most promising start-ups worldwide for their innovation and technology, BIMobject is now the largest provider of BIM objects in Europe with nearly 300 manufacturers as customers, with over 65,000 people registered. users and with more than 1,000,000 downloads from its portal. BIMobject is headquartered in Sweden with subsidiaries in France, Hungary (for Eastern Europe), Germany, Italy, UK and with business partners in other parts of Europe.

BIM work process

Building Information Modeling (BIM) has changed the way most architectural, engineering and construction professionals plan, design, build and operate a structure.

A detailed plan is required to bring the BIM method and model to life. That's where a BIM implementation plan comes in, keeping all stakeholders connected and updated on any challenges or changes along the way.

BIM is not a type of software but a method. Building information modeling refers to a highly collaborative, real-time process for generating and intelligently managing building data collected throughout its life cycle.

First introduced to the market in 1992, BIM began to gain traction a little over 10 years later. Today, in addition to being an acronym that catches the eye of many who are looking for innovation in the construction industry, this process has become an essential part of the world. The global BIM market is expected to grow from $4.5 billion reported in 2020 to $8.8 billion by 2025, with governments paying attention to using BIM in new projects and a growing understanding of the benefits it offers to the AEC industry. America is the leader, followed by Europe and Asia and the Pacific.

Building information modeling integrates intelligent insights with tangible aspects of a building. Not to be confused with computer-aided design (or CAD), which focuses solely on drafting and design, BIM uses CAD as a medium to gather extensive information about a building. Simply put, BIM brings CAD drawings to life. This makes them smarter, more dynamic and provide much more information than many systems that can be integrated into a building. When implemented effectively, it can also influence changes in CAD design.

In addition, it helps to digitize many aspects of the building life cycle and goes beyond the design phase. At a time when smart buildings are becoming ubiquitous, it is critical that facility managers also become smarter in the way they manage them. Can you guess what could help them? Yes BIM This approach may provide a complete context for buildings and the systems that regulate them, and the I in BIM epitomizes information-based decision making.

Take an in-depth look at our proprietary IPSUM portfolio, which offers a solution that maximizes all the benefits of BIM. These past winners of the 2017 Construction Startup Competition have taken their easy-to-use ProPlanner system from South America to North America, and have been recognized as the industry continues to grow. Just last year, we interviewed their CEO, Franco Giacinto, who explained more about their approach and how they are betting on BIM to increase industry efficiency.

How does BIM optimize every step of the construction process?

Although it can be a long and complex process, BIM can help optimize the different stages of the process, making it more efficient and easier for everyone involved. From streamlining the design and planning process to organizing multiple contractors, managing expensive and dangerous equipment, and working on a large construction site, let's take a look at how this innovative method can be implemented and reaped the benefits in a variety of ways throughout the project lifecycle.

Different stages of the construction process

Design and planning

The design and planning phases of a construction project can best be considered as an integrated system. The design process is where a new facility is created and described. The construction planning process specifies the activities and resources needed to realize that design.

With BIM, a very useful tool for simulating, prototyping and analyzing these phases, data inclusion serves as a repository for optimal design and performance analysis.

By implementing it, significant savings can be made not only in terms of time but also in terms of resources. Oftentimes, unforeseen situations or inconsistencies can occur during the construction process—for example, a pipe colliding with another element or not meeting regulations—and these are situations that traditionally have to be resolved on site.

However, through BIM, thanks to the fundamental role that BIM plays in the planning procedures and thanks to the early detection of possible problems in each of the different parts that make up a project.

Construction phase

Following the same story line as the previous bullet, we can describe the construction phase as the execution of a plan envisioned by architects and engineers. In both design and construction, multiple operational tasks must be performed with a variety of priorities and other relationships between the various tasks. Because BIM enables many stakeholders and people involved in a project to come together and facilitate collaboration, exchange information with project managers through smart tools, monitor construction work done on site, and coordinate with suppliers and others in supply. The chain becomes much simpler and more efficient.

BIM allows the visualization of the construction status, which means that it can be compared with the expected evolution as specified in the initial project planning at any specified time. It provides optimal control over the delivery of various elements of a project and enables the identification of possible obstacles.

operation and maintenance

One of the last stages of the life cycle of a functional building is essentially one of the most important. As the delivery and commissioning of the building begins after the completion of the construction phase, implementing virtual platforms that integrate BIM technologies can help make the process smoother and more seamless.

As the BIM methodology goes far beyond construction work, once the infrastructure is in place, it can also provide the client and facility managers with the right tools to operate MEP and HVAC, as well as tackle maintenance issues through a digital twin: Installation date, material, life span, ...

Four important stages of building information modeling (BIM) implementation

Like any management change, the implementation of BIM building information modeling also requires extensive and detailed planning and preparations. The implementation of the change should be done step by step with proper planning and implementation.

Four stages of building information modeling (BIM) implementation

Evaluation and estimation

Provision and preparation of change and transformation/pre-planning of the project

Implementation of design/design and construction

Operation and repair of tunnels through experience and expertise

Evaluation and estimation

Communicate the implementation plan and purpose of Building Information Modeling (BIM) in your organization as part of the internal assessment process. The following steps are some of the best practices to help you get started with building information modeling (BIM).

Building Information Modeling (BIM) Readiness Assessment Assess your team's capability in terms of technology and processes.

Feedback - Organize and manage internal Batim feedback sessions on technology adoption, processes and workflows.

Assess work commitment, verification - legal agreements and expected output from each party.

Management – Ensure that top management fully supports the approach to Building Information Modeling (BIM) adoption in the organization.

Provision and preparation of change and transformation/pre-planning of the project

Project pre-planning is the most important factor for a successful transition to Building Information Modeling (BIM). A standardization in the technology process and trained people are necessary for the success of technology implementation.

Standardization: Adopt rules for uniform standards for software implementation and ensure that information processing processes proceed to simultaneously exchange information, archive and update data, so that none of the important information is lost.

Training: The in-house team must be equipped with the new software, so design multiple training sessions to develop and enhance your skills in using Building Information Modeling (BIM).

Implementation of design/design and construction

The implementation of the plan should be determined with the cooperation of all the stakeholders in the project. This phase defines the social interactions of the project team through the Building Information Modeling (BIM) construction cycle. An implementation of Building Information Modeling (BIM) includes the following:

Management of product portfolio and portfolio
Planning and implementation of the test item
Spatial planning
Rebuilding the team
data transfer
Defining new roles and responsibilities
Performance Measurement

Operation and maintenance

The high-level digital model created in the design phase can also be used as a basis for the operation and maintenance phase. It is best to use the construction data of this model and rework it, in order to integrate implementation and operation and maintenance for ease of work. Here are some factors that determine whether the high-level design model can be used for operation and maintenance.

Which elements are incorporated in the design phase?

Is the digital model regularly updated to include new and accurate information?

Are all stakeholders authorized to access the digital model able to easily retrieve information?

The needs and structure of each organization are different and the activities performed in these stages may be different based on their needs.

The different stages of BIM implementation and the proposed standard methods can ensure a smooth and smooth transition to BIM technology, but the success of BIM implementation largely depends on the willingness and ability of the current organization. Hence, it is recommended to implement this process step by step and work hard for its successful implementation.

BIM capabilities

I'm surprised when I see people using conventional 3D modeling when considering BIM (Building Information Modeling). Many people know all the angles of this format but are not satisfied with BIM objectives that do not limit them.

Sometimes it's hard to convince people that BIM (Building Information Modeling) in itself is broad and logical in nature. The complete form created in BIM is a summary of construction modeling. Many of us know this very well.

It is a platform, a process, a technology, not a software (which many people acknowledge) that effectively and efficiently enhances project delivery.

BIM (Building Information Modeling) helps you to see and predict the resulting virtual model before it is structurally created on the intended site. In addition, it helps you anticipate problems and avoids rework. So the design problems and changes during the construction work are reduced. Digital data is stored in each of the elements in the model to answer questions about the building model. For example, how is this column made? How thick is the wall? And so the complications can increase. Additionally, one of the benefits of BIM (Building Information Modeling) is that it affects the lifespan of every part of the project.

BIM (Building Information Modeling) is capable of providing a multi-dimensional and multi-purpose program for those who wish to use this technology. There are many software tools based on the BIM (Building Information Modeling) platform in the AEC industry that can help solve the challenges of time optimization and cost savings.

BIM (Building Information Modeling) is a critical component for digital industry transformation! This case can soon become a normal law because in many places this case has come into power legally.

Just adding and accepting BIM (Building Information Modeling) in any organization requires an active and patient management that prepares users to use BIM by investing in the early stages. The method of coordinated models can be used to achieve maximum benefits.

BIM model application progress

BIM maturity models have become a significant way to represent the stage of development of Building Information Modeling (BIM) and to help measure BIM capability. However, most of the existing maturity models focus on technology evaluation, but the impact of BIM is not only related to technology, and most of them are more used for comprehensive evaluation of BIM capability after the event.

With the development of science and technology and innovation in management and knowledge, labor productivity has greatly improved in almost all industries except the construction industry. According to research by Paul Teicholz, labor productivity in the U.S. construction industry—measured in fixed contract dollars of new construction labor per hour worked—has declined by an average of -0.6% annually since the early 1960s. Meanwhile, all non-agricultural industries have increased labor productivity at an average rate of 1.8 percent per year. In addition, more than 72 percent of projects were completed over budget, 70 percent behind schedule, and 75 percent of projects overdue by 50 percent over original contract price. Chapman et al. found that the factors affecting construction productivity include:

1) Life cycle construction processes
2) Use of technology
3) Availability of skilled labor
4) off-site fabrication and modularization; They also noted that effective collaboration can improve construction productivity.

BIM can provide solutions for these factors to increase productivity. Thirty-two large-scale construction projects were studied by Stanford University's Center for Comprehensive Community Facilities (CIFE). The results show that the use of BIM can shorten the project budget calculation time by 80%, the total construction period by 7%, and reduce the contract cost by 10%. BIM is defined by the United States as the development and use of a multimodal computer software data model to document a building design, but also to simulate the construction and operation of a new capital facility or a capitalized (modernized) facility. The resulting building information model is a data-rich, object-based, intelligent, parametric digital representation of the facility embedded with detailed information for current and future construction projects from which insights tailored to the needs of different users can be derived; and analyzed to provide feedback and improve facility design. BIM provides revolutionary ways to generate, visualize, exchange, predict and monitor information. It improves collaboration between various stakeholders such as planners, designers, structural engineers, construction managers and field workers, ultimately improving the performance and quality of construction products. . In general, BIM can be used at every stage of a construction project for visualization, change management, code review, collision detection, construction, communication and collaboration, and facility management. In recent years, BIM has been used in many giant construction projects and has brought many benefits. For example, at the National Aquatic Center in Beijing, China, shorter programs and improved sustainability, building performance, fire protection and safety were implemented using BIM. At the Hilton Aquarium, Atlanta, Georgia, BIM used for design coordination, collision detection, and work sequencing. $600,000 in cost benefits were attributed to the elimination of conflicts, and program benefits amounted to 1,143 hours saved.

Due to technical limitations, labor productivity in the traditional construction industry is always at a low level. BIM can reduce the cost of construction projects, shorten the construction period and reduce the workload of personnel, and the introduction of BIM technology provides a solution to the long-term constraint in the construction process and improves production efficiency. But along with the change of production tools, the change of the production process and project organization in the adoption of BIM cannot be ignored. Blind adoption of BIM creates more problems that are against the original intention of BIM development. By recognizing the benefits of BIM and facing the problems of BIM, the effect of implementing and developing BIM technology has been gradually noticed.

Growth stages model

Among the growth stages models, Nolan's growth stages model is the most representative. growth stages models developed by Richard L. Nolan during the 1970s and is a theoretical maturity model that originally included four stages for the development of information technology in a business or similar organization: Initiation, Diffusion, Control, Integration, Data Management, and Maturity Following the thinking of Nolan's stages of growth model, several revised models have been proposed to adapt the model to changes in technology evolution, including the new Nolan's model with three additional stages added.

A growth stages model can be used to help organizations build information systems and implement comprehensive information resource management. It emphasizes the importance of integrating information resources between companies and institutions. Gottschalk proposed a four-stage growth model for law firm knowledge management technology. It aims to develop appropriate strategies to implement the technology at a higher level in the future. The authors presented a conceptual model of growth stages for managing the social media business profile of organizations with five stages from a theoretical and practical point of view.

Small and large BIMs

Can BIM make small construction projects successful?

It's easy to see why some people think that adopting a BIM approach may only be worthwhile on larger projects, but is adopting BIM processes worthwhile for smaller projects? And what is the BIM approach anyway?

BIM is more than the development of a 3D model: it involves a common way of working to present a mass of information on a Common Data Environment (CDE), a digital area for the collection of information.

As a key client, the government used its influence to promote joint working in all public sector projects, so naturally some of the early case studies focused on precisely these types of larger projects. By continuously managing information, actions throughout a project can be optimized to deliver added value. To achieve its potential, all project participants need to discuss the required building data and its impact throughout the project lifecycle – but this may not always be possible on smaller projects.

Adopting BIM is a long-term investment for everyone involved in the delivery of a project. Determining your approach early on will benefit future projects. Determining a consistent approach at an early stage can benefit all future projects. Proponents suggest that the initial investment—in consideration of progress—prevents doing so in the future when the difficulty and cost of integration has increased.

Clients can also benefit from the BIM process, as model and data exchange makes it easier for project teams to communicate. Committed customers have access to an "as-built" preview of their building and can anticipate issues and performance before work even begins on site. However, too much detail in a small project can be overwhelming for inexperienced clients. Saving money and fast delivery are probably more immediate concerns.

The notion that BIM is limited to 3D modeling is a common misconception: BIM is not CAD. Unlike CAD systems, BIM-infused software uses in-system computing and has the ability to interface with advanced specifications with tools like NBS Create. A BIM approach replaces the CAD approach through the depth and breadth of information that is transferred, captured and maintained in CDE. The interconnected features of BIM software can also save time and money on a project. Creating a schedule and the ability to effectively plan work steps will help simplify the project as much as possible. The use of BIM-enabled collision detection – which can reduce the potential for human error and problems – can be diverted during the design phase rather than during on-site construction.

BIM workflows see teams come together to create and share a range of project documents, with the benefits of cross-linking and the ability to search through data to make better project decisions at the right stages of the project. This data really comes into its own when considering post-construction – the maintenance of a building is considered from the ground up and the model provides a means to easily prevent errors.

This data provides value and certainty in a project and is especially important with respect to building geometry. This is where BIM systems can help identify collisions between structural, architectural and MEP conceptual models, and when working with Level 2 BIM, different teams can access and validate this shared data.

BIM can make a significant difference to the flow and development of data, but it is most effective when everyone collaborates with the same digital methods. Another benefit of a small practice comes from the native 3D visualization features in most tools – producing renderings and visualizations quickly, rather than time-consuming in-house production or costly outsourcing. Clients can confirm that the submitted design matches their brief and ensure that the final product meets expectations.

Using BIM in smaller projects

Most small projects are significantly different from typical BIM case studies, and this can make BIM adoption difficult for these projects. Many practices undertaking smaller projects may be reluctant to implement 'full' BIM processes - including protocols, standards and classification to 2BIM level - as this is too complex. However, this need not be the case.

In the delivery of larger projects, it is not difficult to see where the adoption of BIM creates benefits and savings – and more and more commercial clients are directly requesting BIM processes and model information and insisting on the use of standard procedures. Additionally, the scale of many large projects— with increased risk and the need to manage cost and logistics—naturally increases productivity through the use of a CDE that can be accessed and centrally controlled by project participants.

But given the experience and knowledge of the typical customer, the levels of risk and the need for advanced technology for relatively simple data about project delivery or how money is spent, the benefits may not be obvious for smaller projects. For example, larger project investments tend to have the capacity to invest in BIM – they can hire BIM specialists. However, smaller projects do not always have the same resources. With a site office, BIM is much easier to implement than on smaller scale projects, where those delivering the project may be limited to content (no computers).

However, for smaller practices there are benefits to using BIM, which is ultimately about providing improvement tools. Small projects must meet the same environmental standards, regulations and government mandates as larger projects, and if a method fully incorporates the common features of a BIM, CDE can make a significant difference in the circulation and development of this data.

Commentary: Mark Starford, Sadler Brown Architecture

At Sadler Brown Architecture, we found out more from Mark Starford, a Chartered Fellow of the RIBA and RIAS (Royal Institute of Architects in Scotland). The company has considerable experience in delivering large and smaller residential developments.

"I was able to advise the client on things like ceilings and walls, which is very problematic when you have a complex curved shape, but essential for someone like a mason trying to price walls."

Mark proved that Sadler Brown Architecture was reluctant to use BIM in the delivery of smaller projects. As reflected by his experience in the industry, Mark stated that "...customers on smaller projects just want the blueprints so they can talk to builders or get the best prices on materials."

However, Mark agrees that one of the biggest benefits of BIM is during the construction phase. This is when project deliverers need to extract relevant and essential information. It can also help in formulating and implementing maintenance plans.

One of Mark's recent projects required an additional 3D CAD model due to the complex shape of the building. Mark commented that the 3D model gave him many advantages over the last curved building he designed using AutoCAD 2D: "I've been able to advise the client on things like the roof and the floor of the walls when you have a complex curved shape. .very troublesome, but necessary for someone like a mason trying to price walls.

Although Mark recognized the benefits of BIM, he didnt convince that the benefits of BIM on smaller projects were equal to those on larger projects, stating that “from my experience, construction teams on larger projects have a lot more layers of management. Ultimately, larger projects and their design teams were better suited to managing BIM processes.

Mark Crowe, BIM Academy

To find a true advocate for the BIM process, we spoke to Mark Crowe at the BIM Academy - part of the Raid Alliance. Mark provided insight into how BIM can be successful in manufacturing smaller projects.

When asking if BIM is successful in producing smaller projects, Mark had no doubts: "Absolutely, no matter what size project you're working with, it can be successful."

(BIM) is connecting the dots between working methods that currently lead to large amounts of repetition – it's the equivalent of putting bus timetables on Google instead of printing adverts that everyone loses.”

Mark is clear that BIM is not all about practices or software – he feels that the purpose of BIM to "approach design, construction and operation as a whole process in a more innovative and continuous light." For example, Mark noted that “(BIM) connects the dots between ways of working that currently lead to large amounts of repetition. "It's the equivalent of putting bus timetables on Google, instead of printing brochures (which) everyone loses."

Using continuous BIM processes and appreciating the availability of data can help improve the project: "If BIM takes that approach, it can only save costs."

Mark explained his experience with BIM and how he used it in relation to smaller projects, including his own experience renovating his property. Mark used BIM technology to build a fairly complex floor structure in his barn and create a new garden. In doing this, Mark used a wide range of different construction techniques and about 16 tons of materials. These designs were developed by hand, but technically matured into a popular tool with BIM capabilities. The use of the model helped to derive dynamic costs and in the development of logistics plans. Ultimately, the wasted materials from Mark's projects included "half a sandbag and a few pieces of wood." The logistics plan is successful with the correct allocation of items to packages that were on site when needed at the lowest courier cost. BIM being active throughout the project also meant that there is an accurate record of every data along with maintenance data.

There is certainly evidence that BIM adoption is not limited to larger construction projects. BIM implementation in smaller projects can add value to the result by optimizing each work step. BIM can actually save practice time and money because with shared help and information, the initial cost need not be wasted.

BIM is a long-term investment. Although there is an initial investment, once the process is done, much of the work can be repeated from project to project. Each subsequent project will benefit from the previous one and the investment cost is justified by delivering more and more projects.

With so much to gain, why not dive in? BIM is fast becoming mainstream business.

Switch to BIM

An existing on-premises (self-hosted) OpenProject installation can be easily converted to the BIM version. The BIM version extends the normal installation capabilities of OpenProject with special features for the construction industry.

Changing to the BIM version will not affect your existing data. Your team can continue to work as before. By switching to the BIM version, additional features will be available when you enable the "BCF" module in the project settings. Use this guide to select the BIM version during installation.

Application of BIM

BIM is one of the developing and promising tools in the world of architecture, engineering and construction. In general, using this technology, you can have an accurate virtual model that will

provide you with an accurate 3D view and information from the beginning of the construction process to the end of the period.

The use of building modeling (BIM) has many applications due to its high features, and it is not correct to look at it only through the eyes of a software. Building Information Modeling (BIM) is a new change in the design method that gives us useful information about the whole building at different stages of the project.

Realize that the biggest investment you'll ever make isn't software, it's change management. BIM will transform the way you work as an individual and as an organization. The best way to take advantage of this is to take a holistic approach, with fully integrated internal and external teams. Start by looking at where you are now and then determine where you want to be. BIM is about adopting a collaborative and transparent approach, and championing this mindset can start immediately. Recruit BIM champions across the organization with varying levels of authority and ask them to share the program across the business. Take the lead so people listen. They don't need to understand the technical details, but they do need to understand the process. Make technology available to everyone. This allows everyone to focus on the process rather than the tools. Costs can be managed with a little creative thinking. Ramboll Consulting Engineering Group, for example, buys a high-spec PC whenever there's a new startup, no matter what position it's in. The new computer is then given to a power user, while that user's old machine is passed on to someone else, and so on. This trickle-down effect allows four users to view their desired specification devices for the price of one higher-end device. Don't wait to start a project. Train yourself in time and then find an enthusiastic customer to participate in a pilot project. Before you first face a live BIM project, prepare yourself. Approach BIM with a 'business as usual' attitude and make it easy to adopt. Map existing processes to complement a common work style, address security concerns before they become a problem, and set company standards to support BIM processes.

Also, the key is to train well but not too soon. Many early adopters learned this the hard way. They invested in the software, trained their people on it, and then went back to business as usual. By the time it came time to implement the first BIM project, their people had forgotten most of what they had learned. So, invest in training, but time that training so your people can jump straight from it to a project.

Also, avoid the trap of focusing on software alone. Think instead about the broader BIM process. Discrete technical issues imposed by software can easily derail a project. Employees with broader information can see the bigger picture, which means projects are less likely to stall.

Suitable for contractors and project executive team

In construction projects and at different stages, we need a tool that can make different parts of the project understandable to everyone. Using BIM in such a situation will be a very useful option for you; Because by using Bim, you can display specialized and detailed information to the executive group in a more comprehensible and better way. Of course, you should keep in mind that at the beginning of the project, you should teach your staff how to use and work with the building information model (BIM).

Making useful information available to contractors

By using Beam, architects can use the initial models obtained for price estimation, planning, production of prefabricated parts, coordination, purchase of materials, ... Because the BIM model is 3D and you can use it to see the specifications of every component of the building. On the other hand, having this information makes it possible to obtain important parameters from a technical point of view, such as structural loads, connection force, cooling and heating loads, determining the volume and power of the air conditioning system, targeted lighting and other such information.

The BIM model is expandable

When you use the BIM information modeling system, the 3D model of the building can go along with the changes that occur in the project, in simpler words, the BIM model can change during the project, and of course you don't need to change all the parameters manually. This is if you use a CAD system or a drawing system and intend to make changes, you must recalculate and change all scales and parameters.

Understand what BIM means to you

Just as the digital revolution changed the way we access movies and music, BIM is changing the way we do projects. It's not just a new step in digitizing an old process, but a whole new way of working. Because of this, BIM adoption is much more than just hardware and software investment. You can't just appoint a BIM guy and carry on with business as usual. BIM should become your business as usual.

Project delivery requirements and planning

Building Information Modeling (BIM) has been around for years, so we can't really say it's new anymore. BIM is globally accepted and for those countries that have not yet adopted it, many have an agreed program and a planned date for adoption.

At the start of any project, requirements must be established by the appointing party (eg, the client) who may appoint a designated principal or a third party responsible for:

Determining project information requirements: organizational information requirements (OIR), asset information requirements (AIR), project information requirements (PIR)

Determining project information delivery milestones.

Creating project information standards.

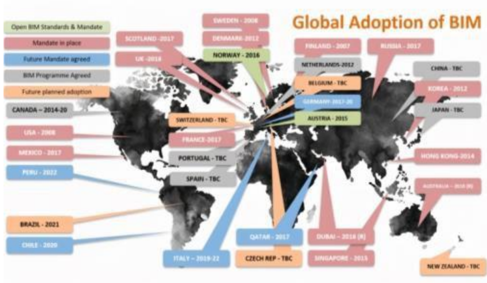
Creating methods and procedures for generating project information.

Create project reference information and shared resources.

Creating a shared data environment for the project.

Creation of project information protocol

Activity to assess and need.



BIM adoption

The above information is highlighted in EN ISO 19650-2:2018 and is given as an example to help understand the information needs of a project. This is what is called the Exchange/Employer Information Requirements EIR.

How: Standards to be met (to name a few):

Software to use

Coordination and cooperation

Level of need for information (LoD and LoI)

Asset information requirements

Classification is applied

Health & Safety

security

Model limitations (individual model volume)

File format exchange and delivery

To ensure that any information is created in a structured way, you need some standard guidelines set from the start, and this certainly applies to model design and production. If there were no road rules, it would be chaos every time you tried to drive somewhere. Therefore, it is important that the appointing party (client) has specified these standards as part of its project requirements. Most importantly, everyone working on the project must actually follow them, and validation checks must be performed on all information before release.

Here are some examples:

Grammar and spelling checks are done

The correct (customer) design title sheet is used

Layering and naming of objects is consistent

All annotation styles conform to industry standards and party assignment standards.

Design or model files are purged (purge/audit) before export.

All edits and notes included.

Model files are identified from the center and working sets are removed.

All disciplines need geo-location of their project models in the early stages of the project in real-world location. This is generally set by the lead designer and then followed by other members of the design team. This should be specified in the BIM Project Implementation Plan (BEP). Ensuring this is done is a key aspect of working with the entire design team. If this is incorrect, it will potentially cause errors, and then rework or even redesign to correct those errors.

I personally get great results using the BIM 360 suite of tools to coordinate and collaborate on a project. All models in this field are stored in BIM 360 Docs and you can coordinate all models in BIM 360 Coordinate. And now with the recent release of BIM 360 Issues for Navisworks, it's only taking things further.

The new EN ISO 19650-1 highlights Level of Information Needs instead of Level of Information (LoI) and Level of Detail (LoD) which can be considered specific examples of Level of Information Needs.

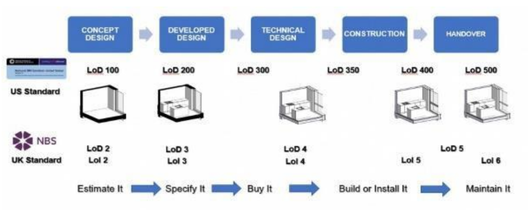
Any information delivered should be determined based on its purpose of the level of information need.

When building Revit® Structure models, we need to make sure we understand those specific requirements. Don't add more detail or information than necessary, as this is over modeling and will cost you time and money.

The level of information in the steel structure model will be very different compared to the construction service model. There will be many maintainable asset elements in the building service model and probably very little in the structural model.

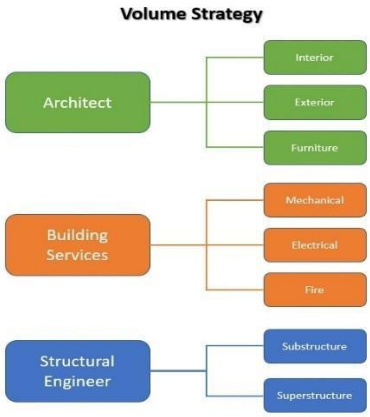
This is similar to the level of development, as a structural engineer's model is generally not as detailed as a steel fabricator's model.

It is very important to create and exchange the correct version and file formats. If the EIR highlights required software, for example Autodesk Revit (2019 version), then unless otherwise agreed, design teams must use that software and version, as deliverables can be RVT, NWC, and IFC.



LoD و LoI

A typical volume strategy varies from project to project, but generally follows certain principles, such as dividing into volumes by major disciplines or sub-disciplines in the case of MEPs, subcontractors. This can be further divided, for example, by building block or substructure and superstructure or steel frame and concrete frame.



At the end of the project, the main contractor will provide both the operation and maintenance (O&M) manual and the health and safety file with all the documents ready. We spend a lot of time creating all this information about the structure to help build a new property or renovate an existing property. We must ensure that it is as made. We have to consider that structural engineers' model is generally updated only until the end of the design phase. The steel fabricator could then take their model and produce a new completely fabricated model with all the fittings.

Model ownership is a gray area. Who owns the model and the intellectual property rights to the elements and data within it may still belong to the originator that allows the client to use them.

Generally, a project's structural information is reviewed and remains in the health and safety file. Structural models are therefore unlikely to be updated until future development or redevelopment, and it is said that some data may be transferred from the model to the CAFM system. It is important that all model files are upgraded to the current version used by the asset operator to avoid data loss.

BIM planning

BIM is not only a 3D virtual representation, a 3D image without further content, but an interactive model full of data. It is a real-time 3D rendering of a database of all building parts, including detailed geometry, shapes, colors, textures, physical properties, codes, and other attributes. It represents the connections of various structural elements to each other and the MEP and HVAC installations. All elements are placed in their exact position in a realistic construction sequence to virtually build the entire building in your plan, solving all possible assembly problems, managing processes and conflicts before the actual construction begins.

Accurate modeling of your 2D maps

Your 2D drawings are the basis of the BIM model

We maintain the same accuracy and information as in the original documents

Inaccuracies will be identified and corrected

Collision detection and design coordination

The entire building is built virtually

All elements with their exact geometry and properties

Realistic construction sequences are recreated

Conflicts are identified and resolved before actual construction begins

Collision management

We handle conflict resolution between different transactions

We propose solutions that are technically and economically affordable

Avoiding delays and cost increases in the implementation phase

Preparation and distribution of construction plans

All drawings originate from the BIM model

Coordination of distribution between project parties

Achieve documentary accuracy

Automatic updates with design changes

Save time and eliminate errors

Departures and quantity evaluations

Everything that is modeled is measurable

We individualize each metric

The budget for each stage can be automatically identified

Avoid cost deviations between design and contract work

We use Presto and Allplan with a two-way connection

Building visualization and analysis

We create individual visualizations of the BIM model

Understandable for people who do not have special technical knowledge

In IFC and PDF-3D formats that can be sent by email

These data formats accept measurements and comments

BIM offers many advantages during construction projects and can be implemented in multiple phases during a project. When implementing BIM, current technology, training and implementation costs relative to the added value of its use should always be considered when determining the appropriate areas and levels of detail required in information modeling processes. Therefore, to successfully implement BIM, a project team must conduct comprehensive and detailed planning in the early stages of a project to maximize the cost and impact of modeling implementation.

When implementing BIM, it is important to develop an implementation plan in order to successfully integrate BIM into project processes. Similar to a project plan, this should be developed early in a project and should be continuously monitored, updated, and revised as changes occur in the project or its participants. The four steps include identifying appropriate BIM objectives and applications in a project, designing the BIM implementation process, defining BIM deliverables, and identifying the supporting infrastructure for successful project implementation.

By developing a BIM implementation plan, project participants and the project team can achieve many benefits. Some of the key benefits gained by following the BIM Implementation Planning Guide are summarized below:

All parties will clearly understand and communicate the strategic goals for implementing BIM in the project.

Organizations will understand their roles and responsibilities in implementation

The team will be able to design an implementation process that is well-suited to each team member's business practices and the organization's typical workflow.

It outlines the additional resources, training or other competencies required to successfully implement BIM for the intended use.

This plan provides a benchmark to describe the process for future participants joining the project

Purchasing departments can define contract language to ensure that all project participants meet their obligations.

The baseline plan provides a target against which to measure progress throughout the project.

To further enhance collaboration and information sharing throughout the project process, the BIM design phase should follow information levels. Information levels are related to the level of detail in the digital representation of the project. The use of levels of information when working with BIM tools helps create a more structured project, where milestones and stages are used as assembly points for different levels and strands of information. The following table shows how different construction stages are used as assembly points for the level of information required in different project disciplines:

Table 1. An example of the use of information levels related to related construction stages

Construction stages	The architect	Structural engineer	Building Services Engineer	Contractor	Supplier	Customer
Design summary	0	0	0	0		0
Conceptual design	1	1				
Initial design	2	2	2		4	
Design plan						
Accurate and detailed design	4	4	4		5	
construction				5	5	
As made	6	6	6	6	6	
operation and maintenance						6

After the implementation of BIM in a project, by following the executive planning procedure, different disciplines and fields of application achieve different advantages and benefits based on its use.

As mentioned earlier, construction projects are heavily affected by a high degree of fragmentation, which puts increasing pressure on new project management tools and practices to increase integration across projects. As stated in ISO-21500, a project can be divided into several subject and process groups. According to ISO-21500, "Project management is the application of methods, tools, techniques and competencies to a project. Project management includes the integration of different phases of the life cycle."

Five misconceptions about BIM

The following can be listed as five concepts that are misunderstood in relation to BIM:

Productivity suffers during the transition to BIM.

BIM applications are difficult to learn.

BIM disrupts established workflows.

Owners and contractors benefit the most from BIM, but designers do not.

BIM increases project risks.

project scope

Different tools can be used to define and manage the scope of the project. 3D modeling provides a means to create an initial visualization of the project and gives the client a better ability to assess whether the project meets form and function requirements. Project scope also includes the processes needed to identify and define the work and deliverables, such as the work breakdown structure (WBS). WBS can be documented more accurately as BIM gives a clearer insight into the composition and deliverables of various building systems such as architectural, structural and installation systems. In addition, by using BIM in the planning phase, when the scope of the project is being established, it is possible to reduce many conflicts between the client and the construction company, therefore shortening the overall project life cycle.

Time

During construction projects, time is managed by creating and controlling schedules. The activities necessary to develop the schedule are derived from dividing the activities into the smallest possible tasks in order to create a work breakdown structure (WBS).

BIM is used both to extract the information needed to create an accurate WBS and to create a more efficient schedule based on a selected scheduling method such as a Gantt chart or location-based schedule. Both of these types of scheduling are based on the critical path method (CPM). By using BIM tools, the critical path can be determined more accurately.

By determining the critical path of a project more precisely, it is possible to reduce the risks and uncertainties caused by the delay of the project or even prevent it.

Cost

To show the impact of BIM implementation on cost management, the fifth dimension (cost) is introduced (the rest is the fourth dimension). There are several BIM cost estimation tools like Sigma ...... that can be used to create 5D models. The implementation of 5D models provides advantages in both the construction and design phases, as they can provide more accurate cost estimates and therefore facilitate more accurate budget control and management.

Quality

The quality management of a project can be divided into four main components, namely inspection, quality assurance, quality control and total quality management. Collision detection is one of the countless applications of BIM that can be used to increase quality control and assurance of construction projects while reducing the time allocated for inspection and consequently increasing overall quality management. A BIM model usually consists of several models that depend on each other. Collision detection works by locating and resolving potential conflicts between different models and finding errors that would otherwise be overlooked.

Beneficiary

The use of BIM brings many benefits to internal and external stakeholders as well as related stakeholder management. The ability to provide a preliminary visualization gives a better idea of how the building fits into its surroundings and looks, which greatly benefits the client and the local community. 3D modeling also allows documentation and assessment of things like volume, height and shadow of the building, which benefits local authorities. BIM also enables faster project execution due to lower defect rates as errors are discovered earlier and in greater detail.

human resources

The easy sharing of information made possible by the implementation of BIM also affects the human resource management of construction projects. Collection, extraction and communication softwares make it possible to create a better overview of the relationship between different fields and at the same time improve the estimation, control and management of human resources during the different stages of a project. The easy flow of information also enables the optimization of resource consumption, both when traditional project management techniques are used and when lean project management is implemented.

Relationship

Communication in project management is a vital part of construction projects. During construction projects, multiple disciplines and participants must work together to achieve a common goal. The tasks and achievements of these different participants are highly interdependent and therefore require a high level of cooperation and information sharing. The flow of information and communication between different participants is also greatly affected by BIM integration, as both of these factors are greatly improved by implementing BIM. The use of BIM not only promotes better communication within the project, but also strengthens the relationship between internal and external stakeholders through early visualization of the project.

the danger

All construction projects have uncertainties, risk events and resources associated with them. This makes it critical to collect and share as much information as possible throughout the project. The reason why BIM is also a necessary and very welcome tool for risk management is the fact that it increases and enables the flow of information in a project and increases the amount of available information and consequently minimizes risk and uncertainties in construction projects. BIM can also be used to generate what-if simulations used to mitigate and better control risks throughout the project life cycle.

With BIM, the pre-construction stages are supported in various ways, which also affect the procurement process. The client will have a better overview of the project and therefore can choose bidders with more confidence due to the 3D visualization tools and related data extraction that make it easier to compare bids. The integration of BIM in the project greatly optimizes the procurement process due to the cost estimation tools as well as the overall increase in quality. This optimization of the procurement process, in turn, forces suppliers to be more productive and competitive.

Limitations

Using BIM as a tool to achieve better and more efficient integration in construction project management has many advantages. Despite these advantages, there are also problems and limitations that should be considered in using BIM. These limitations are mostly related to the communication between different participants and stakeholders and the level of BIM experience and expertise. As shown in Figure 8, the gap in the experience level of different

BIM users creates problems in effective communication between project participants and stakeholders.

Another limitation of using BIM is the lack of standardization. Different languages and units of measurement are used around the world. When working with BIM, it is very important to use the same standards (compatible) for measuring, extracting and sharing information between the BIM tools used by different participants and stakeholders (internationally). Therefore, the implementation of a global classification system is necessary to achieve the full potential of BIM in project management.

BIM is becoming an important and mandatory tool in the construction industry. As a project management tool, BIM has proven to be very beneficial in optimizing the practices of integrated construction projects. The use of BIM as a tool in project integration management has had a very positive effect on various fields of construction projects. Benefits include increased efficiency and integration. To successfully implement and achieve these benefits, a project team must conduct detailed and comprehensive planning in the early stages of a project.

However, there are also challenges and risks associated with the use of BIM. If project participants do not have a minimum level of training and understanding of BIM tools and related deliverables, this can lead to fragmentation due to differences in competency and experience levels throughout the project. The use of BIM requires that all project participants receive a consistent level of BIM training. If any participant lacks the required minimum level of competence, they cannot effectively participate in the project. In addition, the difference in the classification of different ICT tools used leads to problems in information sharing and leads to unnecessary time-consuming and error management.

Despite these disadvantages and obstacles, BIM has proven to be a very beneficial and useful tool in all phases of construction projects and to support the most critical aspects of projects. As a result, BIM is gradually becoming a mandatory and standard tool in the construction industry.

Anatomy of BIM

Building information modeling is emerging as an innovative way to design and manage projects virtually. The predictability of building performance and performance is greatly improved with the adoption of BIM. As the use of BIM accelerates, collaboration within project teams should increase, leading to improved profitability, reduced costs, better time management, and improved client-client relationships. BIM represents a new paradigm in AEC that encourages the integration of the role of all stakeholders in a project. This merger has the potential to create greater efficiency and coordination among players who often saw themselves as enemies in the past. As with most paradigm shifts, there will undoubtedly be risks. Perhaps one of the biggest risks is the potential removal of an important check and balance mechanism inherent in the current paradigm. An adversarial stance often entails a more critical review of the project as a kind of mutual protection of each participant's own interests. In the early stages of BIM, builders worked from architectural drawings because digital models were not shared by architects with contractors. Construction modelers inevitably discover errors and inconsistencies in drawings when creating building information models. This resulted in a natural increase as the construction model contracted the design into this virtual building experiment. With the more reliable sharing of architectural drawings that can be easily imported and serve as the basis for a building information model, this critical review step may be eliminated. In other words, when all players see themselves on the same team, they may stop looking for and finding faults in each other's work. In the past, lack of critical review has been at least one component of building failure.

The future of BIM is both exciting and challenging. It is hoped that the increasing use of BIM will increase collaboration and reduce fragmentation in the AEC industry, ultimately leading to improved performance and reduced project costs.

GIS and building information modeling integration

When integrated, BIM also provides insight into flood-prone areas, giving designers detailed information to influence structure location, orientation and even building materials. With BIM, you can design a physical structure at the object level through BIM data is closely related to GIS to design and build a specific object, structure or shape. This allows design and construction firms to collect accurate and valuable data that leads to much more effective and efficient design and project management.

Building information modeling in MEP

Building information modeling helps MEP professionals design, detail, and document building systems more efficiently. Working in the BIM process gives project teams greater insight into designs and constructability, reducing risk and improving outcomes. These solutions simplify the design, modeling, documentation and construction of these systems and ensure that they integrate seamlessly with the building in which they are placed.

What is not BIM?

The term BIM is a popular term used by software manufacturers to describe the capabilities of their software. Similarly, the definition of what constitutes BIM technology is also controversial. To overcome this ambiguity, it is necessary to describe modeling solutions that do not use BIM design technology.

3D models lacking (having a small number of) object characteristics: these models are only used for graphical visualization and lack any intelligence at the level of objects. These models are suitable for visualization but cannot provide support for design analysis or information integration. For example, the Google SketchUp software is a very good software for quick and schematic design of the building, but due to the lack of information about the objects except their geometry and appearance, it has limited use for other types of analysis.

Models without behavior support: in these models, objects are defined, but due to the lack of parametric intelligence, their position or ratio cannot be defined; that the changes require a lot of work and that protection is not done to avoid creating contradictory and false views.

Models that consist of multiple 2D CAD files and must be combined to define the building: it is impossible to ensure that the resulting 3D model is feasible, stable, countable and represents the intelligence of the objects it contains.

Models that allow changes in one view, but the changes are not automatically reflected in other views, which causes errors in the model that are difficult to detect. (C. Eastman et al. 2011)

On the other hand, the American General Contractors Association notes in its BIM guide that to benefit from BIM, it is not necessary to use BIM in the entire project. In fact, many contractors use smart models in projects without knowing it. It is possible that the designer or a group of suppliers or specialized contractors use the models for their own benefit and do not share the information with other team members. The use of BIM terminology is encouraged, even if it is for a part of the project, for example, steel structure or mechanical systems.

The six characteristics of a simulated model that can meet our goals in achieving and using BIM technology are as follows:

1) Be digital.
2) Volumetric (three-dimensional). (3D)
3) Measurable, dimensional and parametric. (Measurable And Parametric)
4) To be comprehensive and comprehensive.
5) Be accessible to all the factors involved in the project.
6) To be durable and stable in all phases of the project. (Durable)

Definition of parametric objects and components: (Parametric Objects)

One of the most fundamental and main concepts that plays a central role in the definition of BIM technology is the understanding of parametric components. Parametric components are very different from the traditional definition of objects or components (3D), in short and based on this, they can be defined as follows: (Figure 2)

1) These objects contain their complete and comprehensive geometric information.
2) The geometry of objects should be integrated and free of any redundant information that leads to errors and inconsistencies in other components. For example, the view from the top of the object (Plan view) and its side view (elevation view) must be completely coordinated with each other, the same and free of any contradictions.
At the same time, if there is a change in any of the geometric characteristics of the desired object, this change should be automatically applied to all the views produced from it.
3) These objects have the ability to modify their dimensions and sizes during integration into another object (parametric) according to the conditions and geometry of the desired object. For example, a door can be automatically placed inside a wall and a warning will be given if there is a discrepancy between the parameters of the wall and the door; Or a parametric wall has the ability to change the difference automatically after encountering the elements in the ceiling (such as a false ceiling). The placement of mechanical and electrical equipment at the appropriate level and height of parametric walls can also be considered as another example.
4) In objects that have different components, they should be defined at different levels in such a way that they finally work together in an integrated manner. For example, if a wall is multi-piece, if the material of each member is changed, the weight of the whole wall should be corrected automatically, or if the material of each layer of the wall is changed, its heat transfer coefficient should be corrected.
5) It is possible to define special relationships and rules and constraints between the dimensions and sizes of an object or a set of objects, so that it is not possible to change the object if it is exceeded. For example, according to the dimensions and sizes of the door in a particular factory, it is possible to define and change the production range of the factory.
6) Objects should be able to be linked, receive or transfer their information and features to other models and applications related to BIM. For example, any object can easily provide BIM-compliant applications with structural specifications, materials, information related to object acoustics, energy data, ...

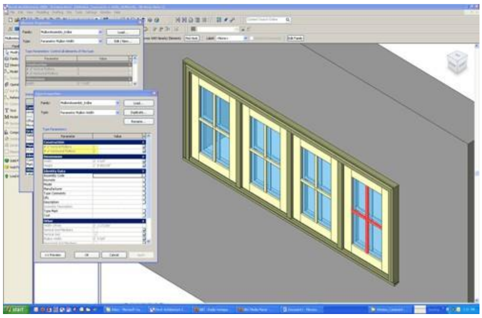


Figure 1. An example of defining a parametric object

What things are not BIM technology?

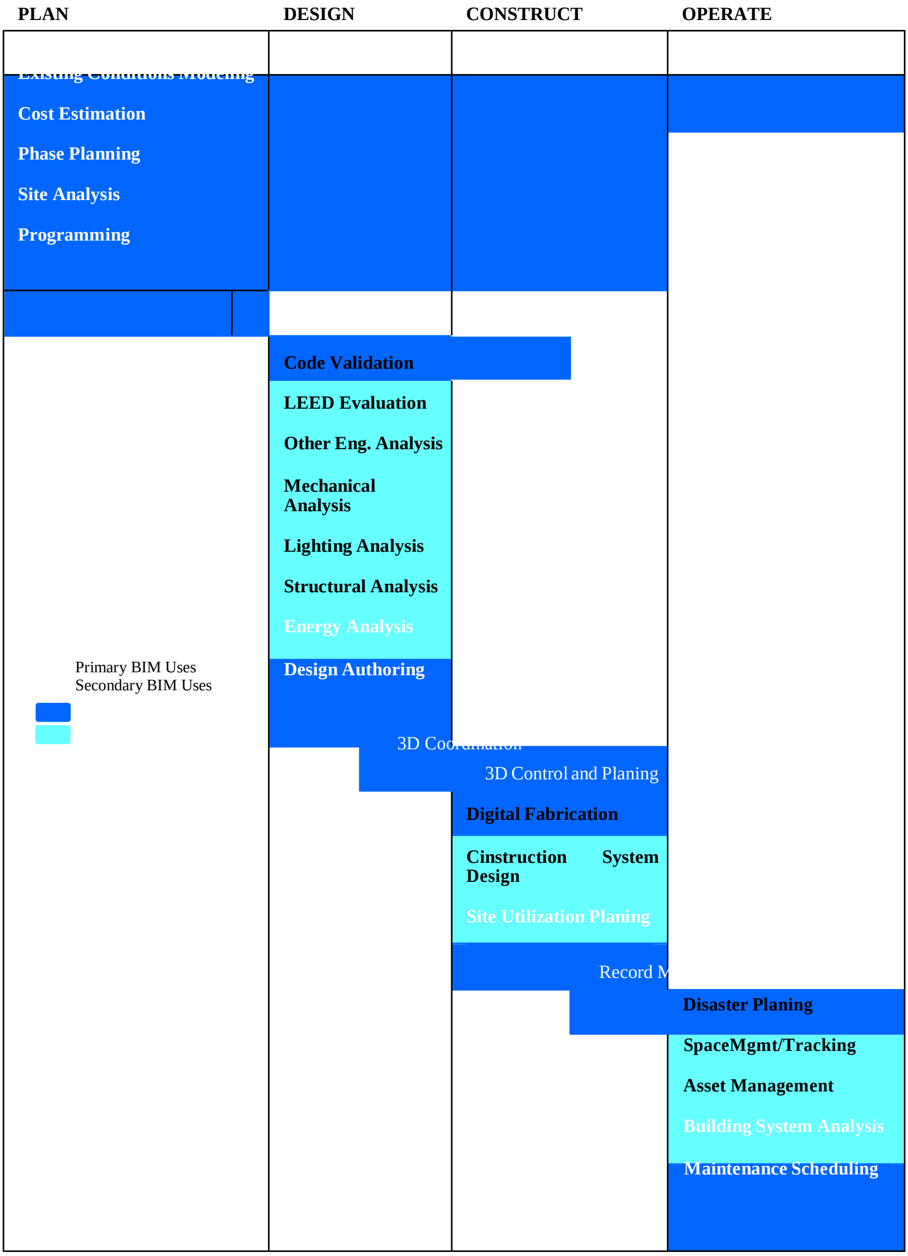
Today, BIM technology is a hot topic in scientific and technical communities. Many well-known manufacturers of computer products are starting to coordinate and produce products based on BIM technology. One of the ways to distinguish between products and tools based on this concept and other products is to introduce characteristics that make a product not be included in the scope of BIM:

1) Models that only contain 3D information of one or more objects and do not contain the characteristic information of the object. These models are used for illustration purposes only, but do not provide any support for feature information that has various uses in the life cycle and construction of a project. For example, Google's sketchup software is a very powerful and useful software for schematic production and a very powerful and useful software for instant schematic and 3D production of a building, but it has a very limited use in the field of analysis related to the building. Google's Sketchup can be included in the BIM process of a project with the help of other applications.
2) Models that do not contain any parametric information.
3) Models that have to be linked to 2D CAD files in order to extract their information, because it is not possible to ensure the existence of an efficient, accurate and intelligent model (based on non-intelligent 2D files).
4) Models that have the possibility of changing one view of the software, but by changing one view, other views are not changed automatically.

Applications of BIM technology

As we know, BIM technology is used as a new concept and method in the entire life cycle of a project. BIM technology can be used from the stage of preliminary studies and project feasibility to finally the demolition stage of a project. The table below shows the use of this technology in different stages of a project's life cycle. (Table 1)

Table 1. Application of BIM technology in different phases of a project's life cycle



Collaboration:

The cooperation between different members of the project team, including the owner, design engineers, executive engineers and operators, starts and is felt from the very early stages. The models produced in this area cause the cooperation and precision of the design and construction team.

Site coordination:

This technology plays a very key role in the sustainable and targeted management of the construction project site and helps to control and increase safety, logistics management, ... By using this technology and using related applications, you can simulate all the daily operations in the executive site as well as many scenarios.

Elimination:

BIM technology will be of great help in reducing technical inconsistencies and incompatibilities, reducing wastage and destruction of materials and technical forces, and finally reducing risk in the project.

Fabrication:

BIM technology is known as a big revolution in the construction industry, so that many manufacturers have significantly increased their ability and accuracy in construction by using the information of the created models. Below are examples of the use of BIM models in the construction industry:

A. Construction of skeletons and structures.
B. Electrical and mechanical components.
C. Prefabricated concrete parts.
D. Internal and external glass systems of the building.

Prefabricated parts and buildings:

By using this technology, it is possible to reduce labor, reduce construction time, and increase accuracy and quality in prefabricated industries. With the spread of this technology, prefabricated industries have been coordinating their software with it, so that many CNC (Compute Numerical Control) machines today have the ability to coordinate with BIM models and produce their products.

The design and construction of prefabricated and complex concrete and metal structures, curtain wall, prefabricated walls, prefabricated electrical and mechanical equipment is an example of the applications of this technology.

Cost estimation and management:

One of the powerful features that can be extracted from BIM models is to help in the discussion and estimation of projects.

Clash detection and reporting:

The possibility of identifying the interactions of different models created in the project design group (architectural, structural, mechanical, electrical) is one of the noteworthy and fundamental applications of BIM. Designers provide their designs as separate models to project managers (BIM Manager). These models have the ability to merge with each other and form a single model of the project. In fact, before the start of any operation, all the future processes can be observed in a simulated form and if any of the members interfere with each other, the problem can be solved so that these problems do not appear in reality. All the interferences are observed by the management teams and the necessary reports are given to the designers along with the exact location of the interference in order to comment on their resolution or maintenance. (Figure 3)

Figure 2. Site safety management and review of different scenarios for the implementation of different phases of the project

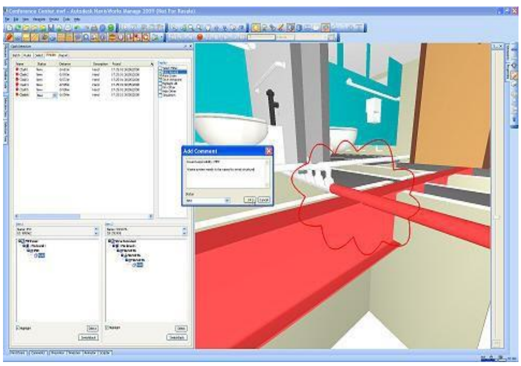


Figure 3. An example of identifying the interactions of structural and mechanical models and specifying it by the BIM management team

Project planning and control (Planning and Scheduling)

Another attraction of BIM technology is the ability to produce 4D models. By adding project management files (Primavera, MSP) and assigning activities to different elements in 3D models, he brought this technology into the field of project and construction management. (Figure 5)

Figure 4. Integration of BIM models and project management models and 4D model production

Due to the increasing complexity of construction projects and the approach of the construction industry to environmental issues and sustainable buildings, the need to use an effective and efficient method is felt more than ever. One of the most successful and efficient methods widely used in the world today is the use of the BIM concept, which can be used in all phases of the project. Currently, in addition to using and implementing this technology in developing countries, researchers in developing countries are also providing suitable solutions for practical implementation in different phases of a project.

Convert to BIM

Converting to BIM For the designer, BIM offers more than a technological change in the way of working. We discover that the shift to BIM is truly a complete description of the entire design process.

A building information model is a digital description of an asset that includes every aspect of that asset. Providing information in each element in order to make better decisions before, during and after construction occurs. For the designer, BIM offers more than a technological change in the way of working; This is a complete description of the entire design process.

Often, the transition from CAD to BIM has been much better than when the industry went from paper to CAD. Paper to CAD automated a process but left the process unchanged. With BIM, the traditional way of working is obsolete and the process itself has completely changed.

First we followed the paper

At the heart of the design, we have two-dimensional plans (plans, sections and elevations) that are designed on the principles agreed upon by all participants. Inherent inefficiencies in this approach include things like architectural plans, which differ from the exact blueprints or drawings used by civil engineers. Similarly, architectural plans focus on the design plan while building plans show what is above the roof and below the floor. This traditional process involves specialists tracing and producing work on individual drawings with paper, at which point coordinated inspections are carried out to check for consistency.

Then we had CAD

The need for more detailed and graphic design solutions calls for CAD layers that take the place of paper. However, an interdisciplinary approach must remain with meetings needed to resolve these conflicts, and while CAD made these conflicts easier, the process is time-consuming and it is too easy for different types of programs to produce changes in architectural or structural details.

We were supported by CAE

In parallel, computer-aided engineering systems (both simple and complex) have been enhanced and developed to support structure calculations under an array of different types, with the results feeding from CAD systems to adjust the model and produce structural drawings thereafter.

Now we get into BIM

The BIM process uses a virtual 3D model of a proposed asset as the single source of all information about that asset. At the heart of this process is a common, shared database that feeds a set of complete project documents. BIM maturity levels define what type of digital information is created. Currently, industry leaders are at Level 2 and are extending to Level 3, enabling construction management throughout the design lifecycle with a range of standards and formats.

Use of BIM

Side benefits

By using a centralized data source that includes all documentation related to architectural and landscape plans, construction and installation plans, bills of quantities and cost estimates, it reduces the possibility of error and allows problems to be flagged earlier. Changes can be made quickly and at a lower cost than the project.

Collision detection in BIM is much more accurate than traditional methods. BIM systems capture standard data (overlap in space), light (clearance and tolerance) and technological interactions (eg, overlap and delivery schedule), guaranteeing significant cost savings during the design and construction phases.

New formats of plans offer more benefits. 3D BIM previously see as a natural extension of 2D design. 4D BIM adds planning to the work process. Elements are assembled sequentially, which offers new opportunities to divide projects into different phases and visualize them with a detailed schedule of work to guarantee products and materials to arrive on time.

Five-dimensional BIM adds estimation and makes it easier to understand how changes in conceptual design impact the bottom line. Six-dimensional BIM allows environmental protection and energy consumption information to be calculated, and seven-dimensional BIM combines facilities management information with the asset being used for the first time through demolition.

Arguably, the biggest benefit of BIM is the ability to analyze conceptual designs to find suitable ones to work with as structural designs. Manual review and calculations to models and conceptual designs are considered under CAD, but under BIM it is presented in a much more efficient way of working. A 3D model created by an architect becomes an analytical model that can be used for structural analysis.

Practical situation

Before starting a BIM implementation process, it is necessary to undertake a skills branch to ensure that your organization has the types of skills and roles in place to take advantage.

BIM coordinator

PAS1192 introduces the role of BIM manager/coordinator. This role is very much about process and change management as it is reviewing BIM deliverables. Key elements of the BIM coordinator role include:

A wider range of responsibilities than an information manager

Close connection with design (design guidance)

Responsible for BIM project setup: setting work objectives and managing requirements

Coordination and maintenance of models: the process, types of models, why they are created, how they fit together, ensuring that models are adapted and up to date

Oversee collision detection, quality audits, quantity and data conversion

A BIM coordinator can act as an information manager; However, an information manager is not a BIM coordinator.

Dimensions of BIM building information modeling

BIM building information modeling is the process of creating comprehensive information models. During this process, graphical and non-graphical information are integrated in the common data platform (CDE) or digital information resource of the project.

As a project completes with its data center, then information models will become more detailed over time. Then, when the project is finalized, this information model will be presented to the client for use in the construction phase.

When we talk about the completion of the model (BIM), we are basically talking about the ability to form a supply chain and logistics that enables the exchange of information digitally.

Of course, as stated at the beginning, the various dimensions of BIM building information modeling technology are different from its levels. Different dimensions of BIM (BIM) is a special way that data of different types are connected to an information model. By adding additional dimensions of data, one can experience more information and a better understanding of construction projects.

How the project will be presented, how much it will cost and how it should be managed and maintained and other such questions are all presented in this platform. All these dimensions can be located in the comprehensive BIM information model (four-dimensional, five-dimensional or six-dimensional BIM model) in a practical way and in the "second level of BIM building information modeling" workflow.

3D Model: Shared 3D comprehensive information model

The three-dimensional model of technology (BIM) is the model that we are most familiar with among the various aspects of BIM building information modeling technology. In fact, the process of creating graphical and non- graphical information and sharing them in the common data platform (CDE) is the same as the comprehensive 3D model.

As the process of forming the project progresses, this information also becomes richer and more detailed. This process goes to the point where the project data is presented to the client in the final stage.

Four-dimensional model: (construction sequence) or considering the time dimension in the comprehensive information model of the project

The four-dimensional model adds a new dimension of information in the form of time data to the project information model. These data can be used to obtain detailed project planning information and visualization based on time. In this way, the construction sequence of the project is presented in an understandable way for the audience. In other words, these data are added to the elements that are being developed in high detail.

There may be time-dependent information for a specific element, including information about the activity time, its construction time frame, its installation time frame, the time required for operation, the time required to check the strength, the time required for repair and improvement, the sequence of installation. Different elements and time dependencies to other parts of the project.

Scheduling managers will be able to accurately develop the project schedule through the time information shared with the information model. Also, by adding information to the components of the model in the graphic display environment, it becomes easy and attractive to understand the project information and check it. As a result, it is possible to show how buildings are constructed and it is possible to show in advance how the building will look at each stage of construction.

It is very beneficial to use this method to plan and make sure that the overall project is done in a real, logical and efficient way. In this way, asset management can be started in the initial plan and even before equipping the workshop. In this way, in the very early stages of the work, feedback is specified and unnecessary and costly rework and designs are avoided in the workshop. Also, when working with all the stakeholders of the project, the visual display of how the projects are built creates a better feeling and leads to a better justification of all the executive factors of the work, and further leads to a reduction in the project completion time.

This gives everyone a clear visual understanding of the plans made for the project. By using this technology and before building the project, it will be clear to everyone how the project will look after completion.

Adding information about delays and leads can be extremely beneficial not only at the design stage, but also at an earlier stage. Because this makes it possible to check the plans from the beginning.

This type of information in the initial stages of the project makes the initial concepts to be examined and discussed in order to further inspire the project executive team to achieve the project's goals. The planning managers of a project are considered key members of the project team, so working with the four-dimensional information model does not eliminate the need for these managers.

But instead of these planning managers preparing and presenting their planning proposals based on the traditional work flow for project management, they work in the form of BIM technology. In the context of virtual modeling, these managers can have the time proposals and solutions of the project under their authority and carry it forward in the desired format. In fact, with these managers being closer to the project executive team and facing early feedback in the overall work process, this potential is created so that the project credits are managed in an optimal way.

Five-dimensional model (cost)

In the form of the five-dimensional model of BIM technology, it is possible to extract the detailed information of the relevant costs from the comprehensive information model by connecting to each of the components of the information model of the project.

This information may include current costs and costs related to the repair, maintenance or replacement of elements. Cost information calculations can be done based on the data linked to the graphical model.

This information enables managers to easily predict the values associated with a desired element in the project. Next, managers can apply the approximate price of different components in the model and calculate the total construction cost.

The benefits of accessing costs through BIM include the ability to easily view costs by selecting components in the 3D model, being aware of changes made, and automatically calculating the cost of project-related components.

Of course, it's not just managers who benefit from seeing costs as part of the BIM process. Assuming the existence of the 4D model program data and a clear understanding of the project's validity, it is possible to easily track the projected and actual costs of the project throughout its duration.

This made it possible to provide a regular report of expenses and budget allocation to ensure that the desired work efficiency is achieved and the project will be carried out according to the allocated budget. Of course, the accuracy in calculating costs depends on the data provided by different teams and shared in the common data platform. If the input information is not accurate, it is natural that the calculations based on it will not be accurate.

In this field, there is no difference between traditional methods and BIM technology. The reason for that is the central role of people who evaluate and estimate these values. These people not only play a role in verifying the accuracy of information, but also in detecting and correcting contradictions in received information.

It should be noted that many project components are still modeled in 2D or not modeled at all. There are probably differences between the models in how cases are classified, and managers should notice unusual cases and take them into consideration so that they do not make mistakes in their estimation of work.

Probably, a comprehensive information model includes three types of quantities. First, the quantities that are based on the real components of the model and can be seen along with its details. These quantities are fully visible and can be examined through models.

The second type are quantities, such as template surfaces, that may arise from model components that are not always visible. The third type are the quantities that cannot be modeled from scratch and can include, for example, temporary works, construction seams, or other similar items.

These quantities can only be modeled in the construction phase and then graphically represented in the design model. A manager who specializes in project cost estimation should also have sufficient skills in determining the quantities that cannot be estimated based on the components of the model.

One of the advantages of cost estimation from an information model is that the data can be checked in any different time frame or throughout the entire length of the project. It is also possible to regularly update the information that plays a role in providing expense reports. Since cost estimation managers are involved from the start of the project, they will help the work team in planning the "real" costs and calculating the project budget.

In this way, the reporting of costs is done in a more accurate and faster way and in the very early stages of the project. In comparison with the traditional approach, in BIM technology, reports related to cost estimates are updated many times during the stages of the project.

Of course, in Bim technology, the cost manager may enter the work process earlier and perform more repetitive tasks compared to the traditional approach. Of course, his role as a project cost manager is much more important and is visible throughout the project.

Six-dimensional model (project life cycle information)

For a long time, the construction industry has had a special focus on fixed and initial labor costs; But at the same time, a better understanding of asset costs during the project life cycle will lead to better decisions in terms of cost control. This approach is possible in the six-dimensional model of BIM.

Sometimes the six-dimensional model is referred to as the BIM technology integrated model (BIM) or iBIM. This model contains information to support the performance and management of the administration and maintenance of the building so that work results can be achieved in a better way. This data may include information about a component's manufacturer, date of installation, maintenance conditions, details of how the component designed and operated for optimal performance, energy efficiency along with its lifespan and expiration date, ...

Adding such details to the information model enables management to make different decisions during the design process. For example, with an economic and practical justification, a boiler with a lifespan of 10 years can be replaced by its 5-year model.

That is, designers can examine the full scope of fundamental changes during the life cycle of assets and understand its effects, which include changes in project costs. When such information reaches the end user during project delivery, it will be invaluable.

This comprehensive information model provides an easy and understandable way to estimate information. Interestingly, with the use of BIM technology, those details that were hidden in paper files can now be presented and checked graphically.

This approach reaches its optimal level when the building administration and maintenance managers are able to plan the building administration and maintenance activities in advance. Thus, the history of asset costs is carried out years earlier than construction and is developed throughout the life of the structure.

In the six-dimensional model, it is possible to calculate when the repairs are uneconomic or when the existing systems are inefficient.

This planned and proactive approach offers outstanding benefits, of which cost management is only one part. The ideal information model should be updated and developed during different stages. A lot of useful data can be loaded into the information model to benefit from a more favorable decision making process.

Check the BIM score in the world

Before the huge evolution of the BIM method in the construction industry, this category only summarized in ordinary components, to the extent that each member of the project team had to perform their duties individually and individually.

After that, with the emergence of complexities in the projects, there is a need to review the tender contracts based on the plans; to the point where only the profit and privilege of the contractors and builders is the priority of the project.

But today, the contracts should be implemented based on the proposed plans and according to them. The two topics of culture and construction information transfers between members of this industry made them think more about reducing costs and waste in the building. The waste generated in the United States alone in 2007 and estimated at 500 billion dollars. So, if we want to do our duties properly in this regard, we must ask ourselves this question: "Why should buyers pay for our mistakes?"

The point of BIM is to create a digital model of the project before putting it into operation. This functionality allows curators to easily design and analyze. They should also be able to prioritize, research and investigate the entire project, its surrounding environment and all the factors affecting it before starting the construction work and be diligent in fixing its defects.

This function has become an important reality today. Today, the use of BIM software and mobile applications in transferring project information has reduced construction errors, and we rarely reach a point where we consider an operation infeasible or impossible, or if there is a problem, we cannot solve it by using technology.

Now we have reached a point where we have become aware of the importance of using a digital model to reduce errors and we know that by making it operational by team members, we will increase creativity and innovation in the modeling process and fix the errors in the project. For example, subcontractors who have the ability to enter into the micro-activities of the project at the very early stages of the work can improve their skills by accessing the valuable information they receive from the project. This information includes the time of arrival and direction of materials, the number of construction workers, the methods of placing elements and prefabs that are extracted from the simulated model.

Also, when the construction manager of a project can enter and cooperate with the architects in the early stages of the design work, he can give advice to the designers and give them effective help in the design according to the demands that are important to the final customers of the project. . He also obtained the necessary information from the design groups to prepare the construction stages of the project. Gathering information makes the members of the design and construction team work together easily to achieve the main and intended goals of the project; that is, instead of separating each department and not having access to the information of both departments, to complete the construction process, they can make full use of group cooperation and coordination with today's new methods and using new technologies.

These collaborations make it easier for team members to access and focus on what they are doing, and precisely explain the performance and impact and acceleration of BIM in this field. Also, the information gathering is moving forward, focusing more on the individual and group needs of the members, on how to use the complete models provided by the design department, so that we can deal with the errors in the project less.

BIM is evolving gradually. The construction industry is also observing these changes in 3D modeling methods and accurate visualization using BIM tools. The work that solves the

problems, sets the priorities, raises and estimates more accurately, and is more successful in setting up and implementing building elements.

Implementation of BIM model in construction and industrial projects

The implementation phases of a construction project can be categorized as follows:

Zero phase (explanatory plan): recognizing the need, specifying the goals, carrying out the location of the project, as well as technical, economic, social and environmental explanatory studies.

Phase one (preliminary design): selection of consultants, technical surveys (geno-fan and topography studies) and preparation of preliminary maps.

Phase two (detailed design): preparation of drawings, preparation of tender documents, selection of contractor and monitoring device.

Phase three (execution of the contract): project implementation and construction operations.

Phase four (Operation): Stopping operational operations, delivery and maintenance of the project.

zero phase

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It is possible to have time-dependent information for a specific element, including information about the time of the activity, the time frame of its construction, the time frame of its installation, the time required for operation, the time required to check the strength, the time required for repair and improvement, the sequence of installation of various elements and the time dependencies to other parts of the project.

Scheduling managers will be able to accurately develop the project schedule through the time information shared with the information model. Also, by adding information to the components of the model in the graphic display environment, it becomes easy and attractive to understand the project information and check it. As a result, it is possible to show how buildings are constructed and it is possible to show in advance how the building will look at each stage of construction.

It is very beneficial to use this method to plan and make sure that the overall project is done in a real, logical and efficient way. In this way, asset management can be started in the initial plan and even before equipping the workshop. In this way, in the very early stages of the work, feedback is specified and unnecessary and costly rework and designs are avoided in the workshop. Also, when working with all the stakeholders of the project, the visual display of how the projects are built creates a better feeling and leads to a better justification of all the executive factors of the work, and further leads to a reduction in the project completion time.

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This information enables managers to easily predict the values associated with a desired element in the project. Next, managers can apply the approximate price of different components in the model and calculate the total construction cost.

The benefits of accessing costs through BIM include the ability to easily view costs by selecting components in the 3D model, being aware of changes made, and automatically calculating the cost of project-related components.

Of course, it's not just managers who benefit from seeing costs as part of the BIM process. Assuming the existence of the 4D model program data and a clear understanding of the project's validity, it is possible to easily track the projected and actual costs of the project throughout its duration.

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Of course, the accuracy in calculating costs depends on the data provided by different teams and shared in the common data platform. If the input information is not accurate, it is natural that the calculations based on it will not be accurate.

In this field, there is no difference between traditional methods and BIM technology. The reason for that is the central role of people who evaluate and estimate these values. These people not only play a role in verifying the accuracy of information, but also in detecting and correcting contradictions in received information.

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This information enables managers to easily predict the values associated with a desired element in the project. Next, managers can apply the approximate price of different components in the model and calculate the total construction cost.

The benefits of accessing costs through BIM include the ability to easily view costs by selecting components in the 3D model, being aware of changes made, and automatically calculating the cost of project-related components.

Of course, it's not just managers who benefit from seeing costs as part of the BIM process. Assuming the existence of the 4D model program data and a clear understanding of the project's validity, it is possible to easily track the projected and actual costs of the project throughout its duration.

This made it possible to provide a regular report of expenses and budget allocation to ensure that the desired work efficiency is achieved and the project will be carried out according to the allocated budget.

Of course, the accuracy in calculating costs depends on the data provided by different teams and shared in the common data platform. If the input information is not accurate, it is natural that the calculations based on it will not be accurate.

In this field, there is no difference between traditional methods and BIM technology. The reason for that is the central role of people who evaluate and estimate these values. These people not only play a role in verifying the accuracy of information, but also in detecting and correcting contradictions in received information.

It should be noted that many project components are still modeled in 2D or not modeled at all. There are probably differences between the models in how cases are classified, and managers should notice unusual cases and take them into consideration so that they do not make mistakes in their estimation of work.

Probably, a comprehensive information model includes three types of quantities. First, the quantities that are based on the real components of the model and can be seen along with its details. These quantities are fully visible and can be examined through models.

The second type are quantities such as formatting levels that may derive from model components that are not always visible. The third type are quantities that cannot be modeled from scratch and can include, for example, temporary works, construction seams, or other similar items.

These quantities can only be modeled in the construction phase and then graphically shown in the design model. A manager who specializes in project cost estimation should also have sufficient skills in determining the quantities that cannot be estimated based on the components of the model.

One of the advantages of cost estimation from an information model is that the data can be checked in any different time frame or throughout the entire length of the project. It is also possible to regularly update the information that plays a role in providing expense reports. Since cost estimation managers are involved from the start of the project, they will help the work team in planning the "real" costs and calculating the project budget.

In this way, the reporting of costs is done in a more accurate and faster way and in the very early stages of the project. In comparison with the traditional approach, in BIM technology, reports related to cost estimates are updated many times during the stages of the project.

Of course, in Bim technology, the cost manager may enter the work process earlier and perform more repetitive tasks compared to the traditional approach. Of course, his role as a project cost manager is much more important and is visible throughout the project.

Six-dimensional model (project life cycle information)

For a long time, the construction industry has had a special focus on fixed and initial labor costs; But at the same time, a better understanding of asset costs during the project life cycle will lead to better decisions in terms of cost control. This approach is possible in the six-dimensional model of BIM.

Sometimes the six-dimensional model is referred to as the BIM technology integrated model (BIM) or iBIM. This model contains information to support the performance and management of the administration and maintenance of the building so that work results can be achieved in a better way. This data may include information about the manufacturer of a component, date of installation, maintenance conditions, details of how the component designed and operated for optimal efficiency, energy efficiency along with its lifespan and expiration date,.....

This comprehensive information model provides an easy and understandable way to estimate information. Interestingly, with the use of BIM technology, those details that were hidden in paper files can now be presented and checked graphically.

This approach reaches its optimal level when the building administration and maintenance managers are able to plan the building administration and maintenance activities in advance. Thus, the history of asset costs is carried out years earlier than construction and is developed throughout the life of the structure.

In the six-dimensional model, it is possible to calculate when the repairs are uneconomic or when the existing systems are inefficient.

This planned and proactive approach offers outstanding benefits, of which cost management is only one part. The ideal information model should be updated and developed during different stages. A lot of useful data can be loaded into the information model to benefit from a more favorable decision making process.

Implementation of BIM model in construction and industrial projects

The implementation phases of a construction project can be categorized as follows:

Zero phase (explanatory plan): recognizing the need, specifying the goals, carrying out the location of the project, as well as technical, economic, social and environmental explanatory studies.

Adding such details to the information model enables management to make different decisions during the design process. For example, with an economic and practical justification, a boiler with a lifespan of 10 years can be replaced by its 5-year model. That is, designers can examine the full range of fundamental changes during the life cycle of assets and understand its effects, which include changes in project costs. When such information reaches the end user during project delivery, it will be invaluable.

BIM model during project execution

At this stage of BIM building information modeling, it is necessary to monitor the progress of the project and control the consumption of resources based on the construction activities.

The output of this step can be solving implementation problems to achieve the rates set in the BIM model or updating and modifying the built model to continue the project as well as future projects.

Among the functions of the BIM model at this stage, we can mention the project procurement and completion of the warehouse capacity of construction workshops to prevent implementation interruptions.

Project safety management is one of the branches that has received the attention of researchers in the field of building information modeling at this stage.

Because research shows that even very experienced project managers and workshop supervisors are not able to recognize safety risks in the workshop in many cases.

Modeling building information by automatically controlling safety regulations and matching it with the progress of the project reduces the safety risks of the workshop.

For example, the BIM model can determine which roofs have been concreted based on the progress of the project.

A safety fence should be drawn around it, or the concrete of which roofs has reached a suitable grip and the jack of its sub-forms can be opened.

BIM in the world

BIM is now widely used in countries such as the United States, England, France, Germany, Finland, Denmark, Australia, Malaysia, and Singapore. Also, at the international level, it has increasingly attracted the attention of construction industries that are involved with MEC, as well as owners and operators of construction projects. The effort to create a BIM standard in the United States, Europe and other regions of the world is based on the assumption that digital information can be shared, interoperable among the information systems of different stakeholders and based on open standards and definable in a contractual language.

AIA[1] product manager Dennis Neely believes that: Owners need to start standardizing their BIM projects as soon as possible. They should provide the necessary objects that they use in their design. They should be consistent throughout the project. Standardization of spatial designs, assembly and objects and all data related to the project is essential. The Spaces section shows how an owner can create complete models of spaces filled with the necessary equipment and supplies, including services such as electricity and communications. During construction, the bim project must be synchronized and updated with changes and substitutions. These measures ensure the downstream value of using BIM projects. These BIM projects can be integrated

1 American Institute of Architects

with companies' GIS[1] systems. The faster owners integrate with BIM projects, the faster they will see incredible savings.

It should be noted that the application of global BIM standards will require the necessity of business perspectives to exchange information between AEC and the project owner. Current standards will be built upon standards that are in use.

England

Many companies in the UK continue to resist using BIM, in part because of the changes in culture that make it necessary. However, this is starting to change and the UK government is planning to make it mandatory for all public projects. They believe that this new technology will facilitate improved working methods that will reduce costs and add long-term value to the development and management of public sector structures. To help create BI in public projects, a working group headed by Mark Bio has been formed to draw a roadmap and its implementation phase within 5 years. It should be known that BIM is not a complete technology in the UK and the level required for them in projects will reflect the capabilities of an industry. However, if the plan is to succeed, the UK manufacturing industry needs to navigate a steep learning curve. A successful example is the implementation of BI at Heathrow Terminal 5, where its use reduced project costs by £210 million.

We are now seeing an amazing outpouring of support for new ways of working as industry challenges intensify in the UK. In this way, the AEC industry in the UK is stimulated to make a significant move towards applying BIM in their projects. One of the main drivers of the AEC industry towards the use of BIM has been the need to accelerate productivity. Autodesk CEO Pat Baxter says: BIM workflows have been shown to create major efficiencies by eliminating inaccuracies, waste, and interference while maintaining transparency and accountability. Not surprisingly, new business challenges have tipped the balance in favor of BIM.

In the UK, the Construction Project Information Committee (CPIC) is responsible for providing best practice guidance on the content, format, preparation of construction information and ensuring that this best practice is disseminated through the UK construction industry. Consisting of representatives from many of the UK's major industry bodies, CPIC has provided a definition of BIM for adoption in the UK construction industry and has also invited all sectors of the UK industry to discuss the issue to reach an agreed starting point. One of the main obstacles in adopting a good work method that can significantly improve the quality and sustainability of products

1 Geographic Information System

delivered from the design and construction team to the owners is the lack of clear definition of terms that add to the proliferation of interpretations that exist.

In fact, the UK government explicitly stated that all projects must be BIM level 2 compatible by 2016, in order to save on re-modeling of objects, which is done several times even during a project by different design teams.

The main goals of the working group are:

Identify how measurable benefits can be transferred to the construction industry through increased use of BIM

Recognizing the UK Government's needs as an owner to encourage wider adoption of BIM

A review of international BIM adoption including federal government solutions

A review of government BIM policies to help the UK maintain and develop its position in international markets

The main recommendations are:

Leaving complexity and competition in the supply chain

Specific behavior with people and supply chain partners

Measurement and active use of outputs

Provide appropriate support infrastructure

Taking progressive steps

Having a clear goal for the construction industry

This report also defined BIM project evolution levels from level zero to level 3. In summary, we can say:

Level zero is when they are adapted for CAD tools only.

Level 1 is when 3D and 3D information is applied to defined standards.

Level 2 is when BIM software is used in collaboration with a fully integrated model.

Level 3 is when BIM models are used for building/project life cycle management.

The main goals of the UK government in this report are:

20% reduction in costs

BIM level 2 by 2016

COBie information must be available to make decisions at critical times in the design and manufacturing process.

COBie[1] Information is a formal schema that helps design teams organize architectural BIM object information. This information is naturally shared with other people involved in project facility management.

Also with BIMForum initiatives, there is now a lot of interest in the Level of Development (LoD[2]) BIM object model. In this way, the owner can get a clear picture of the quality of BIM delivery that he expects.

In general, these levels include:

LoD 100 – Graphical representation of objects mainly used for calculating costs.

LoD 200 – A generic object with approximate dimensions, shape and position

LoD 300 – Design of specific objects with all specifications, sizes, shapes and positions

LoD 350 – Realistic object model with all specifications, size, shape and position

LoD 400 – Similar to LoD 350, plus all relevant project information including rebar and accessories for concrete members and all connections for steel members

LoD 500 – Similar to LoD 400, includes approved reports, test certificates and CE marking information

The difference between a 3D model and a 3D BIM model

After the above discussion, the issue of Building Information Model (not Modeling) is raised, which is actually a three-dimensional beam model; But what is the difference between a 3D model and a 3D beam model? And why are different software provided for each of these two?

Beam 3D model is actually a smart combination of equipment and related information. A combination of 3D shapes and their related data; and this is the main difference between 3D Model and 3D BIM Model, and there are few software that can create intelligent models.

3D BIM Model

1 Construction Operations Building Information Exchange
2 Level of Detail

BIM Management:

Regarding the third M, we said that it means the word Management. Management is a new term in the construction industry; But every other industry has also understood how important it is to use a manager to ensure the work process without disrupting the development of the project. This role is the responsibility of one person to ensure the cooperation of people on the project without interfering with each other's work.

Summary of the BIM term:

Therefore, to say that we use BIM technology, we need to work with all three terms Modeling, Model and Management. If we don't have a three-dimensional model, we can't raise the issue of fear in any way. Also, if we cannot share this 3D model, we have not been able to use BIM; and if this work is not done under the supervision of a BIM Manager, we still have not been able to use BIM; and this is the true definition of BIM.

Examining different levels of BIM (Levels of BIM)

Maybe you have already heard the term Levels of BIM, and you may be wondering what it means? Each of these levels actually shows the maturity of fear. They are categorized from level 0 to level 3, considering whether the data and information are exchangeable or not.

Different levels of fear

BIM Level 0

Level zero (BIM Level 0) is simply the use of CAD or Computer Aided Design. Most of the drawings are 2D and 3D shapes that are drawn with lines called Vector Line (like very old versions of AutoCAD). In a word, it can be said that this level is not BIM at all, but it is a great improvement compared to manual drawings.

Level one (BIM Level 1)

But at the level of a beam (BIM Level 1) you start using tools that allow you to create a 3D model of the beam and intelligent; It means entering information into 2D and 3D drawings; But at this level, you keep this information to yourself and finally you can share a PDF file or a CAD file.

For example, it can be said that the use of vision software is part of this category. To start this level, you can use the product visualization software training package of the Civil Fan site and take a big step in this level.

BIM Level 2

But what about level two? This is where sharing and teamwork come into play. Integrating the work of different people in a shared online environment, which is the Common Data Environment.

where the execution plan is a work guide and is supervised by the BIM manager; But what is the next step? What could be more mature and perfect than iconic models?

BIM Level 3

Level three is an integrated process that is completely hosted and implemented in the CDE environment and also depicts all team members live (Real Time) and at the same time; But today, most of the construction industry is focused on level two. There are still many questions about whether level three is applicable in different areas such as technology, contractual responsibilities and whether it is applicable in different systems.

A number of different associations, such as the buildingSMART alliance, governments and industry representatives, are working to further standardize BIM and make it usable in technology.

Sample standardized format:

For example, the IFC format, which is the Industry Foundation Classes (a type of format for BIM project files), is provided by buildingSMART alliance and approved in all countries, and is the international standard format. IFC has been under development since the mid-1990s, and its purpose to make the BIM file executable in different software.

Today, this format is not editable, but it is used for BIM data exchange. So the IFC cannot be edited and will not be saved, but hopefully it will be updated.

So you don't need to worry about level three. Focus on level two. Level 3 will be a formality for you once you are familiar with group work in BIM as well as its modeling.

Examining different dimensions of BIM (BIM Dimensions):

The different dimensions of BIM refer to the different ways in which certain data are linked to the BIM model. By adding more dimensions, you will have a better and deeper view of your project. How it will be implemented, how much it will cost and how it will be maintained.

The dimensions we are talking about start from the 2D dimension and reach the 7D dimension.

BIM Dimensions, delivery and delivery, time, cost, life cycle, servicing

Two-dimensional model in BIM (2D BIM):

You may be surprised to see the name 2D. Because we have said so far that our model is in 3D; But this two-dimensional is different from other two-dimensional. The 2D we are considering is 2D BIM, which is different from 2D CAD. In 2D BIM, all plans, views and sections are taken from a 3D BIM model. While in 2D CAD, you make separate drawings for each of the above cases, which, of course, is not optimal at all.

Many companies do their work in CAD (software other than BIM software) and then start creating BIM models with it. They basically pay for the re-modelling; Of course, this issue itself may sometimes cause conflicting information. BIM not only helps us to be efficient in our work, but also makes us trust the information much more.

3D model in BIM (3D BIM):

The next dimension is 3D, but this word means 3D BIM, which is different from other 3D; And that is that our 3D model comes with the information stored in the model. As the project grows through its life cycle, this information will become richer and more detailed. This helps us to share information through the BIM process. 3D BIM visualization capabilities help to avoid interference between different architectural, structural, mechanical, electrical, and plumbing disciplines; such as a duct that interferes with a structural member.

The fourth dimension in BIM modeling (4D BIM):

A step further is the 4D dimension or time. This dimension can be used both in the form of information and in the form of images to show the stages of the project through a management software. Software such as Synchro 4D and Navisworks can be mentioned as prominent software of this dimension.

The fifth dimension in BIM modeling (5D BIM):

After the fourth dimension, we reach the fifth dimension or 5D, which is related to project costs. This dimension helps the stakeholders to follow the project budget and costs and analyze them during the construction of the project and during the project life cycle. These costs include the initial costs for setting up the project as well as current costs such as employee salaries, energy consumption costs, renovation costs and even replacement costs.

The sixth dimension in BIM modeling (6D BIM):

The sixth dimension of 6D is energy consumption analysis and is closely related to the term green buildings. If this issue is considered in the early stages of design, it will make the estimation of energy consumption more accurate and complete, as well as the ability to manage energy while living in the building, and this will make better facilities and equipment be used in the building.

The seventh dimension in BIM modeling (7D BIM):

Finally, the seventh and last dimension or 7D is related to the management of building facilities in the life cycle of a building. This feature is a tool for building management and this is where all owners want to be effective and efficient.

All the dimensions we introduced define the purpose and use of BIM. It is very important to determine which dimensions we intend to use before starting the project; And this determines the level of detail in the beam model. Of course, there is no need to remind that 2D and 3D dimensions are not optional, but necessary. Your model must be 3D BIM in order to use the BIM process.

How did BIM revolutionize the construction and urban development industry?

Review of the most software used by companies in the construction process:

As we can see from the Contech survey in 2017, shown in the figure below, after accounting and project management software, software related to BIM has taken the third place in the most used software related to the construction industry in 2017.

How do companies implement BIM in the construction and urban planning industry?

In the past year, companies have shown a shift from BIM staff to more comprehensive virtual design and construction teams with learning processes, optimizing employee performance and improving workflows. Contec's survey in 2017 has been associated with worrying results regarding the changes of VDC or Virtual Design and Construction.

Does your company have a BIM unit?

27% of respondents stated that their company has a separate BIM/VDC department. More interestingly, 28% reported that their company does not provide bids using BIM. Another concern is that 25% of respondents reported that only one or two members were trained to work on BIM projects. Without BIM as a priority or primary responsibility. Similar to this for IT departments, it appears that when companies lose more than $20 million in sales, they consider a specialized VDC department. There are a number of resources for outsourcing BIM projects. However, the same goes for BIM training on existing technologies, training and implementation for companies that have the ability to use BIM locally to do more work. If builders consider BIM as a priority, they will not be able to meet BIM standards such as those implemented in the UK and then implemented in the US. These standards will be released more quickly and the standards ready for acceptance will lead to success. America lacks the pool of experienced BIM workforce to meet the inevitable demands of the future.

Opinions of survey participants: Anyone can work with BIM. This unit is not considered as a special unit, but it is a part of people's job. We only hire or train people with BIM skills.

How do companies maximize their VDC?

Virtual design and construction

Companies feel more confident about their ability to maximize VDC in 2017. The highest percentage of respondents expressed the highest amount of confidence in their company's ability to maximize VDC, while the lowest percentage had little confidence. Although approximately 30% of companies are looking to choose BIM projects, companies that use BIM are more confident in their ability to maximize the output of BIM workflows.

How do companies use VDC?

Few changes have been observed in the way respondents use VDC/BIM over the past year. Clash organization/diagnosis is on p in the answers, so project planning and visualization have experienced little change from last year. The pre-construction process and virtual test model are in the top five for VDC, which can improve quality and safety in construction projects and show that builders can use BIM in construction workflows to save significant time and create value. Finally, BIM seeks to diagnose the problems of solutions digitally before the start of the project in order to avoid physical problems during work.

What software and programs are empowering your BIM workflows?

Regarding the examination of the programs and software used in virtual design and construction, the respondents mostly mentioned Autodesk programs. The first three choices belong to Autodesk tools, each of which accounted for more than 15% of the responses.

SketchUp is the first program that is not offered by Autodesk and is among the first ranks. However, with less than 9% of respondents voting to use SketchUp, Trimble seems to have a long way to go to compete with a powerhouse like Autodesk.

Who holds the top spot for VDC projects?

General contractors are still on the brink of using BIM/VDC on projects. After them, there are architects and mechanical contractors with approximately 17%. We anticipate that mechanical contractors can rank higher in the future, as they often make or break a project based on early collision detection. What are the biggest challenges facing BIM? Respondents to the 2017 Contec survey expressed common issues of lack of skilled VDC workforce, lack of financial investment in BIM workflows, and unreasonable time constraints on organization. Previous sections of the survey have presented this issue as a lack of communication between VDC departments, current knowledge of BIM software and existing attitudes towards VDC as a low priority item.

A review of the written comments (discussed below) highlights these issues as well as other important points such as separate processes and changing regional demand. If manufacturers need to invest time and money in their VDC resources, they need to see other demands or resources relative to their higher priority needs. Builders are better able to monitor the BIM trend regionally and adapt VDC strategies according to the increasing demand of employers to use BIM. The value of implementing BIM is immeasurable compared to the risks involved in trying to provide physical solutions during the construction process. Is the construction industry ready for urban information modeling? What is CIM?

Construction/Civil Information Modeling, in general, city information modeling includes the construction of a three-dimensional model of the city, which includes BIM and other contextual data sources or analysis tools for various city components includes Buildings, roads and public spaces (open data), traffic lights (sensors) and even people on the street (social media) are connected.

The role of CIM

CIM is certainly useful for architects and planners dealing with individual buildings, campuses and city planning projects of any scale. By connecting BIM to CIM, users will be able to use an interactive 3D city modeling environment where data and analysis can be accessed or shared from anywhere in the world. CIM enables architects and planners to collaborate and work on a set of 3D models. This feature, in turn, creates an interactive project that enables collaboration between all involved people at any moment. CIM can be used effectively by planning and sharing project information as architects and engineers collaborate. CIM can be applied to any project of any scale, as small as an individual building or as large as a city. How can the integration of BIM and CIM help city management? Construction workshops are a source of noise and dust and also cause many traffic problems in the city. By providing proper construction site documents and documents, the city council can plan and make informed decisions for constructions in a way that ensures the functioning of the city without any problems. The same applies to the demolition or renovation of old buildings in the city. Data extracted from BIM enables cities to cope with issues such as population growth and rapid urbanization. Buildings are both energy providers and consumers.

With the help of BIM, users can access data related to the main energy requirements of the building in the future and use the information to adjust energy management according to the surrounding environment. In the future, it is possible to plan the national energy network in cities, areas around buildings, buildings and residential houses. In small or densely populated cities, BIM becomes a vital necessity for greater organization and more effective development planning. For example, in Singapore, employers and contractors must provide building-related data to the municipal server. CIM in Construction Autodesk and Bentley, the two leading software companies in BIM, have expanded their technology towards CIM. Products such as Revit and InfraWorks from Autodesk can support the modeling of smart cities.

In this regard, case studies have been conducted in Copenhagen, Barcelona, and Korea University. Likewise, Bentley has used this technology to model large cities such as Montreal, Helsinki and Singapore. With the advancement of technology, its use by users is considered the key to success, in this regard, project owners will play an important role. They need models that can capture all the city-related applications and infrastructure aspects of a building. It is then that architects, planners, engineers and construction companies are under pressure to innovate more to meet wider and more complex needs. Since smart cities require smart infrastructure, BIM not only revolutionizes the planning and construction of buildings, but will become an important factor in the entire city planning process in the future.

At present, people's awareness of CIM is expanding. CIM can be used in various industries. Obviously, those who do not accept this technology will lose their place in the global construction market in the future. CIM improves results at a lower cost, which is what will revolutionize traditional methods in the industry.

Chapter two

BIM and project management

According to the definition of Project Management Institute, a project is a set of temporary activities to fulfill an obligation and create a specific product or service. Before the project is implemented, the scope, time, resources and cost should be predicted and planned as far as possible. The process of preparation and correct implementation of the project plan and related considerations is called project management. A project plan outlines the specific goals and schedule of a project and also classifies the various activities required to achieve the goals. Project planning is an important part of ensuring that a project is completed correctly, on time, and within budget. In the following section, some of the most important applications of BIM in Iran in improving the management processes of construction projects are mentioned:

Illustration

The first use of BIM by different groups in construction workshops is to see the expected outputs and understand better and earlier than what the plan expects to build. Visualization can also be used as a basic lever to see the sequence of activities related to the construction of the structure, temporary components of the workshop and other phases of the project.

Ability to build

Constructability process is defined as the optimal use of knowledge and experience in planning, design, procurement and organization to achieve the overall goals of the project. During the process of building information modeling and 4D pre-construction planning, which can be used in complex stages of projects and construction workshops, specialists often add great value to the project in terms of constructability by providing knowledge and experience of their specialized fields to each other. For example, during the exchange of information, experts may come to the conclusion that in-situ concreting is a more suitable option than ready-mixed concrete or that steel is a more optimal choice for the project in question. In order to control the cost and capability of building the design by BIM Iran, the architect and the construction manager evaluate how to create the construction documents. This process means reaching an integrated project delivery system that shares the risks and benefits of the project with the project stakeholders. In fact, this coordination of information can save projects.

Cooperation

Collaboration and coordination in the project ensures that the information created at different stages of the project will be integrated and continuous. Many commentators have pointed out that BIM is not just a technology but a process that requires the use of existing technology and the cooperation of users, builders, designers and owners to get the most out of BIM. Visualization and manufacturability require a collaborative approach and early involvement of stakeholders to function properly; therefore, if the collaborative approach is included in the contracts and agreements between the groups involved in the project, the integrated delivery of the project will be done well and building information modeling can be controlled by lean manufacturing methods. The use of these methods and organized processes have a significant effect on saving and increasing the productivity of the project.

Interference detection

By discovering the interference, the building information models of different design groups are brought together and the inconsistencies of the geometric designs are controlled. Interfering points in the models are identified and can then be corrected. In addition, visual errors that lead to poor quality in terms of architectural aesthetics can be identified and corrected. Interference detection is one of the common applications of BIM in Iran, which is very valuable during revision by eliminating many problems and saving time and money. Interferences in the models are divided into three groups: hard interference, soft interference and work flow interference or 4D, a hard interference occurs when two objects occupy the same space and place. For example, the installation channel passing through the roof composite beams shown in Figure 4. Soft interference refers to the amount of space allowed; For example, potential hazard prevention zones remain between components to provide space for future maintenance. 4D interference or work flow interference refers to interferences in staff scheduling, equipment manufacturing interferences or materials transportation interferences, and other schedule interferences.

Estimation of 5-dimensional values

With cost estimation, which is sometimes called the fifth dimension of BIM, the objects in a three-dimensional plan are connected to the price list and the type of materials. Price lists are mostly based on the unit volume of materials and materials, but for more detailed estimates, they can include labor and equipment prices. This enables accurate cost estimation at any point in the design phase and creates comprehensible financial information for design decisions. Materials and construction methods can be evaluated economically. BIM modeling can instantly estimate and plan values before the surveyor has to spend time measuring values from 2D maps.

Estimators are aware that BIM reduces their workload, but often the necessary conditions must be provided to use this capability, and other parts of the project services are upgraded and generate the necessary information.

Project progress follow-up

In most cases, 4D planning is simply prepared by connecting the activities of a Gantt chart to specific components of Iran's BIM. The project schedule that is made in project control software such as MS Project. On the one hand, modeling the 3D components of the building with software such as Revit, on the other hand, can prepare the preparations for the work. After that, software such as Navisworks is used to connect the schedule to the corresponding components of the activities, which finally displays the 4D planning. Although it is possible to define the amount of cost and the amount of work done against the corresponding quantities in the BIM model; Therefore, when a quantity in the model changes, the amount of work, time and cost will also change. This can significantly reduce the time spent on estimating and rescheduling and allows for Earned Value analysis.

Integrated project delivery

The traditional construction process is very inconsistent and often associated with disputes between the parties involved in the project, because the involved parties have different goals for themselves. Alignment is the process by which the project group or project stakeholders come together to achieve common goals. The building information modeling process plays an effective role in integrating the goals. In construction, the goal is to prepare and supply a building for customers that meets their needs at the lowest cost, in the shortest time and with the highest quality. This is why the IPD (Integrated Project Delivery) or alignment approach is so attractive in the construction industry. The earlier the discussion and exchange of opinions of the main experts of the project is before the construction stage, the less risk and danger will arise. The integrated project delivery process allows all parties to share in the profits and losses.

Basic concepts and principles in BIM

Let's start with the basics of what BIM means and what its components are. Now this is where it gets tough. There are three abbreviations in the naming:

Building Information Modeling
Building information model
Building information management

Each of the above names consists of three parts:

"Building" in BIM technology

BIM technology covers the entire AEC (architecture, engineering, construction) industry and therefore:

Building construction (residential buildings, public buildings, airports, hospitals,

.....) infrastructure (roads, railways) engineering facilities (bridges, tunnels, power plants, but also offshore facilities or power grids)

Interior designers, building material manufacturers and facility managers also use BIM technology.

Each of these industries has its own characteristics and challenges. It also often uses different software to design or manage a model. There are also different levels of progress in the implementation of BIM technology - in general, cubic construction is the most advanced, there are also engineering structures, and most of the challenges come from road engineering (which is mainly due to constraints).

"Information" in BIM technology

Information is the most important part of the acronym. The advantage of BIM technology lies in the possibility of its organization, ease of searching and clarity of reading of different parts connected to elements.

The higher the investment, the more information will be generated during the project. The traditional model of collecting and exchanging information (email, PDF file, drawing) leads to information chaos. Missing or duplicating incorrect information is a common occurrence. Often the situation at the construction site can be compared to the proverbial dead ringer. The electrical subcontractor needs more information about the project. As a general contractor, we contact the designer. An off-duty designer sends us a document, responds by phone or email. We figure it out our way (after all, we're not electrical designers) and we feed the information back to the subcontractor who figures it out his way and so does the work on site.

Graphical data

These are 3D models, characters and symbols created by designers, a virtual reflection of the built object (so-called Digital Twin) consisting of an architectural body, structure, ventilation, ... It is usually a separate model for each of the threads, which are then combined for coordination purposes in appropriate programs (e.g. Solibri).

The 3D model serves primarily as a placeholder that provides context and relationships between objects containing information. By presenting the information in 3D we can more easily navigate to specific locations in the building (for example, the intersection of sanitary facilities with ventilation) and investigate collisions. Elements are defined in space and belong to a particular system. For example: by looking at a column in a model, we can see its exact location, in which room and its relationship with other objects (beams, ceiling). In addition, that column carries non-graphical information - by clicking on it we may read various information assigned by participants in the investment process.

Importantly, we do not model all information. Many BIM professionals are lost because of too detailed modeling. They lost tens of hours of work by choosing the type of door handles or placing trash cans and carpets in the rooms. The level of development specifies how much and what graphic information should be included in the model at a given stage of development.

Information can be assigned directly to elements of a graphics program (eg ArchiCAD, Revit) by editing its properties or adding new properties. It is also possible to use databases that cooperate with the created model.

A designer can assign non-graphical information to both an object (e.g. a chair, a table), a building object (e.g. a ceiling) and a space (e.g. a room). Additionally, non-graphical information can be assigned to elements that are not physically modeled (such as door locks or wall tiles). Detailed information about the project (Level of Information – LOI) evolves as the project develops. In the conceptual phase, we describe a partition wall as a "non-load bearing 100mm partition wall". At the detailed design stage, this is a "100 mm thick partition wall, an aluminum angle bracket cc 60, 2x plasterboard, EI = 30". However, during the construction phase, we will add information about a specific manufacturer of materials, including price.

To access the information inside the model, you do not need to have an expensive specialized software license. Element data can be read from any free IFC Viewer available on the market (e.g. BIM Vision by Datacomp).

Here is a list of information that is commonly assigned to element properties:

Physical characteristics (fire resistance, soundproof class),
Manufacturer,
Supplier,
Cost,
Reference to manufacturer's documentation,
Durability (facility management phase, eg maintenance every 10 years).
Documentation

In this context, you may find static documents (e.g. PDF format) known more from the current investment process (cost estimates, specifications, schedules) and documents related to the BIM process, e.g. the client's BIM Implementation Plan (BEP). Information Requirements (EIR) In the past of CAD software, this is the most extensive set of information. With the growing presence of BIM technology, this technology is on the decline. The more advanced BIM is in a given project, the less documentation is required.

The most important problem with static documentation is data retrieval. Each document must be found, opened and reviewed. I bet most of us remember how much time we spent looking for various information.

It is not bad if these folders are on the hard disk. I remember exactly how I went through binders with documents at the construction site, because "I remember that there is such information in one of the technical descriptions ... but in which field?" Fortunately, nowadays we can assign more and more information to the model and view it directly in the software (eg cost estimate, schedule). Information is more complete, dynamic and easily recognizable. As a result, we need fewer and fewer documents to be stored on the hard disk.

Examples of the types of documents we collect in fixed formats:

Program,
Cost Estimation,
Contact information of companies and people involved in the project,
Product and material documentation,
Documents related to the management of construction equipment facilities
Shared data environment

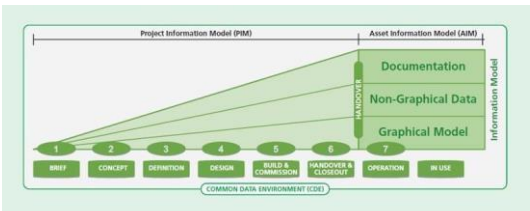
You know how we share the information created during the BIM process. Now I want to describe how to manage and where to store them.

Data storage and flow occurs in a common space called Common Data Environment, which includes all information related to the project. It can be server, cloud or extranet. Each project participant has access to the data they need to do their job.

In practice, as a CDE on projects, we apply shared disk space divided into folders with access settings, eg Viewpoint, Autodesk 360, Project Place, Interaxo, ...

By using a similar source of information for collaboration between project members, we avoid errors and inaccuracies in the flow of information. When an architect needs information about ventilation ducts, they simply open the sanitary model from disk and combine it with their architectural model. If you have any questions, you can mark an item on the model, write a comment, and send a dynamic screenshot to the recipient.

The general principle of working in CDE and the use of three types of information is shown in the diagram below from British Standard PAS 1192-2:



From the beginning of the investment process, information is divided into three types. Their amount will naturally increase with the progress of the project. This model is called the project information model, and it contains all the historical data created by designers, contractors, and suppliers during the development of the project. After delivery, the transition of the building to the operational phase, the information from the project is transferred as a data information model - the final, validated, "as-built" information that is then applied to the management of the building during its lifetime. Data not assigned to a model is simply a collection of random data.

"Model, modeling, management" in BIM technology

The letter M is usually translated as Model or Modelling. At the same time, the development of the acronym BIM as Building Information Management is becoming increasingly popular because information management is more critical to the entire process than modeling itself.

The model is considered as the focal point of the process, which contains all the information and where all the participants of the process work together. However, the model itself is only a graphical representation of the designed information. A graphical model can also be created in Sk.h Up - it's a simple visualization that doesn't contain any information. Since we model in software such as Revit or Archicad, we can enter not only geometric data but also other required information into the project.

BIM principles

A/E/C industry companies using Building Information Modeling (BIM) software are seeing benefits and a strong return on investment. BIM is more than a 3D model. It is an important tool for improving design and manufacturing - increasing efficiency and minimizing risk. Here are 5 principles of BIM that lead to better and more valuable projects for owners.

1. Visualization

BIM provides a 3D virtual model of a project that enables owners to visually understand how a building will be constructed. Instead of the traditional 2D designs used in the past, owners can better visualize the project and, as a result, provide better feedback on what they want. It also allows owners and all players involved to fully conceptualize the building before construction begins

2. Quantification

BIM software generates real-time values for any design changes the owner or architect wishes to make. It can also analyze data to detect cost overruns and wasting efforts. This results in a more efficient project that stays on budget and on schedule.

3. Communications

Cooperation and communication between all actors involved in a project is essential for using BIM. This allows each player to share and update information in real time

BIM also helps increase communication and understanding with potential stakeholders. High-quality digital mock-ups can be created to give potential stakeholders a clear picture of what the building will look like and how it will affect the surrounding area. With a better understanding of the project, stakeholders are more likely to buy in.

4. Coordination

One of the most valuable aspects of BIM is collision detection and resolution. With its advanced system integration, BIM is able to analyze information from multiple systems, such as mechanical, plumbing, and electrical systems, and identify if there is a potential conflict or problem. This is invaluable to the project team as it saves the cost of change orders later in the project which can be very costly. By being able to spot these issues before construction begins, it also keeps the project on schedule by preventing potential setbacks.

5. Simulation

BIM is capable of creating a 4D simulation of the construction schedule - allowing all players involved to gain a better understanding of the entire construction process visually. It also helps determine program logistics and preparation for the construction phase of the project.

These 5 BIM principles will transform the A/E/C industry in ways that increase project collaboration and efficiency. Using BIM software, Hourigan is able to deliver higher quality, lower risk work on time and on budget.

Important concepts in BIM

1. 2D (CAD)

A way to design and document in all stages completely 2D and it can be said that coordination has a very low level in these works and some people know it as BIM level 0 in

2. 3D (BIM)

Modeling the 3D elements in such a way that they have different information, or it can be said that the 3D BIM model is not just a 3D model to be used for display, but it has all the information needed to discuss the documentation of the project.

In this method, the model is used as an information source for creating various documents for making drawings and documentation, as well as the amounts of materials, ...

3. 4D (BIM)

A 3D BIM model that includes time information and includes the hierarchy of installing objects in reality, the time required for construction, prefabrication time, assembly time, and finally the complete execution and delivery of each element.

And all these works are possible with a healthy model and available information, and a 4D simulation can be obtained from the project.

4. 5D (BIM)

We call the 3D BIM model along with time information as well as cost information a 5D model, which can be used for various analyzes.

5. 6D (BIM)

A 3D BIM model with information that is the basis for the analysis of "project impact on the environment and people" is called a 6D model. Such information may be used to analyze the energy of that project or to calculate the "carbon effect of the project"...

6. 7D (BIM)

A 3D model developed along with the information needed for project management and operation is called a 7D model, and this model is usually used as the basis for FM (Facility Management) expert systems.

7. BCF-BIM Collaboration Format

A format created by the TEKLA team and the Solibri team to exchange information and people's opinions between different software, which after some time recognizing as a standard by the building SMART organization. This format is based on XML and RESTful API.

The main purpose of designing this format has been to specify views of the model along with related information, whether in interactions and errors related to elements. This format allows you to exchange people's opinions or issues between softwares, each issue in BCF format is dependent on an element in the model.

8. MVD – Model View Definition

It is a subgroup of IFC that allows you to extract part of the model information based on a series of criteria and specific information flow.

To support proper communication between BIM software, the construction industry created IFC, which can be output in different LODs at each stage of construction but MVD is here to extract the necessary information from the IFC file according to our own criteria, and not to ensure that all information is always safe in the output.

9. CDE – Common Data Environment

CDE is a central repository for information, which is the basis for BIM level 2 implementation, where the information sharing structure must be fully configured, CDE collects, manages, and then acts as a distributor for different project teams with different access levels. .

A CDE platform is usually hosted by a cloud server that is accessible to anyone but with different access levels.

CDE helps in the information cycle by using the automation items in it to speed up activities such as accepting or rejecting comments or sharing files.

10. EIR – Employer's Information Requirements

A document that explains the employer's requirements at the time of service request, these requirements can include things related to the LOD required for work, things related to training employees, management systems and information exchange format.

11. BEP - BIM Execution Plan construction information modeling execution plan

It is a critical document for the BIM process that is usually prepared by suppliers to meet the EIR. In this document, which includes roles and responsibilities, rights and rights, standards, methods and processes, important stages of the project, schedules and schedules, the strategy of information flows for converting and receiving documents, covering components and many other characteristics of the BIM process and it may even be included how to implement IT infrastructure for BIM.

12. BIM Protocol

This document is directly on the contractual relationship between the customer and the supplier, the insurance protocol includes legal conditions and additional rights regarding the relationship between the employer and the contractor.

This document specifies the role of people and members in this process, it also talks about LOD, and there is also the prioritization of the employer's needs,... in this document. An article will be published about this issue in the future.

13. IDM - Information Delivery Manual

It is a document whose purpose is to gather references in processes and information and also specifies the role of information exchange in the project. This document clearly specifies what information should be provided at what time of the project.

The purpose of idm is to deliver the necessary information on time so that activities can proceed properly and also to avoid receiving inappropriate information, which will result in the need for less activity.

IDM proceeds based on its Process Map, which fully explains who is involved in the project and how these processes are divided between members.

This document also suggests the required LOD of each stage of the project, it should be noted that this document applies to BIM level 2.

14. Process Map

This is a part of the IDM Information Delivery Manual, this document determines the activities of people in the project processes, and determines the role of each person in the process, the process map or Process Map also determines the LOD at each stage of the project.

15. COBie – Construction Operation Building Information Exchange
A documentation standard for collecting information to manage an object is in the form of a spreadsheet, the filling of cells in this table depends on the project stage the information in this form, including equipment operation information, as well as technical information and installation and use information, may also be present in this form in addition to this information, it contains information such as coordinates, price and warranty time, installation time, inspection time, ...

COBie specifications:

Communication at the level of users - the information recorded in the COBie standard has better accessibility and is also more comprehensible, even this information is comprehensible to all suppliers, stakeholders and investors.

Information recorded in the COBie standard can be easily imported into FM systems.

Communication at the consultant level - almost all BIM tools have the option of automatic COBie generation and output.

Extent-COBie is quite well connected to IFC

16. BIM Level 0 construction information modeling
The structure of the preparation of project documents and drawings is in the form of 2D code, and the documents and drawings are distributed either on paper or by email.

17. BIM Level 1 construction information modeling
The design documentation structure is usually a combination of 3D model (more for visual understanding) and 2D documentation that should ideally be distributed from CDE (Common Data Environment) channel and platform.

18. BIM Level 2 construction information modeling
The BIM maturity level model shows that in the meantime, all people cooperate with each other and not just one model is made by a few people, but models are made in every field of work, and these models are accessible to project members and also, the exchange of information should be in Open BIM standards and be done with formats such as IFC, COBie, which should be checked before starting all the software so that there is no problem in the exchange of information in the next steps.

At this level of maturity, the 3D model should be the center of information and the main source of work, and this model should include geometric and non-geometric information. Level 2 of LOD construction information modeling determines the amount of information and processes required at each stage and this information should be distributed through CDE (Common Data Environment).

19. The third level of construction information modeling - BIM Level 3

This bluff surface is a bit far from reach and it can be said that it will be the point of the BIM line this level of maturity shows the complete communication and cooperation of all people in all disciplines, and all people must work on a common and central model and all have access to it and edit it.

Four important stages of BIM implementation

As with any form of change management, implementing BIM requires great planning and preparation. Implementation of change must be phased and with proper planning and execution, let's look at the four key steps in implementing BIM.

Application of phases

Four phases of BIM implementation

Assessment
Preparation for transfer / pre-planning of the project
Implementation of design / design and construction
Operation and maintenance through experience and expertise

Assessment

Publish the plan and objective of implementing Building Information Modeling in your organization as part of an internal evaluation process. The following steps are some of the best practices that will help you in the early stages of BIM implementation.

BIM Ready Assessment **-** Assess your team's capability in terms of technology and processes

Feedback – Hold feedback sessions with the internal team on technology adoption, processes and workflows

Due diligence – evaluate legal contracts and deliverables expected from each party

Management buy-in **-** Ensure that upper management fully supports the decision to adopt BIM in the organization.

Transfer Preparation/Planning

Prior to the project, initial project planning is critical to a successful transition to BIM. Standardization in the technology process and trained people are critical to the success of the technology implementation.

Standardization: Establishing provisions for uniform standards for software implementation ensures that a process flow is established for exchanging information, archiving and updating data in real-time so that no important information is lost.

Training: The internal team needs to be equipped with the new software, so plan for multiple training and development sessions to increase your expertise in using BIM.

Implementation of plan/design and construction

The implementation of the plan should be decided jointly and according to each stakeholder in the project. This phase defines the social interactions of the project team throughout the BIM construction life cycle. A BIM implementation plan includes:

- Portfolio management
- Test case based planning and implementation
- Spatial planning
- Team restructuring
- Delivery of information
- Defining new roles and responsibilities
- Performance measurement

Operation and maintenance

The high-level digital model created in the design phase can also be considered as the basis for the operation and maintenance phase. The best practice is to use building data from this model and rework it to incorporate operations and maintenance for the facility.

Here are some factors that determine whether a high-level design model can be used for operations and maintenance:

Which elements were integrated into it during the design phase of the model? Is

the digital model regularly updated to include the most recent and accurate information?

Were all stakeholders authorized to access the digital model able to retrieve the data easily?

Every need and organizational structure is different and the activities performed in these stages may be different according to their needs

BIM delivery process

It has been recognized for many years that conventional procurement routes in construction projects, such as the traditional or design-build route, can lead to under-delivering on a project-by-project (and consequently international) basis. The construction industry as a whole) often suffers from deficiencies in satisfying the “triple constraints” of construction projects (time, cost, and quality) due to their inherent cultural values (Darrington & Lichtig, 2018).

While in recent years there has been a lot of focus on the technology and information aspects of project delivery, it is felt that if the construction industry needs industry collaboration, there should be an equal amount of industry collaboration to rethink these common procurement pathways. to reach the desired pure ideal.

One of the alternative procurement routes that has received international attention is Integrated Project Delivery (IPD), which is most widely cited by AIA (2007) in its original guide, describing it as follows:

A project delivery approach that integrates people, systems, structures, and business practices into a process that harnesses the talents and insights of all participants to collaboratively optimize project outcomes, increase owner value, reduce waste, and maximize efficiency throughout all design phases. Construction.

IPD stands in stark contrast to the traditional procurement model, which is notoriously fragmented and adversarial in nature, instead offering an approach that emphasizes close and genuine collaboration between project participants in a spirit of trust, shared goals and mutual benefit.

Perhaps the most fundamental quality of IPD implementation is the equal sharing of risk and reward. By participating in a project that uses IPD, the participant forfeits the opportunity to manage his or her share of the project work in a way that maximizes individual profit, opting instead for an equal share of the net budget savings generated by the integrated team.

The result of this is that the company's focus can be directed towards effective and value-added collaboration in the early stages of the project, with the perspective of maximizing individual profit through total joint profit, perhaps as an incentive for all participants to optimize their contribution to the project. as far as practically possible (Moylan and Arafa, 2017; Kent, 2010).

With this in mind, the potential importance of the IPD philosophy in an industry striving for higher levels of efficiency, collaboration, transparency and accountability needs no explanation and industry-wide progress in BIM adoption and innovation means the industry is halfway there.

At a high level, BIM and IPD can appear to be very similar concepts, with both advocating close cross-party collaboration with a "collective mind" of information as a tool to enable more efficient and effective interdisciplinary problem solving. However, an important distinction to make is that BIM is largely concerned with the various information management processes that occur throughout the data lifecycle, while IPD is more concerned with the project team – both from a logistical and cultural perspective.

Together, their symbiotic relationship allows all participants to maximize project outcomes for the common good. Simply put, BIM provides the technological platform and robust information management protocols that enable collaborative work and also provide a "common source of truth" while IPD provides a strong cultural backbone that can often be missing from projects (to their detriment).

Therefore, it appears that there is still much work to be done to positively influence the cultural landscape of the UK construction industry and create the spirit of trust and genuine partnership that is essential for its successful implementation. However, as industry awareness of IPD spreads sufficiently to eventually be introduced in the first critical projects, we can expect our industry's overall performance to improve over time and then progress toward the ideal of sustainable lean in construction.

The nature of building information modeling (BIM)

BIM has been the talk of the town in the AEC industry for several years. However, with all the talk, there is a lot of confusion about BIM in construction and how it can help contractors. A common misconception is that BIM is simply a technology, or that it only refers to 3D design (although 3D models are actually the core of BIM). BIM is actually a process of creating and managing all information related to a project, resulting in an output known as a building information model, which contains a digital description of every aspect of the physical project.

While mostly associated with design and pre-construction, it benefits absolutely every stage of the project lifecycle, even after construction is complete. Building Information Modeling allows projects to be built virtually before physical construction, eliminating many of the inefficiencies and problems that arise during the construction process.

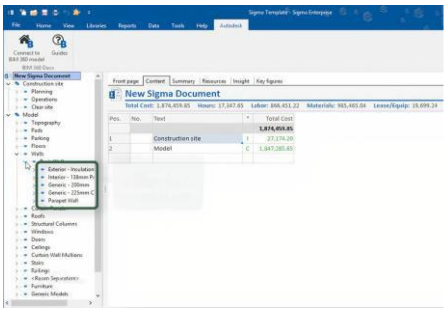
10 big advantages of BIM in construction:

1) Improve on-site collaboration and communication

Digital BIM models allow for sharing, collaboration, and versioning that paper-based design suites do not. With cloud-based tools like Autodesk's BIM 360, BIM collaboration can happen seamlessly across all project disciplines. The BIM 360 ecosystem allows teams to share project models and coordinate planning, ensuring that all design stakeholders have insight into the project.

Cloud access also allows project teams to bring the office to the field. With apps like Autodesk's BIM 360 tool, teams can review drawings and models on-site and on their mobile devices, ensuring they have access to up-to-date project information at any time.

2) Model-based cost estimation

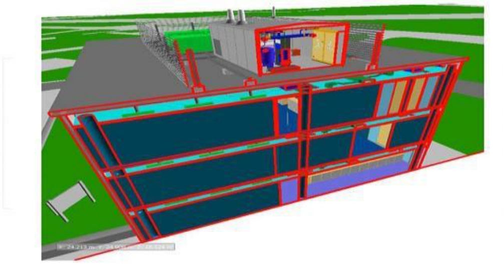


Many AEC firms have found that including estimators early in the planning stages allows for more effective construction cost estimation, leading to the growth of model-based cost estimating (also known as 5D BIM). Using BIM tools such as Autodesk's Revit and BIM 360 Docs automates the time-consuming work of quantifying and applying costs, allowing estimators to focus on higher value factors, such as identifying construction sets and risk factoring.

3) Visualize projects in prefab

With BIM, you can plan and visualize the entire project during pre-construction, before the shovel hits the ground. Space use simulations and 3D renderings allow clients to experience what the space will look like and provide the ability to make changes before construction begins. Having a greater overview from the beginning minimizes costly and time-consuming changes later.

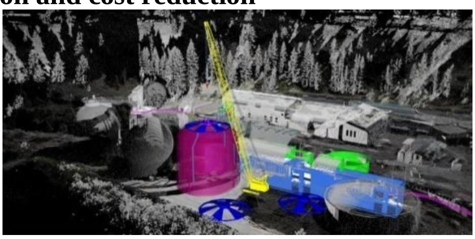
4) Better coordination and collision detection



BIM allows you to better coordinate trades and subcontractors and identify any MEP conflicts, internal or external, before construction begins. Do the electric pipes collide with the steel beam? Do the doors have enough space? With Autodesk BIM 360 Glue you can avoid collisions with automatic collision detection.

Reduce the amount of rework required on any given task by avoiding conflicts. With BIM, you have the opportunity to plan it right before construction on site. You can avoid last minute changes and unforeseen issues by enabling easy review and commenting in multiple threads.

5) Risk reduction and cost reduction



A study by McKinsey found that 75% of companies that adopted BIM reported a positive return on their investment. But if you take advantage of it, BIM can save you money in countless ways. Closer collaboration with contractors can result in lower bid risk premiums, lower insurance costs, fewer overall changes and fewer opportunities for claims. A better overview of the project before it starts allows for more pre-fabrication and reduces the waste of unused materials. Precast elements can be easily bolted into place instead of being created on site. Labor costs spent on documentation work and miscommunications are reduced. Many companies use BIM and construction technology to reduce costs and reduce risk.

With an ever-increasing number of team members using project data, real-time collaboration and a single document repository like BIM 360 Docs reduces the risk of any company using outdated information. Ensuring that the right information is available at the right time is essential to the completion of a successful quality project.

6) Improved timing/sequence

As many of these benefits save money, they also save time by reducing project cycle times and eliminating construction schedule delays. BIM allows design and documentation to be done simultaneously and documents can be easily changed to adapt to new information such as site conditions. Schedules can be more accurately planned and communicated more accurately, and improved coordination helps projects to be completed on time or earlier.

7) Increase productivity with prefab

BIM data can be used to instantly generate production drawings or databases for manufacturing purposes, allowing for greater use of prefab and modular construction technology. By designing, detailing, and fabricating offsite in a controlled environment, you can reduce waste, increase efficiency, and lower labor and material costs.

8) Better safety on construction sites

BIM can help improve construction safety by identifying hazards before they become problems, and prevent physical hazards in advance by visualizing and planning site logistics. Visual risk analysis and safety assessment can help ensure safety during project execution.

9) Implement a better overall build

Increased reliability of a coordinated model directly leads to higher building quality. By sharing common BIM tools, more experienced team members collaborate with builders at all stages of the project, providing better control over technical decisions about design execution. Optimal ways to build a project can be tested and selected early in the project, and structural defects can be identified before construction. Using visualizations, better design aesthetics can be easily selected, such as modeling the flow of natural light in a building. Then, during construction, reality registration technology can be used to improve accuracy.

10) Simplify facility management and enhance building handover

The information contained in a model also powers building operations after construction is complete and provides a good ROI once the project is complete. With construction software, an accurate and continuous digital record of building information is valuable to facility management and renovators for the entire building lifecycle. Data can be sent to existing building maintenance software for use after occupancy. Using a tool like Autodesk's BIM 360 Ops, contractors can transform the building handover by connecting BIM data generated during design and construction to building operations.

Building information modeling has become a valuable tool with many benefits for the construction industry. Projects that use BIM have a greater chance of success and maximize effectiveness for each stage of the project lifecycle and beyond.

Benefits of using BIM

Using BIM and software can improve all levels of a construction project. We've highlighted some of the key benefits of BIM in construction below.

Maximum productivity

One of the key benefits of BIM is that construction projects are implemented with shorter life cycles and greater efficiency. All aspects of pre-construction and planning are completed for easier and faster management.

Architects can create designs faster with BIM software, and estimators can create more accurate estimates through BIM models.

BIM programs also allow for much better collaboration and communication between the various people involved in the project. This allows different professionals to access BIM applications whenever they need to and means that everyone is always working from the same up-to-date model. This helps to reduce errors and rework caused by using incorrect or incorrect information.

Reduce costs and waste

BIM software provides contractors and designers with a variety of tools to improve their processes before construction begins. This can lead to significant cost savings and reduced waste.

BIM helps contractors choose better materials, simplifies construction work, and helps minimize human errors that may occur during construction. By improving the planning process, BIM can help contractors reduce the amount of wasted materials. Therefore, it can lead to cost reduction.

Improved cost estimation

Working with an accurate model enables the estimator to achieve much more accurate results. When you look at a 3D model versus a 2D blueprint, you'll have a much clearer blueprint to work with. As a result, the cost estimation based on the model is more realistic and accurate. Additionally, it makes the estimation process much faster with easier access to information and tools.

BIM is not just a cost estimate that can be optimized. BIM models make quantity estimates easier by providing a more comprehensive model to work with.

Better insight into the project

BIM programs provide a more realistic 3D look at the end result of the project. This means that you will have a better visualization of the end result. This is something that can help contractors as well as the client feel better about the built data.

This not only helps to better understand the building, but also helps to avoid unnecessary rework. By looking at realistic 3D renderings of a project, planners can get a better understanding of what's working and what needs to change.

This allows contractors to make changes in the pre-construction phase before it becomes an issue. Avoiding rework can save time and money.

Communication and cooperation

BIM is an approach that promotes collaboration. Cloud-based BIM software enables everyone involved in the project to easily collaborate and communicate with each other. They can access all the information they need as well as updated models from anywhere and anytime. This helps to avoid unnecessary meetings and work bottlenecks.

All planning stakeholders can work on expanding the entire project at all times. All estimates, models and design notes are created and stored in one place.

This means that architects can adjust designs instantly and contractors can make changes to the model even when they are not on site. Improved communication and collaboration leads to a smoother and more efficient project.

Less risk and waste

Building planning with BIM is safer and risk-free. With this approach, there is closer cooperation with contractors. Thus, it can reduce the bidding risk premium. This allows for a better overview of the project before construction begins.

This in turn leads to better on-site safety, less material waste, less miscommunication, ... Also, there is no risk of contractors using old information.

Through BIM technology and processes, companies can reduce insurance costs and minimize the chance of claims. Therefore, BIM is very useful for reducing risks and reducing costs.

Better end results

The use of BIM focuses on improving planning and construction processes. Doing this generally results in higher build quality and a higher end result.

Better planning with more accurate insight allows contractors to deliver higher quality. Due to the fact that architects can visualize the building earlier, there is more emphasis on the appearance of the building. Thus, BIM produces higher quality as-built data.

Benefits derived from the nature of the BIM process

BIM is increasingly prominent in construction projects due to the fact that it allows optimizing the time and resources allocated to these tasks. However, implementing this method is not without new challenges. In order to take full advantage of the wide range of advancements this system has to offer, we must invest in the equipment and resources necessary to maintain it. Fortunately, with the expected adoption of BIM technologies growing exponentially around the world, its benefits are becoming increasingly clear to the few non-believers who may still be out there.

Among its many advantages, some of the advantages of building information mode are:

sustainability

Sustainability, a key and growing component of a structure's design process, can be easily addressed by BIM. For example, engineers can perform better environmental analysis, examining aspects such as building orientation, energy consumption and daylighting to help identify the best strategies that increase energy efficiency, waste management and water conservation. On a lower but equally important scale, thanks to the use of digital platforms and cloud computing, BIM can also help reduce paper consumption and waste in the design and construction phases.

Increase Productivity

The use of BIM allows construction projects to run a shorter life cycle with greater efficiency, as all aspects of the pre-construction and planning stages are completed for easier and faster management. For example, architects can create designs faster with BIM software, and project managers can create more accurate cost estimates through BIM models.

Advanced communication and collaboration

BIM facilitates the integration of different people involved in the project and enables the reduction of fragmentation and lack of communication in the processes. Since everything can be digitized using BIM-related software, all stakeholders can access plans and other related documents whenever they need them (plus ensure they do so based on an updated, federated model). This helps to reduce errors and rework caused by using incorrect or incorrect information.

Workplace safety

Workplace worker safety has always been a priority for CEMEX and the industry. Today, BIM makes it possible to improve aspects where 3D models help to identify potential hazards and damages much easier and faster than 2D drawings of a structure.

Also, taking into account other factors such as the possible spread of Covid-19 on site during a pandemic, BIM can provide virtual stages of a project, allowing work to continue without unnecessary exposure of workers.

Other benefits

As mentioned earlier, this innovative method offers countless advantages and applications and is rapidly gaining ground in the construction sector. Likewise, it is anticipated that more technologies will be incorporated into its capabilities, which will soon enable the complete digitization of the entire value chain. We are very interested in further developing areas such as virtual reality, off-site construction and 3D printing, which can enable customers to discover exactly how to execute an installation, as well as automatically create mock-ups and generally innovate in the development environment. Who is leading BIM efforts in industry? North America, Europe and Asia Pacific are fast becoming the kings of BIM adoption, according to a recent Market Research Future report.

North America in investment and adoption of BIM technologies, presence of top industry players, increasing investment for development of advanced infrastructure and increasing adoption of cloud-based engineering will add to the growth of the BIM software market in the region.

In Europe, the BIM software market will account for the second largest share by 2026. The growing construction sector, government and private sector regulations, and high demand for BIM software by building owners, architects, and contractors are adding to BIM.

The Asia Pacific region is projected to grow its BIM market at a very rapid rate. With their focus on digitization, growing investment deals made by the real estate sector and the development of state-of-the-art infrastructure for the commercial, industrial and residential sectors, the growing adoption of cloud platforms, the presence of a very mature and experienced construction market in Japan is high. . The growth rate, rapid development of the construction industry in India and the increasing adoption of advanced technologies to enhance the competitive advantage of the design and construction industry in China will add to the growth of the BIM software market in the region.

BIM benefits through an intuitive BIM platform

It is clear that BIM is beneficial from both a construction and business perspective. Therefore, using a platform like bimspot, you can achieve more success.

As a visual BIM platform, you can automate model checks and use any BIM data as your source of information. It can help with project management, planning, communication, quality review, and more. It provides you with all the tools you need to access, validate and use building information. This allows you to achieve your project goals more effectively.

So, with bimspot, you can take advantage of all the benefits mentioned above – which can give you a significant competitive advantage.

Benefits of BIM in the project life cycle

BIM is a holistic approach that all project stakeholders use when planning, constructing and managing a new project. Using BIM provides numerous benefits to everyone involved in the project. And ultimately leads to better results.

The construction industry is rapidly moving towards a BIM-centric approach, and more professionals are beginning to understand the benefits of this technology. Therefore, adopting BIM and using a visual platform, such as bimspot, can contribute to greater success.

Why should you work with BIM construction experts?

Architectural firms and contractors who understand the value of BIM may be able to offer you more in terms of project efficiency and build quality. For example, one of the most important challenges that clients face when starting a project is predicting the time and resources required for a project. While it is impossible to accurately predict a project's cost or completion time, BIM can take some of the mystery out of total project cost and construction timelines.

BIM can do this by helping architects make better design choices from the start and keep projects under budget by optimizing labor, materials and other resources. Even if your budget is limited, an experienced BIM firm like HMC Architects can find ways to achieve your desired design outcome using accurate 3D models and more efficient workflows. With so many benefits, BIM is an important part of the design and construction process and will continue to play a vital role in our industry.

A key feature of BIM is the workflow component for stakeholders, as the construction industry still has a disorganized approach to design and planning. With BIM capabilities, all design work is done in one place as a shared model. Any stakeholder can collaborate in designing a project.

BIM is successful because data sets are synchronized at one point. If someone designs or changes a schematic, BIM records the schematic for each stakeholder. So, everyone is working from the same data and design in real time.

Top 10 benefits of BIM in construction

BIM has been the talk of the town in the AEC industry for several years. However, with all the talk, there is a lot of confusion about BIM in construction and how it can help contractors. A common misconception is that BIM is simply a technology, or that it only refers to 3D design

While BIM is most associated with design and pre-construction, it benefits absolutely every stage of the project lifecycle, even after construction is complete. Building Information Modeling allows projects to be built virtually before physical construction, eliminating many of the inefficiencies and problems that arise during the construction process.

10 big advantages of BIM in construction

Improve on-site collaboration and communication

Digital BIM models allow for sharing, collaboration, and versioning that paper design suites do not. With cloud-based tools like Autodesk's BIM 360, BIM collaboration can happen seamlessly across all project disciplines. The BIM 360 ecosystem allows teams to share project models and coordinate planning, ensuring that all design stakeholders have insight into the project.

Cloud access also allows project teams to bring the office to the field. With apps like Autodesk's BIM 360 tool, teams can review drawings and models on-site and on their mobile devices, ensuring they have access to up-to-date project information at any time.

Model-based cost estimation

Many AEC firms have found that including estimators early in the planning process allows for more effective construction cost estimation, leading to the growth of model-based cost estimating (also known as 5D BIM).

Using BIM tools like Autodesk's Revit and BIM 360 Docs automates the time-consuming work of quantifying and applying costs, allowing estimators to focus on higher value factors, such as identifying construction sets and risk factoring.

Visualize projects in pre-construction

With BIM, you can plan and visualize the entire project during pre-construction, before the shovel hits the ground. Space use simulations and 3D renderings allow clients to experience what the space will look like and provide the ability to make changes before construction begins. Having a greater overview from the beginning minimizes costly and time-consuming changes later.

Better coordination and collision detection

BIM allows you to better coordinate trades and subcontractors and identify any MEP conflicts, internal or external, before construction begins. Do the electric pipes collide with the steel beam? Are the vents sufficiently spaced? With Autodesk BIM 360 Glue you can avoid collisions with automatic collision detection.

Reduce the amount of rework required on any given task by avoiding conflicts. With BIM, you have the opportunity to plan it right before construction on site. You can avoid last minute changes and unforeseen issues by enabling easy review and commenting in multiple threads.

Risk reduction and cost reduction

A study by McKinsey found that 75% of companies that adopted BIM reported a positive return on their investment. But if you take advantage of it, BIM can save you money in countless ways. Closer collaboration with contractors can result in lower bid risk premiums, lower insurance costs, fewer overall changes and fewer opportunities for claims. A better overview of the project before starting allows for more prefab and reduces the waste of unused materials. Precast elements can be easily bolted into place instead of being created on site.

Labor costs spent on documentation work and miscommunications are reduced. Many companies use BIM and construction technology to reduce costs and reduce risk.

With an ever-increasing number of team members using project data, real-time collaboration and a single document repository like BIM 360 Docs reduces the risk of any company using outdated information. Ensuring that the right information is available at the right time is essential to the completion of a successful quality project.

Improved timing/sequence

As many of these benefits save money, they also save time by reducing project cycle times and eliminating construction schedule delays. BIM allows design and documentation to be done simultaneously and documents can be easily changed to adapt to new information such as site conditions. Schedules can be more accurately planned and communicated precisely, and improved coordination helps projects to be completed on time or earlier.

Increase productivity with prefab

BIM data can be used to instantly generate production drawings or databases for manufacturing purposes, enabling greater use of prefab and modular construction technology. By designing, detailing, and fabricating offsite in a controlled environment, you can reduce waste, increase efficiency, and lower labor and material costs.

Better safety on construction sites

BIM can help improve construction safety by identifying hazards before they become problems, and prevent physical hazards in advance by visualizing and planning site logistics. Visual risk analysis and safety assessment can help ensure safety during project execution.

Implement a better overall build

Increased reliability of a coordinated model directly leads to higher building quality. By sharing common BIM tools, more experienced team members collaborate with builders at all stages of the project, providing better control over technical decisions about design execution. Optimal ways to build a project can be tested and selected early in the project, and structural defects can be identified before construction. Using visualizations, better design aesthetics can be easily selected, such as modeling the flow of natural light in a building. Then, during construction, ground-truth technology can be used to improve accuracy.

Simplify facility management and enhance building handover

The information contained in a model also powers building operations after construction is complete and provides a good ROI once the project is complete. With construction software, an accurate and continuous digital record of building information is valuable to facility management and renovators for the entire building lifecycle. Data can be sent to existing building maintenance software for post-occupancy use. Using a tool like Autodesk's BIM 360 Ops, contractors can transform the building handover by connecting BIM data generated during design and construction to building operations.

Building information modeling has become a valuable tool with many benefits for the construction industry. Projects that use BIM have a greater chance of success and maximize effectiveness for each stage of the project life cycle and beyond.

Benefits of BIM for designers

More than 40% of professionals from all three AEC industry sectors stated that the value of BIM is critical during the design development and construction documentation phase. Architects and engineers use BIM to evaluate design options and automatically generate accurate 2D drawings from 3D models. BIM helps to quickly transfer information between different design disciplines, and therefore, the use of BIM increases their collaboration. Architects also use BIM for 3D visualization and communication with owners. BIM helps architects minimize errors and omissions in documents, reduce rework, and reduce design time. By integrating BIM, architects can automate the development of construction documents, such as construction details and shop drawings, which are easily generated from the working model for many building systems. This automation of construction documents allows architects and engineers to spend more time on project design instead of producing and modifying contract documents, while also providing accurate drawings and risk reduction. Individual capabilities and productivity are optimized by software, as the system enables faster modeling and simultaneous data manipulation. One person using BIM can produce more than three people using CAD.

In addition, building information models provide an opportunity to conduct code compliance checks, cost estimates, and sustainability analysis in the early stages of design. A survey conducted by Bynum et al found that the general perception of the AEC industry is that BIM is ideal for sustainable design because it fosters collaboration between parties. BIM tools enable designers to evaluate the performance of each building component, the effectiveness of sustainable design approaches, and their environmental impact. Engineers use BIM to determine structural loads or design requirements. BIM-like automated assembly and digital manufacturing features are used by engineers to process production information and coordinate the sequence of various systems with manufacturers and subcontractors.

Benefits of BIM for contractors

Contractors use building information models to coordinate building systems, identify collisions, and immediately communicate these problems to responsible parties. This analysis increases cost and time savings in the construction phase due to the discovery of design errors in the project and the elimination of conflicts early in the project, that is, before any construction begins. Contractors also use BIM to calculate take-off and cost estimates for bidding and project scheduling purposes, as well as for field management. BIM also improves the planning and scheduling of subcontractors. According to contractors, the two main benefits of using BIM in construction were reduced rework and marketing for owners, so contractors are also actively using BIM for visualization and marketing purposes.

BIM can also be useful for accessing building information models and requests for information RFIs on the construction site, for solving construction problems on site as they arise, and for visualizing the sequence of construction activities, which is especially useful for complex projects. BIM is useful for creating a database of information that is generated on a construction site during the construction phase of a project. Another benefit of BIM is that it facilitates off-site prefabrication of building components, which again reduces the cost and duration of a project.

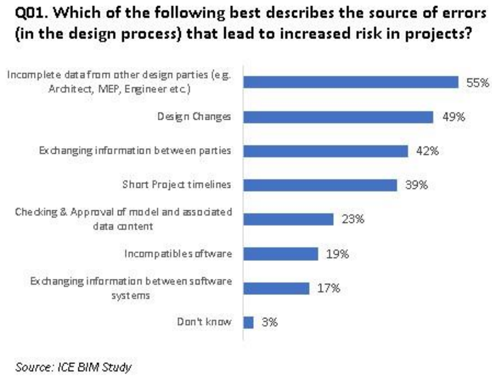
In addition, BIM technology is enabled on construction sites using mobile devices such as iPads and other handheld tablets. Using mobile devices, on-site crews can generate, navigate, modify, access, and review building information models and their features that work in real-time. This sophisticated imaging technology can also enhance on-site training and significantly impact the way parties, including subcontractors and owners, communicate with each other.

Benefits of BIM for Owners

BIM implementation provides a competitive advantage to AEC firms that enables them to offer new services to owners and ensure maximum return on investment for owners. Public owners are finding that BIM-based projects produce higher quality products and more efficient buildings, leading to lower life cycle costs. BIM also increases owner engagement by providing clearer and more accurate design visualizations. This simplifies communication with owners because realistic 3D visualization models are easier to understand than 2D designs.

Relevance and benefits of BIM for civil engineers

In order to be profitable, civil engineers must remove as much risk from their projects as possible by eliminating errors and inefficiencies in the design process. The ICE BIM survey found that incomplete data from other design parties and design changes are the biggest sources of error during design according to BIM experts (73 and 55 percent, respectively), followed by inconsistent information exchange between parties (45 percent). software (43%). The beauty of BIM is that it can help fix all of these issues – here's how.

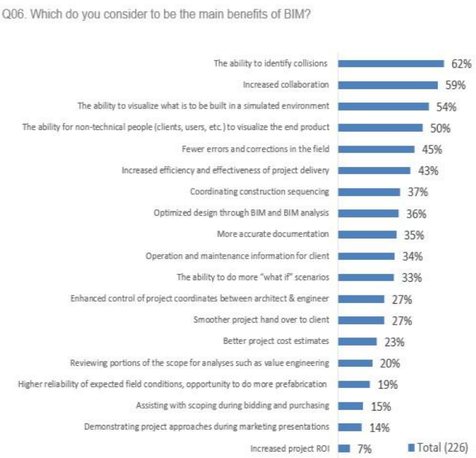


Incomplete data

Increased collaboration is often cited as one of the main benefits of BIM. Part of this increase is due to access to all the necessary information from all parties, which, using the traditional design method, currently resides in many documents maintained by different team members. When designing using BIM- capable software, all information about a project—including specifications and performance data—is stored in (or linked to) the BIM model. This creates a single source of up-to-date project information, eliminating the traditional "sawtooth effect" where information is lost at each deliverable in the design phase, making it easier for teams to collaborate.

Exchange of information

Collaboration is also easier if information can be shared effortlessly among the project team. Often, project information is shared using different civil engineering design software, which creates problems with inconsistency or data loss. Using BIM software with information exchange interfaces, such as Industrial Foundation Classes (IFC), allows different applications to share information with optimal data retention.

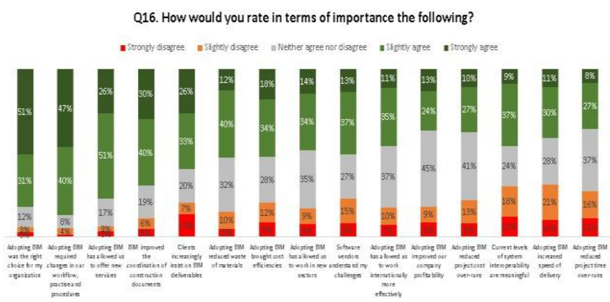


Design changes

Updating all the various design documents—such as specifications, drawings, and plans—to reflect the new design is error-prone and time-consuming. BIM software greatly reduces the time required to implement design changes by automatically updating all drawings and plans. Clashes or collisions between model components can be quickly identified using built-in tools, which is another major benefit of BIM software. As a result, BIM helps ensure more accurate documentation.

Short periods of time

Inefficiencies inherent in traditional 2D design processes—such as manual design changes, calculations and reviews, or tracking down missing information—are eliminated when using the BIM method. Advanced 3D modeling BIM software offers automation opportunities, such as automatically generating a bill of quantities from a 3D model that is easily updated as the design changes.



Source: ICE BIM Study

BIM for civil engineers

This study shows that while many civil engineers have realized the full benefits of BIM implementation, there are still barriers for others who do not know what BIM has to offer and how to implement it in their organization. While training costs and the associated culture change are major hurdles, the investment soon pays off in more efficient project delivery. As BIM continues to evolve and organizations become more comfortable working with 3D products and digital work methods, the proportion of civil engineers who see the anticipated benefits of BIM will increase significantly.

What is the benefit of BIM?

Some of the points mentioned above may give some companies pause and may help explain why many architecture students do not learn BIM in schools. To have this level of interoperability requires technical know-how and workflows that are still a recent innovation. The growth of BIM is undeniable. BIM is quickly becoming the industry standard in design and construction.

Here are the reasons why we offer BIM as a service to our clients:

More accurate estimates lead to savings in construction costs.

While the construction industry is bouncing back from last year's production shutdown, that doesn't mean spending is slowing down. In fact, the opposite is true: Total construction spending is expected to increase between four and seven percent in 2022.

The market for material and labor costs is still very volatile, so any cost estimate is really important. In a centralized platform, BIM can generate cost estimates and documents faster than other traditional tools, while using more accurate data.

This is useful for contractors who need to have accurate estimates for prefabricated models to estimate project costs for materials and contractor works. Our design models help the contractor create more accurate estimates.

BIM reduces conflicts and increases transparency.

By using BIM at the start of a project, engineers can create a more comprehensive package of design and performance for the structure they are building. Having more complete data can give owners, developers, and designers more control over projects. Stakeholders can find design conflicts at an early stage and work on ways to resolve them. This can help minimize change orders and scheduling delays.

BIM also offers companies like ours a way to have more transparent communication on projects. The BIM process brings together our owners, architects, contractors and mechanical, electrical and plumbing (MEP) designers early in the project. This facilitates collaboration and communication at all project milestones, making BIM an efficient way to achieve transparency.

BIM is working towards a new way of thinking in construction.

For us, this is the biggest reason to use BIM. The AEC industry is still very traditional in its approach. While there are many tried and true approaches, they often result in doing the bare minimum to get a project moving. Cost overruns and scheduling delays are a given, not the exception.

For us, that's not good enough. Our engineers are willing to try new technologies so that we can provide the best solutions.

We focus on collaboration because it's the best way to create. Working together, we can build more energy efficient and sustainable buildings using new technologies that minimize risk for our clients to produce the best project experience.

A framework for BIM-enabled construction project lifecycle information management

BIM has been widely used in project management, but applications are generally fragmented and BIM models are not deployed throughout the entire project life cycle. Each participant builds their own BIM, so there is a fundamental problem in how to integrate this dynamic and fragmented data together.

Life Cycle Management (LCM) has been developed as a business approach to manage the entire life cycle of products and services. LCM has also been used for many years in the management of construction projects to reduce whole life cost, time and risk as well as improve service for owners. During the entire life cycle of the building, information about the building must be collected and reused. In addition, the importance of information to enhance communication has been emphasized, so that the efficient management of construction information has emerged as an element to determine the success of a project that involves many stakeholders. However, due to the lack of effective information sharing platforms, traditional approaches disperse information across multiple products throughout the building lifecycle. Therefore, LCM of construction projects is not effectively used in the construction industry. For example, during the design, drawing, and construction phases, almost all the information needed for a facility is developed. Unfortunately, it is usually not recorded and stored for future use.

Building Information Modeling (BIM) is a new technique of simulating the real information of buildings, through tools such as 3D geographic forms and non-geographic forms, which include things such as materials (for building components), weight, price, procedures, scale and size. In order to improve the information management process, BIM is proposed to enable and facilitate an integrated method of project flow and delivery by collaboratively using semantically rich 3D digital building models in all phases of the project and building life cycle. It uses the object-oriented concept to increase the efficiency of information management in the building life cycle. In addition, it provides the ability to visualize and analyze the construction project with near-real fidelity.

There is a lot of research on life cycle management, but most of it focuses on quality, cost, environment and sustainability. Little attention has been paid to life cycle information management. BIM can be used to manage information throughout the life cycle of a construction project. As a technique, BIM has been used by various participants, but the potential of BIM in life cycle information management has not been fully considered. Users may use BIM at any stage of the construction project, but the BIM model is not handed down from one participant to another: each one creates their own BIM. For example, BIM can be used for parametric design and collision detection in the design phase, safety monitoring in the construction phase, and building performance analysis in the operation phase. However, due to the lack of model-based information, there is a bottleneck of BIM development in the construction and operation phase. That is, a large amount of information of these two phases is not preserved in the building information model. This will lead to undesirable consequences. For example, the exchange of information and documents with new partners often cannot be automated or in electronic formats at those stages. In addition, there are other problems for BIM development in the stages of construction and operation, such as information type, input form, information format, ...

Therefore, it is critical to organize this management support information in a standard framework. As a result, it is important to create a framework for model-based information management in order to ensure the retrievability and reuse of information. Succar has presented a building information modeling framework and proved that BIM implementation changes life cycle management relationships, activities and tasks. He did not explain what the change would be.

Information components throughout the project life cycle

Information related to the life cycle of the building often includes different types and formats. BIM is considered as an ideal tool for the digital representation of the data repository of all the information related to the life cycle of the building. It enables us to manage and store information based on information stage to use information well in the future. This section describes the informational components of each phase.

Information components in the design phase

D-BIM includes information generated during the design phase, which is largely dependent on the activities of the design phase. The design phase is intended to represent the client's construction goals, including functional requirements and proposed project standards through an implementation model. Design work requires a multi-disciplinary collaborative approach to ensure that the owners' intentions are maximized.

The main activities in the design phase include those in which owners organize, design and sign tender and contract documents with designers, consultants, supervisors, contractors and other parties.

The owners assign the mapping and design company to conduct hydrogeological research and prepare design specifications, schedule and design estimates. They also audit the preliminary plan and technical design, as well as the organization of contractors and supervisors to conduct construction plan reviews. They then receive approval from the government department responsible for building plans.

It is important to ensure that information can be used by multiple users to enable interdisciplinary collaboration as well as to improve operational efficiency. We categorize the information in the design stage into six categories according to the content of the design, which are:

General information about the project,
Information about similar projects.
Location information about the proposed project;
Review and design information;
Tender and contract information and economic information.
Detailed information for each phase.

Information components under construction

C-BIM contains information generated during construction activities. Information in C-BIM is more abundant because construction control and management is a dynamic process. It is also a long-term and complex work that involves the owner, design company, monitoring company, general contractor, subcontractors, material suppliers, equipment suppliers and relevant government departments. In addition, a large amount of human and material resources must be prepared for use in the construction phase.

In the construction phase, which is the process of construction implementation, projects can be classified into three sub-phases: preparation, construction sub-phase, and also sub-phase of assignment and defective commitment. The main activities of the preparation sub-category include obtaining construction permits and information on regulatory and technical standards, selecting the monitoring unit and subcontractors, signing construction contracts, organizing and reviewing maps, programming, operation, and explaining design and technical aspects, ... Construction execution management is a critical task in the construction phase, which includes site management, resource management, program management, cost management, quality management, as well as generally ensuring safe and civilized management. The main subtasks of handover and defective commitment are project delivery, setting up of equipment and facilities, acceptance of finishing materials and preparation for handover of property. Therefore, the information produced in these activities is diverse and complex and can be mainly classified into three categories: general information, organization-specific information, and project-specific information.

The general information category defines general information about building products, regulations, standard practices, the natural environment, ...

Organization-specific information categorizes all information available for a particular organization, such as standard solutions to design-build problems, often in the form of a library of previously completed projects that are used as reference items within the organization. This may include information about similar projects.

Project-specific information is related to a specific construction project or project type, but is shared by multiple organizations that make up the supply chain. This study is related to project-specific information management during the actual on-site construction phase of the project. Project-specific information includes general situational information, organizational information, construction management information, technical information, resource information, and environmental information.

Information components in the exploitation phase

Operations management is maintenance and operation of construction projects. A good operation management not only provides a beautiful and comfortable environment for users, but also ensures the performance of the building facilities and achieving sustainable applications.

Information flow throughout the project life cycle

Information about multiple departments and participants from the design phase to the operation phase, and the information in BIM is being circulated and updated. Therefore, it is necessary to know how information flows and is exchanged in BIM.

Information flow map in the design process

In general, the design process is divided into three parts: architectural design, structural design, and facility engineering design. Meanwhile, facility engineering design includes electrical design, water supply and drainage design, HVAC design, and thermal power system design.

Architectural design includes graphic design, shape and facade design, profile design, ...

Structural design presents the structural plan of architectural design in an effort to have a harmonious and integrated structure and construction. Preliminary estimates of the overall structure are made on this basis.

The electrical design of the building mainly provides the design for the construction of all electrical equipment and lighting power, as well as the design of the lightning protection ground and weak current supply.

Water supply and drainage design generally includes the design of the building's internal water supply system, the design of the building's internal drainage system, and the construction of a rainwater drainage system design.

HVAC design generally includes heating system design, air conditioning system design, and smoke control and ventilation system design.

Thermal power design for residential buildings is mainly gas system design. The main elements of its design are: the amount of gas required, the design of the pipe network and the hydraulic calculation of the gas pipe network.

Through the coordination between these six specialists, building design can be continuously enriched in the architectural design process.

The construction process includes two main stages: (1) construction engineering and (2) construction equipment installation engineering.

Information flow map in the construction process

The architectural and structural engineering stage is divided into four parts: foundation engineering, main structure engineering, waterproof engineering and building decoration engineering

Architectural and structural engineering

Foundation engineering for architecture and structure includes the relative height of 0.000 mm below the building foundation, foundation, underground waterproofing and protection of foundation pit engineering. Through analysis, we can draw an information flow model for foundation engineering.

Information flow in the operation phase

The operation stage includes accepting the property, using the property, maintaining the property and destroying the property. At this stage, the property management right is transferred from a construction company to a property management company. Therefore, the first task of the exploitation stage is to receive the property. According to property management regulations and service contracts, a property management company organizes the reception work. All information related to this work is inherited from C-BIM, such as project approval documents, all contracts and agreements, operational instructions for facilities and equipment, as well as data management information. The main task of using the property, which is the second task of the exploitation stage, is the management of the property in normal use. Through this we can get information on operational level, life level as well as data management data ..... The task of property management is to support facilities and equipment for normal work. To accomplish this goal, records must be reviewed and maintenance and repair records carefully maintained. The last task in the life cycle is the destruction of property. Demolition work must be in accordance with laws and regulations and be carefully recorded.

Integration of life cycle information

By analyzing the flow of information at different stages, the task of exchanging information is clearly complicated by different stakeholders. It includes large volume, complex types, diverse sources, distributed storage and dynamic processes of information.

In addition, nowadays information systems in construction are mainly designed for a specific phase, which causes a lack of life cycle information and experience accumulation. In other words, the construction phase cannot use the information from the design phase, while the operation phase cannot use the information from the construction and design phases.

BIM is an effective tool for integrating information from different phases to promote communication and information reuse. Also, it is a key element to realize life cycle management in construction. Meanwhile, the value of information is greatly enhanced by the use of BIM.

D-BIM, C-BIM and O-BIM are different parts of BIM, but the information inside them is not separate. Sub-BIM can create information by extracting, expanding and integrating previous sub-BIM as well as adding new information. Thus, as shown in Figure 7, the entire BIM is gradually developed throughout the entire life cycle.

From the design phase to the construction phase and then the operation phase, engineering information is gradually integrated and finally forms a set of engineering information that fully describes the life cycle of buildings. Each of the steps and software systems in each step exchange requests according to their information, therefore, the step and sub-models of information exchange are defined for specific applications. The application system can achieve data integration and sharing by extracting and integrating sub-models. For example, when designing architectural, structural, electrical, water supply, drainage, HVAC, and thermal power based on relevant information in the design phase, multiple geometric data will be generated along with existing requirements to access common data. The sub-model in interaction with BIM can meet such requirements. Therefore, the construction phase can extract some information from the design phase, then apply it to the application software. Similarly, the operations phase can extract some of the information from the design phase and the build phase, then apply that information to the operations application software. Due to the preservation and integration of information by BIM, the problems of information loss and errors are solved.

Application of BIM during the project life cycle

The fragmented nature of a construction project has led to the separate application of BIM at different stages of the project life cycle. Much research has been done on the application of BIM on individual components of construction projects. Many people can benefit from the use of BIM. Cost reduction and control benefits were often observed in BIM-based projects. However, the potential value of BIM in life cycle management is not commonly used.

Building Information Modeling (BIM) allows multidisciplinary information to be included in a model.

Compared to traditional methods, it creates an opportunity to perform these analyzes accurately and efficiently. Integration strategies and interoperability of construction life cycle data have a primary and secondary effect. The primary effects are those that the use of BIM makes information activities (creation, retrieval, delivery and communication) more efficient. Secondary effects are where using BIM in information processing activities makes materials management activities more efficient.

BIM is a digital representation of the physical and functional characteristics of a facility. It serves as a common knowledge source for information about a facility that forms a reliable basis for decision-making throughout its life cycle from start to finish.

Application: Design stage

According to the VE process (value engineering) in the life cycle of the building, changing an electron at the design stage is much easier and cheaper than using a jackhammer to remove a wall. BIM-enabled projects can be more energy efficient by providing easier interactive feedback on the implications of design decisions. For example, lighting designers can quickly see the effect of added skylights on resulting lumen levels, while architects can optimize the angle of exterior louvres to minimize heat gain without sacrificing natural light.

BIM provides all the virtual walkthrough capabilities of today's advanced 3D designs. Many construction projects have been improved through a relatively simple change in the composition of scheduling information in the BIM database. With this, the fourth dimension – time – is included in the model.

In the design phase, the advantage of using BIM is to provide an electronic model that can be mathematically analyzed to meet codes. Two typical applications of BIM-based information are described: collision detection models and building performance analysis.

Collision detection model

BIM allows you to eliminate conflicts that are transformed into change commands with a pipeline collision detection model. In the formation process of collision detection, design information plays a key role. First, it obtains the spatial data required for collision detection, as well as geometric data such as size, coordinates, types of building components, structural components, equipment, pipelines, connections, ... The extracted data are then combined into a single unit. Subsystem Based on this subsystem, appropriate detection indicators, regulatory requirements or experimental data are entered and finally a sub-model for collision detection is formed. In the detection process, the contrast is given to the corresponding screen to ensure that the designer makes timely adjustments. The pipeline collision model is created based on the design information model. This model captures relevant changes to ensure timely communication of information about design changes. It also contains more information about the objects in the parametric 3D model, so that contrasts between components, equipment and pipelines are presented directly. This ensures that engineers are able to accurately identify problems and make changes at the right time. that engineers are able to accurately identify problems and make changes at the right time. Disclosure of problems for resolution helps to shorten construction period, improve project quality and reduce construction costs.

Analysis of building performance

One of the biggest potential benefits BIM can provide for environmentally conscious designers is the ability to predict energy performance quickly and accurately, without the need for complex calculations. Instead, the modeling software itself can provide this information and quickly recalculate the effects that alternative strategies could have on overall efficiency. Due to the added information in BIM, the approaches of environmental impact assessment (EIA), whole life cycle cost assessment (WLCCA) and life cycle assessment (LCA) can be integrated in the sustainability analysis of BIM projects.

Application: construction stage

During the construction phase, a BIM with this scheduling information can help everyone involved in a project (architects, engineers, general contractors, and subcontractors) visualize the day-to-day progress of a project. With this, the construction team can monitor – in advance – an animated version of the planned construction process.

Since the design of buildings has become more complex, it is very difficult for project managers to accurately calculate the planning time and construction schedule. There is an urgent need for advanced computer-aided technologies to develop comprehensive construction planning and scheduling prior to the construction of a project.

Two typical applications of BIM-based information in the construction phase: simulation, progress visualization and construction safety monitoring.

Simulation visualization of progress

In the construction phase, BIM-based planning management is implemented based on the design information model by increasing the time dimension. Then a sub-information model is created that can reflect the construction progress directly and accurately. That sub-information model can achieve construction progress simulation, that is, create a construction schedule in advance based on building information modeling. It can compare this with the actual construction schedule and the planned construction schedule to find the gap, find out the reason, and finally adjust and control the gap to ensure timely completion of tasks. Scheduling information integrated into BIM also helps optimize construction planning and scheduling.

Supervision of construction safety

In addition, one of the biggest potential benefits that BIM can provide to ensure construction safety is the facilitation of construction safety monitoring. In the construction phase, the construction safety sub-model is formed by expanding the construction safety information to the construction information model, which can realize the analysis and monitoring of the whole construction safety process. It can analyze the security of the construction process and the project itself in a timely and dynamic manner. At the same time, it is able to monitor, analyze and assess the safety of the construction process in real time and warn of security risks in time.

Application: operation stage

During the operation phase, a fully equipped BIM project includes information about every piece of equipment and system in the building. Facility managers can then update the virtual model by modifying the real building, so the 3D "virtual" building remains an exact copy of the real structure. As a result, using BIM can mean significant savings for facility owners over time. For example, getting the right replacement part for a broken air conditioner part can be as simple as clicking on the part image in a BIM to find manufacturer and model information.

According to the studies conducted on the application of BIM in operation phases, BIM can be used for facility management and emergency management.

Facility management

According to a study that focuses on the use of BIM in facility management,

BIM can be useful in various areas of FM application, such as locating building components, inspecting maintainability, facilitating real-time data access, space management, emergency management, and energy control and monitoring. The potential application areas of FM based on BIM can be divided into three categories:

Building performance tracking.
building maintenance;
and emergency management

Building performance tracking includes space management, energy control and monitoring, and facilitating real-time data access. Building maintenance includes locating building components and checking maintainability. Emergency management is used to prevent emergencies such as fires or other disasters from occurring.

Emergency management

Before disasters occur, virtual reality, roaming technology and related BIM-based disaster analysis software can simulate the process of disasters, analyze the causes of disasters, and make a disaster protection plan as well as the best evacuation and protection plan. Due to the visual presentation of information, customers can easily understand the emergency maps of the building and rescue personnel.

When disaster strikes, BIM can provide complete and accurate information about the affected part, including location information, component and equipment status, as well as performance information and the best escape route. Based on this information, rescue personnel can immediately respond appropriately to the disaster to improve the effectiveness of rescue and resolution.

Life cycle management

We benefit from the scattered application of BIM at different stages, but we benefit more from BIM-based life cycle management. Some of these benefits include collaborative management, risk management and sustainability analysis for a more effective response.

There is a growing demand for the use of integrated information technology in the building life cycle in China. In pre-BIM projects, all stakeholders work on their part of the project, with automated applications to achieve their outcome. While in BIM equipped projects, the stakeholders in the building life cycle process all contribute to BIM. Each receives and creates value through their participation. BIM-based models are expanding to provide a virtual database of almost all information related to the construction and performance of a building.

The evolution of the BIM model

The term BIM (Building Information Modeling) can be used to describe many different aspects of a design and construction project. Basically, the BIM process involves the development of an advanced 3D model for the proposed project and includes all structural, architectural and MEP components. The ability to view these components in 3D allows project leaders to better coordinate throughout the design process by creating a visual model of how all these systems interact with each other. Accurate BIM models also speed up the installation of building systems during the construction phase, as fewer "hits" need to be made.

In the past decade, Building Information Modeling (BIM) has been widely used and integrated to varying degrees in every aspect of building design, construction and maintenance. But this is not where BIM stops, the future of BIM embraces augmented/virtual reality (AR/VR) and has the potential to extend to automated and intelligent data lifecycle management. The concept of creating a "digital twin" for a physical building or system with the goal of making that physical entity safer, more efficient, and more resilient in the real world begins with building our way to fully integrated BIM.

Although BIM is a relatively new design tool, the concept has been around for decades. The BIM process has been widely used over the past 10 years due to significant advances in software and hardware technologies.

Looking ahead to the next 10 years, we can expect to see further developments as more project teams incorporate BIM into their design process. As project teams explore more of their options for using a BIM system, high-level discussions about project delivery, document ownership, and team assembly arise. These types of conversations are an important part of the process and have the potential to change the design and construction industry.

The current trend in the BIM process is a push for design teams to upgrade their design models to a higher level of detail than previously accepted. Design teams are also expected to model all components of MEP systems, regardless of size, which were traditionally left to the respective trade contractors to complete during the shop floor design coordination process. This process leads to discussions that differentiate the responsibilities of the design team and the contractor and how to effectively transition the model from the design model to the construction model.

Beyond design and construction, the BIM process is also available to the end user to create efficiency in the operation and maintenance of the building. For example, BIM can not only show the physical location of a light, but it can also tag the light with information relevant to the building's operations and maintenance staff (such as the manufacturer and model number of the equipment). type and number of lamps and the date of their last replacement).

Even as these developments unfold, we must remember that at the core of the BIM process is information. The process is only as good as the information provided in the model.

BIM is essentially a digital form of construction and data management that improves decision-making throughout the building lifecycle by putting everyone on the same page. For architects and designers, BIM helps with visualization, improved coordination and even collision detection in the design and planning stages. While the building is under construction, contractors and builders can use it to sequence, specify, and supply chain efficiency.

After receiving the building at a lower cost and with greater speed and efficiency due to the coordinated nature of BIM, clients and owners also benefit from the amount of facility maintenance information provided by BIM. The operation and maintenance of a building can account for up to 85% of its lifetime costs, so the quality of information generated during the design and construction phases to support greater operational efficiency is a key driver for many customers.

The BIM Industry Task Force developed a matrix for determining BIM maturity to describe different levels of BIM integration. Level zero basically means no collaboration, only using 2D CAD drawings. Much of today's industry is well ahead of this level. Level 1 includes a combination of 2D and 3D CAD information and electronic data sharing. Collaborative work and coordinated information exchange distinguish Level 2, while Level 3 BIM describes a completely open process and data integration with a single integrated model used by the entire design team. However, any BIM data is only as good as its input, meaning accuracy in digital components is critical.

Often considered a critical element for complete BIM is the integration and creation of a DBE digital built environment "digital twin". A digital representation of a physical counterpart, users interact with the digital twin through applied intelligence. The level of development of a digital twin can be assessed through four criteria: loyalty, learning, intelligence and independence, respectively. Fidelity is the most basic and refers to the level of detail and accuracy of a system, learning is based on this information meaning that the twin can automatically improve performance by learning from the data without being specifically programmed to do so. Intelligence is the next step, measured here as the digital twin's ability to replicate human cognitive processes and complete tasks, and finally autonomy is the system's ability to act without human intervention.

To test the potential of a digital twin, Kingspan created the IKON, the "Building of the Future." Designed as a living research laboratory for Kingspan, the IKON Digital Twin includes physical display, virtual display and interconnected building sensors. IKON includes fifteen building sensor chambers, each with sensors for sound, light, motion, pressure, and CO2. Data from the sensors is sent to Autodesk Dasher 360, a browser-based application that can then be used to visualize and analyze the building performance data it receives in real time.

Who is the BIM model prepared for?

Building information modeling (BIM) entered the construction industry with the emergence of concepts such as 4D modeling (4D) and virtual design and construction (VDC). The first steps to use this technology in construction projects were taken with the development of CAD software, and after that many other specialized softwares entered this field. Among the applications of this technology, we can mention the synchronization of the design model with the project schedule, the automatic control of instructions and regulations, as well as the visualization of engineering plans for a better understanding of managers and workshop engineers; But what plays a vital role in the efficiency of using this technology is the determination of LOD in building information modeling (BIM) or the level of detail of the model. If there are few details, the model is not very effective. While it should be noted that adding more levels to the details of the model will have a significant cost.

One of the issues that should be considered in determining LOD in building information modeling (BIM) is the person or organization or institution using the BIM model:

If the building information modeling is done for the employer, the purpose of modeling is usually to check the general functions of the plan and monitor the progress of the project.

If building information modeling is for legal entities (for example, in Singapore and England, where the provision of a BIM model is necessary to start a construction project), a model including legal guidelines and regulations must be prepared.

If building information modeling is done for the contractor or manufacturer, the model should be prepared based on the work breakdown structure and include all the project's executive parts.

However, in general, LOD in building information modeling (BIM) can be divided into two levels before implementation and during implementation.

BIM model before project implementation:

Modeling the scope of the project:

At this level of LOD in building information modeling (BIM), the generalities and determining (critical) characteristics of the design should be specified. At this level, the project implementation environment, specifications and dimensions determined for the elements in the design and things such as the concept of each color in the BIM model are discussed.

Functional modeling of elements:

At this level of LOD in Building Information Modeling (BIM), it is necessary to specify the exact technical specifications and the operation of each structural and non-structural element and construction equipment in detail.

Modeling the analysis and planning process:

At this level of LOD in building information modeling (BIM), the resources needed to perform each of the activities, including the amount of required materials and the working hours of manpower and machines, should be determined. At this stage, the planning engine allocates resources to perform construction activities.

The output of this level will be a four-dimensional model of the construction project.

Modeling the project organization process:

At this level of LOD in building information modeling (BIM), organizational and project management issues are added to the BIM model. For example, at this level, it is possible to calculate the costs of securing the project environment and establishing the HSE system in the project, and report its benefits to managers in case of accidents during work.

BIM model during project implementation:

At this stage of LOD in Building Information Modeling (BIM), it is necessary to monitor the progress of the project and control the consumption of resources based on the construction activities. The output of this step can be solving implementation problems to achieve the rates set in the BIM model or updating and modifying the built model to continue the project as well as future projects. Among the functions of the BIM model at this stage, we can mention project procurement and completion of warehouse capacity of construction workshops to prevent implementation interruptions.

Project safety management is one of the branches that has received the attention of researchers in the field of building information modeling at this stage. Because research shows that even very experienced project managers and workshop supervisors are not able to recognize safety risks in the workshop in many cases. Modeling building information by automatically controlling safety regulations and matching it with the progress of the project reduces the safety risks of the workshop. For example, the BIM model can determine which roofs have been concreted based on the progress of the project and a safety fence should be drawn around it, or the concrete of which roofs have reached a suitable grip and the jack under its molds can be opened.

Disadvantages of BIM

Modeling software is required

BIM is a digital process that requires investment in software and computer resources. It should be considered as a long-term investment for the business, with increasing returns over a period of time, rather than expecting significant cost savings and benefits in the first project.

Training and personnel

Investment of time and resources in training is required for BIM adoption. As with any time you learn something new, it means the process can take longer to get started because people train and then essentially learn on the job. There has to be a mindset and commitment that will become easier in the long run as the change becomes ingrained in the day-to-day operations of the business.

Trust and cooperation during the project

The construction industry is known for its approach and reliance on verbal communication. For BIM to be effective and reliable, it needs to communicate centrally in a digital format. This must be understood and practiced by all parties involved in the building construction life cycle to be effective. If information is not entered centrally, there is a risk of unforeseen issues. In the UK construction industry, you often now see BIM as a tender requirement and written into contracts, reinforcing the message to improve trust throughout the supply chain. Data entry must be accurate and planned timescales must be adhered to as much as possible so that BIM can work at an optimal level.

End user interaction

BIM is not just about building construction, it can also help manage facilities after the handover phase. The downside, however, is that contractors can often spend hours of resource time entering data such as product specifications and instructions, only to find it ignored by the on-site facility team.

Incompatibility with partners

Although the use of BIM in the UK has increased rapidly, there are still construction businesses that have not adopted this approach. This means their operations are inconsistent and they are often shortlisted. However, if you practice BIM in your construction business, you increase your chances of success in your bidding process.

LOD

BIM Level of Development (LOD) is an industry standard that defines how the 3D geometry of a building model can achieve different levels of refinement, used as a measure of the level of service required. These development models are developed for various phases of design, 3D visualization, manufacturing caliber values, scheduling, estimates, production control and on-site fabrication. Using industry specifications for Level of Detail (LOD) as a guide, SrinSoft's 3D modeling service creates a 3D model of your projects based on the required feature. We also provide animation services for LOD, virtual construction sequences and simulations to generate insights into how and what is being built.

Level of Development (LOD) specifications allow industry professionals to describe how an element's geometry and related information evolve throughout the process. It represents the degree to which different team members can rely on information related to an element.

LOD specifications help designers define the inherent properties of elements in a model at different stages of development. Clarity in the image gives depth to a model and shows how much and at what level a person should rely on an element of a model.

Using LOD, designers and engineers can communicate with other professionals who use the model further about the usability and limitations of a model. The

LOD specification is designed to standardize the use of the LOD framework and its use as an efficient and collaborative communication tool.

Building Information Modeling is a very broad term that describes the process of creating and managing digital information about a built data such as a building, bridge, highway, tunnel, ...

The level of detail of a building information model increases as the project progresses, often first based on existing information, then developing from a simple design objective model to a detailed virtual construction model, then a built data information model.

Different aspects of the model may be developed at different speeds, may originate from different members of the project team, and may be developed differently.

From the employer to the consultants, to the contractor and suppliers and finally to the employer.

Therefore, it is important that the employer defines the level of detail required at each stage of project development.

This not only ensures that the design is being developed in sufficient detail, but that the information the client needs to make decisions about project development and then the efficient execution of the completed project is actually provided. It also shows a sign of reliable information. The employer defines the level of detail required in the Employer Information Requirements (EIR).

Employers' information requirements may be annexed to a BIM protocol by adding an "amendment-enabled model" to the contract, making the delivery of the required information a contractual obligation. A summary of the level of detail requirements and responsibility for model development may be provided in the Model Production and Delivery table.

PAS 1192-2 Specification for Information Management for the Capital/Delivery Phase of Construction Projects Using Building Information Modeling (now superseded by BS EN ISO 19650) defines two components for the "level of definition":

Model levels of detail (LOD) that relate to the graphical content of models.

Model levels of information (LOI) that relate to the non-graphical content of models.

In fact, the two are perfectly aligned because it's natural for graphic and non-graphical content to develop side by side.

Currently, there are no standard definitions for the timing of data drops or the levels of model detail and model information, other than the suggestion that they should be aligned with the employer's decision points and should be consistent across appointments. This is because they are expected to vary depending on the nature of the project. However, some very broad guidance is provided in PAS 1192-2:

Abstract: If a graphical model exists, it is probably developed from an existing data information model. Other information may relate to existing buildings and structures (there may also be plans of requirements).

Concept:

Graphic design may show mass charts and 2D symbols to represent general elements.

Definition:

Objects are based on public representations, and specifications and attributes enable the selection of products.

Designing:

Objects are displayed in 3D with attached specifications along with space allocation information for operation, access, maintenance, installation and replacement.

Construction and commissioning:

Generic objects are replaced by constructor objects, with necessary information added back to the replacement objects and constructor information.

Delivery and closing:

The project representative model is built and all necessary information is included in the delivery documents including maintenance and operation documents, commissioning records, health and safety requirements, ...

Operating and in use:

Performance is validated based on client information requirements and the project brief, and the model is updated if changes are needed. Information about maintenance, replacement date, ... may be added.

The NBS BIM toolkit, which developes following a government competition, can be used to help define information requirements for projects that align with specific project phases.

The American Institute of Architects (AIA) has also published a LOD framework for the AIA G202-2013 Building Information Modeling Protocol form. Here, LOD refers to the "level of development" required for the content of the model elements. The term "level of development" rather than "level of detail" is used to recognize the fact that a highly detailed visual element may actually be general and, despite appearances, may be at a low level of design development.

AIA suggests that the LOD framework recognizes that different project elements develop at different rates and allows project participants to effectively communicate to each other how far a model element is developed. It also allows project participants to express the extent to which a model element is used and relied upon.

Level of development vs. level of detail

LOD is usually interpreted as level of detail rather than level of development. This specification uses the concept of development level. There are important differences.

The level of detail is actually the proportion of detail that is enclosed in the model element. The level of development is the degree to which component specifications, geometry, and attached information are considered—the degree to which project team members may depend on the information when using the model. Basically, the level of detail can be considered as the input of the element, while the level of development is a reliable output.

SrinSoft specializes in providing LOD for various levels. SrinSoft offers five LOD options from 100 to 500. We adopt the internationally accepted standard for LOD.

Level of Development (LOD) in BIM

Level of Development (LOD) is a set of specifications that empower AEC industry professionals to document, express and specify BIM content effectively and clearly. As an industrial standard, LOD defines the stages of development of different systems in BIM. Using LOD specifications, architects, engineers, and other professionals can communicate clearly without confusion for faster execution.

Origin of LOD

LOD first introduce by the American Institute of Architects (AIA) in 2008, when it defined five different levels of detail to define levels of detail in a BIM model. But the concept of LOD existed long before that.

The first example of the use of LOD can be traced to a construction analysis software company called Vico Software, which used a LOD-like system to relate digital models to the cost of a project. The company made all the parameters and details related to a digital model available to everyone at different stages of the design process.

There are now six levels of development with the addition of LOD 350 (details below) and it can be seen that 80-90% of the elements of a model should at least reach LOD 350.

LOD and design phase

LOD does not appear to be intentionally specified by the design process. Instead, the completion of design phases, as well as any other milestones or deliverables, can be described through the LOD language. There are several important reasons for this approach:

1) The first reason is that no exact standard is available for the design phase. Previous architects have created standards, but they exist within an organization. Standards vary from one organization to another and can even vary within a single organization based on the requirements of a project.

2) Building systems progress from concept to precise definition at different speeds, so at any given time, different elements will be placed at different points along with this progress. For example, after the schematic design stage, the model will contain many elements at LOD 200, but also many elements at LOD 100, as well as some at LOD 300 and possibly even LOD 400.

Basic definitions related to LOD

Currently, there are six different levels of development defined by the American Institute of Architects (AIA). According to the AIA, the LOD specifies the design requirements at each stage.

At LOD 100, which is the pre-design stage, the model consists of 2D symbols and masses to represent the presence of an element.

At LOD 200, elements are partially defined by specifying their quantity, size, shape, and approximate location.

With LOD 300, elements are accurately defined with precise dimensions and their relative positions.

LOD 350 accurately describes the information about an element and describes the relationship and connection of an element with other elements.

LOD level 400 specifies basic information about the construction of various elements.

At LOD 500, the model begins to represent the actual functions of elements in a real building. Here all development levels are detailed with their definitions.

LOD 100 – The model element concept may be represented graphically in the model by a symbol or other generic representation. Information about the model element can be obtained from other model elements. Any information derived from LOD 100 elements should be considered approximate.

LOD 200 - Approximate geometry

The model element is represented graphically in the model as a system, object, or general assembly with approximate values, size, shape, location, and direction. Any information derived from LOD 200 elements should be considered approximate.

LOD 300 exact geometry

The model element is represented graphically in the model as a system, object, or collection specific in terms of quantity, size, shape, location, and direction. Non-graphical information may also be attached to the model element. The origin of the project is defined and the element is precisely determined according to the origin of the project.

LOD 350 detailed geometry with fittings

LOD 350 A model element is graphically represented in the model as a specific system, object, or assembly in terms of quantity, size, shape, location, direction, and interface with other building systems. Non-graphical information may also be attached to the model element.

LOD 400 ready to build geometry

LOD 400 Model elements are graphically represented in the model as a system, object, or assembly specific in size, shape, location, quantity, and orientation with detail, fabrication, assembly, and installation information. Non-graphical information may also be attached to the model element.

LOD 500 operational models/built models

LOD 500 The Model Element is a field-validated representation of size, shape, location, quantity, and orientation. Non-graphical information may also be attached to model elements.

Capability of a BIM model according to the LOD level

The User Guide approved by the US General Services Administration (GSA) Real Estate Division provides guidance on the use of BIM models at various stages of development. That is, LOD 200 BIM can be used to create a cost estimate based on the measurement of a generic element.

Advantage of resolution due to LOD for an AEC project

The level of development is a very important element in the whole BIM process. Without LOD, it can become difficult for everyone to work on the same page and create inconsistencies that can disrupt the vision of the project. With the help of LOD specifications, communication and collaboration can become easier and faster, creating space for efficient deployment of resources at all levels of design and construction. Here are some benefits of specification level development in the design process:

Better cooperation and communication between different teams

With the help of standardized specifications and detailed information about all elements, designers can provide instructions and data to people working downstream to ensure uninterrupted operation and maintenance. LOD makes standard definition easier for contractors who have to take care of BIM implementation. At the same time, design managers can better explain requirements at different levels of the design process to teams.

Detailed scope associated with a BIM deliverable

With the help of LOD, BIM models become more accurate. At the same time, all teams, including owners, can specify exactly the level of detail they want from a BIM model and provide clarity on the scope of the final BIM deliverables.

The importance of LOD in an AEC project

In an age where everything is done digitally and every critical project uses a 3D model, it becomes difficult for designers to communicate project expectations to other teams. Often, managing a BIM model comes with a unique challenge.

- Different people understand different definitions of completion.

LOD creates a standardized definition of what completion means and eliminates the potential for inconsistencies associated with project completion. By using LOD, teams working under different disciplines can communicate with each other in a better way and more clearly. LOD enhances clarity in design using advanced techniques and technology.

Overcome LOD vocabulary

If used without standardization, 3D BIM models can cause large errors due to differences in definitions of accuracy between two teams. LOD is designed to minimize errors with the help of a numerical vocabulary that designers and end users of a BIM model share for common understanding.

LOD is just like the key to a lock that can open the right gate to complete the project. In other words, it is a method to accurately implement different elements in a model. With LOD, design and implementation teams can get on the same page and clearly see the elements of a model and understand when an element has reached the desired level of maturity that can be called completion.

LOD abbreviation keyword

LOD is an alternative to the word Level Of Development (expansion amount or level of detail), which itself consists of two parts LOI (Level Of Information) and LOD (Level Of Detail); The grading and classification of each may be different in different countries. Tat Beam's exclusive video goes into this thoroughly, but it should be noted that Tat Beam create this video based on US standards, and small details may differ from countries such as the UK but you can use this video to understand this subject more.

What is LOD?

LOD is one of the most important success parameters of BIM as well as BIM (execution plans), so it is necessary to know it for all the people who are considered as beneficiaries in this case.

History of LOD

Also, the idea of making these softwares proposed with Vico Software, a commercial company that produces construction integration softwares, and this company is trying to connect the digital model with the building culture.

In 2011, the BIM Society began developing the LOD specification and formed a working group with participants from both the design and construction disciplines. The working group first interpreted the basic AIA American Institute of Architects definitions of LOD for each building system and then compiled examples to illustrate the interpretations.

The main objectives of LOD are to help the team, including the client, to specify the output of the BIM process and to get a clear picture of what the BIM process will involve. Explain at different points of the design process. Providing a standard that can be referenced by contractors and BIM implementation programs.

Basically (Level Of Detail) is the amount of detail that the model element has. Level of development is the degree of geometry of elements and attached information. The degree to which project team members can trust the model's information when using it. Basically, (Level Of Detail) can be considered as the input to the element, while (Level Of Development) is the reliable output.

Advantages of LOD

LOD provides the group and team of information and project engineers with a clear framework, purpose and organization for effective collaboration with other engineers and experts and provides a clear view of each stage of the design; Therefore, LOD is a tool that can be considered to provide data information from each stage of design in order to improve productivity and time management.

LOD includes the control and organization of the elements of a building, which is considered an essential tool from the initial concept stage to the construction stage; And when used effectively, it improves communication, saves time and gives the owner a new view of building progress and greater control over construction costs, among other benefits of LOD.

New processes and workflows with BIM

Now the traditional approach is compared with the BIM approach to project delivery that is expanding in the construction industry. The implementation of IRA's BIM process for building design begins with the creation of coordinated and reliable information for project design. This information is displayed in an intelligent 3D model of the building, where the components of the design are dynamically connected with each other with rich information. In this way, BIM can facilitate the evaluation of more designs. As part of the design process, engineers can apply building information modeling and perform building simulation and analysis to optimize the design in issues such as constructability, sustainable development, and building safety. Also, with the BIM process, project deliverable items can be prepared directly from the building information model. Deliverables include not only the 2D construction drawings, but the model itself and all valuable information within it which can be used for measuring and estimating the amount of materials and work, order of construction stages and comparison of plans and models such as construction and even operation and maintenance of the building.

What is different about the BIM approach? The use of modeling, 3D visualization and model analysis are not new topics in the field of building design. The difference is that in the traditional approach, design, analysis, and preparation of construction plans are separate processes that cause inefficiency and impose exorbitant costs for examining different scenarios.

By creating an effective connection between the stages of design, analysis and preparation of construction drawings in the BIM workflow, most of the workload of the design process in the project is transferred to the previous stage of the project life cycle, i.e. detail design, and the cost of performing the terms of detail design is transferred and this is despite the fact that at this stage, the possibility of influencing the project implementation process is high and the cost of making design corrections is low. In this situation, engineers can spend more time on reviewing design optimization scenarios and spend less time on creating construction plans.

In the following, according to the information obtained from the literature review, case studies and the analysis of the information obtained from the interviews with experts, project managers and those involved in the construction industry, the classification and separation of BIM applications at each stage of the project life cycle will be discussed:

Phases of the project life cycle of BIM applications	start	time		Finish
	Concept design phase	Concept design phase	Concept design phase	Concept design phase
meters and cost estimates				
Modeling the existing conditions of the project				
Planning project stages				
Initial planning				
Analysis of the construction workshop				
Reviewing and reviewing plans				
Review of standards and regulations				
Structural analysis of the design				
Analysis of the mechanical facilities of the plan				
Analysis of electrical facilities of the project				
Energy analysis				
Investigating the environmental effects of the project				

Making a detailed design model				
3D coordination of designs				
3D planning and control of designs				
Simulating the virtual execution of the project				
Implementation system design				
Planning how to do activities in the workshop				
Information archiving model				
Building maintenance and repair planning				
Building system analysis				
Building Management				
Crisis management and unexpected events				

The main causes of productivity in the construction industry were the fragmented nature of the traditional project delivery system, the use of traditional 2D CAD technology. The labor productivity gap can be closed through the concept of building information modeling; Because as the results of the current survey and research showed, BIM has useful applications in all phases of the project life cycle, and some of its applications exist in more than one phase of the project life cycle. In the integrated project delivery system with the use of BIM, the roles of designers and project managers will not be separated from each other and a collaborative approach will be created among all members involved in the project. As it mentioned, the more we move away from the initial stages of the project life cycle, the lower the impact of the reforms on the project implementation process, the higher the cost of making design reforms in the project. In the traditional approach of carrying out the project, the largest amount of activity of designers and engineers is in the stage of preparing the construction drawings after the design finalized; But by using BIM and creating an effective connection between the stages of design, analysis and preparation of construction plans in its workflow, most of the effort and activity of the designer process in the project is transferred to the previous stage of the project life cycle, i.e. detail design and this is the fact that at this stage, the possibility of influencing the project implementation process is high and the cost of making design modifications is low. Also, conflicts and differences are resolved in the initial stages of the project, and it is possible to integrate the plans with the schedule and budget, and it will save the economy for the project.

Implementing a Security-Based BIM Approach (Part II)

Implementing a security-based BIM approach (Part II), here we show how the principles of PAS 1192-5 can be implemented to provide a security approach for built assets in a collaborative digital construction project that is both appropriate and robust.

Process and transcription

Once the risk management process has been performed and the need for a security approach for a constructed asset has been assessed, the analysis and decisions should be evaluated in an asset security strategy (bass), a document in which all security management and information requirements should flow. .

This plan is an asset security management plan (BASMP) that will ensure risk reduction and will be adopted consistently and comprehensively, taking into account people, process and physical and technological security. These elements must work in tandem or the overall security regime will be ignored or rendered ineffective. This system should include a set of policies that define the business rules for managing risk and support it with processes and procedures that support its successful implementation throughout the supply chain. Both BASS and BASMP should feed into the development of each project's strategic business case and brief at the definition stage to ensure they are addressed.

As-built information (BASIR) is used to collect the requirements specified in the BASMP.

BASIR in turn addresses Asset Information Requirements (AIR) and Employer Information Requirements (EIR). It aims to ensure that the capture, handling, dissemination, storage, access and use of information in relation to secure sensitive assets and systems reaches the supply chain where the security type of the BIM protocol is used.Therefore, it enables them to perform according to the contract.

Establishment of databases

It is BASIR that manages and oversees the establishment of databases that ensure information security throughout the operational life of an asset.

Regular security reviews are an important part of the process. It is essential to review and assess the risks that are changing and ensure that appropriate actions are taken through BASS to BASMP and BASIR if they affect the built asset.

If a breach occurs, it is essential to review how the incident handle to assess the effectiveness of the response and determine whether existing standards should be changed or new measures created and then implemented throughout the asset security documentation.

Chapter Three

A technology roadmap is a document produced in the technology roadmap process and represents a powerful technique to support technology management and planning, especially for examining and communicating the dynamic links between technology resources, organizational goals, and the changing environment.

Technology mapping is a strategic tool that can be used by various organizations to integrate science and technology with production and business planning in order to achieve a desirable set of goals. The roadmap process is to identify, evaluate and select strategic options to achieve the desired goal.

In the short term, technology mapping is a logical method of agreeing to select technology that will help achieve the organization's goals. It is also a framework for program regulation and technology development. According to the definition of McMillan (2003), the road map is a useful tool for knowledge management and communication. The roadmap first propose by technology mapping in the late 70s and early 80s. Motorola company used this method for the first time in the field of information technology and coring in the field of providing automotive parts. The long-term focus of the two on technology. Motorola used the roadmap to develop products and support its technologies. According to various definitions of the road map, we can generally define it as follows:

Roadmap is a step-by-step and layer-by-layer method of process planning in the context of time and oriented towards the future.

An effective roadmap should answer the following 3 questions:

1. Where do we want to go? Or what are the goals that the roadmap will help to achieve?

2. Where are we now? At what level of technology development are we?

3. How can we reach the destination? What R&D technologies are needed? And what policies do we need to implement?

Nimmo describes the positive effects of developing a technology roadmap as follows:

Technology mapping helps predict technologies that will be important in future markets. A strategic roadmap for commercialization of appropriate technologies guides industry to create many new market opportunities, guides R&D decision-making, creates new collaborations, and provides definitive input for government policy.

Technology mapping can be used for all types and in all areas of technology, and in fact, it creates an effective communication tool for the final goals and makes the path to achieve these goals completely clear.

Technology roadmaps provide an important link between technology investment decisions and business planning; It also provides a kind of structured approach for mapping the evolution and development of complex systems.

A study of UK manufacturing companies in 2001 showed that at that time 10% of medium to large companies had implemented technology mapping, 80% of these companies used this method more than once or continuously. In the years 2000 to 2010 worldwide, there has been an important increase in the use of technology mapping in various sectors such as companies, organizations, partners and governments and industry. According to the study of 2004 to 2005, among the different types of roadmaps, the technology roadmap has the most repetitions, from about 52,000 to 168,000 cases, and after that, the product roadmap has the highest repetitions, from about 26,000 to 120,000 cases.

Types of technology maps:

Technology mapping can be classified into different types in terms of purpose and format.

Advantages of the roadmap:

Many researchers have been trying to explain the benefits of technology road mapping. They claim that road mapping can help create agreement and consensus among decision makers on a set of science and technology needs. It also provides a decision-making mechanism for the implementation of considered innovations in target areas. It reduces the complexity of decision-making and the speed of implementation, so direct investment in new and existing systems can be made rationally.

The roadmap provides a framework to facilitate the planning and coordination of science and technology developments at all levels:

Within an organization or company, across a sector or industry, even at inter-industry, national or international levels.

In general, the main advantage of technology mapping is gathering information to improve investment decisions in the field of science and technology. Kappel (1998) believes that the mapping process not only creates more informed individual decisions, but also causes greater alignment with organizational decisions.

Overall, the roadmap provides the following:

Ordering resources, forces, views, needs and...

Coordination between different departments of the organization

Finding the best answer to meet needs and achieve goals

Improving the decision-making process in the organization due to the creation of a relative consensus among experts

Risk reduction

Determining actions in the time periods ahead of the organization

Showing the necessary steps to realize the desired future

Evolution of technology roadmap

Since the 1970s, technology mapping has been widely used as a process in different types of organizations for different departments, different purposes, and different audiences.

There are many benefits to expanding the scope of the technology mapping process from single organizations to consortia of organizations and even entire industries, which is a major driver for the evolution of technology mapping.

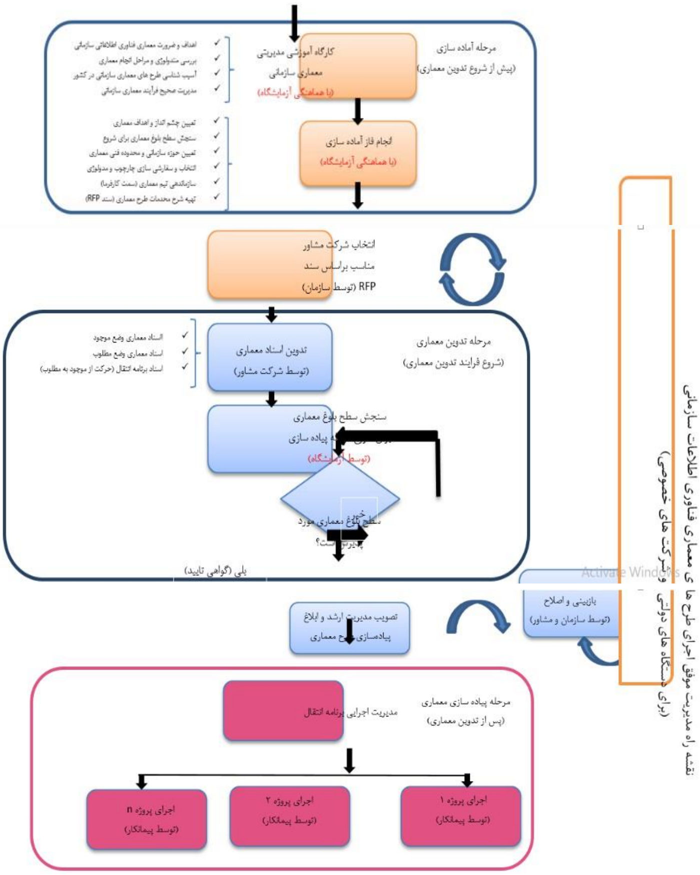
The importance of the development of technology roadmapping among industry sectors and diverse stakeholders such as academia and industry include encouraging cooperation, knowledge exchange, sustainable networking and more efficient use of scarce resources. The distinction between traditional technology mapping and multi-organizational technology mapping is established by Phaal and his colleagues and distinguishes between the technology mapping approach applied at the company level and at the sector level. More key features exist simultaneously in multi-organizational technology roadmapping that aims to develop the roadmap collaboratively across multiple organizations. While new types of technology mapping are emerging and adding to traditional technology mapping such as process technology mapping, they evolve and are used by different organizations for different purposes. However, traditional single-organization technology mapping is still widely used as a strategic planning tool around the world. In an evolution from traditional technology mapping to multi-organizational technology mapping, single-organizational technology mapping infers both drivers and their goals.

Success factors for multi-organizational technology mapping are different from traditional technology mapping and require new criteria to evaluate the level of success.

Successful management roadmap for the implementation of enterprise architecture plans

For government agencies and private companies that intend to use the organizational information technology architecture approach (Fava master plan) to organize FAVA development programs, but need correct and accurate advice to choose the best maturity path,

Service-Oriented Organizational Architecture Laboratory, in cooperation with the Information Technology Organization of Iran, is carrying out a series of measures for the standardization and management of organizations. To help those who are interested in the enterprise architecture approach (FAA), a graphic diagram of the "Successful Management Roadmap for the Implementation of Enterprise Architecture Plans" has been prepared, which can be a guide to the correct implementation path and the order of the work steps.



Based on the roadmap, interested organizations are advised to first participate in the organizational information technology architecture training workshop for organization managers to learn about the correct management of the architectural process. Then, the preparation phase before starting the organizational architecture plans, which plays an important role in the success of the next steps, based on the method approved by the laboratory. If the readiness of the organization is recognized from various aspects and preparations are made, the next steps, including the selection of a consulting company for the development of the architecture (based on the prepared RFP), will be carried out and in the order given in the diagram, the architectural process will go through a complete cycle until the end.

Compilation of technology development roadmap

At this stage, after explaining the strategies and macro policies of the transfer to the desired state, the proposed transfer scenarios are presented and the risks of each are identified. Finally, one of the scenarios is selected for implementation in the organization. The three main actions in this phase are as follows:

Preparation of a portfolio of proposed information and communication technology projects in line with the compiled architecture along with the schedule and priority of implementation of the transition architecture, separated into four architectural design topics (mission architecture, process architecture, information systems and information technology). In fact, the transition architecture connects the existing architecture to the desired architecture.

Mechanisms of integration and management of current systems and determining the strategy of dealing with existing systems (Legacy system)

Product roadmap (a guide for product managers)

I've always seen how a product roadmap can improve the way a product team works. It is a dynamic and collaborative tool that allows us to build our own product insights and strategy. That's why I decided to write about it in commas.

The following text is composed of various sources and experiences.

A product roadmap is not a literal map that you sit down and use like a route finder for your own planning. Before you start, you need to know why you need it, how you can build it, what format you will use, what initiatives you will prioritize and how to consider and inject user needs above all else.

This is too much! That's why you're here: you're looking for ways to start or improve your product roadmap.

1. **Defining the product roadmap**

For product-centric companies, the product roadmap creates alignment.

A product roadmap shows the product's high-level strategy and shows how a product will be completed over time. It can vary depending on the maturity level, size and structure of your company. In some cases, companies will have two versions of the roadmap: an internal version for the company and an external version for external stakeholders (often the case with B2B products.

One of the most important things a product manager has to do is turn the product roadmap into an important organizational statement.

This helps us not see the product roadmap as just a "communication tool".

A tip for professionals:

A product roadmap with a clear strategy can be all you need when convincing customers, especially large companies. Especially when the product has a high cost, it is the best solution to show that your product is the right solution for them in the long run.

Right and wrong approaches to product roadmap

The right approaches to the product roadmap

A visual communication tool: presents the product vision and strategy at a high level, the various initiatives each team has taken to achieve this vision, and how the product has evolved over time.

An external communication tool: keeps product teams, customers, and stakeholders fully informed about what has been done to bring the end product closer to the vision.

A tool for company and stakeholder alignment: Helps product teams make informed decisions and keeps stakeholders updated.

Adaptable and focused for the short term: responds to continuous user research, market observations and strategic changes (especially for medium to large companies driven by innovation and iterative manufacturing).

Incorrect approaches to the product roadmap

Not a Gantt chart: A Gantt chart is a bar chart that displays a set of linear tasks to be completed by a specific date. A roadmap should show your strategic direction, not just when things will be done

Long-term feature release schedule: Product, market, and user needs are dynamic. Scheduling predetermined features on a rigid timeline can only spell disaster.

Created alone: When a roadmap is created without any input from different parts of a company (marketing, sales, design, development), it is doomed.

A Timed Checklist: Nothing is more deadly to team productivity and creativity than time pressure.

Problematic points

Problem point 1 - Managing the expectations of the team and stakeholders

This is where making a product roadmap becomes your savior's big organizational statement: it smooths the process and creates a sense of acceptance among managers and stakeholders. Because they're not just checking out a visual tool, they're making an important organizational statement! Have you ever encountered these problems?!

How to meet the expectations and demands of different teams? (Sales, Marketing and Implementation) How to balance their expectations?

How to cultivate a common sense among everyone that adheres to the product roadmap?

Solution: Turn the product roadmap into an important organizational statement

Wait Management Tactics:

Hold regular product roadmap meetings involving key teams and stakeholders. You can use this opportunity to make it easier to decide the next steps in prioritizing your work.

Train the product team to see ideas or roadmap items not only from the perspective of customer problems, but also to align them with the vision, goals and strategy of the product and the organization.

Only add items to the roadmap that the entire team is confident about. As soon as something deviates from the strategic product picture, remove it from the product roadmap.

Problem point 2 - The product roadmap is a fixed document

Here again, the product roadmap becomes your savior's major organizational statement: this time, it helps the product roadmap grow with the company.

As organizations evolve, so do roadmaps. In young companies, product roadmaps are sometimes a list of features to be implemented—that's fine, but as your business grows, you need a separate, high-level product roadmap that outlines the strategy for achieving organizational goals.

A product roadmap is especially useful in agile organizations that don't necessarily run on schedules. A product roadmap provides a flexible framework during a volatile phase of your product's life.

This becomes problematic in larger companies, where roadmaps are more complex and often involve tight, tight timelines.

Problem point 3 - The product roadmap is far from the real problems of the users

This is where the product roadmap becomes your savior's important organizational statement: because it helps you have a customer-centric roadmap by hearing from different teams.

The worst thing can be the promises you make to users and you don't keep them; And it usually happens when the product roadmap is a list of features rather than a user-centric strategy document.

We all know that the items in the product roadmap may change; But the roadmap is supposed to express intent rather than commitment, allowing us to create passion while managing expectations.

A product roadmap is a powerful communication tool that enables other teams to schedule their work based on a strategic product vision. (Sales team for informed conversations, marketing team for HR advertising campaigns for recruiting.)

2. Ways to prepare a product roadmap

Some teams love the time-based approach, while others want time freedom

There is a lot of debate about what the right product roadmap is. Some say that it should be arranged based on goals, some prefer strategies. Some people don't need time, and some say that it is even possible to have a dumb time, for example, a seasonal or approximate time of sprints is enough. Some are concerned with how many product roadmaps we should have and some are concerned with who should manage these.

The truth is that there are no easy answers to these questions. It depends on your team, the needs of your product and its life cycle, goals, industry, ...

Product management practices can have a direct impact on company culture

If your company values deadlines, your roadmap should reflect that. If your maps are freer, your roadmap should be too. As I mentioned before, it all depends on the culture, and the way the product manager sets the roadmap affects how that culture evolves.

In general, your product roadmap can fall into one of the following three categories:

Theme based
Time based
hybrid

Topic-based product roadmap

Providing a roadmap in this case helps us to understand the expectations of the stakeholders more easily and build our own product roadmap based on their mental needs. Topics or "templates" help us to easily identify dynamic product strategies and address them in different topics. A topic-based product roadmap does not take into account time constraints (it is considered a "dated" roadmap type).

This type of roadmap is especially well-suited to teams operating under an agile methodology where deadlines and timelines are lost. By avoiding the date, you can keep all of your focus on building the product—not on the schedule. A theme-based roadmap does what your team promises as a solution to a problem, rather than building a specific feature.

	INFRASTRUCTURE	NEW FEATURES	STICKNESS	IMPROVMENTS	INTEGRATIONS
WEB APP	Metrics Automated Tests	Feature & Scope Integrated Prototype Undo Function	Onboarding Flow Desktop Delighter (TBD)	Dialogue Styling Import Engine Update Navigation	Salesforce Marketo
MOBILE APP	Demo Staging Regression Back-End Analytics	Feature Requirements Front-End Prototype Feature B Scope	Reward (Progress Bar) Mobile Designer (TBD) Gamification	Performance Overhaul	Stack Treilo
DESIGN / UX	Design Process	MVP Requirements Archiving Search	Status Updates	Multiple Environments	Jira Zendesk

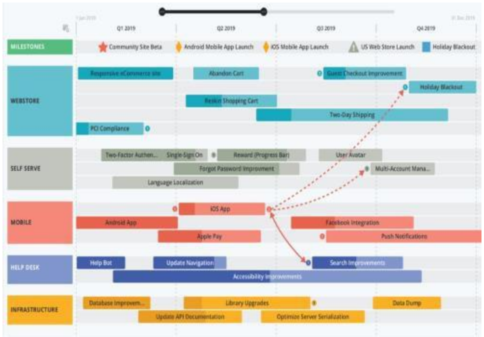
Topic-based product roadmap

Time-based product roadmap

The timeline is completely descriptive. The chart shows how your product has grown and evolved over time. When you want to provide a time-centric view of the roadmap across your organization.

In some large companies dealing with multiple departments, dependencies, and deadlines, a time-based roadmap is your best (and sometimes most necessary) roadmap.

In larger companies, there are several departments that work together and need a clear framework to coordinate their efforts. Marketing cannot work and plan properly with a roadmap without a date. Sales need to fulfill their obligations by the announced dates. The product team must understand and respond to the needs of other departments.



Product roadmap - time based

Combined product roadmap

There are many arguments as to why a timeline-less roadmap is the best way to move a product forward; But for many teams, dates are a necessity:

Planning for the long term
Notify stakeholders about delivery
Managing a large number of priorities and expectations

This is why there are many roadmaps that include different forms of keeping dates and times, also called "flexible" roadmaps. They are ideal for teams that work in some kind of agile philosophy, but still like to see the concept of time defined at one level (without hard dates).

Sprint roadmap

If you work in a structured agile environment, another option is to set your product roadmap based on a cycle or Sprint structure and not tie those Sprints to a specific date.

Sprint Roadmaps allow agile teams to work in two short chunks of one or two weeks. Sprints work well for teams that don't like to see specific dates in their roadmap. They define the amount of work to be done, but not the stress of deadlines.

Sprint roadmap

Fuzzy Time Roadmap

Many agile teams also define their product roadmap according to "fuzzy time". This means that the product roadmap may include open-ended time buckets such as In Progress, Future, and Complete, rather than specifying exact dates.

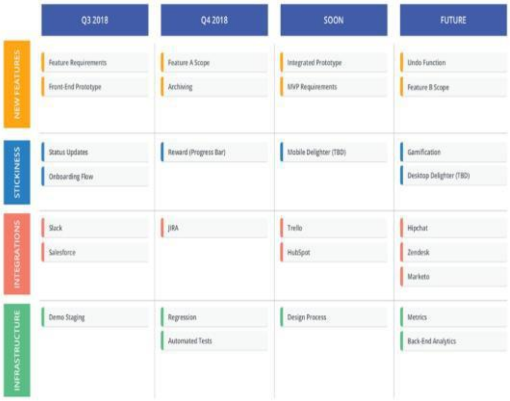
Growing agile teams can't ignore time, so a "fuzzy" approach for teams that don't want to be locked into specific dates is to use this method because those teams still can't give these exact times, they still need approximate time frames. This way you create a projector that is useful but not restrictive.

Fuzzy Time Roadmap

Agile roadmap

If you're an agile team that still incorporates elements of Waterfall, your product roadmap tends to have a history. The dates that are closer to the present time are more specific and precise, but as we move away from them, the times become more abstract (fuzzy). If history is the most important thing, it will not be agile.

For teams approaching an agile roadmap, the closer they are to today, the more confidence they have in what they can deliver. The further we go into the future, the greater the uncertainty.



Agile roadmap

3. What do you need to create a product roadmap?

Well, now that you know about the different types of product roadmaps (and hopefully you've chosen the best solution for your company),

It's time to take a look at the various moving parts that go into building a product roadmap.

Your product roadmap often lives at the border between your product strategy and your teams' tactical initiatives. It should also be a thorough look at the strategy of all teams to achieve the business vision.

So, the big question is, what do you need to build a product roadmap that actually gets everyone on the right track? Here we try to provide some general guidelines and best practices for product roadmap planning.

1) Set goals in the product roadmap that are consistent with your product vision and strategy

It doesn't help if your product roadmap is just a release plan, backlog, or a number of features in the order you want to release them. (This is exactly what a Gantt chart is, as opposed to a product roadmap.

This incomplete approach does not include goals or metrics to measure how close you are to those goals. Any professional product manager will tell you that a product roadmap that is just a "feature map" is a recipe for disaster. Remember that your roadmap should have goals that directly align with your product vision and strategy. More than just creating a strong vision and strategy, this ensures that your leadership team and internal teams understand these strategic values and make decisions based on them.

Key questions to ask:

How do these themes/functional categories bring us closer to realizing our product strategy?
Do these functional categories satisfy a basic need or problem of our users? By linking them to qualitative and quantitative data you can show exactly how this works.
Do these topics drive our performance categories towards achieving target KPIs? You must show exactly.
What have we done to prioritize these themes/functional categories? For example, we have used one of the prioritization frameworks.
Value vs. Complexity [Value Vs. Complexity], ROI score, delay cost and...

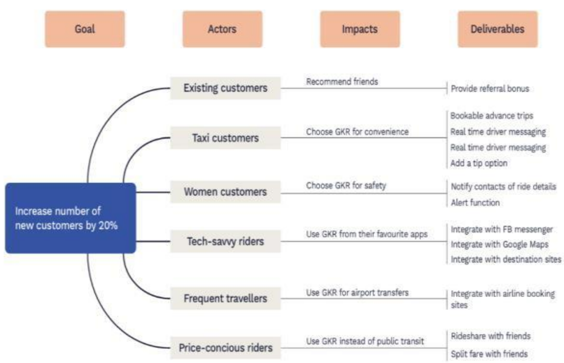
Key deliverables:

Product vision
Product strategy
Business objectives
Presentation of OKRs and KPIs

Product Roadmap Planning Session Exercise: Influence Map

What is an influence map?

Impact mapping is a mind mapping technique that allows teams to plan and visualize the strategic initiatives they will use to achieve organizational goals. These goals can be business-level, product-level goals, or individual team-level goals.



Example of influence map - Scrum.org site

What are the benefits of an influence map?

Impact mapping is a team exercise that teaches participants (the product team or stakeholders) how their efforts and ideas relate to the outcomes specified in the product strategy and vision. This is a great exercise for planning a product roadmap that allows everyone to gain a clear understanding of the product and its business goals.

How to make it?

There are four main roles in the influence map:

Objectives (why):

A goal is a measurable result that businesses want to see. An influence map can also be used to determine specific user goals. Always make your goals SMART: specific, measurable, attainable, relevant and time-bound (Specific, Measurable, Attainable, Relevant and Time-bound)

Effects (How):

These are the things that actors ideally do for you to achieve your goal. It is also important to define behaviors that prevent you from getting closer to your goal (negative effects). This way you can define the desired effect to minimize that negative behavior.

Actors (who):

These are people who can help you achieve results. Actors can be people who use your product, people who prevent you from reaching that goal, and people who can bring you closer to that goal.

Who are you doing this for?

Who can stop you from doing this?

Deliverables (what):

The main question to ask here is, "What can you do. Will it reduce the positive impact or the negative impact?" Once you define a deliverable in each impact, you'll have the specific tasks and deliverables necessary to create an action plan.

Hunt and collect inputs and needs

Gathering input from your internal and external stakeholders isn't just a collaborative exercise, it's an opportunity to gain insight from the data provided. In general, the most important sources of input and priorities are from the following groups:

- User/customer/user needs
- Internal stakeholders, heads of departments, sales managers, customer service, design, development
- External stakeholders, investors and managers

A good product roadmap is a combination of justified strategy decisions and goals from every team and stakeholder involved in your product development. When you involve the right people in the product roadmap process, you allow everyone to connect their daily efforts to the company's mission. Other advantages of the joint product roadmap planning process include the following:

- Faster product delivery by implementing a transparent mapping process
- By encouraging stakeholders to discuss their priorities, you reach a compromise on their importance.
- It teaches the team how to link their solutions to overall goals, KPIs and product strategy.
- Helps to gain new and previously undiscovered perspectives on old and new problems.

Define the themes in the map by defining user needs

If you're using a topic-based roadmap, one way to define these blocks is based on customer needs. Tailoring product roadmap activities and features based on customer needs allows you to reduce stakeholder resistance because you're essentially solving real user needs; And you show them that your plan isn't aimless or focused on the wrong metrics, giving them confidence that the product is set in the right direction. Gather the necessary information to define the themes of your roadmap from the following sources:

- Reviews
- Face-to-face meetings
- User interviews to understand audience pain points
- Customer feedback and support requests
- Audience survey

Category	Feedback
User metrics	I really love the way you show me the statuses and percentage so that I can learn more about how I.m performing against the others.
Reporting	I don.t understand how ti export my user data to use in XLS
Mobile	It would be great if I could use this on my ipad.
User metrics	When I click on the number I expect it so show me a breakdown of each instance of the test.
Reporting	Why can.t I filter my data on this view? It would be really helpful.
User metrics	I really need to see a keyboard breakdown without having to run a complicated SOL query

Example from Product Perspective

Share and present your roadmap

Now, let's move on to the interesting part which is presenting the product roadmap to the stakeholders. By now, you've done the following:

Collaborated with stakeholders (internal and external) to determine their priorities for the product and business.
You used quantitative and qualitative research to create product roadmap themes around customer needs.
You created what was the best product roadmap template for your specific needs.
Worked with different teams to find out if there is a limit to each of these activities

You mapped these strategy-related activities using a product roadmap. The presentation is where you validate that final product roadmap you've spent so much time building. A good roadmap during construction has the chance to be shown to stakeholders and have their feedback, understanding motivations and adding them during the planning process. This presentation is an opportunity for them to publicly emphasize their alignment.

Providing a product roadmap is just an acknowledgment of the alignment already built during the roadmap planning process. Think of the presentation as an opportunity to "deliver" the product roadmap to the rest of the company. You share the final plan that everyone has input on and give everyone access to it.

Product roadmap presentation categories

Short term updates

These frequent syncs take place on a weekly or bi-weekly basis, addressing built-in features and showing their impact on other departments. These types of meetings are common in smaller teams, and because these meetings happen regularly, it is not necessary to talk to all stakeholders before the presentation; But the product roadmap should be communicated to everyone before the meeting to avoid any surprises or serious reactions.

Long term updates

For larger organizations and teams, product roadmaps happen monthly, bi-monthly, or even quarterly. For these conversations, before the meeting, you should have talked with all the stakeholders and used their opinion in making the roadmap, this is very essential. These sessions can often involve content-intensive projects that rely on extensive alignment and dependencies.

What do you really need to provide when presenting your product roadmap?

As we mentioned earlier, we can't tell you exactly how to create the right product roadmap for your organization, but I recommend that you at least consider the following criteria:

flexibility

Personalization

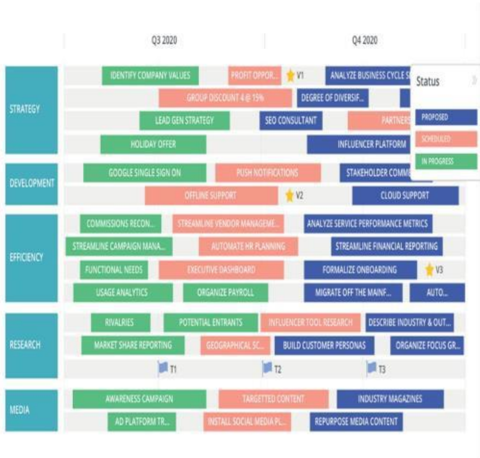
Cooperation

Clarity + attractiveness

1. Flexibility

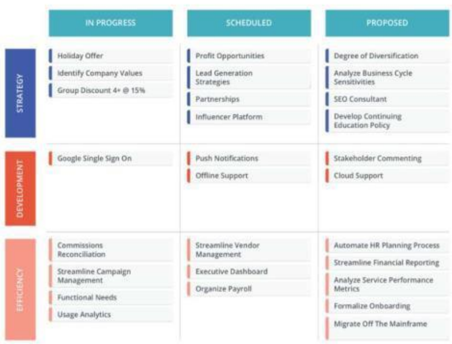
Does your roadmap distinguish between what is planned and what is not yet done?

It is very useful to communicate between operations that are in progress and operations that have not yet started. One of my favorite ways to build a product roadmap is to organize items under In Progress, In Plan, and Proposal. If your organization works on a timeline, you can code the items in your roadmap.



If your organization prefers to avoid scheduling, you can also create a Swimlane show with the titles In Progress, Planned, or Suggested.

Stakeholders clearly and immediately specify which features they are committed to and which activities are undecided.

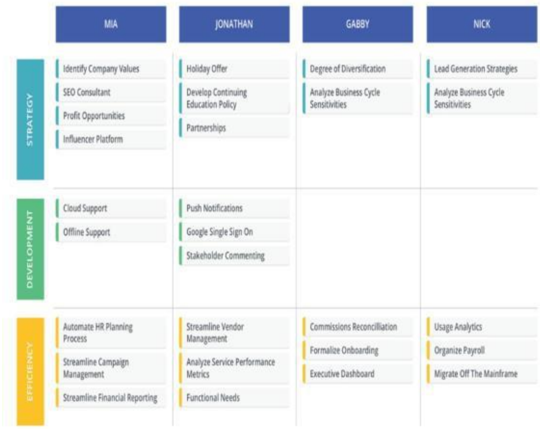


2. Personalization

Does the product roadmap meet the needs of each department or stakeholder?

As we mentioned above, visualizing ownership when presenting a roadmap can also be effective. A great way to do this is to organize your roadmap by sections, even by the person responsible for each task. The roadmap below contains the same data as the roadmap above, but this map includes captions that show individual ownership of each project.

If you really want to record holdings, you can use the Swimlane View roadmap, which highlights sections, resources, and individual holdings. In this case, the focus is on who will do what for which department.



3. Cooperation

Can you quickly change the product roadmap during the presentation?

One reason why sticky notes are a sustainable way to create a roadmap is that: It makes change very simple and quick. Before the ideal presentation, you should have talked with all the stakeholders and used their opinion in creating the roadmap, and if you are able to change quickly during the meeting, your meeting will be much smoother.

4. Clarity + attractiveness

sounds good? Is the product roadmap clearly visualized?

The main purpose of your roadmap is to visualize your strategy and make it clear to everyone in the organization. "We might build something beautiful," but if your roadmap is illegible or unclear, you'll sabotage your end goal.

Obviously, the content of your roadmap is more important than the appearance of your roadmap; But highlighting key information is a very simple move that has a significant impact.

Chapter Four

Dedicated BIM software

There are several major software developers creating products with varying functionality and capabilities in the BIM world. These developers primarily provide BIM tools for the construction industry. It is important to note that there are numerous companies competing in this market, all making different claims that need to be carefully substantiated before a customer makes a purchase decision.

Just as a car buyer will need to assess his needs from a car to determine which model is right for his purpose, a software buyer also needs to evaluate the needs of the activities very carefully in order to choose the product that meets his needs from among the various products.

Most people buy a particular product primarily based on hearsay or assumptions, which leads to unpleasant results. It is recommended to buy a software product only based on the necessary research about the needs and processes in the project in order to achieve the real result and greater satisfaction.

Learning a product and researching its specifications is difficult. Most potential buyers want to be sure that they will get the job done easily and without any problems. Of vital importance in BIM is developing a proper understanding of the concepts and applications of BIM processes to enable intelligent choices between available products. Once you have a proper understanding of BIM, answering the following questions will be helpful in choosing a specific product.

What is the purpose of the software? Is it used to make a model? (What needs to be modeled)? Will the model be used for management and observation? Will the model be used for analysis? Which data and parts of the model are critical, for example lists of values, 3D visual forms, central databases, ...

Who will use this software? How will the software be built? How long does it take for people to become experts in this software? When do most developers update software? How long has the particular product been on the market and how much has the software changed in these 10 years?

What file formats can easily be played in the software? What is its original format? How other formats can be imported from the software?

Are there examples of case studies of other users who have done something close to what the software needs, exactly how the software company could solve it?

Levels of BIM software

If we consider BIM concepts as the "soul" of the system, BIM software will play the role of the "body" of the system. In other words, software's play the role of human executive arm in dealing with these concepts. BIM software can be used at three levels. These levels are as follows:

BIM tools

It is a program with specialized task and special output. For example, modeling tools, map generation, cost estimation, identification of physical conflicts and errors, energy-related analysis, rando, time planning and visual display are included in this group. The output of this level of software is often independent; But sometimes these outputs are entered into another software (such as the output of estimating values that can be entered into another software for cost estimation). In other words, BIM tools lack the necessary structures and rules to update the design and only achieve a specialized purpose, including performing an analysis on a designed model.

BIM software platform

BIM is a program typically used for design that generates data for multiple purposes. This level of software, unlike tools, has stored parametric rules and other rules needed to maintain the accuracy of the model. Most of the software platforms have the capabilities of the tools, such as map generation and identification of physical conflicts.

BIM environment

Data management in an organization, for one or more information channels that include several applications, including tools and software platforms. The purpose of the BIM environment is to integrate tools, software platforms and communication between people.

The use of these environments makes it possible to use a variety of high-volume information that is used for project management (including video, photo, recorded voice, email, ...). Software platforms do not have the ability to manage such a wide range of information.

Although BIM is a new category in the construction industry, a large number of software have been developed for BIM. Here is a list of BIM software according to their application category.

BIM modeling software

This software will be used for modeling in BIM projects. Many of these softwares have many users in the world of building information modeling, which we will explain more fully in the future. Some of these software are as follows:

AUTODESK REVIT

ARCHICAD

VECTORWORKS

TEKLA

AECOSIM

ALLPLAN

CATIA

SOLIDWORKS

DESIGN FOR FABRICATION

RHINO BIM

BRICSCAD BIM

AUTODESK FABRICATION

BIM parametric modeling software

Parametric software is designed to develop and speed modeling. Many of these software currently derives their power from high-level programming languages such as Python and C#. In other words, modeling using visual programming is common in these software, and the user must be able to model with original software. Some of these software are:

DYNAMO

GRASSHOPPER

XGENERATIVE DESIGN

HYPAR

EDGEWISE

Beam analysis and design software

These software work in the direction of project design and optimization. In fact, this group of software can be used to design various elements of the structure, facilities, energy and construction process. Keep in mind that various factors are involved in the selection of these software in the design, which will be decided by the BIM team according to the conditions. Some of these software are:

ROBOT STRUCTURAL ANALYSIS

Etabs-Safe

STAAD

SEFAIRA

SCIA

GREEN BUILDING STUDIO

LADYBUG

BIM workgroup software

One of the features of the BIM process is the use of a working group in all engineering groups and project stakeholders, therefore, various software are designed for the simulation and cooperation of different groups. Currently, with the progress of each of these software, the power of collaboration in the BIM process has intensified. Some of these software are:

BIM 360

TRIMBLE CONNECT

ALLPLAN BIMPLUS

BIMSIGHT

DROFUS

BIMX

BIM validation and interference software

The most important part of using the BIM process is finding conflicts between BIM files. In fact, before construction, all these interferences should be checked and each one should be examined professionally. This capability is very difficult and tiring in traditional methods, so due to the development of technology, softwares have been designed to discover these interferences, some of these softwares are:

NAVISWORKS

SOLIBRI MODEL CHECKER

BIMCOLLAB

BIM TRACK

REVIZTO

BIM ASSURE

SIMPLEBIM

vision

Revit vision is a suitable software for building information modeling, which can be used in design projects to improve modeling.

New features and settings in Revit software have made it easier to use in various designs and modeling.

Vision software is also an application software for the field of architecture, and the tools and features in this software are specifically created to perform building information modeling tasks.

This feature of the vision software has made it easy to create complex structures and completes design and documentation in a short period of time and with great accuracy.

Smart models created by visualization software include an overall project and are stored in a database file.

Vision in architecture

The options for adjusting the performance calculation in the visualization software have made visualization more efficient, because the performance of visualization in modeling in large projects has been increased by the new settings.

The use of vision software in the field of architecture is of great importance and maximizes productivity in creating designs and documenting workflows.

In addition, the use of vision software speeds up the designs and updates the project faster when changes are made.

Visualization software is used in architecture to create detailed construction plans in the shortest possible time, and the use of coordination and designs in vision makes ideas more quickly implemented and the degree of coordination in the project process increases.

Vision software features

Creating perspective scenes in Vision

The productivity of the vision software has increased due to the creation of perspective settings in this software, and there is no need to make quick changes in the designs, and only by making small changes in the settings related to the creation of perspective scenes, the desired changes can be applied in the design.

Improved productivity with new ability to make adjustments to perspective views. You no longer have to change quick changes.

Preparation of MEP details:

Contractors and MEP agents can prepare models prepared in-view using the contents of the products for a more coordinated model.

The construction of components, joint definitions, more control over joint definitions and standardized section lengths are done in this way, which leads to an increase in exact lengths and greater coordination of values.

Structural analysis:

This vision software feature improves data integrity during information modeling operations, and by using it, you can create compatible parameters by assigning the expected parameters.

Preview designs in Revit

Parametric modeling in vision software has provided a significant tool for conceptual design. Using visualization software, architectural designers can quickly design the net plan of each floor or make changes to the standard building plan and immediately provide previews of future homes to clients.

Design perspectives and 3D modeling provide designers with the opportunity to try out different design ideas and guide their design decisions at an early stage.

Fast design changes, without repetition with Revit:

During the design phase, the building structure and floor plans change regularly.

With visualization software, design and modeling in architecture becomes very fast and accurate. In the vision software architecture model, all building components such as plans, sections and elevations are intelligently connected to each other.

Whenever a change is made to the model, the software automatically displays each relevant component and affects the entire building model.

Advantages of the visualization software (Revit)

BluEnt, a globally recognized construction company, lists the following benefits for vision software:

A preview of the future house in 3D BIM modeling

Visual parametric modeling is an important tool for conceptual design. Using this software, architect designers can very quickly draw the general plan of the floors or make changes in the standard building plan and immediately provide it to the customers so that they can have a preview and an idea of their future home. 3D images of designs allow designers to try out different design ideas and guide their design decisions from the early stages.

Fast design changes, no repetition

During the design process, the building structure and floor plan need to be modified regularly. By visualizing, architectural design and plan revision becomes very fast and accurate. All building components, such as plans, sections, elevations, and views are intelligently linked together in the view. Whenever a change is made in the model, the software automatically applies the change to other components and affects the whole building model.

A large collection of parametric building components

It is a powerful visualization software with a complete set of parametric building components. Visibility allows us to easily and very quickly make changes to existing components. Also, these changes and new parameters can be saved and used in another project. When you as an architect plan a new project, you can use the saved parametric objects as a reference for your potential clients.

High quality construction documents

The high modeling capacity of Revit Architecture enables designers and modelers to easily identify possible problems and bugs and fix them in the early stages. This feature is the result of error-free and quality documentation of this powerful software.

Accurate meter evaluation and estimation

One of the most important advantages of using information modeling software is the automatic generation of quantities and costs (BOQ). BIM modeling software such as Vision provides the exact amount of material required as a by-product, with minimal effort. This advantage helps contractors and employers to estimate the budget needed to complete the project.

Improved coordination

Vision software has been able to separate design, modeling, structure and facility management in a single environment. This feature allows all stakeholders to be up-to-date and aware of their responsibilities while improving coordination between these departments. In this case, each person's complete understanding of the project occurs and design conflicts and risks are eliminated.

High level of flexibility

Unlike AutoCAD, Vision allows all project data to be stored in a single project file. This feature allows multiple users to work on a single project and changes are saved to it with each save. In addition, you can take DWG, DXF, DGN, PDF, JPEG input and output from the view file.

Introduction and history of ArchiCAD software

ArchiCAD software is a software in the field of CAD that is widely used in the simulation of building information. As mentioned, this software is used for modeling and simulation in the field of BIM, and this capability has been extended for Windows and Macintosh laptops and computers. By using Archicode, you can apply and implement all the necessary points and details in terms of aesthetics and aesthetics, as well as technical and engineering points in your design.

Evolution of ArchiCAD software

1982 may be considered the first year when ArchiCAD software released. In this year Archicode developed and launched for Apple Macintosh. In 1987, the Hungarian company Graphisoft presented a new concept called unreal or virtual building. A concept that caused a huge transformation in the way of building designs in the fields of architecture and civil engineering. For this reason, many experts in the mentioned fields and disciplines consider this software as the creator and initiator of building data simulation.

ArchiCAD is known as the first product in the field of CAD software that develope for personal computers and not just for organizational and office uses. Also, ArchiCAD software, which has extensive capabilities such as creating and constructing different dimensions and volumes in three dimensions, is known as the first product in the field of BIM. Among the key features that distinguish Archicode from other software operating in this field, we can mention the ability to store a large amount of information and data in the desired 3D model. The mentioned ability has caused this software to create a revolution in the building design industry and urban and non-urban environments.

History of ArchiCAD software

ArchiCAD; A complete set of many applications

If we want to have a general look at Archicode software, we can consider Archicode software as a complete set for designing and modeling in the field of BIM or Building Information Model. This software provides many functions and extensions to the user, which are very necessary for all types of 2D and 3D design, to visualize information and provide other information that helps to better understand the map.

The add-ons and capabilities mentioned help students, architects, surveyors, and other professionals in the field to do the best possible building information simulation. Another unique feature of Archicode is its integration with other software in this field. This feature makes the user unnecessary to learn and work with many similar software and can implement all the requirements that should be considered in designing a good map using Archicode software.

In this regard, in order to learn more about the capabilities of Archicode software, in the following, we will mention some of the software with which Archicode has a complete overlap.

ArchiCAD software

ArchiCAD's relationship with 2D CAD software and 3D simulation software ArchiCAD software has a complete overlap with 2D CAD software to meet all the needs of its users. This overlap is such that if the user has enough mastery of Archicode, he can easily use the tools available in it for drawing and achieve a complete and accurate output, in terms of details.

In addition, among other capabilities of Archicode, this software has the facilities of 3D simulation software. ArchiCAD software allows the user to design various types of buildings and very powerful 3D volumes. Therefore, it should be said that Archicode, having great software features, can solve many of the needs of its users in the field of design and mapping.

Ability to render plans and maps

Another feature that has made ArchiCAD software so popular is the availability of architectural rendering software add-ons; This feature helps to visualize the data and increase their comprehensibility.

It is interesting to know that these days the use of 3D software for rendering as a preview of the desired design has become very common. Using the Rendering tool makes the design created in three dimensions more intuitively understandable and easier for many people to understand. Also, by creating a real model and viewing the plan in three dimensions, you can understand many points and details forgotten in the plan and take action to fix them. Therefore, by providing visualization facilities for 3D designs, ArchiCAD software allows its viewers and users to view and check design features, required materials and other important items in a more realistic and advanced manner.

ArchiCAD overlap with desktop publishing software

If we want to prepare texts with page layout and regular and organized structure, desktop publishing software will help us a lot. Due to their wide range of features, these softwares allow their users to print and design posters, business cards, ... using Archicode software. Also, Desktop Publishing software, with its features, help the texts that need to be pasted next to various maps and designs to be placed in the desired place with the utmost accuracy and quality. ArchiCAD software, having such a powerful tool in its structure and facilities, allows the user to implement his printed designs with great precision and elegance.

Archicode software has the features of document management software

Undoubtedly, one of the challenges of any huge project is the accurate and regular collection of data and information. To overcome such problems, many softwares have been developed in the fields of document and information management. By using such software, it is possible to classify various information, files and data and have an organized and documented archive of information.

Also, one of the other key features of such software is maintaining data security. Therefore, by using document management software, while classifying and organizing information and data, you will be safe from theft and keep your key data safe. Having such a feature, Archicode software has helped its users to organize various codes, information and data. By using Archicode software, you will not need a separate software to classify your information and data. Also, while keeping your data safe, you can access them even remotely and take multiple backup copies of your data.

Rhino[1]

Rhino software is a powerful 3D modeling software born in 1980 by Brian McNeel in Seattle, USA, and it uses the non-uniform rational B-spline system.

which is actually a mathematical system for calculating and presenting curves and surfaces in computer graphics. Defining geometry with mathematical lines has made Rhino ahead of other modeling software in converting geometry into real examples. Another advantage of this software is the modeling of complex shells with simple commands.

Rhino provides users with accurate modeling tools that can be used to prepare their designs for rendering, animation, analysis, construction, ... Rhino software provides unlimited possibilities to users so that they can design their ideas without restrictions.

The applications of Rhino software are in interior decoration, architectural design, industrial design, furniture design, mechanical design, face and personality design, cartoon and caricature design, ...

In a more precise definition of this software, it should be said that Rhino software is a powerful industrial software that is used to design complex surfaces and volumes. The tool used in Rhino ceros software is much more accurate than the tools used in other software, and for this reason, this software is more popular among architectural software such as 3D Max software and sketch up software, ... This software is flexible and has the ability to read the output files of other software and has special commands that are unique to this software and this feature is seen in few software, and on the other hand, the high speed of this software is a feature that makes it very special.

1 Rhinoceros 3D

History of Rhino

Rhino Software is a powerful 3D modeling software from McNeill. This software is based on inappropriate lines. Nonlinear lines, as defined mathematically, are more accurate than mesh-based software such as Max, Skype, AutoCAD, ... Another advantage of this software is complication with simple commands. In the past few years, Rhino has been able to compete with other 3D modeling software to produce professional 3D modeling tools.

Today, large design and production companies use this powerful software in the design of their products in various fields, including the following:

Adidas - BMW - Boeing - Fiat - Ford - Nokia - Nike - Motorola - Kawasaki - Intel - Hyundai - Honda - Hitachi - General Motors - Pioneer - Samsung Electronics - Sharp - Siemens - Toyota - Yamaha Motor

Applications of Rhino software

Gold and jewelry design

Interior decoration

Architectural Design

Industrial Design

Vehicle Design

Marine design

Film and series design

Mechanical design

product design

Architectural plan design

And …

Rhino software features

Unlimited 3D modeling

Using Rhino, you can implement and create all your desired ideas and designs.

Excellent accuracy and features

Designing, prototyping, engineering, analyzing, documenting and manufacturing any design in various sizes.

The possibility of unlimited changes and edits

You can change and edit the files you want without any restrictions.

Compatibility and coordination with software and hardware

Rhino is compatible with all other software and it is possible to import files from other software, such as Archicode architecture software, which is mostly used in BIM modeling, ...

Quick and easy learning

Instead of learning other complex software such as 3D Max software, which has multiple tools and difficult functionality, and has architectural plugins for 3D Max and other complex plugins such as v-ray plugin, learn Rhino.

Super speed

With its incredible speed, Rhino can be run on old and low-end Hei systems without any problems.

Ability to formulate and model three-dimensional forms

extreme accuracy; Design, prototype, engineer, analyze, document and manufacture anything in size

Unlimited edits and changes

2D mapping and illustrator;

support and coordination with software and hardware;

Support for all standard 2D and 3D formats;

File transfer with all software models (including Solid works, Catia, 3DsMax, Sketch, ...).

Features of Rhino software

Rhino software is a free surface modeling software that uses the NURBS mathematical model. The structure and Open SDK of Rhino software makes it modular and allows the user to customize its environment and create custom commands and menus. Many plugins have been provided by McNeil and other software companies that enhance the capabilities of Rhino software in specific fields such as rendering and animation, architecture, marine science, jewelry making, engineering, prototyping and other fields.

File format

The (3D.Rhino) software file format is useful for exchanging NURBS geometries. Rhino software developers started the OpenNURBS project to provide computer graphics software developers with tools to accurately transfer 3D geometry between different programs. OpenNURBS, an open source tool, includes the 3DM file format, documentation, C++ source code libraries, and .NET2.0 assemblies to read and write the format on supported platforms (Windows, 64-bit Windows, Mac, and Linux).

NURBS curve

Compatibility:

Rhino software is compatible with other software and supports importing and exporting more than 30 CAD file formats.

When importing CAD formats other than local format. 3dm, Rhino software converts geometries to their native format. When adding a CAD file, the geometry is added to the current file.

When the AutoCAD file format changes, the Open Design Alliance reverse-engineers the file format so that these files can be loaded by other software. Rhino's Import and Export modules are actually plugins, so they can be updated with service versions.

Rhino software is also compatible with a number of graphic design programs. One of these programs is Adobe Illustrator. This method is more suitable when working with vector files. First, save the file and save it in Adobe Illustrator (*ai) format from the opened menu. You can then control the vectors created in Rhino and modify them in Adobe Illustrator.

3D printing

Rhino 3D software relies on a number of plugins that facilitate 3D printing and allow exporting to STL and OBJ formats, both of which are supported by many 3D printers and 3D printing services.

In a recent study, i.materialise firm, a leading 3D printing service, compared 25 popular 3D modeling software. Despite Rhino's later plug-ins to support 3D printing, the software ranked 13th in the survey, ranking below industry-standard 3D suites such as SolidWorks.

Scripting and programming

Rhino software supports two scripting languages. Rhino script (which is based on VBScript) and Python (V5.0+ and Mac). It also has an SDK and a complete plugin system. One of McNeil's plugins, which is a parametric modeling and visual programming tool called Grasshopper, has attracted many architects due to its ease of use and the ability to build complex algorithmic structures.

A robot modeled in Rhino and rendered in flamingo plugins and extensions

Commercial third-party plugins for Rhino software include:

Import and Export

Analysis

Scan&Solve for Rhino: fully automates the structural simulation of Rhino solids

Diva for Rhino by Solemma LLC: Environmental Analysis for Buildings.

This plugin originally developed at the Harvard Graduate School of Design and is now developed and distributed by Solemma LLC.

render

Brazil for Rhino: Robert McNeil developed the Brazil rendering engine for Rhino

KeyShot by Luxion: rendering and animation

Octane Render for Rhino by OTOY

Maxwell Render for Rhino: by Next Limit Technologies

nVidia Iray for Rhino: by Nvidia

Realtime Renderer Plug-in for Rhino: by Autodesk

V-Ray for Rhino: by Chaos Group

This render makes using v-ray for Rhino and shows advanced v-ray effects such as light refraction and caustics.

CAM

madCAM by madCAM AB: Mold and casting CAM system for making 2.5, 3, 3+2, 4 and 5 axis tool path

RhinoCAM, RhinoART, Rhino3DPrint, RhinoCAM-Mill, RhinoCAM-Nest, RhinoCAM-Turn by Mecsoft: turning, rapid prototyping.

Animation

Bongo: Animation for Rhino 5 by Robert McNeil et al

Other

RhinoGold, RhinoNest, RhinoEmboss, Clayoo by TDM Solutions: Jewelry Making, Manufacturing, Modeling

VisualARQ by Asuni CAD: BIM architectural modeling tool

RhinoWorks by Bricsys: Constraint-Based Parametric Design in Rhino

Shape Modeling for Rhino by Autodesk: creation, analysis and modification of free surfaces

T-splines for Rhino by Autodesk: T-spline modeling

Urban Network Analysis by MIT-SUTD Joint International Design Center:

Tekla Structures software

TEKLA Structures software is a very powerful software for designing and modeling massive steel and concrete structures. Tekla Structures is sometimes known by its old name, XSteel, which is the name of the steel part of this software. This Finnish software is a drawing tool and its first version released in 1966. Tekla Structures initially used as a tool for designing steel structures; But over time, other capabilities have been added to it, including the modeling of concrete structures. However, the capabilities of this program for modeling steel structures, especially bolted structures, are rare.

Civil engineers, measurement and estimation experts, structural designers, metal building builders and executive plan producers are among the main audiences of this software. Tekla Structures can be placed in the category of CAD and BIM software. In other words, Tekla Structures is a software for computer-aided design and building information modeling. 3D rendering of construction and industrial structures is the most important thing that users can do using Tekla Structures. Revit and Architectural Desktop are the main competitors of this software.

Features of Tekla Structures

Tekla Structures has more than 30 different working environments and supports various standards and 14 living languages of the world. This wide coverage has made Tekla Structures very popular among users of different countries. The ability to transfer data to software such as ETABS, SAP2000 and AutoCAD is another feature of Teklastructures. Also, the structures designed in this software can easily be analyzed in STAAD Pro software. This software, while simple, has very extensive features, which are compiled in the following list of these features.

Structural modeling in TEKLA Structures software

Modeling of all types of steel and concrete structures:

Modeling structural components such as beams, columns, slabs, foundations, joints, stairs, braces, ...

Having a rich library including all kinds of details and tools such as all kinds of profiles, screws, nuts, rebars, welds, ...

Ability to define new connections by the user

Providing all kinds of material estimation reports and listofer for executive works

The possibility of networking systems and the simultaneous activity of several people on one project and under one server

The possibility of carrying out each phase of a project on different systems and the final integration of all of them in an integrated manner

Automatic production of workshop drawings, including cutting drawings, construction and assembly drawings, and installation drawings.

With all the details and without the need for any manual drawing

Production of cutting plan in order to reduce sheet waste in the workshop

Generating readable information by various CNC machines

Modeling structural components in TEKLA Structures software

TEKLA Structures consists of three main parts: modeling, mapping and reporting. By using the capabilities of this software, it becomes possible to design and model many structures easily. Stadiums, industrial sheds, oil platforms, refineries, power plants, factories, bridges, towers and residential buildings are among these structures. Factories producing steel parts and factories producing prefabricated concrete parts are also users of TEKLA Structures.

One of the biggest football sports stadiums in the world built by using this software. London's Wembley Stadium is the tallest stadium in the world with a capacity of 90,000 people. 215 thousand tons of concrete and about 23 thousand tons of steel were used in the construction of this stadium. In addition to construction companies, many reputable oil, gas and petrochemical companies also use this software in their designs. Big companies around the world use Tekla Structures capabilities to carry out their projects. PIDEC Company, SEZA Turkey Company, DAFOUS Group, Tasha

Machinery Company and Germany's LINDE Company are among these companies.

Building Information Modeling (BIM) software

The software market is flooded with different types of software. This can be architects, engineers

and surprise construction (AEC) on the BIM solutions they should use when executing their construction projects.

List of the best BIM software

AutoCAD

Navisworks

Infuria

Vectorworks Architecture

Autodesk Revit

Autodesk BIM 360

ALLPLAN

Tekla BIMsight

Trimble Connect

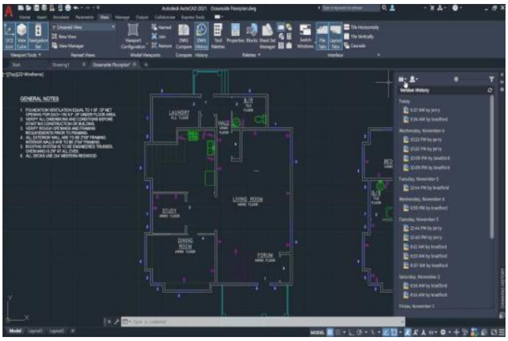
DataCAD

What is building information modeling software?

BIM software provides a model-based process used by the construction industry to plan, organize, design and manage buildings and infrastructure. The software collects data and provides a realistic representation of buildings and infrastructure before, during and after construction.

To achieve its goals, BIM software should help construction industry professionals complete the various tasks involved in creating a structure. For example, it should facilitate collaboration and communication, provide tools for turning theoretical ideas into concrete ideas, and explain what each phase of the project will cost.

AutoCAD is the best BIM software for automation



AutoCAD is a software that is used to produce CAD drawings from the available facilities and systems. AutoCAD uses 2D and 3D modeling to render buildings, from exterior walls to many spaces and sections within the structure. It does this in scale and detail to give as realistic a digital representation as possible.

Beyond walls, doors and windows, AutoCAD software can simulate everything from plumbing to HVAC and electrical to provide a top-to-bottom context for the facilities inside as well as the facilities themselves.

AutoCAD provides industry-specific features and libraries for the various specialties of project team members. The software solution provides access to more than 750,000 objects and smart parts in its libraries.

AutoCAD speeds up design time by automating routine tasks such as inserting doors and generating invoices. The designers of this software cite several productivity studies in various tool sets - architectural, electrical, 3D drawing, mechanical, MEP, Plant 3D and Raster design in AutoCAD, showing an average of 63% increase in productivity. AutoCAD starts at $275 per month.

Advantages

It saves time

accuracy and validity

Lots of file formats that can be opened on other software

Excellent mobile response

Disadvantages

Long learning curve

Does not integrate with MS Excel

It is expensive for small companies

Building Information Modeling (BIM) is a big concept. There's a lot going on when it comes to understanding the difference between what BIM is, how it's used, and what it facilitates. After seeing models of buildings and the systems within them, many people naturally ask if AutoCAD is a BIM. This is a good question – one that invites opportunities to discuss BIM versus what it facilitates.

The short answer is no, AutoCAD is not BIM. It is a BIM facilitator. Computer-aided design (CAD) drawings—like those created in AutoCAD software—are an integral part of a BIM system. All the information that represents BIM is generally placed on CAD drawings and models, giving context to the infrastructure, systems, and design elements of a building.

CAD and BIM are combined, the former being a building block for the latter. You can't have BIM without CAD, but an AutoCAD mockup doesn't necessarily represent BIM by itself.

BIM vs. CAD

CAD drawings are an essential part of BIM. Without accurate and comprehensive markup of a building and its systems, BIM and the information it provides have no context. Where a blueprint may only show measurements, a CAD drawing shows the materials. BIM takes information from both and pairs it with other facility information to quantify each aspect of the facility. Without CAD drawings, BIM is incomplete.

Many people have trouble distinguishing BIM from CAD because BIM information is constantly represented in the form of CAD drawings. On the surface, CAD drawing can easily be confused with BIM. However, CAD drawings alone lack the critical contextual insights that make BIM such a powerful resource for facility managers.

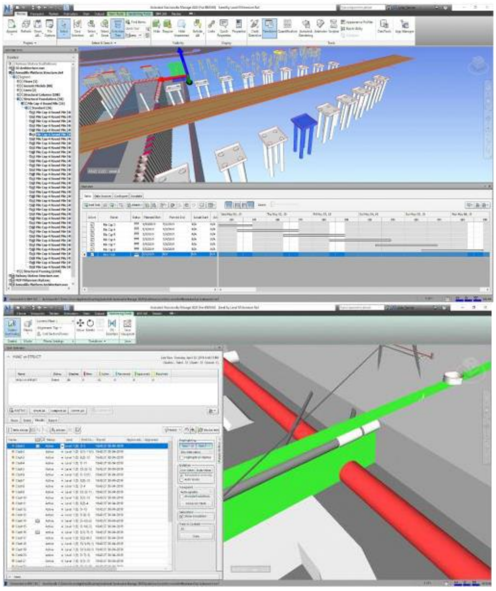
A look at BIM software

To further complicate the relationship between CAD and BIM, BIM software often includes CAD functions. Since so much of BIM depends on CAD drawings, there is considerable value in bundling CAD tools with BIM software. Of course, established modeling software – such as AutoCAD – usually has more robust features and capabilities, and it can be more beneficial to import more detailed CAD drawings rather than using generic tools...

In response to the question "is AutoCAD a BIM", the answer may be no, but this does not mean that CAD is less important in the context of BIM as a discipline. You can't have BIM without CAD. CAD is the canvas for digitally recreating facilities, and BIM shows all the details and colors that create an immersive image of the building and its multiple systems and functions.

The relationship between CAD and BIM is symbiotic, and this is one thing managers should be aware of as they immerse themselves in BIM as a discipline. Whether they use stand-alone AutoCAD software to digitally reconstruct facilities and import them into the BIM platform, or use CAD tools in BIM software, the fact remains the same: BIM starts with CAD. It provides context and clarity to the vast amount of information collected in BIM and helps facility managers understand their building in a visual way.

Navisworks is the best software for simulation



Navisworks allows users to create 3D programs as well as perform 5D simulation analysis.

Navisworks is a review and project management software for AEC professionals and teams. It offers two products: management and stimulation. Navis Manage offers 5D simulation analysis, collision detection, advanced coordination and simulation tools.

Navisworks analyzes and communicates project details using a feature known as 5D Analysis and Simulation. The software promises to improve project team workflow through integration with Autodesk BIM 360 Glue.

Navisworks is another BIM solution developed by Autodesk. The main difference between Navisworks and Revit is that Navisworks is more of a project review solution for AEC (Architecture, Engineering and Construction) professionals. Like Revit, it can also work with MS Windows and it can also work with other Autodesk 3D solutions to open and combine their models, inspect them and navigate through them effortlessly.

Due to its nature, Navisworks is more important in the first stages of any project, i.e. the pre-construction phase, controlling and predicting the outcome of the project from the beginning. Both model coordination and collision detection are included to help identify any problems before actual construction begins. There is also model simulation, animation, aggregation of data into a single model, and a host of other features. Navisworks pricing starts at $115 per month.

Advantages

Cost-effective for all company sizes

Free trial

Access to previous versions/versions

Disadvantages

Mobile devices are not supported

Used primarily in the construction industry to complement 3D design packages (such as Autodesk Revit, AutoCAD, and MicroStation), Navisworks allows users to Open and combine 3D models. Move around them in real time (no WASD possible). And review the model using a range of tools including Comments, Redline, Perspective and Measurements. A set of plugins enhances the package and adds interference detection, 4D time simulation, realistic rendering and PDF-like publishing.

UK-based developer NavisWorks (a subsidiary of Lightwork Design, Sheffield) originally create this software. Autodesk acquire NavisWorks for $25 million on June 1, 2007.

components

Navisworks (formerly Jetstream) is built around a core module called Roamer and has a number of built-in functions:

Core Roamer allows users to open models from a range of 3D design and laser scanning formats and combine them into a single 3D model. Users can then browse the model in real time and check the model with a range of markup tools. Publisher allows users to publish a complete 3D model in an NWD file that can be freely opened by anyone using Freedom, a free viewer, Clash Detective feature to enable clash detection. This means that users can select parts of the model and look for places where the geometry conflicts. This is to find flaws in the design

Infurnia is the best web-based BIM design software

Infurnia's easy-to-use architectural tools allow you to create detailed designs.

Infurnia is a cloud-native BIM design software that allows you to seamlessly implement BIM while creating your architectural drawings, easily collaborate across functions, and efficiently manage your data. Infurnia is the perfect choice for residential architects looking to add BIM functionality to their designs.

Infurnia is free for individual architects to use, while a dedicated plan for teams starts at $50 per month.

Vectorworks Architect is the best BIM software for coordination

Vectorworks is flexible and designed for designers.

Vectorworks is flexible enough to support a construction project throughout its lifecycle: from conceptual design to coordinated BIM models and construction documents. This software solution is loaded with designer-focused tools and features, allowing the workflow to have a lot of freedom and flexibility.

Vectorworks Architect is a solution package that includes both CAD and BIM tools. Its main purpose is to work with the design process, 2D and 3D, without compromising the creative vision of the original model. You can use this package to improve your entire workflow, from conceptualization to actual construction.

There are design-oriented capabilities, parametric objects, industry-leading BIM tools and more - all to simplify the process of creating your virtual dealership. It's not a replacement for a creative process, but an extension of it, giving creators a much wider range of choices and tools. Vectorworks starts at $210 per month.

Advantages

Fast rendering of 3D models

Easy to learn and use

Excellent automatic saving and data backup

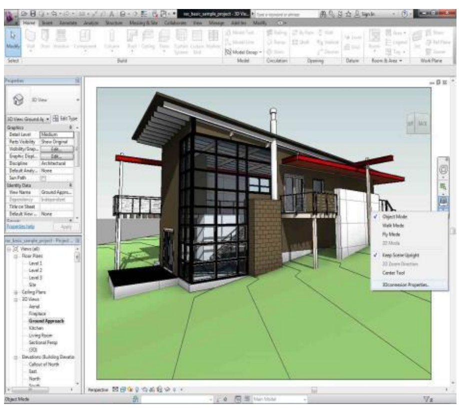
Disadvantages

It may be impractical for smaller companies

Requires high-performance personal computers

There are many bugs in the MacOS version

Autodesk Revit is the best software for floor plans



Design floor plans and visualize building plans with Autodesk's Revit.

Autodesk's Revit is a BIM solution that helps architectural and construction firms design floor plans. It provides the possibility of cooperation with experts in different fields. It can be used to manage construction for the entire life cycle of a construction project.

Autodesk Revit starts at $1,850 per year.

Advantages

Seamless integration with other Autodesk solutions

Many ready-to-use templates

Great for project management

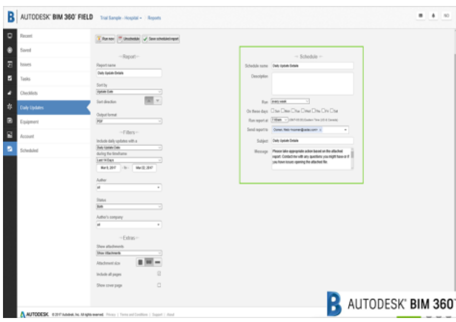
Disadvantages

Uses an annual subscription per user

A high-performance computer is required

Users must create their own object libraries.

360 BIM Autodesk



Autodesk's BIM 360 allows users to create 3D, color-coded plans.

BIM 360 is an integrated platform that communicates real-time project teams, data and workflows throughout the entire project lifecycle. This leads to informed decision making.

Another Autodesk creation is their BIM 360 software, which works with construction management and project delivery. It unifies the various design, project and construction processes into a single process. At its core, it's a cloud-based web service to avoid delays and improve decision-making by giving different teams access to relevant data.

Your entire project lifecycle can be managed with Autodesk BIM 360. Some of the notable features include design review, BIM coordination, safety program checklist, issue management, deliverable coordination, ...

BIM 360 starts at $480 per year.

Advantages

Great for project management

Live design updates between project teams

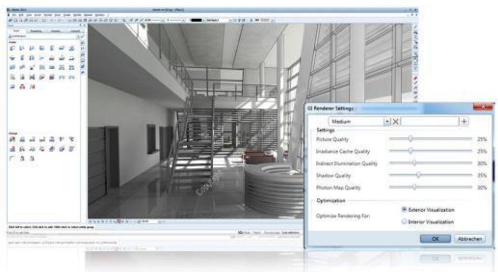
Disadvantages

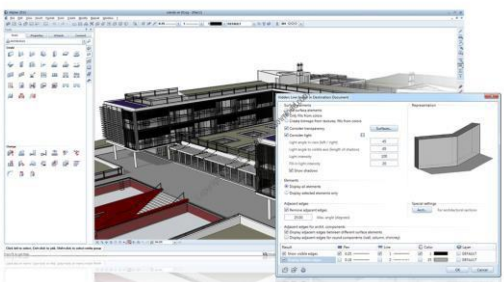
The interface is not user friendly

High learning curve

Unstable CAD file collaboration

ALLPLAN is the best comprehensive building information modeling software





ALLPLAN is designed to help architects plan and draft buildings. ALLPLAN is a solution for architects that covers the entire design process. From initial draft submission to production of working drawings, it supports the provision of detailed plans and costing of the construction project.

ALLPLAN pricing is available upon request.

Advantages

Short learning curve

It does not require high-performance hardware

Free trial

Disadvantages

Not compatible with Linux operating system

The interface is not user-friendly

Detailed automatic drawings sometimes require manual completion

Tekla BIM sight is the best free BIM software solution

Tekla BIMsight allows users to visualize schedules, conflicts, and conflicts.

Tekla BIMsight is a free BIM solution that provides an environment for professionals to combine 3D models, share data and information, resolve conflicts and explore conflicts in the design process.

Advantages

Mobile platform is supported

Does not require high-performance hardware

Easily predicts costs

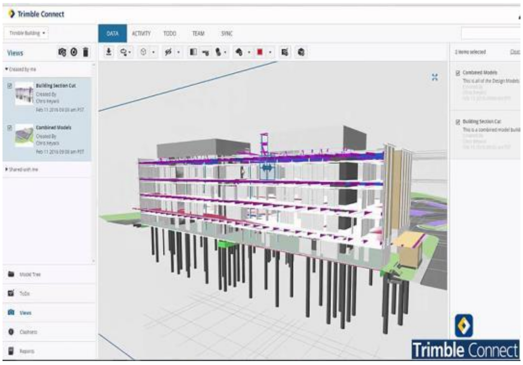
Disadvantages

It requires considerable training time

Sectional views of the design cannot be printed.

Not available on Windows

Trimble Connect is the best software for connecting team members to the right data



Trimble Connect helps users visualize construction projects from different views and angles.

Trimble Connect is a free collaboration tool that promises to streamline decision-making and increase project efficiency by connecting the right team members to the right data at the right time.

Trimble Connect is a cloud-based BIM information exchange product. Its core expertise is in providing the right data to the right professionals at the right time. Some of the people who can benefit from this technology are MEP professionals, subcontractors, architects and others. An environment focused on collaboration is what Trimble strives to create.

Providing critical information in a timely manner may be critical to various stages of your workflow. Some of the main features are design coordination, on-site/off-site communication and project management. It can also be integrated with many building tools to make your work easier.

Pricing for Trimble Connect is available upon request.

Advantages

A free version is available for a personal account

A free trial is available for a business account

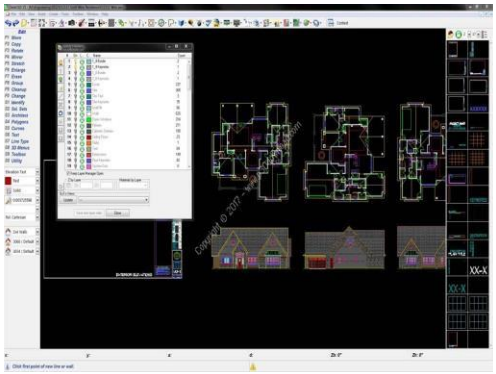
Disadvantages

Requires a strong internet connection

The interface is not user friendly

It does not support 2D design

DataCAD is the best BIM software for beginners



Create floor plans, visualize buildings, and create 3D models with DataCAD.

DataCAD is a Windows-based CAD software that enables architects, engineers and construction professionals to draft, design, 3D model and document. This software solution provides integration with SketchUp 3D modeling tool for production design and model development. It also offers photorealistic rendering and associative dimensions.

DataCAD pricing starts at $395 per license.

Advantages

Easy to learn

Easy to use and intuitive

Very fast 2D creation

Disadvantages

It only supports Microsoft Windows operating system

Minimum facilities

3D capabilities are not great

What are some uses of building information modeling software?

BIM software can be used throughout the project life cycle. It plays a role in early stages, including virtual mock-ups, design visualization and validation. The software also provides collision detection/avoidance, detailed trade coordination, scope clarification and options analysis.

At the end of a construction project, BIM software provides tools for marketing. Other elements that the software focuses on include: facility operations, traffic routes, environmental sustainability, sight line studies and construction sequence planning/phasing plans/procurement.

Other software

Revit

Revit is a famous BIM construction software that aims to solve various architectural and design problems. It is developed by Autodesk and is one of the most popular solutions in the industry. Many different professionals can use Revit's feature list, including architects, designers, MEP (Mechanical, Electrical, and Plumbing) professionals, contractors, and more. This software provides an intelligent approach to the various stages of the construction process through models.

This software is exclusive to Microsoft Windows and can significantly reduce miscommunication problems by managing different parts of the process in one system. The same system also increases overall coordination efforts and you can even simulate visuals of different projects with it. Because Revit is considered a 4D BIM – it can also track the entire life cycle of a particular construction project, from the first concepts to regular maintenance or demolition.

Revizto

The core of Revizto is to provide an integrated collaboration platform in the BIM environment for 3D and 2D workflows that enables users to communicate with all project participants and stakeholders in a common environment. Revizto solutions can be used at all stages of construction and include features such as collision management, problem tracker, synergy for 2D/3D models and even the ability to explore your models in VR. This tool is a centralized and user-friendly platform to have everything you need at your fingertips. This enables accurate and critical data to be available to all stakeholders regardless of skill level, allowing them to make better, faster and more efficient real-time decisions.

ArchiCAD

ArchiCAD is a 3D BIM software with design and modeling as its main goals. It is developed by Graphisoft and can work with both MS Windows and Mac desktop systems. ArchiCAD is very popular in urban planning, design and architecture because it can improve the entire workflow for these professions. All of ArchiCAD's features are as useful as possible for the purposes, including its aesthetic and technical aspects.

ArchiCAD is also considered one of the first BIM implementations and can work with both 3D and 2D geometry when needed. The variety of BIM visualizations and functions allow ArchiCAD to be useful for any construction or architectural firm, and that's why ArchiCAD is considered one of the most innovative examples of BIM software on the market.

Edificius

Edificius is a unique BIM platform for architectural design. Architectural design is much easier with the ability to work in 2D and 3D dimensions, taking into account all the new technologies and rules. There is also garden and landscape visualization, static and real-time rendering, and more.

Some of the BIM features also include real-time cost estimation and structural engineering, a list of free in-house resources through a free catalog, and more.

General Midas

midas Gen is one of many products produced by midas.

The main purpose of midas Gen is building management with BIM features. It can be used to perform structural analysis by considering various theories and functions to get practical and accurate results.

midas Gen can also be used to simplify various structures to be more convenient, efficient and versatile. CAD-like features are used to create a visual modeling experience with nodes and elements. Other features include full analysis, automatic design, user-friendly interface, ...

SketchUp

SketchUp is an easy-to-use modeling tool that enables users to transform regular lines and shapes into various 3D shapes. Thanks to the built-in set of 3D models, there is no need to do everything from scratch.

There are many different tools that can be included in SketchUp. A typical free 3D modeling tool can be accessed from a web browser. A more comprehensive solution, Pro has its own desktop client and can offer more versatile options for your 3D projects. And finally, Sk.hUp Studio offers you to analyze various parameters of your models and works before they are built in real life.

Buildertrend

Buildertrend is an in-construction BIM tool that is best suited for remodelers and home builders. This cloud-based BIM product offers various features including real-time access to your project from anywhere, warranty management, change orders and access to all subsequent data attached to the project such as photos, documents, ... Coming Soon.

This set of tools makes it a popular choice for residential construction professionals. There are also features like overall project management, customer management, financial tools and pre-sales process. Each of these features includes a variety of functions and features such as plan markup, budgeting, and more.

BIMobject

BIMobject is one of the few free BIM content platforms. This solution is widely used by architects, contractors and designers to access industry-specific BIM objects. The only requirement to access this platform is a registration form that you can fill out for free. There are thousands of different BIM objects organized into different categories based on type, size, region, file type and more. Advanced filtering helps a lot to find exactly what you need.

Civil 3D

Civil 3D is another BIM product created by Autodesk with a focus on civil engineering, but it also offers some BIM-related features and workflows. Civil 3D helps develop projects more accurately, with fewer errors and risks, and faster adaptation to project changes. Simplifying more difficult and time-consuming tasks is also possible with Civil 3D (intersection and corridor design, site grading, ...).

BricsCAD BIM

Another comprehensive BIM software is BricsCAD BIM – an all-in-one solution that can manage every process of your project, such as detailing, designing, and turning it all into a fully functional building information model. You can freely control the elements and features of your project regardless of its size.

Another way to specify something in your model is to include additional information such as definitions, layers, ... There are also intelligent structural modeling capabilities that you can use to automatically classify linear solids.

Saphira

Sefaira is a BIM design analysis program that mainly works in the early stages of construction. Its primary purpose is to study HVAC and ventilation systems for energy, daylight, and comfort goals. It can easily interact with programs like SketchUp or Revit and can provide a wide range of inputs and controls for your analysis process.

Hivacamp

Another solution that addresses specific BIM issues is Hevacomp. This software is specifically built to perform building energy analysis, allowing you to build energy-sufficient infrastructure with predictions based on real- world performance.

The solution itself includes several different BIM tools such as Dynamic Simulation, Electrical Designer, Mechanical Designer, ... For example, Dynamic Simulation allows you to create building simulations based on UK Building Regulations. Simplification of the construction process is possible through a single standard building model.

Creo

In today's modern world, it is natural for someone to try to use the benefits of artificial intelligence in favor of BIM. This is where Kreo comes in and works as a cloud-based intelligent scheduling software that brings AI capabilities to your work. Kreo is divided into two different parts: Kreo Plan and Kreo Design.

Kreo Plan can analyze existing BIM models and try to improve them through detailed reports, forecasts and other necessary information. On the other hand, Kreo Design is a tool that helps companies create BIM models in the early stages.

VisualARQ

VisualARQ is a built-in BIM program whose main purpose is to enhance the usability of the Rhinoceros 3D CAD program - widely used for industrial and architectural designs. One of VisualARQ's main specialties is free-form modeling, which allows users to transform any free-form geometry into complex shapes that can be filled with various unique geometries. It can also offer dynamic documentation, an integrated object editor, and more.

Wild

The Wild is another remote collaboration platform, but this one can use virtual reality and augmented reality to help you save time, make better decisions, and make fewer errors by visualizing your designs. Both Sk....hUp and Revit are supported out of the box. The Wild is trying to bring everyone into the virtual future of collaboration on a completely different level than before.

Allplan architecture

As the name suggests, Allplan Architecture is a BIM solution built primarily for architects. You can easily use this software to create professional visualizations and drawings while having accurate costs and quantities of required materials.

Working with 3D or a combination of 2D and 3D is easily managed with Allplan Architecture. At the same time, the user-friendly interface helps an architect's overall productivity, and you can easily exchange data with different planning partners for better teamwork and collaborative efforts.

AECOsim building designer (designer of open buildings)

AECOsim Building Designer is a BIM software design infrastructure developed by Bentley Systems. Can work simultaneously with multiple disciplines including architecture, electrical, structural, mechanical, ...

Recently, a significant increase in overall productivity, speed, connectivity and other parameters has been observed for AECOsim Building Designer. It can also work seamlessly with mesh modeling to create parametric BIM concepts and content.

ActCAD BIM

ActCAD BIM is an extension of ActCAD 2020, which is a 3D modeling software, but with additional functions related to BIM. For example, it works natively with DWG and DXF files and can open many other files as well. ActCAD BIM base is IntelliCAD 9.2 engine with ODA 4.3 libraries. You can add generic build parts to your model with simple commands. There are also a number of BIM-related tabs in the Tool Palettes menu alongside your standard 3D modeling options.

BIMx

BIMx is a multi-platform solution that allows users to render BIM models in 3D and 2D, bridging the gap between the drawing board and the actual construction site. The list of supported platforms is as follows: MS Windows, Mac, Android and iOS.

The root of this software is a Hyper-model concept that allows you to quickly change 3D models in the form of design sheets. There are three main apps: Mobile Viewer, Desktop Viewer and Publisher. At the same time, the 3D models themselves are presented in an interactive approach, making the whole interaction more user-friendly.

dRofus

With Rofus, extensive workflow support and building information can be accessed at any point in the construction lifecycle. It can be freely integrated with popular BIM modeling software such as Revit, ArchiCAD and IFC to synchronize data both ways. There are also many other features available, such as more accurate decision making, converting data into a single standard format, increasing project credit efficiency, significantly reducing risks, ...

Procore

Procore is another construction management platform that promotes extensive collaboration between all parts of the construction process. This technology itself is user-friendly and intuitive. It's easy to use to streamline your workflow. The overall user-friendliness makes it very valuable for people who are not well versed in 3D modeling .....

Procore is considered one of the best solutions in the market today and consists of 4 main areas: field productivity, construction finance, quality and safety, and project management. Each part represents a specific area of the area in a project and they should work together to be even more effective when used by both professionals and ordinary people.

ArCADia BIM 11

ArCADia BIM 11 is a software that can accelerate design work through many useful solutions. For example, there is an object library that you can use to avoid wasting time modeling each window, and the whole design is object-oriented. A degree of BIM technology is also supported, such as document sharing and comparison, use of the original DWG format, detailed design using coordinates, printing capabilities, and other useful features.

Tekla BIMsight

Another contributor is construction collaboration software Tekla BIMsight, which allows you to combine models, identify conflicts, and resolve issues with other participants in the process. The main purpose of this software is an advanced BIM and structural engineering system. It's even easier to identify and solve problems when you can find them in the design phase before construction begins.

There's 3D navigation, markup, IFC support, object transparency, multiple model viewing, and tons of other features. Additionally, all Tekla BIMsight features are now available in Trimble Connect.

Manager of BEXEL

Another example of comprehensive BIM software is BEXEL Manager, developed by Bexel Consulting. It is a sophisticated solution that specializes in managing construction project activities. There are also plenty of integration opportunities, IFC-certified standards, and more than a decade of general experience in the market. BEXEL Manager's feature list includes features like budgeting, schedule optimization, cost analysis, change management, progress tracking, and more.

PriMus IFC

The main purpose of PriMus IFC is to take measurements from various 3D models and generate bills of quantities automatically. This tool is a reference standard for many 3D BIM solutions. With this tool, you can easily stay on top of your estimates. It can also update itself whenever changes are made to the relevant 3D model, perform IFC file viewing, manage price lists, and more.

IrisVR

IrisVR is one of the few companies that offers immersive design review and collaboration using virtual reality capabilities. There are many integration opportunities with software such as Revit, Navisworks, Sk....hUp and others, allowing you to have an easy and immersive VR experience when presenting your projects. IrisVR is represented by a desktop app called Prospect, which can work with the HTC Vive, Oculus Rift, and the Microsoft MR headset. A mobile app is also available that supports Samsung GearVR, Google Daydream and Cardboard.

What are some of the benefits of BIM software?

BIM software offers benefits that can benefit the life cycle of a building project in the construction process and the performance of the building once it is handed over to those who manage it. Below, I briefly look at some of the benefits of BIM software for architects, structural engineers, project managers, investors and other players in the real estate sector.

Real-time updating of data: BIM data incorporates the collaborative work of the project team, allowing the integration of automatic changes to the details and drawings of the building or infrastructure when a critical element changes. This means that modifying one element of the design also results in changes to other related elements through parametric modeling (the ability to reshape the model geometry whenever a dimension value changes).

Accurate Timeline: This software enables the transfer of work resources, deliverables, materials and all space requirements within the team. Therefore, it provides an information model that helps all team members understand where the project is at any given time.

Project site geographic assessment: BIM software applications provide an analysis of the social and geographic impact of a building or infrastructure on a construction site. It indicates the viability of a given project at a particular site.

Simulation and Visualization: The software offers several simulations that allow designers to visualize all aspects of construction projects – simulations such as sunlight in different seasons and other weather conditions. Also, calculating the required energy of a building can be done using BIM technology.

Conflict resolution: BIM software also automatically detects potential collisions between different building elements (e.g. electrical conduits collide with pipes, beams, ...) early enough for users to adjust their parameters. It also ensures the perfect fit of off-site manufactured elements.

Complete presentation: A completed and detailed 3D model of the construction project can be presented to consumers to sell commercial spaces and obtain regulatory approvals required to begin construction projects.

Transparency: The open collaboration feature makes all data and information about a project available to all project team members who need it.

Access from Anywhere: The database provided by the software solution and its cloud capabilities means that the model or data can be accessed from anywhere with any device. Therefore, improved efficiency, productivity and the ability to make changes to project details should be available even when you are away from your office or home computer.

What industries were inspired to move to BIM software?

The gradual decline in labor productivity experienced by the construction industry since the 1960s led to the development of tools that eventually led to BIM software. This reduction meant more working hours per contract amount. Therefore, labor saving ideas should be generated.

The fragmented nature of the construction industry has led to this decline in labor productivity due to traditional methods—the project delivery approach, two-dimensional computer-aided drafting (CAD) technology, and the size of firms in the construction industry.

2D CAD technology does not adequately integrate design drawings with cost and schedule. It does not adequately and effectively support collaboration between the project team. Hence, the team—architects, engineers, and construction professionals—had to provide their own separate CAD to stakeholders (contractors and owners). Such designs can easily lead to conflicting information.

In this context, BIM software became a necessity as a way to bring together different aspects of a project.

BIM software comparison criteria

Below, I list some of the important details and criteria I use when searching for the Building Information Modeling software solution that is the best fit for a project and company:

User Interface (UI) Is the software clean and attractive?

Usability and reliability: Is it easy to learn and master? Does the company or vendor provide good technical support, user support, training, and education for those who want to use the design tool?

Integration: Is it easy to connect with other structural engineering software, BIM modeling and BIM tools? Are there pre-built integrations?

Automation: Does the software improve efficiency through automation? Value

for Dollars: How well is the price for the features, functionality, and use cases? Is pricing clear, transparent and flexible? Some 3D BIM software can be used for free.

Key features of building information modeling software

Here are some features to look for when looking for the best building information modeling software for your needs. Of course, the specific features that work with a particular project depend on the specifics of that project.

Architectural Modeling: The software should help teams go through the incremental steps that lead to the final design. It should also allow them to provide tokens that are easily recognizable, so modifications can be made to different file formats.

Workflow process management: Check if the software provides insights into workflow processes based on collected data and history.

Content and document storage: This feature ensures that documents are stored in a retrieval system, allowing those who need to use them to find them easily and optimizing knowledge transfer.

Data management and analysis: The software should help users manage and analyze data in an automated way throughout the entire building design process. It should also have the capacity to generate reports.

Finance and Accounting: Construction projects can easily go over budget if teams have no idea of the costs of various processes. Therefore, you want to find software that has financial and accounting capabilities.

Collaboration: Project teams thrive when there is collaboration. Therefore, you want to make sure that the software you choose allows teams to work interactively.

Chapter Five

An overview of the ISO standard

The International Organization for Standardization (abbreviation ISO; / ˈ aɪ soʊ /) is an international standard development organization that is composed of representatives of national standards organizations of member countries. Membership requirements are listed in Article 3 of the ISO Constitution.

Founded on February 23, 1947, this organization develops and publishes standardization in all technical and non-technical fields except electrical and electronic engineering. It is headquartered in Geneva, Switzerland, and operates in 167 countries as of 2022. The three official languages of ISO are English, French and Russian.

The International Standard Organization is an independent and non-governmental organization whose members consist of different national standard institutions. As of 2022, 167 members are ISO representatives in their country, each country having only one member.

This organization develops and publishes international standards in all technical and non-technical fields except electrical and electronic engineering, which is the responsibility of the International Electrotechnical Commission. As of April 2022 ISO has developed more than 24,261 standards covering everything from manufacturing products and technology to food safety, agriculture and healthcare.

History

The organization known today as ISO began in 1926 as the International Federation of National Standards Societies (ISA), which focused primarily on mechanical engineering. ISO suspended ISA in 1942 during World War II.

However, after the war, recently formed United Nations Standards Coordinating Committee (UNSCC) approach the ISA with a proposal to form a new World Standards Organization.

In October 1946, ISA and UNSCC representatives from 25 countries met in London and agreed to join forces to create a new International Organization for Standardization. The new organization officially launched on February 23, 1947.

Structure and organization

ISO is a voluntary organization whose members are official standards authorities, each representing a country. Members meet annually in a general assembly to discuss ISO's strategic goals. This organization is coordinated by the central secretariat based in Geneva.

A council with a rotating membership of 20 members provides guidance and governance, including setting the annual budget of the Central Secretariat.

The Technical Board is responsible for more than 250 technical committees that develop ISO standards.

Technical specifications available to the public

Technical specifications may be provided when "the subject matter is still under development or for any other reason there is a possibility of an agreement to publish an international standard in the future but not immediately". A publicly available specification is usually "an intermediate specification published prior to the development of a full International Standard, or in IEC it may be a 'dual logo' publication published in collaboration with an external organization". By convention, both types of specifications are named in a similar way to organization technical reports.

ISO 19650

ISO 19650 is an international standard for information management throughout the entire life cycle of built data using Building Information Modeling (BIM). It contains all the principles and high-level requirements.

BS EN ISO 19650 Organization and digitization of building and civil works information including building information modeling - Information management using building information modelling: concepts and principles.

BS EN ISO 19650 Organization and digitization of building and civil works information including building information modeling - Information management using building information modelling: data delivery phase.

BS EN ISO 19650-2020 Organization and digitization of information on buildings and civil engineering works including Building Information Modeling (BIM) Information management using Building Information Modeling Data operational phase.

BS EN ISO 19650-5:2020: Organization and digitization of building information and civil engineering works including building information modeling (BIM) Information management using building information modeling Security approach to information management

These standards are based on the UK standards for information management using building information modelling, i.e. BS 1192:2007 + A2:2016 and PAS 1192-2:2013. The principles remain consistent with these standards and changes in terminology are maintained through the UK National Forewords and the National Annex.

The following document also published along with the standards:

PD 19650-0 **-** UK Transposition Guide which, together with the UK National Prefaces and National Annex, helps to implement ISO standards in the UK.

What is "building information modeling based on ISO 19650 series"?

"Building Information Modeling (BIM) according to the ISO 19650 series" is about obtaining benefits through better specification and providing appropriate information about the design, construction, operation and maintenance of buildings and infrastructure using appropriate technologies.

This will help deliver the efficiencies and savings envisioned by the UK Government and others. The ISO 19650 series applies to the entire life cycle of a data and applies to all types of data in the built environment – buildings, infrastructure and the systems and components within them. A successful outcome of adopting BIM processes in accordance with the ISO 19650 series will have the following characteristics: clear definitions for the information required by the project client or data owner and the standards, methods, processes, deadlines and protocols that govern its production and review. The quantity and quality of information produced is sufficient to meet defined information needs, while not compromising health and safety or security. Too much information represents wasted effort by the supply chain and too little means customers/owners are making uninformed decisions about their projects/data. Efficient and effective transfer of information between people involved in every part of the life cycle – especially within projects and between project delivery and data operations. Informed and timely decision making. The end result will be efficiencies gained through reduced waste/rework in design, construction, operation and maintenance activities, as well as reduced risk.

BS 1192

It is widely recognized that uncoordinated construction information is a significant cause of delay, cost and conflict. BS 1192 sets out a method for managing the production, distribution and quality of construction information.

This includes construction information generated using CAD systems. It originally based on the work of Avanti and CPI.

the second edition BS 1192-5:1998 replaced the first edition BS 1192-5:1990, in 1998.Third edition, joint production of architecture, engineering and construction information. The Code of Practice published on December 31, 2007, providing a more comprehensive Code of Practice that can be applied to information systems based on 2D and 3D models.

It applies to those involved in the preparation and use of construction information during the design, construction, operation and decommissioning of projects. It is applied to buildings and infrastructure projects.

The British Standards Institution (BSI) suggests that it may provide useful guidance for software developers.

It establishes common methods for naming, categorizing, layering, and exchanging data when setting up projects that involve collaborative work as well as defining roles and responsibilities.

Data exchange is managed through a Common Data Environment (CDE).

It is the single source of project information used to collect, manage, and disseminate documentation, graphical models, and non-graphical data to the entire project team. Information in CDE is classified as follows:

BIM process implementation standards

As a relatively new technology, Building Information Modeling (BIM) will sooner or later have a list of accepted standards.

BIM itself can be defined as a shared knowledge resource that hosts various information about a specific project and helps to make appropriate decisions at all stages of the project.

BIM has been known as a hot topic for the past few years, and for good reason. The potential benefits of adopting a comprehensive BIM system are huge and far outweigh any possible disadvantages. When it comes to efficiency, speed, collaboration, accuracy and much more, you can see the fundamental differences.

However, for several reasons, the spread of BIM is still quite limited. There is a severe lack of understanding of how everything works, how much investment is required to have all the benefits and more. But one of the biggest factors holding back the spread of BIM is the number of different software currently on the market – the lack of standardization.

The existence of many different BIM tools makes it very difficult to choose the right solution, and the number of proprietary formats is simply staggering. This is why BIM needs a set of standards to be truly popular and widespread. The existence of standards allows for the existence of several different levels of BIM, and each has its own list of capabilities and benefits.

BIM standards, different levels of BIM

In fact, there are some BIM-related standards that already exist, and one of the earliest international lists of BIM standards is called ISO 19650. The International Organization for Standardization creates these standards and currently includes and operates at least two divisions:

In general, ISO 19650 refers more to the organization and digitization of various information about civil engineering buildings - including BIM as one of the methods of interaction with this information. The origins of ISO 19650 can be found in two British standards, BS 1192 and PAS 1192-1.

Both of these standards focus on efforts to reduce overall construction costs and provide a more effective framework for helping various process participants with collaborative efforts that improve nearly all phases of construction. Additional sections of ISO 19650 are also in the development process, they should focus on BIM security, data management, operational phase of the process in general, ...

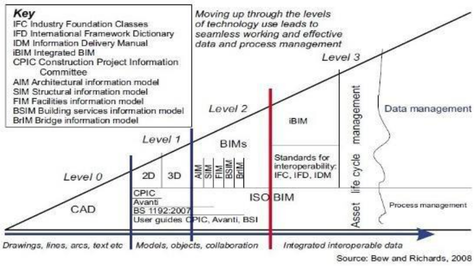
In general, there are three different levels of BIM information that are now commonly known, and there are also some other levels that are not used as much as others. For example, BIM still exists, although this level is essentially non-collaborative and only works with 2D CAD drawings. It is safe to say that the industry as a whole has exceeded this level for some time. However, some levels of BIM are not as widely accepted as this one.

BIM levels chart

All of these different levels of BIM (sometimes described as "BIM Maturity Levels" or the "UK BIM Maturity Model") can be visualized in the form of a BIM Levels Chart. Often referred to as a "wedge" due to its shape, this type of diagram is used as a key component of the UK's national BIM policy.

However, the relative simplicity of this BIM levels chart allows it to serve as a good example of the different levels of BIM and what they are intended to do in the first place. Some model variations may include the desired minimum level of BIM integration, and others may describe different standards and processes.

Mervyn Richards created first this model in 2008 by and Mark Bio and below you can find an example of this model.



The potential that BIM holds is truly enormous and can improve almost every aspect of the construction process for various projects in engineering, architecture and more. But it is also important to have a standard that everyone can trust so that there are no problems importing file formats, exporting data to different software devices, ... This is why BIM standards are so important now, and the ongoing process of BIM integration in many industries is accelerating this transition.

Map of BIM standards in the world

With the publication of the first part of the standard package ISO 19650: 2018 (Information Management – IM), the basic regulatory framework of BIM has assumed a picture like the picture presented in Figure 10. Although the last born, ISO 19650 (in its various parts) becomes the reference standard, applicable in all markets. In Europe, this standard is applied together with subsequent CEN standards (the first to define the level of information requirements: EN 17412:2021)

The basic relationship of the BIM standard

Today, only Italy and Great Britain have decided to use the faculty provided in ISO 19650 to insert a national continuum to facilitate local markets in its application. Other countries are considering their own annexes (Spain, France, Germany, Morocco, ...).

In particular, while Italy has taken the path of annexing the entire international package to national standards UNI11337 as a separate package, Great Britain has decided to withdraw its 1192 group standards and procedures as the basic principles of these assumed in ISO 19650. Place the remaining parts that have not been moved at the bottom of the UK national version of ISO 19650 Part 2 (in these regulatory annexes).

Italy's decision to implement the entire package of UNI 11337 standards is justified by the need to verticalize in the Italian market not only ISO 19650 but also all important ISO and CEN standards.

openBIM

openBIM extends the benefits of BIM (Building Information Modeling) by improving the accessibility, usability, management and sustainability of digital data in the built data industry. At its core, openBIM is a collaborative process that is vendor neutral.

openBIM processes can be defined as sharable project information that supports seamless collaboration for all project participants.

openBIM facilitates interoperability so that projects and data are useful throughout their lifecycle.

openBIM ensures that:

Interoperability is the key to digital transformation in the built data industry

Open and unbiased standards should be developed to facilitate interoperability

Reliable data exchange depends on independent quality measures

Collaboration workflows are enhanced with open and agile data formats

Flexibility in technology selection creates greater value for all stakeholders

Stability is protected by long-term mutual data standards

You can read the full definition here: openBIM Definition

International home of openBIM

Who is responsible for setting the standards that apply to openBIM?

buildingSMART International is recognized as the international home of openBIM.

buildingSMART is a global organization that is changing the built data industry through the creation and adoption of open and international standards. buildingSMART develops and maintains industry standards such as IFC, bSDD and BCF. IFC is standardized by the International Organization for Standardization (ISO). These rules allow the AECO community to use a common language for data export and import by creating a common standard. buildingSMART promotes the benefits of BIM to end users as a better way to collaborate and exchange data. With this foundation, buildingSMART takes a leading role in developing the value of BIM by providing more open and collaborative ways to move forward.

In 2019, buildingSMART took the first steps towards IFC4 software certification. The software certification program expands the range of industry stakeholders and provides open and unbiased certification for software applications. Certificates allow customers to specify service and data delivery without worrying about the format, compatibility or versioning of platforms used by service providers or customers internally.

The IFC4 certificate is split into two specific view definitions to better support the purpose of IFC data exchange. The design of Transfer View aims to support the transfer of model data for further use in design, analysis, estimation and facility management tasks. This can be understood as a CV2.0 with a wide range. The purpose of the reference view is to support the coordination of programming disciplines.

What are open standards?

To write a report, you usually use a word processing program. Perhaps, Microsoft Word or Apple Pages Once the report is complete, you'll probably want to share it with your audience. Normally, you don't send your reports as a native file, you usually publish a PDF version. There are several reasons for this:

First, if you submit a native file, anyone can make changes to your document without you knowing.

Secondly, native files are proprietary or closed formats. This means that the recipient must have the same app or a compatible app to view them.

Alternatively, if you export a PDF, the document can be viewed with a simple PDF viewer. PDF is an open standard. It's a lightweight file, but still packs a lot of functionality. The recipient can view the document, search for words, add comments or markup, but cannot change the original text.

This PDF workflow is comparable to openBIM.

In BIM, we start by creating a model using a commercial modeling software. Here we work in native or proprietary format.

At some point we want to share our model with the project team. If we export the native model, the receiving party must have similar or compatible software to view it. They can also make changes to the model without our knowledge. However, if we publish the model in an open exchange format, such as IFC, the model data is freely viewable—measurable and usable. But the content of the model is protected. Changes cannot be made to the IFC file. They are built into the original modeling software.

Therefore, creating model data in a native format is called NativeBIM. If we exchange the data of this model with an open standard like IFC, we are in openBIM.

But is there a closed BIM?

Some people refer to working in native file format instead of NativeBIM as a BIM package. This is a bit misleading as it suggests something anti-openBIM. In fact, NativeBIM is the basis of openBIM. You can only start an openBIM process by creating a model in the native format. You don't build models in IFC, you export them to IFC.

And at any stage of the NativeBIM process you can exchange data with open standards, thereby starting an openBIM workflow.

The term BIM package should really only be used to describe a scenario where openBIM standards are deliberately left out. For example, where the file exchange is exclusively in native format.

BuildingSMART

buildingSMART, formerly the International Alliance for Interoperability (IAI), is an international organization that aims to improve the exchange of information between software programs used in the construction industry. The company has developed Industry Foundation Classes (IFC) as a neutral and open specification for Building Information Models (BIM).

Date

IAI began in 1994 as an industry consortium of 12 American companies invited by Autodesk to advise on the development of a set of C++ classes to support the development of integrated applications.

This industry alliance for interoperability opened membership to all interested parties in September 1995 and This industry renamed the International Alliance for Interoperability in May 1996 because Autodesk users insisted that IFCs should be non-specific, and the development of the IFC standard led to the release of the first version of IFC in June 1996, at which time 26 companies, including Autodesk, Bentley, Nemetschek, and IEZ, committed to making their software compatible with IFC. IAI restructured as an industry-led non-profit organization and promoted the Industry Foundation Class (IFC) as a neutral product model that supports the building lifecycle.

In 2005, it changed its name to buildingSMART, partly because its members felt the name IAI is too long and complicated for people. It has regional divisions in Europe, North America, Australia, Asia and the Middle East.

activities

BuildingSMART says it develops and maintains international standards for openBIM buildingSMART Data Dictionary maintains the International Framework for Dictionaries (IFD) library

buildingSMART manages the data model organization of Neutral Software Industry Foundation (IFC) classes.

buildingSMART also maintains the BIM Collaboration Format (BCF), a structured file format used for problem tracking related to building information models.

MVD

Model View Definitions (MVDs) are buildingSMART's solution for creating IFC-based standards that can be implemented and tested.

MVD consists of three main components:

A set of conceptual templates These conceptual templates define additional conventions on how to use the IFC schema. A set of exchange requirements. It is a set of entities and properties from the IFC schema that are suitable for selecting use cases. A description of how the software handles the data being exchanged. For example, can the software use the data as a reference, or must the data be mapped to internal objects during import.

The buildingSMART software certification team, which operates the b-Cert platform (b-cert.org), uses MVDs to test software implementations for compliance.

In the buildingSMART community, the term MVD is mainly used to define the exchange requirements in a project. In buildingSMART solutions this is covered by a combination of IDM and IDS.

In principle, anyone can define their own MVD. Without common guidelines, these MVDs are unlikely to be interoperable and may require specific software implementations.

What is MVD?

In general, an MVD, or "model view definition", is a specific application of IFC to describe a particular usability or workflow facilitation. MVDs can be as specific as an entire schema (eg, for archiving a project) or as specific as a few object types and associated data (eg, for pricing a curtain wall system). It can add additional restrictions to the IFC scheme and even cancel some agreements.

The IFC scheme is designed to accommodate various configurations. For example, a wall can be shown:

as a line (curve) section between two points; As a type of 3D geometry for visualization and analysis (such as extruded solids or triangular surfaces). In simple forms or with specific construction details (taking individual studs, pipe fittings, wiring, ...) with data such as engineering properties, responsible person, schedule and cost information.

The IFC is a large set of agreements. An MVD uses IFC entities to define an exchange standard for a particular item or workflow. This exchange standard (MVD) is implemented by software vendors.

Since an MVD is implemented by software vendors, MVDs are the foundation upon which MVD-based software certification (b-cert) is performed.

Software implementation is reviewed based on the requirements of an MVD.

Example number 1

An architect sends a simple model to the client to embed it into a larger urban fabric model, allowing the client to visualize the design. The architect does not need to send all the data for complex modeling operations (e.g. CSG and object attributes). But you can send a simple surface-based geometry model with a simple color or texture map. This is a simple example for the reference view.

Example number 2

Prefab builders define how they want to receive IFC data. They define the use of sets and that they must represent exact geometry with BREPs. In addition, they specify what properties Precast elements should have. This is an example of IFC4Precast MVD.

MVD today

For a long time, everyone could create their own MVD and go to software vendors to implement it. This situation made several created MVDs not interoperable with each other and require more effort to implement in software tools. Software that supports example 1 (reference display) cannot automatically support example 2 (prebuilt). Software tools must update and extend their code to support multiple MVDs.

Historically MVDs have been a good solution to deal with technology limitations, but in today's market users and software vendors expect a different approach. Therefore, IFC 4.3.x has several basic MVDs defined by buildingSMART as the basis for several use cases. This increases interoperability between domains.

The IDS standard works with IFC to define computer-interpretable exchange requirements on a case-by-case basis.

MVDs in the near future

In IFC5, this will be more limited to ensure interoperability between different domains and IFC software implementations. IFC5 will be modular with a common foundation that has a limited number of implementation levels. Exchange requirements will be defined using the Information Delivery Specification (IDS).

Examples of MVD

The most common type of MVD for IFC version 2x3 is coordination view. The coordinate view is a filtered version of the full IFC schema. It is also created to coordinate the project among several users and different disciplines in the project. Finally, this is one of IFC's main programs in BIM technology.

Official MVD smart building for IFC 2x3

Coordination View - Spatial and physical elements for design coordination across architectural, structural, and facility (MEP) disciplines.

Space Boundary - Identify and export additional spatial boundaries (polygons that define the amount of space contact with adjacent direct surfaces (such as walls, floors, ceilings) and openings). It can be used for building energy analysis and quantitative harvesting.

FM Handover main view - a basic data presentation view for facility management (facility management). Transferring model information to CAFM Computer Aided Facility Management and CMMS (Computer Maintenance Management System) applications. The main scope of the vision can be summarized as a list of spaces and equipment for spatial and technical object systems. This view conforms to the following requirements in the aforementioned coordination view:

The ability to assign equipment and furniture items to rooms,

Allocating rooms to areas

assigning a classification to spaces and components,

Assigning main manufacturer properties to components (IFC standard and non-standard properties)

Allocation of doors and windows to the space,

Assign Component Type Information (IFC Product Type)

Exporting initial values for all project components and spatial structures

An example is COBie, a specification used to provide information about facilities management. This is a spreadsheet data format for providing a subset of building model information, not geometric model information.

Structural Analysis View - A structural analysis model developed in a structural design program and sent to one or more structural analysis programs.

EIR

The Employer's Information Requirements (EIR) forms part of the appointment and tender documents in a BIM project to enable suppliers to prepare their BIM Implementation Plan (BEP).

This document is created as soon as possible (pre-appointment or pre-contract document and before design or construction suppliers are appointed) either internally by the employer or often by their professional advisers.

EIR documents

BIM building information modeling is a very broad term that describes the process of creating and managing digital information about a built asset such as a building, bridge, tunnel, ...

In the UK, the government requires fully collaborative 3D BIM (with all project and asset information, documents and data being electronic) as a minimum on public procured projects. As of 4 April 2016. This represents the minimum requirement for BIM Level 2.

Projects that incorporate Level 2 BIM ensure that the right information is created and shared in the right format at the right time to make better decisions during the delivery and operation of the built asset.

The Employer's Information Requirements (EIR) defines the information that the Employer requires from its internal team and suppliers to develop the project and operate the completed built asset. Relevant extracts from the employer's information requirements are included in the procurement documents for the appointment of any supplier appointed directly by the employer. which may include; Consultants, contractors, ...

Prospective suppliers respond to the client's information needs with a pre-contract BIM implementation plan against which their proposed approach, capability and capacity can be assessed. Developing employer information requirements is likely to be an iterative process:

Initially, this may take the form of a simple information requirements process map that identifies the key decisions that must be made during the project to ensure that the developed solution meets the business needs, and defines the information requirements very broadly. .

To make those decisions to identify materials needed, operational and functional information about facilities, floors, and spaces is developed.

As the design progresses, it identifies more specific requirements for proposed systems and building components to support logistics.

At the end of the project, it defines the information needs to support the maintenance and operation of the systems and components that are actually installed.

Information requirements The employer must clearly state the information requirements of each supplier and describe the expected information in terms of documents, model files and structured information.

It should also specify how and when to exchange information in the project life cycle. However, the exact nature of the client's information needs depends on the complexity of the project and the client's experience and requirements.

Experienced employers may establish very detailed employer information requirements, while others may set only high-level requirements and some ground rules and allow the supplier to suggest how these requirements can be met.

In general, depending on the employer, employer information requirements may include:

Standard methods and procedures that define how information is created, named, and exchanged.

Information-related roles and responsibilities provide a clear definition of information-related roles and what is expected of them.

An information delivery plan or release schedule that specifies which deliverables should be delivered, by whom, and when.

A COBie demand matrix that specifies which structural data about facilities, floors, spaces, areas, and building components must be delivered and when.

PAS 1192-2:2013 Information Management Specification for the Capital/Delivery Phase of Construction Projects Using Building Information Modeling specifies BIM Level 2 requirements and suggests that the client's information requirements should include:

Data management:

Levels of detail (requirements to submit information in defined phases of the project)

Educational requirements:

Work planning and data separation (model management, naming conventions,.....)

Coordination and conflict detection:

Requirements for bidders' proposals to manage the coordination process.

Requirements for bidders' proposals to manage the cooperation process.

Requirements for tenderers' proposals for BIM shared data environment supporting CDM health and safety management.

A schedule of any security and integrity requirements for the project.

A plan of any specific information to be excluded or included in the information models.

A program of employer-imposed limits on the size of model files, the size of extranet uploads or emails, or the file formats that can determine the size of a volume. Other project-specific items such as pre-construction inspections or the employer's requirement to receive information models that describe new products and assemblies.

Definition of any coordinate system origin:

Timeline of each software format, including version number, to be used by the supply chain for project delivery (formats of each output NB PAS1192-2 suggests that:

Public sector employers may be unwilling or unable to specify software packages for use by their suppliers, but instead can specify formats for each output. Private sector employers may specify software packages.

Business Management:

Alignment of information exchange, work steps, purpose and required formats.

Details of the expected goals for the information presented in the models.

A primary responsibility matrix that identifies any discipline responsibilities for producing the model or information in line with the defined phases of the project.

A table of standards and guidance documents used to define BIM processes and protocols for use on a project.

A schedule of any changes in the roles, responsibilities, powers and standard qualifications specified in the contract.

Competency assessment:

Details of the competency assessment that candidates have to answer.

Changes in related tender documents

BIM tender evaluation details.

The contractual status of the employer's information requirements can be determined by reference to it in the BIM protocol or annexed to the protocol.

BIM protocols such as the freely available CIC BIM protocol provide a contractual definition of BIM responsibilities, obligations and limitations. The contract used for appointments can be appended to a BIM protocol by adding a model modification clause.

The EIR defines what the client wants to get from the project information model at the end and at each stage. For example, if a client wants their facilities management (FM) team to implement a variable maintenance schedule, this should be set out in the EIR so that the project team knows to input full product specification details into the model. It basically creates an EIR

Who shares the information? - Draw the responsibility matrix

Information Required - Detailed information requirements

When is the information required? Project milestones

Why is the information needed? Defined informational purpose

It is important to note that regardless of BIM maturity, both Level 1 and Level 2 BIM require clearly defined information requirements. The approach should be tailored, while a Level 1 EIR focuses on CAD deliverables, a Level 2 EIR focuses on model-driven deliverables.

The information requirements specified in the customer information model should be defined as part of the client's requirements. This is often as an information delivery schedule in attachments. The EIR defines which data, information, and models should be produced at each stage of the project—along with the level of definition required and their purpose. These models are key deliverables in information exchange that help facilitate effective decision-making at key project stages. Employer information requirements usually include the following:

Standard methods and procedures provide clarity in information formats and naming conventions and guidance on how to present information.

Prescribe the standards and processes that suppliers must adopt as part of their contract or appointment.

Information-related roles and responsibilities provide a clear definition of information-related roles and what is expected of them.

An information delivery plan or information schedule that specifies which deliverables must be delivered, by whom, and when.

The content of the EIR covers three main areas:

Technical - details of software platforms, definitions of levels of detail, ...

Management - Details of the management processes adopted in relation to BIM on a project

Business - Details of BIM deliverables, timing of information exchange and definitions of information objectives.

Typical EIR contents

The table below shows the typical contents of an EIR (as defined by the UK BIM Task Force template) in three main areas.

commercial	Management	technical
Data drop timing	standards	Software platforms
Strategic goal	Roles and Responsibilities	Data exchange format
Customers	of Stakeholders	Coordinates
Delivered products	Work planning and data separation	Level of Detail (General)
BIM defined project	security	Level of detail (components)
BIM-specific competency assessment	Collision detection and coordination process	Education
	Collaborative process	
	Model review sessions	
	Health and safety and construction design management	
	System performance limitations	
	Compliance plan	
	Asset information delivery strategy	

Difference between EIR and BEP

In the construction industry, acronyms are widely used for repetitive yet important documents. The more regulations, project management processes, or other rules are exposed, the more documentation must be produced by the project team. The Building Information Modeling (BIM) method has given rise to new acronyms including Employer Information Requirements EIR and BIM Implementation Plan BEP. People often confuse them because BIM has not yet entered every project or every company. So what is the difference between the two?

In 1969, 5 people in the United States decided that it would be useful for any profession to develop rules for managing projects: The Project Management Institute (PMI) born in united states.

Over the years, PMI has defined key concepts and processes for managing and planning a project. These processes are divided into 5 groups:

start

planning

in process

Monitoring and control

Closure

In order for each stakeholder to have a common understanding of the project, and since there is a large amount of shared data, it is important to draft documents detailing each of the above processes.

Over the years, new technologies have also been introduced. These technologies created new layers of communication: we moved from meetings and letters to phone calls and emails, to live chats and real-time changes to deliverables. This made the information management of the project to be adapted.

Across the pond at this time, BS1192:1990 defined processes and methods for information management. In the 1990s, this is still mainly 2D information, but the third edition of BS1192 in 2007 introduced 3D model-based information (which later became ISO 19650). Like the PMBOK Guide, British Standards set the foundations for the scope, quality and resources of BIM through the production of Employer Information Requirements (EIR) and BIM Implementation Plan (BEP).

When an owner or a real estate developer starts a project, they draft a project brief and technical requirements with the help of some experts. In these documents they describe what they expect from the property and what they are trying to achieve. They also provide important information about the environmental conditions and laws, regulations and certifications applicable to that project so that companies can price the implementation of the project. In addition to pricing, each company drafts a response to the client's briefing called a "Tender Proposal."

Upon conclusion of the contract with the appointed company, the project brief, technical requirements and tender offer become contractual documents. Both parties are legally bound by them.

If the appointing party has decided to carry out the project using the BIM method, it must prepare a draft Exchange Information Requirements (previously called Employer's Information Requirements in BS1192) which becomes part of the technical requirements and thus becomes a document. It becomes a contract.

Similar to the tender proposal, the appointed company will submit a BIM implementation plan as part of its proposal.

Broadly and simply, the Information Exchange Requirements document describes the following topics:

The reasons why the client decided to use BIM (to obtain a model for the FM phase, to manage data across the asset portfolio, to increase productivity and efficiency in the design phase, ...)

Responsibility for management, production, collection and control of exchanged information

Technical aspects (deliverable format ....)

The BIM implementation plan is a response to the EIR from the firm responding to the tender (a contractor, an architect, or an engineering firm). Its details:

How they produce what the customer needs

Define detailed responsibility matrix

Detailed technical aspect (software used, data reduction, programming, ...)

Why are they often mixed up?

As mentioned in the introduction, the BIM method is not widely used in the industry. Most projects are done without a common space to share and store data. Information management is still very fragmented and every company uses its own servers and file cabinets. Therefore, the first reason will be lack of experience.

This may be their first managed BIM operation and therefore they have never heard of EIR, BEP ....

Or it might not be the first time that they didn't understand different concepts because it explained in a complicated way.

Another explanation could be the terminology itself: in English, these two documents have very different names, and people can easily understand which phase of a project they are referring to (preliminary design requirements and statement of requirements, implementation in the construction phase). However, in French, for example, these two documents have very similar titles, Charte BIM and Convention BIM. Therefore, if a project team wants to enter the BIM method, it should be supported by good professionals.

Before and after BEP

Here's an important quote from the PMBOK Guide: "Given the potential for change, project management plan development is an iterative activity and is described incrementally throughout the project life cycle." As the project progresses, manage it to a greater level of detail."

This is also true for the information management plan. While an EIR is rarely updated during a project due to its contractual value, this may happen when new stakeholders join the project (such as a facility manager) or new technologies are implemented at the client company (like BOS - Building Operating System) Usually for companies, BEPs write pre-contractual BEPs to demonstrate their BIM knowledge when responding to a two-stage bid on a design-build project.

Once appointed, the company must provide further details of its BEP, resulting in a post-contract BEP.

The second is written from the Pre-BEP and includes more details such as the actual project planning and information delivery schedule. As the project evolves (meaning new parties, new constraints, ...), this document will be continually updated to incorporate those changes. The Post-BEP is more of a working document than a contract and matures as the project progresses.

The difference between an EIR and a BEP is who wrote them, for what purpose, and when. One way to avoid mixing up these two documents is to designate interested stakeholders to help develop their knowledge during project delivery. And meanwhile, if you're looking for a supporting document for your draft BEP, you can always download our template here.

Fun fact: "Development or acquisition of a new or modified information system (hardware or software)" is on the list of "Project Examples" in a PMBOK.

PIM project information model

The PIM must be developed in accordance with a Master Information Delivery Plan (MIDP) and delivered to the employer through a series of information exchanges (information drops) that typically include:

A collection of federal building information models, including non-graphical data and associated documentation, including industrial and interior base class (IFC) files.

Building Information Interchange (COBie) files and other structured data such as programs.

Reports and other documents These PDF files may be read-only, but native files can be more useful because their contents can be more easily interrogated, copied, and edited. This data exchange takes place at key points in project development that coincide with the employer's decision-making processes (gateways) as defined in the employer's information requirements.

PIM is managed in a shared data environment. It is the single source of project information used to collect, manage, and disseminate information to the entire project team.

Information contained in a CDE can have many different levels of status, however there are typically four main areas of information:

The work is in progress.

Common area (common customer). This information has been reviewed, reviewed and approved for sharing with other organizations.

Released: This information is "signed off" by the client or their representative (often the lead designer).

archive This area is used to record progress on each project milestone as well as all transactions and change orders.

The CIC BIM protocol suggests that a client-appointed information manager should set up and manage the shared data environment. The information manager is essentially a procedural gatekeeper who controls the shared data environment to ensure that it follows the agreed BIM protocol and that the data is secure, facilitating federated model management. Ownership of information in CDE does not interact with the innovator, individual models remain, they have clear authorship and remain separate.

OIR

Enterprise Information Requirements (OIR) are defined in the PAS 1192-3:2014 specification for information management for the operational phase of assets using building information modeling.

Enterprise information requirements describe the information an organization needs for asset management systems and other organizational functions in the sense that they are enterprise-level information requirements rather than asset- or project-level information requirements.

Activities that may help define organizational information requirements are described in Annex A of PAS 1192-3.

When a contract is entered into for specific asset management activities, or instructions are given to an internal team for asset management activities, specific asset information requirements (AIR) must be prepared. These are generated based on organizational information needs. Where there are significant capital works, the Employer's Information Requirements (EIR) are required, as described in PAS 1192:2 2013 Information management specification for the capital/delivery phase of construction projects using building information modelling. In this case, asset information requirements help inform the client's information requirements and help define the plain language questions the client will ask at key decision points for the client to assess whether the project is progressing satisfactorily.

CDE Common Data Environment

Common Data Environment (CDE) first written and described in BS 1192-2007 by Mervyn Richards OBE and BSI publication BIP2207.

A single source of information used to collect, manage, and publish documents, graphical models, and non-graphical data.

The entire project team (whether all project information is created in a BIM environment or in conventional data format) creating this single information source facilitates collaboration between them. project team members and helps to avoid repetition and mistakes.

Ownership of information in CDE remains with the creator of that information. Individual models produced by different project team members do not interact with each other, they have clear authorship and remain separate.

This means that the originators' liabilities will not change when their model is integrated into the federal model. However, there may be complications where ownership changes as the project progresses, for example, replacing design team objects with specialized subcontractor objects.

Generally, a license is granted to the client to use the information contained in the individual models for a "permitted purpose" (for the purpose for which that level of information detail is intended).

A sublicense from the client enables project team members to use models developed by other project team members.

The CIC BIM protocol suggests that an information manager appointed by the client should set up and manage the shared data environment. The information manager is essentially a procedural gatekeeper who monitors the shared data environment to ensure that it follows agreed protocols and that the data is secure.

They are not a BIM coordinator and have no design responsibility and no responsibility for collision detection or model coordination.

A common data environment may include a number of different information environments.

It may include a common supply-side data environment used by the project delivery team and a client information environment that provides a client-side document and data management system to receive, validate, and validate project information delivered by suppliers.

The responsibility for providing and managing the shared data environment of the supplier must be clearly defined in the client's information requirements.

PAS 11922 Specification for Information Management for the Capital Phase of Construction Project Delivery Using Building Information Modeling indicates that a CDE may use a project server, an extranet, a file-based retrieval system, or other appropriate toolset.

It suggests that the benefits of CDE include:

Ownership of the information remains with the creator, although it is shared and reused, only the contributor should change it.

Shared information reduces the time and cost of producing coordinated information, and "any number of documents can be produced from different combinations of model files."

If information sharing methods are consistently used by design teams,

Spatial coordination is a byproduct of using CDE processes and provides production information that is right the first time.

It provides the ability to produce. Traditional maps or documents as views of multi-author data in CDE also give more control over edits and versions of that data.

Information in CDE can have a wide variety of status levels. However, there are generally four main areas of information, with a marking process that allows information to be transferred from one area to another:

Work in progress (WIP): This section is used to maintain unconfirmed information for each organization.

Common area (or common customer):

This information has been reviewed, reviewed and approved for sharing with other organizations, perhaps including the customer.

published:

This information is authorized or accepted by the customer or their representative (often the original supplier (designer/manufacturer)).

Archive: This area is used to create a consistent record of progress throughout the lifecycle as well as all transaction and change orders.

While this may sound complicated, in small projects the CDE may be as simple as common folders on a server or may use a free web-based file sharing program. Even in large projects, where complex software may be used, in the early stages of the project it may be as simple as creating four folders in which the files are stored, naming the files according to a standard naming protocol such as that specified in BS. 1192:2007 (now replaced by BS EN ISO 19650).

It should be noted that CDE is not a collaboration tool itself, although it may be used with one or more collaboration tools.

NB Information management based on BS EN ISO 19650, part 2 guidance:

Project Delivery Processes (3rd Edition), published by the UK BIM Alliance, the UK Built Digital Center and the British Standards Institution in January 2020, suggests:

A CDE solution can be software or it can be some other form of tool.

If information is exchanged by a non-digital solution (e.g. a postal service) and stored in an organized copy cabinet (which may be required, for example, in a sensitive project where digital methods are not permitted), then this can also be described as a CDE solution.

COBie

Building Operations Building Information Exchange (COBie) is a non-proprietary data format for publishing a subset of BIM building information models that focuses on providing property data rather than geometric information.

It is formally defined as a subset of the International Standard Industry Foundation Classes (IFC) for sharing and exchanging BIM data across different software applications, but it can also be communicated using worksheets or relational databases.

William East of the US Army Corps of Engineers developed COBie, who in 2007 developed a pilot standard to improve the process of delivering information to building owners, occupiers and operators that enables them to better manage their assets.

It became COBie in 2008 when it revised to conform to international data and classification standards.

COBie helps collect and record critical project data at the point of origin, including equipment lists, product data sheets, warranties, spare parts lists, preventive maintenance schedules, and more.

This information is necessary to support the operation, maintenance and management of the asset after the constructed asset is in service.

COBie does not increase the need for information, it simply structures it in a more accessible format. To make it easier to use and reuse. This template is intended for easy management by any organization regardless of size and IT capability.

Its simplicity means that all levels of the supply chain should be able to contribute to the dataset, even if only by entering it directly into a spreadsheet. This template also "insulates" the client from unnecessary complexity.

In May 2011, the UK Government published its Government Building Strategy and announced its intention.

By 2016, BIM Level 2 will require 3D BIM shared with project and asset information, documents and electronic data in their projects.

For level 2 they are in COBie format. These submissions or "data drops" are required at key milestones through the development of projects to ensure their proper validation and control, enabling the client to review available data for technical compliance, brief compliance, cost, ... Generally, the data drops are aligned with the project stages and the required information reflects the level of development the project should reach at that stage.

As developed, the COBie file may contain data from consultants, subcontractors and suppliers, and even the customer.

Finally, the data provides information for the efficient operation and management of the facility.

COBie contains several sheets documenting the characteristics of the facility, its systems and assets, and details product types, warranties, maintenance requirements, ... As the project develops, additional features, issues, and documentation can be associated with specific items.

BIM CIC protocol

The Building Industry Council CIC Building Information Modeling Protocol The standard protocol for use in projects using Building Information Models

(BIM) first published in February 2013. CIC launched this protocol as part of its response to the UK Government's construction.

The strategy stated: “Government needs fully collaborative 3D BIM by at least 2016 (with all project and asset information, documents and data electronic).

This is a requirement for BIM Level 2 on centrally procured public projects. Level 2 is a managed 3D environment with attached data, but created in separate string models.

The CIC BIM protocol claims to be suitable for use in all Level 2 BIM projects.

This is a 7-page supplemental legal agreement that can be incorporated into professional service appointments, construction contracts, subcontracts and innovation contracts by adding a model amendment.

It imposes certain obligations, commitments and limitations on the use of building information models and can be used by clients to oblige specific work.

This is one of a number of standards, protocols and tools available to support the adoption of Level 2 BIM in the construction industry:

A protocol is a contractual document that takes precedence over existing agreements. Clause 2.1 states: "... in case of conflict or inconsistency between the terms of this Protocol and other documents contained in the Agreement and part thereof, except for cases where the Protocol states otherwise, the terms of this Protocol shall prevail." Parties to the protocol may wish to consult with their insurer to confirm that they are not accepting uninsured contractual obligations by accepting the protocol.

Therefore, it is important that the protocol and its appendices are made available ahead of time and that changes to it or its appendices are considered as changes to the contract by following appropriate change control procedures.

This protocol provides a definition of responsibilities, obligations and limitations for project team members and defines deliverables to a certain level of detail (LOD for "data loss" at key stages during project development.

This is set out on a project-specific basis in the Model Production and Delivery Table (MPDT) in Annex 1 of the Protocol. Annex 2 specifies the information management standards that will be adopted.

The protocol requires that the client appoint an information manager.

This designation may change during the project (e.g. lead designer or lead consultant).

information manager in the early stages but then the contractor during construction).

The Information Manager is not a BIM coordinator and has no responsibility for collision detection or model coordination. They are essentially a procedural gatekeeper that monitors the model to ensure that it follows the protocol and that the data is secure.

As with copyrights for conventionally designed buildings, the protocol gives the client a license to use the information contained in the model(s) produced for a "permitted purpose" (for the purpose for which that level of information detail is intended).

A sublicense from the client enables project team members to use models developed by other project team members, but only if the client wants third parties. A new license may be required to use the model. The protocol guidelines support the use of collaborative practices and the adoption of PAS
1192-2 Publicly Available Specifications for Information Management for the Capital Phase of Construction Project Delivery Using Building Information Modeling) but there is no reference of these practices or specifications in the CIC protocol itself warns that any future move to Level 3 BIM will create a single online project model with construction sequence, cost management and life cycle information).

It may create very different issues of responsibility, copyright and liability that require the development of new projects.

In April 2018, CIC published the second edition of the long-awaited BIM Protocol to reflect current practices and standards for the use of BIM.

This protocol is the UK's only standard contract BIM protocol and has been developed by international construction law specialists Beale & Company, following consultation with industry and legal professionals.

The new edition has been updated to reflect the significant development of BIM standards and practices since it first published in 2013.

CIC describes the updated version as "a more flexible document that can be used alongside a range of different contractual arrangements".

Beale & Company employee Andrew Croft said:

We are very pleased to be involved in a very interesting project and hope that the second edition of the protocol will help to provide more clarity on how to address contractual obligations in relation to BIM.

Graham Watts OBE, Chief Executive of CIC, said;

"CIC has had a seven-year partnership in leading the promotion of best practice in BIM, which continues with the work of our BIM Forum. The second edition of the BIM Protocol demonstrated our ongoing commitment to the potential for multi-professional BIM collaboration.

IFC

Industry Foundation Classes (IFC) is a CAD data interchange file format intended to describe data from the architecture, building and construction industry.

IFC industry foundation classes in BIM is a global standard for data exchange in the construction industry, which stands for: Industry Foundation Classes, which means it contains a communication model for transferring and exchanging information related to the building and construction industry. It is a platform neutral open file format used to facilitate interoperability in the architecture, engineering and construction (AEC) industry. This data model is basically a topic-based file developed by SMAR Construction. IFC is usually used in building information modeling projects as a collaborative approach and is an open platform and not controlled by one or a group of individuals (vendors).

The genesis of IFC began in 1994 and today it has become a full-fledged model and is registered by ISO 16729:2013 as part of the international standard. Due to the core focus and expertise in interoperability between different software platforms, many countries have mandated the integration of public construction projects into IFC.

It is an open, platform-neutral file format specification that is not controlled by a single vendor or group of vendors. It is an object-oriented file format with a data model developed by buildingSMART (formerly the International Alliance for Interoperability, IAI to facilitate interoperability in the architecture, engineering and construction (AEC) industry) and is a common format in building information.

Project Based Modeling (BIM) The IFC model specification is open and accessible. It is registered by ISO and is an official international standard ISO 16739-1:2018.

Focusing on ease of software cross-platform interoperability, the Danish government has mandated the use of IFC format(s) for publicly funded construction projects in 2010. In 2017, the Finnish public facility management company Senate Properties began requiring the use of IFC and BIM-compliant software in all of its projects. Norwegian government, health and defense client organizations also require the use of IFC BIM in all projects, and many municipalities, private clients, contractors and designers have integrated IFC BIM into their business.

History

The IFC initiative began in 1994, when Autodesk formed an industry consortium to advise the company on developing a set of C++ classes that could support the development of integrated applications. Twelve American companies joined the consortium.

These companies included AT&T, HOK Architects, Honeywell, Carrier, Tishman and Butler Manufacturing. Originally named the Industry Alliance for Interoperability, it opened membership to all interested parties in September 1995 and changed its name to the International Alliance for Interoperability in 1997. The new alliance restructured as an industry-led non-profit organization with the goal of publishing the Industrial Foundation Class (IFC) as an AEC neutral product model that addresses the AEC building lifecycle.

Another name change occurred in 2005 and the IFC specification is now developed and maintained by buildingSMART.

File formats

IFC defines several file formats that may be used and support different encodings of the same underlying data.

IFC-SPF is a text format defined by ISO 10303-21 ("STEP-File") where each line usually consists of a single object record and has the file extension "ifc". This format is the most widely used IFC format, which has the advantage of compact size and at the same time readable text.

IFC-XML is an XML format defined by ISO 10303-28 ("STEP-XML") and has the file extension "ifcXML". This format is suitable for interoperability with XML tools and exchange of partial building models. Due to the large size of typical building models, this format is less common in practice.

IFC-ZIP is a compressed ZIP format embedded from an IFC-SPF file or an IFC-XML file with the file extension "ifcZIP".

Terse RDF Triple Language (IFC-Turtle) is a textual semantic data format that uses RDF and is expressed in the ifcOWL ontology. IFC-RDF is an XML-based semantic data format that uses RDF and is expressed in the ifcOWL ontology.

ifcJSON uses JSON, a modern format often used by web applications.

ifcHDF uses HDF and is based on the ISO 10303-26 standard for representing STEP data in HDF.

IFC-SPF is in ASCII format, which, although human-readable, suffers from common ASCII file problems in that file sizes are bloated, files must be read from start to end sequentially, mid-file extraction is not possible, files are slow. for parsing and definitions are non-hierarchical.

the architect

IFC defines an EXPRESS-based entity relationship model consisting of several hundred entities organized in an object-based inheritance hierarchy. Examples of entities include building elements such as IfcWall, geometry such as IfcExtrudedAreaSolid, and basic structures such as IfcCartesianPoint.

At the most abstract level, IFC divides all entities into root and non-root entities.

Rooted entities derive from IfcRoot and have an identity concept (having a GUID), along with properties for name, description, and revision control.

Non-root entities have no identity, and instances only exist if they are referenced directly or indirectly from a root instance. IfcRoot is divided into three abstract concepts: object definitions, relationships, and property sets:

IfcObjectDefinition captures events and types of concrete objects

IfcRelationship records relationships between objects

IfcPropertyDefinition registers dynamically extensible properties on objects.

Ifc Object Definition

IfcObjectDefinition is divided into object instances and object types.

IfcObject records object events such as product installation with serial number and physical location. IfcTypeObject captures type definitions (patterns) such as product type with specific model number and common shape. Events and types are further divided into six basic concepts: actors ("who"), controls ("why"), groups ("what"), products ("where"), processes ("when") and resources ("How ").

IfcActor represents individuals or organizations.

IfcControl displays rules that control time, cost, or scope, such as work orders.

IfcGroup represents a collection of objects for specific purposes such as electrical circuits.

IfcProduct represents events in space such as physical building elements and spatial locations.

IfcProcess represents events in time such as tasks, events, and procedures.

IfcResource represents the use of something with limited access, such as materials, labor, and equipment.

Edit IfcRalation

IfcRelationship records relationships between objects. There are five basic types of relationships: composition, assignment, connection, association, and definition.

IfcRelDecomposes a whole-part relationship that has exclusive constraints, such as dividing a building into floors and rooms or a wall into studs and pods.

IfcRelAssigns depicts assignment relationships where one object consumes the services of another object, such as a labor resource assigned to a task, or a task assigned to a building element.

IfcRelConnects shows the connection between objects such as a floor slab connected to a beam or a pipe connected to a sink.

IfcRelAssociates indicates external references to an object, such as an external IFC library file in which an object is defined.

IfcRelDefines an instance of a relation, such as if a piece of pipe is of a particular type.

Ifc Property Definition

IfcPropertyDefinition captures dynamically extensible property sets. An attribute set contains one or more attributes, which may be a single value (eg, string, number, unit measure), a bounded value (with a minimum and maximum), an enumeration, a list of values, a table of values, or a data. Structure While IFC defines several hundred feature sets for specific types, custom feature sets may be defined by application vendors or end users.

IfcPropertySet represents a set of properties attached to an event or object type.

IfcPropertySetTemplate [IFC2x4] depicts property definitions and their data types.

Products

IfcProduct is the base class for all physical objects and is divided into spatial elements, physical elements, structural analysis items, and other concepts. Products may have related materials, display shape and placement in space. Spatial elements include IfcSite, IfcBuilding, IfcBuildingStorey and IfcSpace. Physical elements of the building include IfcWall, IfcBeam, IfcDoor, IfcWindow, IfcStai, ...

Distribution elements (air conditioning, electrical, plumbing) have the concept of ports where the elements may have specific connections for different services and are connected to each other using cables, pipes or ducts. It is used to form a system of various connection relationships for building elements such as walls that have openings filled by doors or windows.

processes

IfcProcess is the base class for processes and is divided into tasks, events, and procedures. Processes may have durations and are scheduled to occur at specific time periods. Processes may be arranged in such a way that a successor task may start after the previous task finishes, following the critical path method. Processes may be collapsed into sub-processes for aggregation. Processes may be assigned to products that represent the output produced by the work performed.

References

IfcResource is the base class for resources and is divided into materials, labor, equipment, subcontracts, crew, ... Resources may have different costs and availability calendars. Resources may be nested in subresources for granular allocation. Resources may be assigned to processes that represent tasks performed on behalf of a resource.

Areas

IfcProject encapsulates a generic project and displays the project name, description, default units, currency, coordinate system, and other textual information. A valid IFC file must always contain exactly one IfcProject instance to which all other objects are directly or indirectly related. A project may include several buildings, several participants and several phases according to a specific use.

In addition to project-specific information, IfcProject may also refer to external projects from which common definitions such as product types may be imported.

Each external project is encapsulated using IfcProjectLibrary [IFC2x4] along with IfcRelAssociatesLibrary and IfcLibraryInformation to identify the specific revision of the imported project library.

Projects support revision control where each IfcRoot-based entity has a unique identifier and may be marked as added, modified, deleted, or unchanged. Such functionality allows multiple IFC files to be definitively merged and ensures data integrity without human intervention.

What is the importance of IFC for BIM?

One of the most important goals of IFC is to create a global standard for BIM data exchange, which is mostly used in the data exchange format today. For example, if you have designed a building in Autodesk Revit software and now you want to import it into the Archicode environment, IFC is the best solution for this problem. Without the need to manually convert huge files, IFC provides a simple solution that can easily reduce the entire process of transferring files to third-party software, especially when you need to import your design into different software. You only need to import the IFC file into Autodesk Revit or Archicode software, then the software will automatically match the file with the executable components. For example, when you open a Revit file in Archicad software, the Revit file properties are replaced with Archicad properties. It's about how to convert internally. Challenges arise when they want to see and understand what you're most comfortable with in the software you sent them if they don't have that software; Therefore, to solve this gap, IFC inventes, which has the ability to convert files from one platform to another without losing any data. In this way, a high-performance data and file exchange can be achieved and is a great help in BIM modeling services.

Since this is an open standard, it is constantly striving to achieve the maximum level of precision and refinement.

The best way to use IFC

What is the best workflow when using IFC files? It is often said that you can start a 3D model in one software, export the IFC to another program, and continue working on that model. Some programs have the ability to convert IFC to their original objects (Tekla Structures), but it is not the best solution. In an overall process, you should consider IFC as a reference or perform another scope of work on the project.

For example, we can imagine an architect working in his native software to create an architectural model of a building. The model is then exported to IFC, which passes it on to HVAC designers, where it is used as a reference for running ducts. If there is a problem or a change is needed (e.g. moving a wall or making a hole in a channel), they do not change the IFC model themselves, but send a request with the specified changes to the architect. This one makes the necessary changes and exports the updated IFC model.

Why IFC and why now?

IFC is a global standard for data interchange in the construction industry. IFC is both a common data model and an open file format. Construction industry professionals can use IFC to share data, regardless of what software they use to do their work. Similarly, data from one stage of the building life cycle can be used in the next stage without the need for re-entry of data, custom import interfaces or proprietary plugins.

The use of BIM tools is increasing. It is necessary to benefit from the benefits of BIM information exchange. BIM implementation plans usually specify the requirements for this exchange. Building owners should be able to express their wishes. Today, importers and exporters of BIM tools have different quality. Most require custom settings. IFC has its strengths and weaknesses. It really shines in certain areas and in certain settings. In other fields, the use of IFC can be counterproductive. If you are reading this, you probably either need to use IFC or are bidding on a project that requires the use of IFC. To be successful, your team must go beyond the initial understanding of the IFC standard and stay abreast of developments around it.

IFC models include a structured combination of geometric and non-geometric data. This data can be displayed, analyzed and modified in different ways in several application software.

IFC models include building geometry and building data. They contain "all" or a subset of the information contained in BIM files. Converting and exporting native data to an IFC file is a way to transfer data from one application to another. The exchange format is open, free and well documented. By providing IFC export and import interfaces that conform to the IFC standard(s), the application vendor is able to provide interoperability with hundreds of BIM tools and other domain applications.

Use of IFC in design and construction

Nowadays, the use of IFC is more common in the design and construction stages. In design, the main application is design visualization and collision detection. The design team can now cross-thread models regardless of the original application, the same way DXF files were used to merge CAD (XREF) files in the past (overlaying, referencing, or merging previous designs). In addition to referencing models from other disciplines, IFC files are used to import data from one program to another. BIM objects with geometry, data and schedules can be exported from one main application and then imported into another for further design or analysis.

IFC string models and integrated/federated model

During design and construction, each thread typically has its own model. Models are integrated or referenced for design and production coordination tasks

Having a virtual building model in an open format has also been a big win for contractors who can see the design intent in easy-to-use applications and plan and take off based on the virtual building model.

In addition to the "integration between bim tools" scenario, a set of specialized tools that use the IFC format are evolving. Examples include quality assurance tools, model displays, scheduling, punch list programs, ...

IFC as a data model - What is the IFC model structure?

The model contains geometric (3D and 2D) and non-geometric data about the building project. Technically, a schema defines an entity-relationship model based on "EXPRESS". For further explanation, we use door as an example.

A door element is defined as one in the system. As a door it is currently classified in the building area. There are definitions that allow similar doors in the same project and different projects to share their data. Both types and instances can have attributes and properties attached to them. this is important. You attach common information such as maintenance instructions, model number, size, ... to the type, but you also attach specific characteristics such as serial number, installation date, condition, ... to the specimen.

The properties themselves have a special structure. Features are usually grouped into feature sets. Some of them are defined in the IFC standard, some are defined in the BIM implementation plan, ... If you want specific O&M data for the operation being delivered, this is one place to put it / look for it.

IFC also has other ways to group elements. The most important of these are the systems used to group building elements and components that work together. This is especially important in MEP models where systems such as water supply, air flow, ...

IFC also defines relationships between building elements. Some relationships are used to create the connections we talked about earlier, systems, types, attribute sets, ... Other relationships describe how building components become buildings. These relationships include the spatial structure (how the site is made up of buildings, building floors, rooms (spaces) and how spaces are grouped into areas). Other relationships connect the location of elements to this spatial structure, which is very important for facility management. Relationships can also be external pointers to tasks or documents with an external address

IFC as a File Format - Alternative Representations

IFC in its most common form is a plain text ascii file. This scheme specifies how to convert plain text into an object collection with type relationships and inheritance. Even if the data is somehow readable, it is the software programs that are the producers and consumers of the file content. The format of the IFC file itself is based on the ISO standard (10303-21) called "STEP-file".

The plain text content of an IFC-STEP file

The IFCXML file format uses the same data model as the "normal" ifc format, but instead of an ascii representation, the file is represented as an xml document. Having this xml document can mean easier machine-to-machine data exchange. It's also easier to look up the model directly. However, these uses have not been widely adopted and we don't see much of this format.

Since FC and IFCXML files are both text files and contain a lot of data, they are prime candidates for compression. By using a compression tool like "zip" or "rar" you will usually see a reduction in file size of about 80% and 90% respectively. IFCZIP is a standardized file format that uses specific compression algorithms and includes only one ifc or ifcxml file. Our experience is that the ifcxml file format is not well received.

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Since FC and IFCXML files are both text files and contain a lot of data, they are prime candidates for compression. By using a compression tool like "zip" or "rar" you will usually see a reduction in file size of about 80% and 90% respectively. IFCZIP is a standardized file format that uses specific compression algorithms and includes only one ifc or ifcxml file. Our experience is that the ifcxml file format is not well received.

Schema Versions

The IFC schema is published in different versions and is constantly changing. The two versions that are currently relevant are IFC 2x3 and IFC 4 (the names of the two are a bit confusing so let me explain. The previous version history is 1.0, 1.5, 1.5.1. Then there's 2x, 2x2; and 2x3. Following this, the newest version could have been called IFC2x4, but instead they simplified the naming of the current version to IFC4 and then the upcoming major version to IFC 5.

Even though IFC 2x3 is an older version, it is still the version we see most used at the moment and will likely be the dominant version for the foreseeable future. The reason for this delay is partly because the main BIM tools take time to implement support for this new version. Also, many ongoing projects currently use BIM implementation plans, the exchange format should be IFC2X3. IFC 2x3 has limitations and has been criticized. These are addressed by buildingSMART in the following versions (IFC4, IFC5 and others).

IFC4 extends support for geometries and parameters, extends building services and the structural domain, and includes a simplified XML format.

IFC5 is the new major version. It's currently in early planning, so we don't have an expected delivery date yet. The main driver of this release is expected to be the further expansion of parametric capabilities and the inclusion of the infrastructure domain.

IFC MVD Smart Filters

The goal of IFC is to describe a common scheme for exchanging all data that can be exchanged between BIM tools. However, not all data needs to be exchanged every time two tools need to collaborate. The information required depends on the process of which the exchange is a part. This schema subset is called Model View Definition or MVD for short. MVDs are best described with examples

MVD for IFC2X3

The IFC2X3 (version 2) coordination view is the most common export format in use today. The usage for this MVD is quite generic. It is used to combine models for collision visualization and detection. As you will see below, this model representation is split into two parts to be more specific to IFC4.

It is important to note that this MVD has optional plugins, and depending on the configuration of the bim tool, these plugins are not necessarily included by default.

The space boundary add-on view adds a "structural element to space relationships". The purpose of this add-on is primarily to support thermal and energy analysis, but our experience shows that it is also necessary to identify elements in rooms when identifying objects that require operation and maintenance.

Quantitative takeoffs add the ability to export baseline values for all spatial, building, building service, and structural elements.

The 2D annotation view supports the display and annotation of additional 2D elements. This can be important for creating proper floor plans.

History of IFC

The IFC initiative began in 1994, when Autodesk formed an industry consortium to advise the company on developing a set of C++ classes that could support the development of integrated applications. Twelve American companies joined the consortium. These companies included AT&T, HOK Architects, Honeywell, Carrier, Tishman and Butler Manufacturing.

Originally named the Industry Alliance for Interoperability, it opened its membership to all interested parties in September 1995 and changed its name to the International Alliance for Interoperability in 1997. The new alliance restructures as an industry-led non-profit organization with the goal of publishing the Industry Foundation Classes (IFC) as an AEC neutral product model that addresses the AEC building lifecycle. Another name change took place in 2005.

IFC versions

IFC 2x3

ISO submitted and published IFC 2x3 version to ISO in 2008 as ISO/PAS 16739:2005. PAS stands for “Publicly Available Standard.” In ISO, this term is used for “a normative document that represents consensus within a working group. After six years, a PAS must either become an international standard or be withdrawn. In March 2013, ISO approved IFC version 4 as a full international standard.

IFC 2x3 TC1

The IFC2x3 version and the IFC2x3-TC1 update are equivalent in terms of the IFC interchange file, and both are used for IFC2x3 implementation and certification.

The IFC2x3 technical correction is intended to correct several known minor technical problems that have been found since the release of the IFC2x3 specification and generally improve the documentation.

A technical correction is usually a collection of errata published separately from the specification to which it applies. Users are expected to enter corrections by hand in the (printed) version of their original specification. This process is basically impossible with electronic specifications. The model support group has decided to release the corrected specification in its entirety, but calls it a technical correction because it is essentially a modification of the existing specification rather than an extension of scope and functionality.

A specific technical change in TC to change the defined type of Ifc Compound Plane Angle Measure to optionally allow expressing angles in fractions of a second. This minimizes specification changes (and existing software implementations), but it is an important first step in aligning IFC and geospatial specifications. This change to a building model specified by the IFC allows a set of spatial coordinates to be referenced with the accuracy required for geospatial work.

Today IFC2x3TC1 is known as IFC2x3 and is the recommended IFC version to use. Almost all IFC exchanges are currently in 2x3 practice.

IFC4

IFC4 (formerly IFC2x4) has been released in 2013 as the new IFC platform for the coming years. The platform includes several IFC extensions in buildings, building services and structural areas, geometry enhancements and other resource components, and many quality improvements, fully integrated. Simplified ifcXML specification and new document format.

Since its initial publication, IFC version 4 has been revised through two annexes published by buildingSMART International in July 2015 and July 2016. According to the IFC4 Add2 Release page, the new version of ISO 16739 and certification for IFC4 will be based on the Add2 release. The certification uses the "Model View Definition" specified as the IFC4 V1.1 Design Transfer View and the IFC4 V1.1 Reference View.

IFC4 Add1 is the first IFC4 add-on that contains the necessary improvements identified during the test run and development activities for the first Model View definitions.

IFC4 Add1 released in July 2015 as the final buildingSMART standard and is the basis for the IFC4 Reference View V1.0 and IFC4 Design Transfer View V1.0 model views.

IFC4 Add2 – The second IFC4 addendum containing the necessary improvements requested before the start of the IFC4 certification process for the IFC4 reference view and the IFC4 design transfer view, in particular for the improved geometry definitions.

The final version of IFC4 Add2 released in July 2016 as the final buildingSMART standard and is the basis for IFC Reference View V1.1 and IFC4 Design Transfer View V1.1. IFC4 is essentially the fourth extension of IFC version 2; Therefore, IFC2x3 is a subset of IFC4. Basically, IFC4 is the same schema as IFC2x3, but with additional features. In practice the difference is subtler and there are exceptions.

IFC5

IFC5 is currently in the early planning stages, and is expected to include full support for various infrastructure domains and more parametric capabilities.

The first active project under buildingSMART International that expanded the definition of IFC for the infrastructure domain is the IFC Alignment Project.

IFC's role in BIM

Anyone who works with AEC software (architects, structural engineers, mechanical engineers, project managers, ...) will definitely come across the concept of BIM and use it in their daily work. A direct method of exchanging information between BIM tools used by different stakeholders is very difficult and almost impossible.

There are many different types of software, and as a result, there are many different ways to describe the structure of a project or even an element. In addition, direct sharing of models and data between applications is a time-consuming process and requires unique solutions.

We can easily understand that a common language is needed that every participant can understand. In the field of BIM, it is the IFC standard (Industry Foundation Classification), which is an open standard and can be the basis of BIM data exchange methods and communication between different stakeholders.

Communication within a project

Within a project, there are two ways of communication: global communication where all stakeholders are present and direct information exchange when a group of participants share data among themselves. IFC is used as a reference for participants to create their own models. An example of direct communication is data exchange between a structural designer and a manufacturer.

Development of IFC standards

BuildingSmart created the IFC standard in 1994 to support and monitor the progress and life cycle of construction (even bridges and infrastructure objects).

IFC files can be saved in different formats depending on the size of the model with formats supported by different software. Besides the official formats (.ifc, ifcxml.ifczip), there are also temporary and experimental formats (.json.hdf, .sqlite) that are not currently supported.

IFC Structure Hierarchy

The IFC model is based on the EXPRESS schema and is a relatively complex hierarchy of objects that describes entities and their attributes and relationships in the model. EXPRESS is an ISO standard data modeling language that defines data connections.

IDM

What is the Information Delivery Manual (IDM)?

It is information that drives a construction project – but what information is needed, in what order, when should it be delivered and who is responsible for providing it? We examine the information delivery plan (IDM) that documents the exchange of information within a project.

For BIM to be effective, information must be available when needed and must be of satisfactory quality.

By ensuring that project participants are aware of information requirements, more reliable information exchange should take place. This, in turn, should lead to better quality, timely information and help with decision making and overall project success.

It is an Information Delivery Manual (IDM) (sometimes referred to as an Information Delivery Specification (IDS)) that identifies a set of processes performed during the lifecycle of a data construct, along with the information required to perform these processes...

The built data industry (including buildings and civil infrastructure) is characterized by bringing together many different companies and authorities in a project-specific organization.

In order to be efficient, it is necessary for all participants in the organization to know which and when to communicate different information. This becomes even more important when digital tools are used, as most industrial tools have a very low tolerance threshold when it comes to being able to interpret digital data.

The ISO 29481-1:2010 standard "Building information modeling - Information delivery manual - Part 1: buildingSMART developed Methodology and format" to have a method for recording and specifying the processes and flow of information throughout the life cycle of a facility.

Are there standards for producing information delivery manuals?

IDM standards can be found in:

ISO 29481-1:2016 Building information models - Information delivery guide - Part 1: Methodology and format ISO 29481-2:2012 Building information models - Information delivery guide - Part 2: Interaction framework

ISO 29481-1:2016 is intended to facilitate interoperability between software applications used in all stages of the life cycle of construction works, including specification, design, documentation, construction, operation and maintenance, and demolition.

It promotes digital collaboration between participants in the construction process and provides a basis for accurate, reliable, repeatable and high-quality information exchange.

ISO 29481-2:2012 provides a method and format for describing "coordination activities" between participants in a building construction project throughout the project's life cycle. To this end, it defines a way to describe an interaction framework, a way to map responsibilities and interactions that provide a process context for information flow and a template for an interaction framework.

By ensuring that project participants are aware of information requirements, more reliable information exchange should take place.

The information delivery manual forms part of the buildingSMART interoperability model.

The other two sections are the buildingSMART Data Dictionary (descriptors to key concepts) and the Industry Foundation Classes (IFC), which allow you to store and exchange related data between different software programs.

What type of information is included in the information delivery manual?

An IDM should describe the life cycle processes of a structured data in detail by showing relationships and dependencies. This document should detail the information requirements that must be provided for each process to be successful. The user manual should also indicate who is expected to create, use and benefit from the information, along with any requirements for data to be provided by the user. It can also detail the software solutions used to read, manipulate and augment the information provided. It is also important to have a clear idea about the end results of the project.

The documentation will likely include interaction, transaction, and process maps along with trade-off requirements (what must be traded to support the requirements at a given stage of the project).

How is IDM used?

This method can be used to document existing or new processes and describe relevant information to be exchanged between parties. Then, the standard output can be used to determine more detailed specifications, which can be the basis for the software development process if necessary.

It is important to mention that the information delivery manual must be supported by the software to be operational. The main purpose of a data delivery manual is to ensure that relevant data is communicated in a way that can be interpreted by software on the receiving end.

Today, this method is accepted as an ISO standard. It is expected that additional material will be added to the standard to make it more specific regarding the documentation of exchange scenarios, as well as to have well-defined steps in a communication process between parties. A number of IDM projects were started simultaneously with the development of the method.

A number of IDM projects have resulted in specifications that have been tested in real construction projects or competitions. Today, this concept has been investigated and joint efforts are being made to create usable IDMs. Despite the progress, it is certain that building IDM is a challenge in some areas, as there is a lack of structured and documented processes. In such cases, it is necessary to agree on the relevant processes and activities and exchange requirements. In some cases, it is necessary to follow the IDM development work and the software development stage. This means that if there is no software development, the expected results cannot be achieved.

BCF

BIM Collaborative Format (BCF) is a structural file format suitable for problem tracking with building information models. BCF is primarily designed to define the views of a building model and information about collisions and errors associated with specific objects in the view. The BCF file format allows users of different BIM software and different disciplines to collaborate on project issues. Using the BCF format to coordinate changes to a BIM is an important aspect of OpenBIM.

Tekla and Solibri developed this template and later adopted as a standard by buildingSMART.

Most major BIM modeling platforms support integration with BCF, usually through plugins provided by the BCF server vendor.

Although Tekla and Solibri originally conceived BCF as a file base, there are now many implementations using the common server-based workflow described in the bcfAPI, including open source implementations as part of the open source BIM suite.

Research work has been carried out in Denmark to use BCF for a wider range of information management and exchange in the Architecture, Engineering and Construction (AEC) sector.

Support software

There are two main types of support for BCF. Authoring software and coordination software. Authoring software can create and share BCF problems. Coordination software is the most powerful in coordinating issues and providing a user interface for managing and tracking issues. Coordination software is typically a web service that allows easy and real-time coordination across multiple authoring software platforms and geographies. Most software has a combination of these functions.

BCF natively by authoring software such as

Vectorworks, ArchiCAD, TeklaStructures, Quadri, DDSCAD, BIMcollabZOOM, BIMsight, SolibriNavisworks and Simplebim are supported.

Standalone BCF plugins include BCF Manager, BCFier. Coordination software as a cloud service provider for BCF-based issue tracking includes BIMcollab, BIM Track, Vrex, Bimsync, Bricks, and OpenProject.

SEC

Structural engineering companies (SEC) currently have a series of deficiencies that hinder their processes and interactions, reduce their productivity, lack collaborative and interconnected processes, without including current work methodologies such as Building Information Modeling (BIM). The BIM method seeks to integrate processes and professionals involved in engineering tasks by working on platforms with coordinated and intelligent 3D virtual models. BIM has great potential for structural engineering companies (SECs) and solves their most pressing problems.

In a building or an infrastructure project, structural design, which is realized in the analysis, design, and documentation of structures, is a complex and dynamic process that undergoes permanent changes and restrictions during the project's life cycle at the request of the client, the architect, or the participation of other professionals. In structural engineering companies (SECs), interactions between professionals inside and outside the organization and workflow lead to conditions that reduce productivity, interaction problems between different professionals, inefficient presentation of information and insufficient communication channels, rework and frequent changes.

Building Information Modeling (BIM) is one of the most important and promising changes in the architecture, engineering and construction (AEC) industries.

Because it represents a paradigm shift in the concept and estimation of projects that allows the development of a precise virtual space. Model for different stages of the project life cycle By improving collaboration and coordination and achieving higher levels of efficiency, BIM enables integration in the AEC industry, which is usually characterized by fragmentation. Currently, with complex and large engineering projects, these methods and technologies make it possible to manage and process the generated data.

The design phase of the structure represents one of the most complex and dynamic tasks in the life cycle of a project, considering that the behavior of the structure must be strictly analyzed in compliance with a series of regulatory regulations. This importance makes the structural design phase an essential component of BIM model production. In addition, modern architectural designs increasingly include complex geometric configurations of buildings, which complicate the structural analysis of buildings. Despite the above, there is still no consensus method for information transfer in the structural design phase, and therefore it is still the weak link in the BIM model workflow. It is therefore essential to be able to solve this latter obstacle and effectively incorporate structural processes into the work chain of typical projects, taking advantage of the fact that the success of BIM depends to a large extent on the efficient exchange of information produced by different disciplines. Implementing BIM in a structural engineering company is not a trivial task, as it represents the evolution of the work process development method.

The main purpose of this document is to review and provide solutions to current problems in traditional industry standards, develop a methodology for implementing BIM in structural engineering companies (SEC), including procedures, interactions and workflows, and recommendations for computer programs and communication networks; and other variables necessary for success.

Current procedures in structural engineering companies are dynamic and iterative. The analysis and design of the structure is based on the process of trial and error until the convergence of the structural models and the definition and design of its various constituent elements. The process is also constantly fed by changes from the chief structural engineer and architect, creating frequent design revisions that must be read again. In addition, the interactions between different professionals at this stage are high, but poorly systematic and not optimized, creating professional communication channels that cause information gaps and disconnections. These situations require a series of interactive problems, both within the company and with external specialists, which leads to a decrease in productivity, in addition to the fact that they have not incorporated collaborative work methodologies to optimize their processes.

Building Information Modeling (BIM) is a collaborative work method that seeks to establish connections between people, processes and digital models in construction and infrastructure projects, thereby enabling fluidity in information transfer and communication; Therefore, with a digital graphic representation of the physical characteristics and performance of the project, it seeks to manage the stages of design, construction and management during the life cycle, taking into account the information related to the graphic representation that allows it. Work and use for different functions.

In particular, it has been shown that BIM facilitates communication and information transfer between professionals from different disciplines during the structural design process, allowing greater access and continuous updating of information even in real time. BIM increases knowledge sharing management, reduces the time and cost of resolving manufacturability issues and coordinating projects. In addition, it allows architects and structural engineers (two-way flow) to visualize changes and contrasts and helps make immediate decisions, significantly reducing rework and optimizing project time and cost. Also, by identifying errors in advance and automating variables that were traditionally used in "manual" processes, BIM also increases the automation of detail engineering and documentation processes, reducing labor time and increasing project quality. It controls the possibility of integrating structural and non-structural elements in the overall performance model. Once the structural analysis is done and the member parts are approved, BIM allows the SEC to monitor how structural behavior affects non-structural elements and other project components (considerations that would otherwise be too complex without the use of this type of tool). Therefore, a reduction in repair costs when the structure is used differently, or when it is affected by adverse natural effects (earthquakes, hurricanes, among others).

The correct exchange, extraction and storage of quality information is linked to the success of BIM. There, the importance of global archives, such as the IFC format, is linked to the achievement of these goals.

Despite the above disagreement, there are methods or guidelines for BIM implementation, mainly from developed countries such as the United States, the Netherlands, and the United Kingdom, among others. This list of recommendations for BIM is built around project development, the roles involved, and the tasks, goals, and responsibilities of each participant in the process. However, the stages of BIM implementation in companies should be specified: programs, training, studies, progressive changes, ...

It is important to clarify that implementing BIM does not change design criteria or standards, but rather restructures the way professionals and processes develop and interact with each other. Therefore, each team member is aware of the importance and goals of the process, has clearly defined roles and responsibilities, and is aware of the skills, competencies, processes, and interactions required for the success of the project. In addition, the implementation plan serves as a guide for new professionals to join the task at hand and is a reference for future evaluations of success in the company.

Methodology for implementing BIM in SEC

BIM implementation method for structural engineering companies (SEC) has different steps as shown in Figure 2. This method preserves the implementation of manual principles from prominent authors, methodological recommendations, templates and guides of the "BIM Guide" and "Project Execution Planning Guide", while expanding and adapting the same for SEC. It is mainly characterized by transparent and flexible processes for company requirements, objective evaluation of resources and processes, identified actual implementation requirements and optimized maximum costs.

Business analysis and diagnosis

In order to refocus the company's activities using BIM methodology, it is necessary to understand how the organization works, the resources it has and its expectations and forecasts for the future. In this way, the implementation is in line with the goals, vision and mission of the company and uses the available resources and creates the most suitable program. From the very first contact with the company, the management staff should be trained about BIM to bring them closer to the methodology and show them its potential. Then, in order to fully study the company's operations and specify its needs, all the necessary information points below are compiled.

General information

In general, information about the organization should be collected that is useful for identifying the company and future management. The following are requested: company name, address, contact person, professional contact, organizational chart, number and type of professionals, working hours and available timetable for training sessions.

Company focus and expectations

The implementation plan must be aligned with the company's vision, mission, and goals it seeks through BIM implementation. Therefore, three concepts should be defined:

The vision of the organization.

Target market and developed projects; And

The purpose of BIM implementation

Identifying the company's vision and mission requires understanding your own definitions of how you envision, how you act, and how you envision the future. Respondents should be prepared to answer how BIM contributes to these organizational goals.

The organization must be clear about its target market and the size, type and approximate duration of the project being developed in order to communicate timely requirements and regulations to relevant contractors in line with BIM deliverables.

The organization should also state the objectives for which it wants to adopt BIM. These may include lower costs, improved project quality, reduced time, participation in new markets and regulatory requirements, ... The organization provides these goals, which are expressed in specific goal expectations (tasks and dates).

Evaluation of available resources

Available resources are evaluated through three categories: (1) Human resources. (2) technological resources; and (3) physical space and office furniture.

For each of these cases, it is necessary to know the investment, renovation and development plans in order to identify previously allocated resources and balance some implementation costs.

Human resources available to obtain information about capabilities and competencies, with technical and personal skills such as Technical Competences (TC) Personal and Collaborative Work Skills (PCWS) Mindfulness and Willingness to Change (MWC) and Alignment with the Company's Vision and Development (AVDC) To obtain high levels of accuracy during counseling, the self-assigned scores of each professional (Pp) should be weighted with the evaluation of their direct supervisor (Ps) at the evaluator's discretion.

Items for measuring human resources

The company's technological resource inventory should include hardware and software. All software or virtual tools and platforms used must be considered. Therefore, at least 3 broad categories of these media items are available:

Equipment (brand, model, processor, video card, RAM, hard disk and video adapter).

Software and virtual platforms (name, developer, local provider, type and cost of licenses, description of use).

Local and "cloud" servers (brand, model, capacity and network description).

BIM implementation requires fluid interaction between project team members and it is essential that the physical workspace in the company allows this type of interaction. That is why the organization must provide its plans for the existing physical facilities, detailing the location of facilities, networks, furniture and people to understand the conflicts of employee interaction inside the office and propose new structures adapted to the current scenario during BIM implementation.

Analysis of current deliverables

The company must report current deliveries. The need to know organizational deliverables lies in the fact that the product obtained through BIM implementation must be aligned with current indicators.

Any deliverables that an organization currently has should be included in a document called "Traditional Design and Drafting Practices Guide" that details the development of programs done based on the traditional way of working and standardizing the work done at the SEC. The goal is to clarify three characteristics of the organization:

Minimum regulatory framework required.

The standards set by the SEC above are regulatory requirements and the creation of checkpoints to confirm information at all levels of project development to prevent the spread of errors and seek timely correction. Many companies already have this document for administrative criteria, so identifying it should not be complicated.

Evaluation of current processes

Evaluation of current processes (and their components) in the organization is developed in three lines: workflow and current processes. programs used in each activity; and current workflow problems and processes within the organization should be identified for all types of resources and deliverables. In general, companies active in this field do not formally define processes. However, experts usually have a clear definition. The evaluator then translates the declared processes into a workflow model. For each activity declared in the work flow, any application used to develop or support the work must be specified. It helps to identify the current problems in the organization.

Typical problems in structural engineering companies (SEC)

The statement of goals that the organization seeks to achieve by incorporating BIM in some cases may result from partial or incorrect knowledge, rather than the full potential of BIM. Considering this issue, when the company's goals are defined and placed in the framework of its characteristics (size, resources, ...), the goals to be achieved through BIM should be reviewed in order to optimize the use of resources for investment or location. . Specific goals regarding the expectations raised for the realization of the goals should also be distributed in the short, medium and long term.

Requirements for BIM adoption

The implementation plan identifies all the necessary requirements for the SEC to work with BIM, taking into account the important contributions of the current organization's characteristics and resources.

Team roles

Since the implementation plan is focused on SEC, it is necessary to adapt the general roles of traditional BIM to the development of structural design and calculation under BIM methodology. Constructing BIM roles for the work team expanded four roles and 15 competencies from the BIM role matrices proposed by the Dutch BIR and the Chilean BIM initiative and it adapts considering that they propose in a simple and complete way the general roles that should be assumed in the BIM methodology. In addition, the BIM approach of England, the pioneers of BIM worldwide, is studied with regard to the articulation of the tasks and roles involved, with a focus on the aspects of training and skills that should be considered. It is important to note that BIM roles assign responsibilities and tasks to different members of the work team. They are not necessarily related to specialties or positions, and moreover, they can be developed by more than one person or allow one person to fulfill more than one role.

Technologies used

The interoperability of the software chosen to work in BIM environments is important to the success of the workflow proposed by the BIM methodology. While Industry Foundation Classes (IFC) seem to be a universal language for connecting many software applications in BIM environments, this technology is still not fully resolved. The only 100% effective way to correctly connect models from different platforms is currently through the use of native applications, i.e. from the same provider or with partner providers. In addition, due to the variety of options offered by the market, it is necessary to choose a specific tool that best solves the desired objectives, which favors its scale of use and interoperability.

Each BIM specialist will have different uses for each computer program and therefore different levels of mastery to successfully perform tasks (although further training should not be overlooked) within the framework of company-defined objectives. Considering these variables, educational resources can be optimized and planned.

BIM software requires more computing power. The recommendations presented in Table 5 correspond to the specifications provided by consensus among application brands and expert user opinions. The required hardware capabilities are closely related to the size of the projects to be modeled. Therefore, these items are specified to reduce the costs of equipment that is not used to its maximum potential in the short or medium term. Five evaluation categories are defined: operating system, processor, hard disk, RAM and graphics card. Table 5 shows the general hardware requirements and provides recommendations based on project size. "Type I" projects are considered single-family homes and small residential buildings. "Type II" projects are considered medium and large residential buildings and medium-sized office buildings and complex works (such as medium-sized clinics). And "Type III" projects are considered large skyscrapers and complex works (e.g., large hospitals, airports, ...).

Since the core of BIM is the connection of processes, files, models and professionals, a network (server) is needed to connect all the computers of the administrative team members. For example, working under the Windows Server platform (Microsoft) has several security advantages and cloud storage capabilities.

In addition, visualization and coordination of models should be possible from any physical location. For this purpose, it is recommended to use cloud computing environments, such as A360, BIMsight Key, or Solibri Model Viewer, among others, to allow for continuous work on the Internet with the rest of the people involved in a project. In the future, when there is a project with a large amount of data, computer support will be necessary to manage it. Big data optimization projects will be relevant to its management.

Organization of physical spaces

The distribution of physical spaces directly affects the way professionals develop their activities, even more so in a collaborative environment such as BIM, it is necessary to restructure work spaces within the company to achieve more and better interactions. Field observations were made for 10 structural engineering companies in Chile and it notes that in all of them the engineers were separated from the modelers. In addition, experts state that there are communication problems between engineers and modelers, mainly due to the way jobs are distributed, as they must travel from site to consult on projects. Based on the field observations made in different companies in the region, a physical arrangement named "3 pairs" has been proposed. This layout has professionals in 3 types of simultaneous pairs: engineer-model (blue-yellow interaction). Modeler-modeler (blue interaction); and engineer-engineer (yellow interaction). Therefore, engineers are able to communicate directly with modelers, and engineers as modelers (designers) are able to provide feedback to each other, ... In short, each can explore the technical and theoretical ambiguities of his profession directly with the colleague next to him. It is recommended that at the end of the "chains" there are more experienced professionals, where only one professional remains without a pair partner, because they do less consulting with their colleagues and spend less time in general.

At the same time, professional BIM modelers and coordinators need to be in an integrated and related collaborative workspace integrating other specialties (in addition to engineering-designer computational work) in what is called a "highly collaborative environment".

Here, professionals can automate with a PC and see a central model on the screen. In addition, the highly collaborative environment serves as a meeting and decision room for all project members (including architects and builders) to identify errors or ways to build models. In this room, real physical collaboration between different professionals involved in the project is achieved by real-time visualization of how decisions are realized (in 3D).

BIM workflow

The workflow of the proposed BIM method provides fluid communication and document production processes, facilitating model revision and reducing overall time spent. This workflow is an adaptation of the general BIM flows suggested in the Project Implementation Planning Guide and is based on professional interactions in a central model:

The BIM platform for a given SEC (e.g. Revit) will include volumetric models, reinforcing steel or other structures, if necessary, and detailed plans and drawings; Therefore, all models may be "super" in order to visualize conflicts and optimize interactions. The workflow also suggests coordination meetings between all professionals to advance criteria and agree on changes.

BIM protocol

Structural design firms have their own guidelines and standards that define their work, which is based on national design standards and codes. Currently, based on documented CAD-2D drawings (supplemented with 3D analysis models), companies are guided by 2D design guidelines and design practice guidelines to standardize their design outputs and details. Now, to work in BIM, the counterpart document must be produced for documentation under the BIM method, which is called the "BIM protocol". This includes the minimum legal framework required, the standards set by the SEC, rather than the regulatory requirements for modeling, with respect to the objectives defined by BIM. and control points to confirm information at all levels of project development in order to prevent the spread of errors and their timely correction. It should be aligned with the BIM Implementation Plan (BEP) and seek to standardize model generation on BIM platforms, create work platforms, define channels and connect models and professionals. It will be a dynamic document that adapts to regulatory requirements and technological changes.

Recommendations for BIM protocol

All BIM protocol information that is repeated in traditional drafting and design practices manuals should be explicitly incorporated into this protocol (ideally referencing the traditional standard as a user guide).

In addition, office project plans should clearly show any special features of the products produced to check whether the work is properly standardized, especially in the early stages of the project. After the first models are produced, examples of them should be attached to serve as a guide for future practitioners and questions about how to model specific complex situations.

This protocol is flexible and may be modified in the future provided there is progress in BIM objectives. For example, this protocol may include new construction planning or tactics (eg when a construction model is produced).

Business requirements for BIM software

It is assumed that the company will already have a "blueprint" of how its products will be structured and presented (blueprints), as described in the "Traditional Design and Drafting Practices Guide". With this in mind, it is necessary to generate all the templates used in the BIM program documentation, so that the office specialists only use models from previously created templates. These resources should be made available at the initial stage of implementation and delivered to the office for free use.

Determining the execution gap

BIM implementation undoubtedly represents a significant cost to the company, which is why it is necessary to optimize the use of current resources That is, refocusing and adapting them to work under the BIM methodology. After identifying the goals and creating the tools used, the BIM method suggests that the current resources should not be ignored. On the contrary, they should be considered as a starting point for implementation. From there, lost resources must be made up to meet total needs.

Determine the "run gap".

Therefore, BIM requirements in terms of job roles, technologies, physical space, BIM workflow, modeling protocols and patterns) must be subtracted from the company's available features and resources to implement only those missing requirements. In other words, technology implementation does not start from scratch. The company will already have equipment that can be reused in whole or in part, sufficient to provide parts or improve systems to meet BIM requirements.

By determining the implementation gap, it will be possible to identify the costs of the actual implementation requirements. The economic cost of the latter will be less than the demands that do not take into account the company's current resources and therefore will be less significant for company managers looking to plan for future investment.

Implementation planning

The implementation plan should be clear, specific and detail the actions that will be taken. The general guidelines provided must be adapted to the characteristics of the company. The points discussed in this section should be included in the BIM Implementation Plan (BEP) that guides the successful development of BIM projects. The essential points of planning are discussed below and details of the objectives and content of each section are given.

General strategy

The overall strategy should be the primary motivational drive for the entire work team, and the vision and mission of the company should be strongly present. It should show the BIM objectives (previously defined with the company), the scope of the implementation plan and a general timetable showing the actions required to achieve the objectives.

Parallel and incremental execution

A parallel and gradual implementation is to be developed in the company. On the one hand, the implementation will be gradual. That is, there will be training and procedures for implementation (use) that, upon successful completion, will allow the company to proceed with the next implementation. In this way, quality is guaranteed in the realization of small goals and errors are avoided downstream. On the other hand, its implementation is supposed to be done in parallel with traditional techniques (so that the current project is not compromised). When that stage or goal is successfully mastered, parallel work can become part of the real chain. That is, in subsequent projects, work that was previously done in parallel (but is now confirmed) can be included in the actual process lines.

Definition of pilot project

The implementation process is to be done with a pilot project which may be a current company project or a previously completed one. If an existing project is used, its implementation on BIM platforms should be done in parallel with the work done under the traditional method. Thus, the changes in working methods and ease of use provided by BIM platforms can be demonstrated with evidence. On the other hand, when working with a project that has already been completed, there are advantages in implementing contrasts under BIM compared to the traditional method. (for example, how previous problems are now simplified with BIM) and also to compare the results after the completion of the experiment (results), for example, from the material for the previous project).

Defining the percentage of professionals involved

Professionals trained in BIM should be created. For small and even medium-sized companies, training and implementation of BIM should be done by all specialists of the company. However, in medium or large companies, a group of professionals should be appointed. In small companies, it is much easier to manage and train a small group of people (enhanced by the proximity and possible trust among the work team) and consider their different professional roles. This is especially true given that there are not enough experts to assign specific tasks to each. On the other hand, large companies generally create workgroups and development areas, and it is impossible to work with all specialists in the first place.

Instead, the goal is to create a BIM liaison within the organization that is generally responsible for the future dissemination of BIM knowledge in other parts of the organization and with any new professionals who can be strengthened by formal training.

Strategic alignment with BIM workflows

BIM requirements suggest an ideal workflow. However, initially, the gradual integration of BIM in the office should encourage compliance with this flow from part to whole. With this in mind, the workflow must be adapted to what the company has announced, reformulated and started towards a partial, gradual replacement and eventually the ideal BIM workflow. The speed of these changes will be in accordance with the tracking capability of the obtained targets.

Determining roles

Selecting the professionals who best match the required specifications of the new BIM roles is possible by identifying the current competencies in the work team roles and the characteristics of each of the professionals the office currently has. This choice should be made first according to personal and collaborative work skills, followed by technical knowledge. Technical skills are easier to teach than soft skills.

Technology implementation plan

To define the technological gap of a company to work in BIM, it should have the following information: current capabilities of technologies and technological characteristics. Here, it is also important to know the schedule of purchase and renewal of equipment and licenses in order to use any resources already planned in the purchase of platforms and equipment necessary for the operation of the BIM methodology. This procurement schedule should also be planned according to the traceability of the defined goals.

The implementing company should be responsible for installing licenses and configuring the enterprise intranet network. In this way, it will be possible to provide the service of selling licenses (through a strategic partner that distributes programs) or leaving the right to choose for the organization. In addition, there should be a technical team to install the necessary equipment and networks.

Physical space reconstruction plan

A restructuring plan should be proposed in relation to the physical space resources required by the BIM workflow and the current physical state of the company in order to accommodate the size of the office. A phased plan for site changes and switching to another branch, as planned with the owners, should be proposed. Here it is interesting to know the acquisition and expansion plan of the organization to channelize it with the required changes.

The BIM protocol and the extent to which it has been reformulated in the Manual of Traditional Design and Drafting Practices should, like the latter protocol, be structured and disciplined in order to facilitate and expedite the understanding of new requirements, details and necessary revisions. The executive company is responsible for preparing the document and requesting all the necessary background information from the company and providing examples and recommendations for its use. The various updates that the protocol undergoes as it evolves in the use of BIM should be monitored.

The company cannot start its work in BIM if it does not have this document or if it is not distributed and socialized by all team members.

Standardize and create elements to work in BIM

Vignettes, templates, parametric elements (eg, families), required information sheets, and interference detection sheets, among others, must be created and adapted so that the office has all the necessary elements at the beginning of the pilot project. BIM platforms are available for successful project development. The goal is to draw and visualize deliverables in a BIM platform (e.g., Revit) with the same detail and features in 2D CAD (referring to the final product in the plans). Indications for this will be specified in the BIM office protocol.

Compliance and quality indicators

Conformance and quality indicators are related to achieving the goals and objectives of BIM in the organization. In this sense, the evolution of the implementation is measured according to its degree of capacity, which is understood as the company's aptitude in developing BIM features and services, and maturity, as the degree, depth, quality, and repetition of BIM features and services [41]. The above measurements are general indicators of progress. They present BIM methodology (and concepts) in a global context. In other words, they serve to compare and classify companies within a specific range that is useful, for example, in identifying compliance with the due date specifications requested by a contractor (eg, the tendering criteria). In this way, to measure the progress and realization of the proposed goals, the subjects necessary for the realization of each goal (theoretical and technological acquisition learning) should be identified and evaluated in three possible categories.

Monitoring compliance with goals and plans

This process should fully document all company actions taken and decisions made in a context that the implementing company deems appropriate. This record should pay attention to the progress and compliance with the indicators. This allows plans and actions to be created to reorganize and restructure planned actions that have not yet been completed.

Knowledge monitoring

The knowledge acquired by professionals must be continuously monitored. For this purpose, knowledge tests should be conducted on the use of programs and methodologies in accordance with the progressive development of knowledge acquired by professionals. Such evaluations, created by the implementing company and university or technical bodies (house certification programs), certify specialists and thereby increase the competitiveness of the work team (for example, with regard to the training of personnel in tenders). The type of certification depends on the resources available in the organization.

Clearing doubts

Active communication channels should be established between the organization and the implementing company in order to determine the methods, times and dates of the evaluation regarding the procedures and technical aspects of the use of the programs. Professionals are encouraged to learn through self-study and collaboration with team members, gradually allowing the organization to become self-sufficient.

Development of parametric elements

To facilitate modeling on BIM platforms, family building services are to be provided. This service allows the company to optimize the modeling time and access requirements of the projects it undertakes. Family building services are not considered part of the initial implementation costs, but are intended to contribute to the development of BIM in the office.

Chapter Six

BIM implementation

Every major construction project should begin with the creation of a comprehensive BIM implementation plan so that it can be implemented and improved throughout the various phases of the project. The BIM implementation plan is a comprehensive document that helps the company to identify all the different benefits that can be achieved by implementing BIM at different stages of the project.

It's not uncommon for a BIM implementation plan to become over-complicated and filled with unnecessary details, and it's harder to identify the main parts of the project to prevent the entire process from stagnating. On the other hand, a proper BIM implementation plan will keep everything on track and focus on the most important details, saving everyone involved a lot of time.

Benefits of BIM implementation

Next, we'll look at some of the most prominent benefits that a proper BIM implementation plan can provide.

Collaboration: It is not uncommon for any construction project to have significant differences from other types of projects, including requirements, international standards, regulations,.... BIM implementation plans enable real-time collaboration and schedule correction to minimize problems and unnecessary silos among project tasks, allowing each project to be treated equally regardless of different standards.

Save time: Schedule compression is one of the worst nightmares for almost any construction project. Surprisingly, a proper BIM implementation plan can focus on the most important benefits of the project, allowing the various parties involved to avoid bothering with unnecessary details and thus delaying the delivery of projects. The way it works is that only the most important details are highlighted and described, helping everyone stay on schedule and rarely causing delays in the first place.

Communication: As one of its important cornerstones, BIM generally encourages immediate communication between the various teams and parties involved in the project from the beginning and facilitates the delegation and management of different expectations and responsibilities. BIM also helps in communicating with stakeholders.

Execution: A BIM implementation plan that focuses on the project at hand is much easier to work with and makes communication and collaboration easier. It also eliminates the confusion and slowness that occurs when there are many file formats and standards in play. A properly executed schedule keeps everything on track to ensure the project is completed on time and on budget.

Data sharing: Another common benefit of a BIM implementation plan is the transparency that makes BIM implementation data available to everyone at every stage of the project, including stakeholders, contractors, and others. BIM implementation data includes file formats, details, model dimensions and much more – all in an easily shareable way with the ability to update the information to real-time information in no time.

Here are the six main steps to creating a BIM implementation plan. Start by gathering information and proceed as follows:

Define your project Basic project information is necessary when starting to form your BIM implementation plan. One reason is to provide at least a baseline of project scope to all parties involved. Some of the parts that should be included in this step are:

project name.

Project owner.

Project duration.

Project localization

Key team members

General milestones of the project

Make a list of specific goals for your project. This step is all about understanding what benefits a BIM implementation plan can have for your specific project and defining those criteria. Some examples of the benefits of this step are:

Increasing the safety and efficiency of the project

Improving the abilities and skills of the team.

Looking for new areas of BIM implementation

Improving the quality of the project itself, ...

Choose specific ways in which BIM can be useful for your particular project at different stages. There is no shortage of different ways you can apply BIM to a particular project. Some of the most common BIM applications include:

Cost analysis

3D modeling

Analysis of light performance

Acoustic analysis

Stability analysis

Structural analysis

Space management.

Maintenance supervision

Create various BIM processes based on the information gathered. Despite the fact that there are a large number of possible BIM applications, it's also important to know your limitations – which means you'll need to calculate which tool is most useful and prioritized for your particular project. Once you understand this, it is also recommended that you create a BIM blueprint for yourself, connecting the various BIM tools, their outputs, and the resources they need to work properly. For example, 3D coordination in the form of collision detection requires several different models to be applied simultaneously, including plumbing systems, electronic systems, ... Visualizing a BIM implementation, in general, is incredibly useful for determining your next steps, as well as for deciding whether a particular BIM program is worth pursuing.

Set up methods and methods of information exchange. Different methods and procedures of information exchange between project parties can be planned in advance. This is usually done in the form of a table showing who interacts with whom, what tasks they have, ...

Before you begin, choose the right implementation infrastructure. It boils down to looking at all the previously gathered information and figuring out which BIM infrastructure platform is best for your specific goals and needs. This step depends a lot on the many things we have already mentioned and therefore should be decided as the last step of the plan.

Additional information on BIM implementation plans

Another important part of this is that there is no universal BIM implementation plan for every project. This means that for each project there should be a unique management plan, with its own benefits and caveats, as well as various small details or some industry-specific effects. From this perspective, it becomes clear that only teams that fully understand the purpose and characteristics of their project will be able to create a good BIM implementation plan. Fortunately, there are ways to prevent companies from starting from scratch every time a new project is created.

For example, it is not uncommon for companies to have templates on which implementation plans are based, filling in different types of information according to different needs for a particular project. All in all, there are many benefits to be gained from following a BIM implementation program and companies should not be afraid to try new things to reach new heights.

BIM implementation steps

BIM implementation includes three stages: pre-construction, construction and post-construction.

BIM in the pre-construction phase

Applying BIM in the pre-construction phase can be summarized in the following cases:

Estimation: Using the modeling done, contractors can calculate and forecast project implementation costs relatively accurately. Based on the data of 32 super projects, the research center of Stanford University has reported that the accuracy of BIM forecasts of the upcoming costs has increased by 3% and the estimated time for the implementation and completion of the project has decreased by 80%.

Coordination: using different dimensions of BIM such as fourth dimension for time and the fifth dimension for cost, contractors and contractors can plan for various problems that may come their way and think of solutions to solve them before those problems cause time and cost damage to the project.

Analyzing the building: by using the methods that BIM puts in front of people, the designer group can analyze the building from different perspectives, such as energy, before it is implemented and in this way, to assure the employers that the projected systems will meet their demands in the best possible way.

BIM in the construction phase

During the building construction phase, the operational team can use BIM in the following activities:

Showing the progress of the project continuously with its implementation schedule (4D)

Coordination between different groups by holding meetings between them

Integrate changes, fixes and inconsistencies between different teams

During the construction period, the project team must continuously update the initial proposed model, which is implemented based on BIM standards, and thereby refer the latest changes to the people involved in the shortest possible time.

Advancements made in the field of mobile phones and tablets have given contractors the opportunity to use the information needed for execution at the same time on the construction site. Some of the suitable and used BIM programs in such tools and equipment are: BIMX, Bently, Navigator, Buzzsaw. Recently, Autodesk company has placed its information systems in the Web environment so that it can be used by the project parties as much as possible.

BIM in post-construction stages

A building information model or any plan designed and implemented based on BIM contains all the information about the building and its supplies and prerequisites. This information can be a very useful tool for builders to know and control the building. All the information that is needed for people when using this collection can be stored in the information of this model. In this way, this information can be used efficiently in the event of construction problems during operation.

Nowadays, experts are looking for answers to questions such as what are implementation tools? How should the implementation be done? How to analyze the data? Should the implementation be done on all the company's projects or on some of them?

It can be said that although recognition has happened quickly, the adoption of BIM has not spread among all design professionals, and where this adoption has happened, there have been delays and interruptions in all cases, and the adoption of BIM has been scattered and incomplete and in general, BIM acceptance has happened in terms of technology and commercial adoption, but social acceptance and full understanding of BIM results in the company and the people who make up the company have not happened. For this reason, deep, meaningful and long-term adoption and adoption has stopped not because of technological or commercial factors but because of human factors.

According to the interview conducted with Dr. Taghods (faculty member of Tehran University), the ideal situation for implementing BIM is from the initial stages of the project. In fact, BIM should be reflected in the entire life cycle of the project, and this is while in Iran, BIM is introduced from the phase after design and consultation, and this issue makes the implementation of BIM unable to achieve its main goals in a project.

Draw a correct process

When the project does not have a logical and correct BIM process, your organization will be confused and you will have many questions that you do not have answers to. For example, you don't know where you and your company stand in accepting this process and what are you going to achieve? Where do you see yourself along this chain? You may have no idea how BIM will become your company's future competitive edge.

You may be looking for a detailed explanation of what this technology software includes and how this technology will affect your performance. You may be looking for a scientific explanation that separates the facts from the reality of marketing, you may have software but it is not being used to its full extent, or it is not being used as satisfactorily as you expected.

Old way and new technology

The question that may be raised is, what role does the old and traditional method play in process drawing? Do you just accept this technology and let go of what you've worked and developed over the years to get to where you are today? It may be that your company's policy is to accept and commit to the technology as it is invented and introduced without compromise. You may not talk about it or even acknowledge it, but how you react to new technologies over the years is part of your company's tradition. In fact, the BIM model, like a complete set, should consider all issues.

change management (change or destruction)

Suppose an informed and informed person tells you from a reliable authority that you need to make difficult and continuous changes in the way you think, feel, and act. If you don't, your time will soon be up. Are you able to create this change at a time when changing the subject is of vital importance? If you can, would you like to make a change? Change must be accepted, even if we do not fully believe in it. Tradition is changing. Architects who are not convinced of this issue, have not known the time and, in other words, the world they are in, and are in a state of denial and denial, and their work will soon end.

Based on experiences, the use of BIM and IPD improves a project by 8% in terms of time and cost, as well as improves quality and physical progress, and significantly increases the transparency of information in various stages of the design-bidding-construction project.

First acceptance, then implementation

Acceptance and implementation of BIM are often used with the same concept, but these two each have their own meanings, and part of the reason for the companies' failure to use BIM is to combine these two concepts. To begin the process, it is very important that each of these two concepts is examined separately and that none of these are neglected. Acceptance of BIM is the first step for the implementation of this technology, if BIM is entered directly and without sufficient review in the stage of accepting BIM, the probability of BIM implementation will decrease. Because in this case, challenges gradually appear in the effort to learn new technology. While serving customers and returning profit and efficiency is associated with fear and panic, and many new skills and habits have been introduced and training should be used for better management and more effective use of the work process and technology.

The meaning of accepting and accepting BIM is that the technology is chosen for use by an individual or an organization by conducting sufficient studies; But the existence of BIM's potential in reducing certain problems or creating a more comfortable and efficient job, why accepting and implementing BIM should be difficult and difficult. There are several reasons for this.

Challenges on the road to BIM adoption:

software

Concerns about obligations and responsibilities

Learning curve

Investment in the education sector Making

changes to the existing system Knowledge

and awareness about construction Products

under construction

Who to trust?

Management of information, technology and personnel

Managing expectations

Five main barriers to BIM implementation

In a move to comply with the UK government's mandate to work at Level 2 BIM by 2016, organizations are likely to face challenges in the process.

Time and capital must be invested, and smaller organizations in particular view BIM implementation with trepidation. Furthermore, the construction industry in general lacks transparency on this issue and there will be a common perception that BIM belongs to the larger organization rather than the smaller one.

The 2014 NBS BIM National Report identified the top five reasons cited by those organizations that have yet to make the move. These are specified below.

1. No customer demand

73% of practices employing five or fewer employees cited this manner. While government is implementing BIM for publicly funded works, clients from smaller organizations often don't have the same requests – and the smaller they are, the less likely it is.

2. It is not always related to worked projects

71% of small facilities (five or fewer employees) felt that BIM was simply not applicable or suitable for the nature of their typical workload. They may feel that the level of complexity is not there to warrant BIM, but the reality is that even interior projects can be complex.

3. Cost

A common observation is "the need to break through the recession" before BIM considered. The recession has increased caution, especially when it comes to financial spending. And there's no denying that this move involves the cost of software, training, and time. But the costs must be weighed against the possible benefits. Those who have adopted BIM typically report that the experience is better than they anticipated.

4. Projects worked on are considered too small

Contrary to popular belief, BIM can work on any size project from a home renovation upwards – the biggest deterrent to its effectiveness is the quality of the survey carried out, but this is actually true regardless of whether a building is drawn in 2D or not. 3D Although small contractors may initially be resistant to technological changes in work practices, the workplace is always evolving and can still be taken advantage of in the early stages of a project.

5. Lack of internal expertise

62% of facilities with five or fewer staff members expressed this concern, and 77% of practices with six or more staff members. Although organizations – especially smaller companies – may not currently have the skills in-house, the boom in the industry is leading to increased recruitment and this is an ideal time to attract employees with the necessary skills. Smart employees will be more skilled during a downturn, and smaller practices can be more agile in responding and adopting BIM while benefiting from lower overall training costs.

Despite any reluctance to make a change, organizations can take comfort from the fact that only 4% wished they hadn't adopted BIM. Perhaps more importantly, 61% of users found that BIM brought cost efficiencies, 52% increase the speed of delivery, and only 16% did not feel that it increased profitability.

Of organizations that have not yet adopted BIM, 59% believe they will be left behind if they don't. With the relentless pressure on professional wages for architects and others, it seems that BIM may offer a way to get more work and make it more profitable.

The experience of those who have adopted BIM shows us that the process, although not easy, is worthwhile. Adopting BIM may be less risky and more cost-effective than not doing it at all.

Benefits of implementing BIM in projects

The implementation of BIM in projects is influenced by the willingness of the project manager, field engineer and architect to use BIM, the owner's request to use BIM and the complexity of the project. The size of the project and the type of project, as well as the method of project delivery and the creation of shared working environments have a significant impact on the implementation of BIM in projects.

According to Ahn et al. Kayseri and Iri-Zari and Wang et al. BIM can be implemented in different stages of the project life cycle (planning, design, construction, operation and demolition). Therefore, a BIM product is a digital model that provides information on, for example, design (3D), schedule (4D), cost (5D), and life cycle analysis (6D). Gow and London showed that BIM does not have to be used in all phases and activities of the project. The level of BIM implementation in a project can vary from the complex multidisciplinary use of BIM in an online collaborative environment through all phases of the project life cycle to independent individual building information models and phase-specific disciplines. For example, Cao et al. found that in China, approximately one-third of projects use BIM in only one project phase.

BIM improves decision-making, construction worker safety and facility operation and maintenance, as well as reducing the number of change orders, the number of lawsuits and claims, and uncertainty. Using BIM in projects means encouraging joint effort from all participants and sharing ideas and information in a more effective and organized way than the traditional approach. In addition, BIM improves the quality of project work to deliver a better quality product. It also enables information sharing and improves work efficiency.

2 Strategic planning for BIM implementation

An organization should conduct a strategic planning process to establish BIM goals to focus future implementation efforts. Planning activities help the organization to determine goals and objectives and at the same time direct the means and methods of achieving them.

While organizations may look to resources that offer a "one size fits all approach" to planning for BIM implementation, it is important to recognize that no two organizations are the same. Considering this limitation, the BIM strategic planning procedure can be divided into three main phases: 1) assessment, 2) alignment and 3) development.

The need for a strategic plan for BIM integration

Strategic planning helps ensure that the organization is ready to implement a new process or technology with planned resources. If implemented correctly, it can promote collaboration within an organization and greatly reduce the likelihood of failure. Several benefits gained through the creation of a strategic BIM plan include the development of:

A clear understanding of organizational goals and BIM objectives in a given time frame; Effective allocation of organizational resources to key BIM competencies and priorities Provide a benchmark against which progress in each competency category can be measured at milestones to assess transition. and promote teamwork and a unified vision for planning with multiple opinions from different people in an organization.

As with any new process, implementing BIM in an organization has an associated learning curve. This is important for organizations with relatively little or no experience with BIM, as lack of familiarity can present risks during the implementation process. With more detailed planning, an organization will be able to achieve improved clarity in the process, which will reduce risks and increase the overall value of the implementation.

BIM planning committee

A BIM planning committee should be formed before strategic planning begins. Team members should include individuals who have background knowledge and experience with BIM and its processes and should represent a diverse group of members from across the organization. In cases where the organization cannot form a planning committee with prior BIM experience, it may be beneficial to enlist the help of third-party BIM implementers. The planning committee should include the following:

BIM Champion an individual who is technically skilled and motivated to guide the organization to improve its processes by supporting adoption, managing resistance to change and ensuring implementation of a new technology or process should be selected to lead the BIM initiative. The BIM Champion must have the ability to direct budget and staff as necessary to support BIM efforts. It is important that someone with authority, leadership and motivation is chosen to champion this process.

Executive delegation: Without the involvement of high-level managers, the planning team will most likely not be able to obtain the necessary resources to plan and implement the recommendations. By including executives, key decisions are easier to make going forward.

Middle Management Delegation: Middle managers are responsible for running their departments and achieving the goals set by the planning process. They are responsible for the day-to-day operations of their department by supervising and delegating work to the technical workforce. These managers should be involved in the master planning necessary to manage resistance to changes that may occur during the BIM implementation phase.

Technical Workforce Representation: The technical workforce consists of personnel directly involved with the technology and processes that drive BIM implementation on a day-to-day basis. They are the most experienced employees in terms of operations and implement and use technologies to improve processes within the organization. They are likely to be most impacted by any BIM adoption process. With responsibility for standard workflows that are subject to change due to BIM integration, they are likely to resist change. Involving the workforce in planning can be quite beneficial to the committee, as their participation can aid in the adoption of new processes and provide insight into process modification challenges.

When forming a BIM planning committee, it should include personnel with specific responsibilities and capabilities:

Person(s) who can support planning across the organization. Decision makers who have the authority to access resources needed by the team (such as time, budget, personnel, and infrastructure). People who may be directly affected by the adoption or change.

Motivated people who can contribute to the process and support process improvement through change.

The mission of the BIM Planning Committee states the purpose of the BIM effort. The mission statement for the BIM Planning Committee stems from understanding a number of things including:

Type of organization. the organization's mission and vision;

group(s) of facilities that support the organization;

And the challenges facing these operational units.

The scope and focus of a committee's mission statement can vary based on the committee's expertise and level of understanding. The committee's statement generally explains their existence to achieve the organizational mission and vision using BIM or expands the details by citing an improvement in a process or technology specific to the organization.

Committee Mission Statement for BIM Planning

Mission Statement the Kaiser Permanente National Facilities Services (NFS) BIM Task Force defines its mission as gathering information and contributing to the NFS BIM strategy for planning the adoption and implementation of BIM for Kaiser Permanente. The mission is to "gather information from across the NFS enterprise, report findings, provide recommendations for the NFS BIM strategy and identify action plan work paths to implement the strategy".

The Healthcare BIM Consortium (HBC), a collaboration of healthcare owners, software vendors, designers and manufacturers, has a more specific BIM mission. The consortium exists to "pursue interoperability solutions to support Facility Lifecycle Management (FLCM). "

BIM roles and responsibilities

As BIM needs increase on projects, HR departments and hiring managers in the AEC industry may struggle to gather job titles and descriptions when building their teams to adapt to BIM.

The shift to BIM brings with it a change in job titles and job descriptions, while some may disagree, the last 5-10 years have seen the emergence of a large number of specific job roles.

Preparation of BIM implementation plan

A BIM Implementation Plan (BEP), also known as a BIM Execution Plan, is a comprehensive document that helps project participants move forward with clear roles and expectations. A BEP is an essential element to create before starting any construction project, especially for projects that are large or complex and involve many collaborators.

Through roles, responsibilities, and real-time communication, a BEP keeps everyone aligned while ensuring construction stays on track. This is vital when sticking to intensive programs. A thoughtful schedule also ensures that details don't get lost or become last-minute change orders that cause delays.

A complete BEP is a powerful project accountability tool that keeps work moving forward at various stages of planning and construction. A well-coordinated project begins with a well-constructed BEP.

Why should AEC companies have a BIM implementation plan? Communication

is key in any collaborative project, and this is certainly true in the construction industry. An AEC firm working on a large project plays an important role, but is still only one cog in a larger machine. A BIM implementation program can ensure that each player and stakeholder knows what role to play and when – as well as what – to expect from other people, teams and organizations.

Types of BIM implementation programs

There are two types of BIM implementation plans: pre-contract and post-contract BIM plans. The information they contain will vary by type.

1. BIM plan before the contract

Pre-contract implementation plans are the initial plans presented in the tender stage. The supplier will provide the approach, capacity and other details of his offer. The exact details included in the pre-contract plan may be set by the supplier, or may refer to requirements set by the employer in a document such as the Employer Information Requirements (EIR).

2. BIM design after the contract

Once the contract is closed, another BIM implementation plan "post-contract BIM plan" is drawn up to confirm supply chain capabilities and refine details in motion. A master plan can also be added. Individual task information delivery plans can be used to further indicate responsibility for each strand of information being delivered.

Benefits of having a BIM implementation plan

A BIM implementation program can provide a number of key benefits. As a guiding document that helps different team members identify and implement the functionality that BIM provides at different stages of the project, it can help everyone stay on the same page and provide a clear plan of goals and objectives every step of the way.

Stronger communication

Having a program in place encourages early communication. It also determines who is responsible for the transfer of information at different stages of production, while prescribing responsibilities in specific areas.

Alignment based on standards and collaboration

This is especially important for large or international projects where different regions may have different protocols, standards or regulations. International teams can collaborate through a single plan, avoiding silos and multiple plans or ideas about how to do things that may not all fit together.

Save a lot of time

The plan may be time-consuming to put together, but once it's up and running, it will provide key deliverables, procedures and other information that will streamline the BIM process and keep everyone moving forward. This can save a lot of time in the long run.

Elements of a good BIM implementation plan

An efficient and effective BEP sets your team and project up for success while avoiding miscommunications and unnecessary delays. Elements of a good wording plan:

The roles and responsibilities of each team and organization are clearly defined

Strategic planning, BIM scope definitions and defined key deliverables

Project milestones and realistic timelines

Project objectives / BIM objectives

Model quality control methods

Project reference information, including key project contacts

Work procedures

File naming conventions

Construction tolerance expectations

A project approach to annotations, abbreviations and symbols

Technology infrastructure requirements, including hardware and software used

BIM iteration management

Data transfer management

The success of your BIM project is a small part of developing an effective BIM implementation program.

The development of such a plan, to facilitate the information management of a BIM project, is defined in PAS 1192-2:2013, where it is defined as a "plan prepared by suppliers to explain how the information modeling aspects of a project will be done."

This plan, often abbreviated as BEP or BxP, is developed both pre- and post-contract in direct response to the Employer's Information Requirements (EIR).

The BEP details the project deliverables defined by the contract and the information exchange requirements contained in a BIM protocol, such as the CIC BIM Protocol (a supplementary legal agreement incorporated into construction and professional services contracts through a simple amendment).

What is the difference between pre-contract and post-contract BEP?

In the bidding phase, before a contract is agreed, a prospective supplier will develop a BEP aimed at demonstrating the approach, capability, capacity and competence of its proposal to meet the EIR as a whole.

After awarding the contract, the winning supplier is required to submit a further BIM implementation plan. The focus of this document is post-contract validation of supply chain capabilities. A master information delivery plan (MIDP) is also provided that specifies when project information will be prepared throughout a project, who is responsible for preparing the information, and what protocols and procedures will be used to develop the information.

This information is based on a series of Task Information Delivery Plans (TIDPs) that indicate who is responsible for each information deliverable.

Who is responsible for the BEP when multiple suppliers are appointed?

Where a contract has specified a number of suppliers, there is likely to be a master BIM implementation plan (with production responsibilities set out in the contract documents). Subsequent BEPs from subsequent appointees should then be aligned with the existing BIM master plan.

What is required of a pre-contract BIM implementation plan?

A pre-contract BIM implementation plan is designed to address the client's EIR information needs.

The EIR determines the information required by the client at points in the project where key decisions must be made. The EIR is complementary to (but distinct from) the project summary. While the project brief defines the nature of the constructed data, the EIR defines the constructed data information that the employer wishes to provide. The objective is to ensure that the design is developed in accordance with the client's needs and that the client is able to implement the completed development effectively and efficiently.

The pre-contract BIM implementation plan should address everything requested in the EIR and outline the PIP project implementation plan, project objectives for collaboration and information modeling, and key project milestones and where it fits into the broader project plan. It should also specify how to assemble and deliver the project information model.

What is required for a post-contract BIM implementation plan?

After concluding the contract, the contractor must comprehensively specify how to provide the information requested in the employer's information requirements. Therefore, the post-contract document requires much more effort from the appointed lead designer.

The BEP should list agreed objectives for on-time delivery, exchange, reuse and final delivery to customers. It also lists all agreed elements as specified in the EIR, Summary, BS 1192:2007, PAS 1192-2:2013, CIC BIM Protocol and Contract Documents.

What aspects should be covered?

There are many things to consider when determining how to manage, plan and document information, standard methods and procedures for providing information.

The BEP should include agreed roles and responsibilities (and relevant authorities and approval processes), a strategy for key deliverables and available information to be used and guidance on project milestones and where these will be extended as part of the programme.

The BEP should also describe the methodology in detail. How will BIM volumes be managed and maintained? What file name conventions will be adopted? What construction tolerances and data are required? A common approach to annotations, abbreviations and symbols is also needed to avoid possible ambiguity. You should also determine what software will be used, what data formats will be used for exchange, and what other data management systems will be employed.

Key Aspects of a BIM Implementation Program (BEP)

Ziggurat Global Institute of Technology June 7, 2021

BIM implementation plan is a key and dynamic document that defines the objectives of implementing BIM methodology in a project. It considers the requirements specified by the customer and defines the scope, use cases, process flow, roles, responsibilities, milestones, tasks and tools to be used.

A BIM Implementation Plan (BEP) is a basic document written to provide a framework for implementing BIM in a project.

There is no standard implementation method for every project. Only a team that understands the needs, goals, and capabilities of the client's team can effectively implement BIM.

Developing, updating and revising this document at every stage of the project is essential to get the maximum benefit from BIM implementation.

Is there a pre-contract and post-contract BEP?

In the bidding phase, before the contract is agreed, potential suppliers will develop a BEP aimed at demonstrating their capabilities, competencies and approach to meeting the customer's needs.

After awarding the contract, the winning supplier submits a BEP containing the master plan for the delivery of information and defining the project workflow.

What are the benefits of BEP?

The main benefits of BEP are as follows:

Stakeholders will have a clear understanding of the strategic objectives for implementing a BIM project.

It helps to understand the roles and responsibilities of the members of each work team.

By explaining the strategies, methodology and increasing the level of planning, the number of uncertainties in the implementation process is reduced.

It encourages communication and collaboration between teams from the beginning of the project.

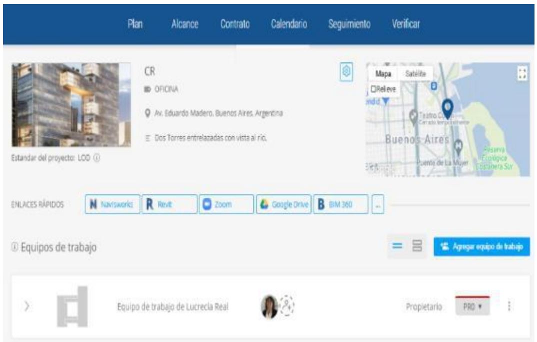
Data is shared by everyone in a structured way.

It provides a reference point for describing the process to future participants joining the project.

What kind of information should be included in the BEP?

A BEP should address the following categories of information:

Project information: project number, location, project description and specifications.



It is difficult to imagine the life cycle of a construction project without the collaboration of today's contractors, engineers and architects who all combine their efforts to achieve their goals of meeting customer expectations, minimizing construction errors due to lack of communication, ... And of course, while this is easy to do with smaller projects, larger and more complex construction projects will struggle to achieve the same level of collaboration without BIM software.

Overview

BIM – Building Information Modeling – is a complex process that includes not only 3D modeling, but also planning, design, construction, collaboration, and more. The ability to share relevant data with all project participants makes BIM a great collaboration tool in general.

While 3D modeling is a part of BIM and is one of the important things, it is not the only alternative to previous types of 3D modeling such as AutoCAD. A comprehensive BIM also includes maintenance data, project schedules, cost information, and more.

The benefits of BIM can be seen in any project size, but it is most effective when working with large construction projects, where you can benefit greatly from collision detection, cost tracking, scheduling, and more.

BIM itself works with so-called BIM objects—components that can be added to the intended 3D models, such as plumbing, electrical components, doors, windows, and other building elements that can change the final outcome of the construction.

The most important trend so far in the BIM industry is the attempt to unify and standardize. So far, there are still different interpretations of the existing general specifications from different BIM companies, which cannot be said to be industry standard, but there are still improvements that can be seen on a yearly basis.

Free BIM solutions

You've seen in this BIM overview that the paid solutions are all extensive and feature-rich, but there are also many free open source solutions that can perform some of the same functions at no cost to help your team get started with BIM. To make this easier, we divide our examples into five different categories: a free BIM viewer, an application-based office standard BIM, BIM as an add-on to CAD software, a complete BIM software tool, and a complete BIM from scratch.

As we mentioned earlier, BIMx is a great free solution for visualizing your BIM projects. Another alternative is BIM Vision, which can work with models from systems like Revit, ArchiCAD, Advance, Tekla, ... It is also the IFC standard, a set of standards that ensure that software can perform a set of basic features in the sense of data visualization.

Our second example is, surprisingly, Microsoft Excel and an initiative called COBie (Construction Operations Building Information Exchange). COBie is a specific data format that aims to record the most important data about a specific project. This data can then be stored in a spreadsheet – for example an Excel spreadsheet.

The requirements of our third example are a compromise between CAD software and BIM software. A combination of these two is called FreeCAD. FreeCAD is a CAD program that provides BIM features to help users perform BIM-related tasks. FreeCAD is also IFC compatible and can be further developed with Python. This is a good way for any user already familiar with CAD software to use BIM.

Another challenge in our next category is making the connection between software terminology and a practical solution. One of these examples is xBIM (Extensive Building Information Modeling). Originally created as a software development tool, it can also provide practical examples from real building contexts. It may be difficult to understand in some cases, but the benefits of using it far outweigh these small problems.

BIM is represented as a complete system facing a processor B. the ground up as a BIM software created this software from, not as an adaptation of CAD software, which is why 3D modeling is somewhat simpler here. Users can expand information about specific models with "tags," and these tags can then be used to provide information such as cost breakdowns, carbon footprint data, and other information.

BIM 3D modeling tools

BIM and 3D modeling services are often considered interchangeable. However, these are completely different processes, each with its own purpose and characteristics. Therefore, it is vital to know the difference between the two in order to make the right choice to improve a particular area of the workflow.

An architectural firm received a project from a significant organization that is difficult to impress its representatives. That's why architects want to use more advanced data to avoid losing such important customers to competitors.

However, the architecture firm has only used CAD drawings before, so they don't know much about other digital tools. A quick Google search revealed many different modeling services for architectural projects, but how do we decide which one to choose? And what exactly, 3D or BIM, is better for their case?

As a CAD company that offers both 3D modeling and BIM services, we know exactly what each technology is used for. So to save you a long Google search, we've come up with a simple explanation of the differences between BIM and CGI. Read on and find out which solutions can improve your workflow!

Application areas

3D modeling services make it possible to develop realistic models of any object, which is why this technology is used in a wide variety of media. Top industries include product design, videography, gaming, architecture, advertising and marketing, medicine, industrial design, geology, and science. These fields use 3D modeling technology for multiple purposes—to assess project potential, effectively integrate designs, or solve potential technology problems.

BIM services are mostly used for construction projects, so it is the main choice for architecture, civil and structural engineering, as well as mechanical, electrical and plumbing projects. These industries use BIM services to predict and solve issues related to construction processes. Specifically, this technology is implemented to manage facility design and construction, foster higher work efficiency, accelerate processes, and improve collaboration throughout the project lifecycle.

Main features

3D modeling means using a set of points in 3D space that are connected by various geometric elements such as triangles, lines and curved surfaces. These are the main entities used to form a complete model. Therefore, geometric data is the only information that this type of modeling stores about the object. In addition, the 3D modeling service allows the creation of photorealistic 3D models with high polygon density with the help of texturing tools and shaders. These features allow covering the surface of the model with real structure to convey the visual aspect of the object.

The main feature of BIM is that it has detailed and accurate data about the structural features of a building. Specifically, BIM contains information about the facility's wall systems, structural and electrical systems, heating, ventilation, air conditioning equipment, plumbing equipment, door and window planning, and the square footage of each material specified in the project.

In addition, BIM stores all technical information about building materials. For example, a BIM object of a wall can display a wide range of parameters such as strength, heat, density, diffusion, permeability, porosity, reflectivity, and electrical resistivity.

Practical use

3D modeling services are used to visualize building design and architectural objects. For example, a 3D model can be used to provide a final view of the building and assess the outcome before the construction phase begins. Apart from that, 3D models can later be used to create digital visualizations or animations for various business purposes – to get high-quality images for marketing materials or to create immersive project presentations for clients and stakeholders.

Architectural CAD has a strategic application in the field of construction. First of all, it is often performed in the pre-construction phase to calculate the amount of materials required for a facility. For example, by having an information model of a building, contractors always know how much plaster is needed for major repairs of a house and how long it will take to complete the work. BIM services can also be used to educate facility operators about the construction process to help better coordinate building operations. Finally, BIM is used to control and manage the building life cycle, from first conception to demolition.

Advantages and limitations

One of the biggest advantages of 3D modeling services is that it allows a digital representation of an object that does not yet exist. In this way, architects and designers can quickly and realistically visualize a completed building. In addition, 3D models can also accurately reproduce and display the exact dimensions of each facility and each design element. This feature allows them to spend less time in the design phase of their projects and more time to actually complete each task.

On the other hand, 3D modeling only serves as a digital version of the object being built. Accordingly, it cannot be extended for use as an intelligent facility operation system.

Meanwhile, a BIM model stores detailed information about how to best operate the facility. For example, CAD services can be used to track changes in the building structure, track the current condition of the building, calculate the required amount of materials and take timely measures for renovation if necessary. This feature of CAD modeling helps to significantly reduce construction time and costs. In addition, BIM services are used for the practical exploitation of existing facilities, both technically and economically.

There is a risk that a contractor may accidentally modify the BIM object after it has been created and distributed. Needless to say, such changes may undermine communication between project members and disrupt the building process.

software

Among the most popular software for 3D modeling services are 3Ds Max, Maya, Cinema 4D, ZBrush, and Marvelous Designer. These programs help develop photorealistic 3D models and modify them by applying different textures to achieve high-resolution results after rendering. All examples of 3D modeling software have different toolsets, learning curves, and functionality, so
3D artists choose the programs with the most appropriate user interface for their workflow.

As for BIM tools, the most widely used ones are Revit, Archicad, BIMobject and Sk..hUp. The aforementioned software can hardly produce photorealistic effects like 3D modeling tools because their rendering performance is quite limited.

However, they allow the creation of detailed and "intelligent" models capable of storing object-related data, construction and engineering details, structural systems, ... Construction models, while others recreate the smallest technical details of a BIM object.

In most cases, companies that provide CAD services have professionals who are solely trained in BIM software and have drafting skills. For example, most CAD artists who use Autodesk Revit also know how to work in AutoCAD. The reason is simple – many architectural projects require CAD drafts first and then BIM construction based on the drawings.

BIM services and 3D modeling are both excellent tools for architecture, construction and design firms. They allow optimizing project workflow and customer service, but they have completely different goals, tools, and capabilities—and are therefore not interchangeable. 3D modeling is the process of making a realistic representation of an object's surface in 3D - a 3D model and therefore great for visualizing ideas and end results. Meanwhile, BIM services create a digital representation of the physical and functional characteristics of a construction, facility or infrastructure. The product produced by this technology is called building information models. These are files that can be shared and mined to make better engineering decisions about a building.

BIM analysis tool

Most architects and engineers have come across the concept of Building Information Modeling (BIM). This is a method that can have many benefits for your company. Building information modeling allows you to centralize your project information. Instead of dealing with a lot of documents, you can collect all the relevant data in a single database.

The benefits of this are immediately apparent. As your projects get more complex, they generate a lot more paperwork. Your company must spend hours plowing through all this information. Designers have to compare lots of different drawings to make sure everything matches. Even the smallest inconsistency can damage the project.

A missing piece of information may not appear in the design phase. However, when you come to build your structure, it will definitely have an effect.

Building Information Modeling eliminates all manual work. You can be sure that both your calculations and information are correct. After all, the methodology warrants it. For example, Revit BIM software stores every bit of data entered by anyone on the team in a central database. You work from a model that all team members can access. Revit notes any changes and applies them immediately.

This allows you to check issues early in the project. Your company creates more accurate prototypes that lead to better models. When you start building, you can trust your model to provide all the data you need. Best of all, you can access that information at any time.

The downside is that building information modeling is not straightforward to adopt. In some cases, your company needs to undergo a complete culture change. This is why you need as much information as possible before making the switch. Let's look at the basics of BIM models and how to use BIM for structural analysis.

Basics of BIM models

There are two main types of BIM models:

Energy models: These building information modeling models deal with all the big questions. You often use an energy model in the early stages of your analysis. The energy model helps you to interpret the basic information. At this point, you will understand what you need to know about the form and direction of your structure. Often, you just use basic geometry to build your models. A more realistic and defined specification will be provided with subsequent energy models.

Lighting models: This is all about presentation because the lighting model controls the visual aspect. They tend to be much more detailed than energy models. You examine your geometry and use this model to define your material properties. It's a model that helps you figure out exactly what you need and how everything should fit together. Generally speaking, your finished lighting model will look similar to the one you present to your customers.

There are other models as well. However, most BIM professionals agree that the energy model is the most important.

A word about BIM energy models

Lighting models are certainly important. However, your energy model is critical to the success of your project. Let's explore energy models in more detail.

As mentioned, the energy model helps you assemble the basic geometry of your structure. However, it serves a much more important purpose than that. Building Information Modeling is all about sustainability. It is through your energy model that you can determine the environmental impacts of your structure.

For example, the analysis of the energy model allows you to understand the energy consumption of the structure. From there, you can calculate how much it will cost to power the structure. You can also calculate the carbon footprint it produces.

As a result, your energy model is implemented throughout the design process. This is the basis of everything you build in your models. It will also be useful in the post-construction phase. Further analysis of your energy model may reveal areas for future improvement. Or it may highlight current problems with the structure that affect its performance.

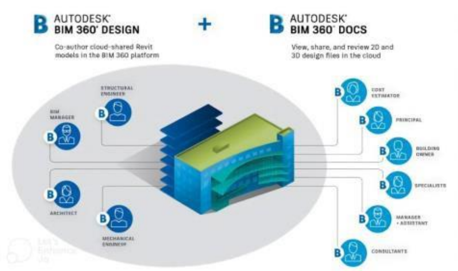
Think of it as a holistic building model. Brings all the elements of the model together. Therefore, it creates a coherent whole. As you progress through the design process, you will build more information into your energy model. You will also be able to understand how different design elements are combined.

You can think of your energy model as your design playground. Continuous testing, along with parametric analysis, leads to model optimization. You will have a better understanding of the energy efficiency of your structure. Most importantly, you'll understand how different components change things. This leads to fast analysis as you can track the most important parameters.

Accordingly, there are many more energy models than those mentioned above. While your initial energy model deals with the basics of the building's shape, over time you will build the details into this model. Finally, it will answer more questions. For example, you will be able to understand how the air conditioning system should work. Or you can check that the lighting system is optimized.

As a result, your energy model is the key to BIM success.

Do I need multiple models?



Building information modeling focuses on providing a centralized source of information. However, that doesn't always mean you only need one model.

For example, you can create multiple models, each analyzing something different. One might monitor power consumption, while the other provides visual clarity. Sometimes you may even use several models to analyze a target at different stages.

However, building information modeling does not lose its centralized nature by using several models. It actually helps you build multiple models. Remember that all models are related. A change in one is reflected in the others. Revit BIM software shows this in action.

As a result, you can build multiple models for different types of analysis. However, all these models are derived from a centralized data set.

What model inputs do I need?

So what inputs do you need for your analysis? It all depends on what model you use for analysis. You may be looking for anything from energy consumption to lighting arrangements. The inputs you use are specific to the analysis you run.

As a result, the geometry of the structure is not sufficient. You may also need to enter the heat quality of the materials you are using. Or you may need to consider how well these materials fit into your energy goals.

Let's go back to the energy model, which is critical to building information modeling. Here is a list of inputs you should use to get the desired outputs:

Information about the geometry of the structure This includes basic information, such as the shape of the structure and its layout.

The technologies you build into the structure to meet the building's energy needs. For example, you should enter information about the lighting system, the ventilation system, and the air conditioning units.

Thermal performance information for each material used in the geometry of the structure. For example, you should consider the type of Windows you are using. A single-glazed window does not have the same energy performance as a double-glazed window.

The surrounding weather and how it affects the energy performance of the building. For example, if the building uses solar panels, you need to know about sunlight.

The number of people who will need to use the building. As a general rule, more people lead to more energy demand.

Which energy sources do you have available for the structure? This includes information on the costs of each source and whether you can combine multiple sources to get better results.

So where does all this information go? In many cases, you send it to the model simulation engine. However, you can also use a simulation tool like Green Building Studio. In any case, this information leads to a more complete energy model. You will get more accurate outputs. In addition, you can use this information for other models.

You'll also find that your inputs improve as the project progresses. Initial inputs are often slightly better than estimates. As you continue to tinker, you'll notice how everything fits together. The fact that Building Information Modeling keeps all information in a central database also ensures that you can perform these tricks faster.

What about outputs?

As with inputs, the outputs you return depend on your goals for the model. This means that you need to think about your goals before deciding on inputs. Additionally, you should have metrics in mind that will allow you to analyze the output.

You can then use these metrics to compare different designs. Whichever best meets your goals becomes the top model.

Here are some examples of the types of outputs you might expect from your models:

A basic energy model may help you understand how much energy the structure will use per year.

A lighting model may show you how natural light will cast shadows on the structure at different times of the day.

These are just two examples of the outputs you can create using Building Information Modeling. There are many others. Which one is more important to you depends on the project.

Geometry and building information modeling

The key thing to remember here is that building information modeling allows you to analyze the structure. As a result, geometry is secondary to accurate measurements. In fact, most architects and engineers use simple geometry in models that allow them to get practical outputs quickly.

Additionally, precise geometry will slow down your simulation time. If you're using this model to retrieve data, you can't wait a long time for your software to create a simulation.

Instead, you'll use material parameters to define things like wall thickness and surface properties.

Of course, this may not suit your needs when presenting to clients. However, in the early stages of business information modeling is very important. When you're in the early stages of design, focus on the data. This will help you design accurate prototypes that use all the information you have. You also run faster simulations that move the project forward.

More complex geometry can wait until you are satisfied with your business information modeling analysis.

As you can see, building information modeling is not a simple matter. In fact, it requires you to change the way you do things. This is especially true for architects. Many architects focus primarily on the attractiveness of their models rather than how efficient they are. BIM allows you to work with more information. It is a holistic methodology. You can still make cool models, just now they have much more reliable data behind them.

Analyzing your building information modeling benefits the project at every stage. You'll quickly create better prototypes. The information collected in your database helps you discover important metrics. These include energy consumption, material needs and many more. As the design progresses, you can train your construction teams. Additionally, the collaborative nature of BIM means that every project member can contribute.

BIM guidelines

The goal of these AIA award-winning BIM guidelines is to create highly effective BIM standards that ensure GSA receives consistent BIM data for BLM (Building Lifecycle Management) and also gives architects and designers the freedom to create high-performance/high-design buildings... Achieving this goal means that this site will rapidly evolve based on project feedback. To make suggestions or ask questions about the guidelines, we encourage you to consult with any GSA BIM Champion or Richard Gay, Region 5 BIM Champion.

BIM guide

Use this guide to edit the BIM SOW to improve workflow by clarifying and synchronizing the BIM scope, schedule, and project AE and GC responsibilities. Avoid adding BIM to old practices. Consult with a regional BIM champion as needed. Generally, the SOW identifies project-specific BIM requirements beyond the macro-level expectations of the Guide Series. After the AE and/or GC is selected, the BIM approach can be further refined through the BIM Implementation Plan (BEP).

Many paragraphs now outline BIM requirements for AE and GC to clarify roles and workflow transitions. On projects where AE and GC partners will be involved, the goal is to represent both so that the scope of work (and pricing) is within the project team's needs. When possible paragraphs are bulleted to aid reading and editing. BIM based analyzes and laser scanning are considered as options and should be added/edited as necessary.

The SOW, once edited, can be used for projects ranging from small renovations to large new construction projects by selecting and editing optional BIM Enabled analyses.

BIM objectives

The first step in the development of BIM project implementation is to identify appropriate BIM applications based on project and team objectives. The current challenge and opportunity faced by the initial project planning team is to identify the most suitable BIM applications in a project according to the project characteristics, the goals and capabilities of the participants, and the desired risk allocation. There are various tasks that can benefit from BIM integration. These benefits are documented as BIM applications, and this guide includes twenty-five applications to consider in a project.

Define BIM objectives for the project

Before identifying BIM applications, the project team must outline project objectives along with their potential relevance to BIM implementation. These project objectives should be specific to the project at hand, measurable, and strive to improve the success of the planning, design, construction, and operation of the facility. A set of objectives may relate to overall project performance, such as reducing project planning time, reducing project cost, or increasing overall project quality. Examples of quality goals include developing more energy efficient design through rapid iteration of energy modeling, creating higher quality installed designs through accurate 3D coordination of systems, or developing more accurate models of record to improve the quality of performance modeling and commissioning.

Other objectives may target the efficiency of specific tasks to enable overall time or cost savings by project participants. These goals include using modeling applications to create more efficient design documentation, developing estimates through automated take-off, or reducing data entry time into a maintenance system. These are just suggestions of the potential goals a project team might have when starting to decide how to implement BIM in a project. This is by no means an exhaustive list and it is necessary to identify the specific goals that motivate the implementation of BIM in the project.

It is important to understand that some goals may be relevant to specific applications while others may not. For example, if the project goal is to increase the productivity and quality of field work through large amounts of prefab, the team could consider using BIM "3D design coordination," which allows the team to identify and correct potential geometric inconsistencies before construction... On the other hand, if the team's goal is to increase the sustainability of the construction project, multiple users might help achieve that goal.

Twenty-five BIM applications, organized by project phase of project development, were identified through multiple interviews with industry experts, analysis of implementation case studies, and literature review (Reference Figure 2-2). A one-page summary description of each of these BIM uses is included in Appendix B of this guide and is available on the BIM Implementation Project website. These descriptions have been created to provide a brief overview for project team members who may not be familiar with the use of BIM and to provide additional information that the project team may find valuable during the selection process. Each explanation includes an overview of BIM use, potential benefits, required team competencies, and selected resources to refer to for more information on BIM use.

For a successful BIM implementation, it is critical that team members understand the future use of the information they are developing. For example, when an architect adds a wall to an architectural model, that wall may contain information about material values, mechanical properties, structural properties, and other data attributes. The architect must know if this information will be used in the future and if so, how it will be used. Future use of these data can often influence the methods used for model development or identify quality control issues related to data accuracy for information-based tasks.

To emphasize the life cycle of information, the main concept of the BIM design procedure is to identify the appropriate uses of BIM, starting with the potential end use of the information in the model. To do this, the project team must first consider the next stages of a project to understand what information will be valuable at that stage. Then, they can move through all the phases of the project in reverse order (operations, construction, design, then planning). This view of "beginning with the end in mind" identifies intended downstream uses of information that must be supported by earlier processes in the project life cycle. By first identifying these downstream BIM applications, the team can focus on identifying reusable project information and sharing important information.

How to choose to use BIM

After defining the objectives, the project team must identify the appropriate tasks that the team wishes to accomplish using BIM. This analysis of BIM uses should initially focus on the desired outcomes for the overall process. Therefore, the team should start with the operations phase and identify the value of each of the BIM uses that are specific to the project, giving each user a high, medium, or low priority. The team can then progress to any previous project phase (build, design, and plan).

To help facilitate the BIM Use review process, a BIM Selection Worksheet has been developed. The template includes a list of potential uses of BIM, along with fields to review value, responsible party, capabilities, additional notes, and the team's decision to implement BIM use.

The purpose of using BIM in construction management

The purpose of construction management is to control the time, cost and quality of projects. Project construction management includes the following basic actions:

Determining project goals and plans, including defining the scope, budget, schedule, required performance characteristics, and selecting project agents and workers;

Improving the efficiency and effectiveness of the project through the efficient management of supply and procurement of manpower, materials and equipment;

Complete management of the processes of planning, design, cost estimation, holding tenders and appointing contractors and construction and delivery of the project;

Establishing appropriate mechanisms and establishing effective communication to resolve conflicts;

Fortunately, VDC technology has made it easier to manage construction projects. This technology uses BIM BIM technology to create a virtual model. It provides different potential and actual possibilities for managing the design and construction processes, and the project design and construction managers can use it to simulate different project processes before starting the actual construction operations. With the help of this technology, the economic evaluation of projects, schedule and design processes is done before the start of executive operations. Also, this technology has an effective role in procurement management, construction and installation management, quality management, time management, cost management, safety management, contract management and project delivery management.

There are two main methods for using BIM:

Central Repository Approach

Distributed Repository Approach

In the central repository method, it is assumed that all project information is stored in a single database file. For example, all project scheduling and financial estimation information will be added to its 3D model information. This method is not very reasonable and practical; Because the type of information required by the designer is different from the contractor. While the designer is involved in issues such as checking the energy consumption of the building and applying regulations and designing spaces, the contractor is interested in determining the work schedule and cost estimation; Therefore, in order for the estimation work to begin, the designer's work must be finished. This is not practical, at least in the initial stages of work.

The extended reservoir method is the method used by most designers and contractors. In this method, the BIM model accesses a set of separate databases created by independent programs. For example, all the information needed for the financial estimation of the project is in the relevant independent program. In order to do its work, this program needs a two-way communication with the three-dimensional BIM model to exchange the necessary information. This work is possible in the very early stages of design; Therefore, despite the use of independent data sources, due to a property called Interoperability, all the information of the different groups involved in the project are integrated. In this order, the design group, including architecture, structure, electrical and mechanical facilities, prepared their models separately in software such as Autodesk Revit, and finally with the help of software such as Autodesk NavisWorks, they were superimposed to obtain an integrated BIM model.

BIM competence and competency

The vast majority of data that makes up the built environment is already available and not under construction. It's an obvious statement that doesn't seem worth it, but it has implications for the use of BIM. BIM can be applied equally to existing data and new construction projects. In fact, given that there is obviously a much larger set of existing data that needs to be managed and that benefit from a BIM approach in terms of maintenance and renovation, its application will be much broader.

The use of BIM in data management recognized with the publication of PAS1192-3 in March of this year. As you may recall, a PAS (Publicly Available Specification) is not a British Standard (BS), but is in many ways a precursor to a BS and is withdrawn from it once its content is published in a BS. A PAS can be used to rapidly develop a specification to meet an urgent need in less time than formulating and developing a BS. The PAS 1192 series is based on the existing code of practice for the joint production of architectural, engineering and construction information contained in BS 1192:20 07 is found.

PAS1192-3 is a companion document to PAS1192-2 that specifies the information management process to support Level 2 BIM in the capital/delivery phase of projects.

PAS1192-3 focuses on the operational phase of data and will apply regardless of whether the data is initiated through major operations, acquired through a transfer of ownership, or is already contained in a data portfolio. The operational phase of a data starts from delivery, but the requirements in PAS1192-3 may also be useful during the main works phase as they are obviously intended to be linked to PAS1192-2.

It's worth noting that data management is different from facilities management, although both are concerned with managing an organization's key data at an optimal whole-life cost. Data management is defined in clause 3.1.6 of PAS1192-3 as "the coordinated activity of an organization to realize value from data". Interestingly, PAS1192-3 does not define facility management, but we can consider it as a process in which services and systems are managed in a given data for optimal whole-life cost.

Therefore, PAS1192-3 is essentially about the availability, integrity and transferability of data and information during the operational phase of the data life. While it may not be exciting reading, and to be fair it probably isn't, it does contain a lot of useful information on how to approach data management effectively and efficiently. Basically, this is through the creation of a data information model (AIM).

Individual BIM competency

A common problem for organizations that provide BIM-enabled services is how to assess their employees' abilities, improve their performance, and hire new qualified people.

To avoid any confusion, I'll start by defining a few terms. First, the term "individual" in the BIM Individual Competency (IBC) refers to an employee of the organization regardless of his discipline, position or role. This means that a person can be a senior manager, project leader or junior employee of any organization that is involved in the design, construction or operation of facilities. Second, the term "competence" is used here to denote a combination of knowledge, skills, experience and - in some cases - attitudes and personal characteristics of individuals (friendliness, leadership, ability to work in a group, ...). Third, the term BIM refers to...ah well, you know.

Who is qualified and who is not?

When a person has demonstrated sufficient skill in performing a specific role, activity or task, we refer to it as competence. In other words, individual competence cannot be general and must be evaluated based on the requirements of a specific position or role. For example, a great model manager may be a below-average BIM coach, and vice versa. A great BIM manager may be a technical master but the reverse may not be true.

Introducing individual BIM competencies

Individual BIM competencies are the knowledge, skills, and personal attributes required to produce model-based results that (a) can be measured by performance standards and (b) that can be acquired or improved through training, education, and development.

IBCs can be grouped under nine headings: managerial, functional, technical, support, administrative, operational, implementation, research and development, and core competencies. Below is a brief description of each + one sample competency:

Managerial competencies: decision-making abilities that lead to the selection/adoption of long-term strategies and initiatives. Managerial competencies include leadership, strategic planning, organizational management, ... Example: "Ability to understand the business benefits and business risks of model-based workflows".

Administrative competencies: the day-to-day activities of an organization that are required to meet and maintain strategic goals. Management competencies include tendering and procurement, contract management, human resources and recruitment, ... Example: "Ability to identify BIM knowledge and BIM skill requirements for large joint projects".

Functional Competencies: Non-technical and general abilities needed to initiate, manage and deliver projects. Functional competencies include collaboration, facilitation, project management, ... Example: “Ability to facilitate a multi-disciplinary BIM meeting

Operational Competencies: The day-to-day and practical individual efforts required to deliver a project or aspect of a project. Operational competencies include design, analysis, simulation, quantification, estimation, ... Example: "Ability to use models to produce bill(s) of quantities".

Technical Competencies: Individual abilities needed to produce project deliverable products in disciplines and specializations. Technical competencies include modeling, drafting, model management, ... Example: "Ability to use BIM software tools to produce accurate and error-free models."

Implementation Competencies: Activities required to introduce BIM concepts and tools to an organization, implementation competencies include component development, BIM library management, standardization, ... Example:

"Ability to develop specific protocols for generating and maintaining a library of model components".

Supportive Competencies: Supportive competencies are the abilities needed to maintain information technology and communication systems. Support competencies include file and network management, hardware selection and deployment, software troubleshooting, ... Example: "Ability to help others troubleshoot basic software and hardware problems."

Research and Development Competencies: The abilities needed to evaluate existing processes, investigate new solutions, and facilitate their adoption in the larger organization or industry. R&D competencies include change facilitation, knowledge engineering, training and coaching, ...

Main competencies:

An individual's expertise, overall experience (in months/years), market exposure (in terms of geography) and project experience (in terms of project type, size and budget). Core competencies also include a person's personal characteristics, such as those measured through the Myers-Briggs Type Index or similar personality assessment systems.

In performing a complex activity, a person needs a combination of competencies. For example, in order for Thomas to coordinate the delivery of projects with other consultants, he needs technical, functional and managerial competencies. However, for a simpler task - for example exporting a 2D design from a 3D model - he only needs a relevant technical qualification.

How many qualifications are there?

Depending on the scale one uses to define competencies, individual BIM competencies (IBCs can be in 10s, 100s, or even 1000s. For example, the ability to use Revit, Tekla, or Vico is a technical competency that can be broken down into "the ability to create new modeling components, the ability to export CAD files, the ability to produce material schedules." Another non-technical example, "the ability to collaborate with other consultants" can be Endlessly divided into “ability to create a BIM project execution plan”, “ability to facilitate model management meetings”, “ability to identify”; and “reduce collaboration risks”, ... Each of these sample competencies can be divided into countless more detailed ones.

Understanding competency levels

A person's competence is often assumed to be binary: disabled competence. This is a simple understanding of competence because it eliminates many of the shadows that exist between two opposite poles.

Build BIM competency

It is very easy to establish the competence of someone we know or chance to evaluate at work. However, it is much more difficult to determine the competence of a person whom we do not know or have not had the opportunity to evaluate his actual results. Do you ask Thomas, a newbie, "how to do BIM" or call his previous boss and ask if Thomas is a "good CAD manager"? Of course, the quality of the answer lies in the quality of the question.

The term competence

The term also applies to exclusive BIM specialists and external consultants, model managers, ...

The term competency can generally be used to describe the maturity capability of organizations and project teams (two or more organizations).

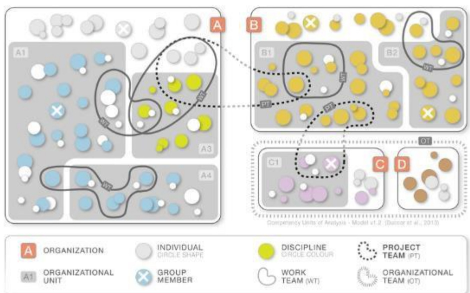
A model manager is usually responsible for keeping the project model up-to-date, error-free, and compliant with organizational or project-specific standards.

A BIM Trainer is a role dedicated to training and supporting staff in the use of BIM software tools and their associated workflows.

A BIM manager is a well-defined role, but is typically responsible for supporting (implementing) the BIM deployment process within an organization, supporting the development/delivery of BIM products and services, and facilitating collaboration with other project participants.

Model-driven deliverables (also known as model uses or BIM uses) are deliverables that are expected to generate, collaborate, and link data-rich 3D models to external databases. Model-based deliverables include specifics of facility design (e.g. immersive environments), construction (e.g. logistics and construction flow) and operations (e.g. data tracking) – see Figure 1 in Part 15.

Training on improving awareness, knowledge, understanding (such as learning design theory and how to calculate thermal gain), training focus on improving skills (such as how to use Tekla or working with a laser scanner) and development on improving attitude/characteristics (such as leadership, ability to work in a team, ...).



This conceptual model identifies several units for competency analysis purposes:

Individual competence is the unit of measurement of a person's ability to perform an activity and provide a result. Individual eligibility applies to a single individual regardless of role, position or employment status.

Group competence is the arithmetical sum of several individual competences, but - as a measure - does not reflect the efficiency gained or lost from such aggregation.

Organizational capability is a measure of the capability of an organization and its sub-organizational units (branches, departments, business streams, ...).

Team ability is the unit of measurement of the combined abilities of team members. In contrast to group competence, team competence reflects the routines and dynamics of the gathering (eg, team adaptability, communication, and cooperation). There are at least three sub-units of team capability:

A work team (WT) capability applies to a purposeful group of people who work together to deliver a project/result within an organization or an organizational unit.

The project team (PT) capability applies to a purposeful group of people who work together to deliver a project outcome across two or more organizations. And organizational team (OT) capability applies to two or more organizations working together (through partnership, alliance, ...) to pursue a common mission or deliver a common project outcome.

There are three competency levels in the competency hierarchy – core, scope and implementation:

The line of core competencies reflects the personal abilities of individuals that enable them to perform a measurable activity or deliver a measurable result. This main tier is divided into the following four sets of competencies: Foundational Traits - Inherent personal qualities of an individual that are not acquired through education or training. Situational enablers - personal characteristics related to nationality, language and other criteria that may play a relevant role in the provision of a service or product. Qualifications and Licensing - Personal characteristics related to the existence or adequacy of academic qualifications, scientific publications, professional credentials, certificates or professional trade licenses; and historical indicators - characteristics related to employment history, project experiences (including project types and sizes), roles played, and job positions.

The domain competency tier refers to people's professional abilities, the tools they use to perform multitasking activities, and the methods they use to deliver results with complex requirements. There are eight sets of competencies in this tier: four core sets—managerial, functional, technical, and support—that represent the main types of professional abilities. and four subsets—management, operation, implementation, and research and development—recognize the capabilities that emerge from the overlap of the primary sets.

The line of performance competencies represents a person's ability to use specific tools and techniques to perform an activity or deliver a measurable result. The ability to use a software tool (eg, a 3D modeling tool), drive a vehicle (eg, a 30-ton dump truck), or operate specialized field equipment (eg, a laser scanner) are examples of performance-level competencies. Also, the ability to use specialized techniques (such as programming, drawing and plastering) is also classified in this row.

The BIM Competency Hierarchy consists of three BIM Competency Tiers, which are divided into several BIM Competency Sets, which in turn are divided into BIM Competency Topics. These tiers, sets, topics—and their detailed division into competency items—represent all the measurable capabilities, outcomes, and activities of the people who deliver the model-based products and services.

stream of merit

The competency flow framework describes how individual competencies can be identified, classified, aggregated and then used/reused. The framework includes a number of components:

Identifying competence through the analysis of job advertisements. Description of specific BIM roles as defined in BIM manuals, BIM management plans and similar documents.

BIM challenges

All types of industries are witnessing a paradigm shift with the introduction and implementation of innovative technology. The construction industry is no exception to this rule. BIM technology has revolutionized the way the construction industry works since its introduction, especially in the last few years. Many countries, such as the UK, have mandated the use of BIM for large-scale public projects.

The impact of BIM leads to optimal use of resources as well as greater productivity and profit. The Indian construction industry is moving forward with BIM technology, but it faces many challenges.

Mr. CB Amarnath, founder of BIM Association of India says, "We have around 30-40 thousand people who use BIM for projects, but most of the people who provide these services are for global markets, there are very few who use BIM. They provide services for Indian projects mainly because they cannot convince clients about the benefits of BIM. When we talk about the development level, mainly for modeling, scheduling, It is an estimate and not for tracking construction or using FM .... There is a need to provide information on how to use this for different phases of projects.

Challenges of BIM adoption in India

BIM has been around for nearly two decades, but only recently has it become mainstream in professional consciousness. The adoption of BIM technology in India has been slower than expected due to some inherent challenges. Here are some of the major hurdles facing BIM adoption in the Indian construction industry:

1. Lack of expertise

The biggest challenge facing the construction industry in adopting BIM is the lack of broad expertise. Some organizations (such as Excelize) offer specialized BIM services. But it is fair to say that most Indian construction companies do not have many employees who are qualified or knowledgeable enough to seamlessly integrate BIM and construction projects. Lack of internal expertise leads to BIM experiments. Projects suffer from inefficiencies and lost profits due to increased operating costs. This creates the impression that this technology is difficult to adopt.

2. Lack of awareness

The second most important obstacle is the lack of knowledge about BIM technology. In a country the size of India, there is no dearth of construction projects – both public and private. But it is still true that a significant portion of the real estate industry is not in tune with the most modern construction practices. There is a lack of awareness of BIM implementation and potential benefits. This translates into a lack of management support or financial support without which no strategic initiative can be successful.

3. Cost effective for small projects

BIM has proven its ability to save large amounts of money on large projects by reducing operational and inventory costs. However, this cannot always be said for smaller projects. These projects easily help to make intuitive and experience-based decisions. The penalty for mistakes is also less like the budget. This makes BIM implementation less attractive with operational costs and effort commitments. Hiring experts and training the existing workforce requires significant investment. Small and medium-sized construction companies see this as a cost rather than an investment, as they are less likely to see the long-term benefits of investing in BIM services.

4. Resistance to change

An increasing number of construction companies have adopted BIM for their construction projects. But the implementation of BIM also requires changes in the operations of the construction company. Better planning means more responsibility for perfect execution. There is less room for error and therefore more pressure to perform. All these factors contribute to the resistance to accept technological changes. Companies concerned about cultural impacts prefer to operate traditionally instead of investing in training their existing workforce or hiring a new workforce that is more attuned to a BIM-based approach.

5. Lack of cooperation between stakeholders

The most important advantage of BIM technology is the integration of the workflow of all involved stakeholders. Currently, this requires high levels of cooperation from interested parties. This is a significant challenge that only gets bigger as the project gets bigger. Large infrastructure projects have multiple teams associated with specific point responsibilities. Often, the involved parties do not have the will to cooperate. Conflicts caused by a lack of cooperation between stakeholders make it difficult to get the job done—BIM-led or otherwise.

Successful adoption of BIM requires a level of expertise within the organization. It requires a change in the way the organization works. The cost and effort of using BIM has limited its impact to larger and more ambitious companies and projects. That being said, this is the direction the world is moving and India needs to catch up. It's time for the Indian construction industry to embrace the power of BIM.

Challenges and potentials

Technology adoption in construction has been slow, but the industry is becoming increasingly aware of BIM's potential in this area. BIM promises better decision making throughout the project life cycle.

Because BIM addresses age-old problems in a cost-effective way with better problem-solving, more effective communication, and faster project construction, several BIM challenges have been identified before implementation becomes commonplace.

Building Information Modeling (BIM) is defined as "a process involving the structured sharing and coordination of digital information about a building throughout its life cycle" (Eastman et al., 2011). BIM is valued as a collaborative technology that eliminates many of the industry's communication challenges.

Over the past two decades, effective and efficient delivery has been a major challenge in the construction industry, with fragmentation as one of the key factors in the industry's delivery process. The mentioned issues were: Uncertainty of cost and time in the delivery process. quality of the final product; hostile culture; Unmanageable delegated risks and rewards (Navondern et al., 2014).

Lack of integrity in an unplanned delivery process prevents any effective communication or collaboration.

Transforming this into a single, well-coordinated process seems to be a catalyst for the improvement of the construction industry (Arayici et al., 2011). Virtual 3D communication is emerging as a new process that is revolutionizing the scope of integration and collaboration with the project delivery system, and this process is BIM.

BIM projections

Although BIM has been around since the 80s, it has only been widely used in recent years (Eastman et al. 2011). In the UK, BIM has become more widely discussed, as the UK government's construction strategy to implement Level 2 BIM in all government projects by the end of 2016 is on the road map to global BIM adoption across the industry.

The UK government's expectations include delivering efficiency, improving carbon performance and reducing costs by up to 20% in public projects through the systemic adoption of BIM. The achievements of these objectives are expected to be provided through the benefits associated with BIM.

However, there are several social and technical issues that undermine the realization of these benefits. They will be discussed in the following sections along with the benefits of BIM.

What is the biggest challenge in BIM?

The BIM Corner team has already written hundreds of pages on the pros, examples and tutorials on how to successfully use BIM processes. However, we know that BIM is not as perfect as we would like it to be. Hence the question in the title – What are the biggest BIM challenges?

All six of us work in the industry long enough to have our own opinions and thoughts (Konrad Naborczyk even wrote a post about it a while back). However, in this entry, I want to talk to other experts. I asked 10 experts to share their thoughts and answer that question. They have different backgrounds and operate in different countries. They range from BIM coordinators, managers, software vendors to salespeople and CEOs. Take a look at what they think about it.

Corporate BIM strategy

A strategic BIM plan organizes a three-year plan for all things BIM and Revit, from drafting to analysis. The plan identifies areas of office operations that need improvement and identifies new software avenues to explore. Specific tasks to be performed by the design and drafting office operations of a building are listed and categorized. We will go through the process of creating a plan including goals and action plans. Implementation and revision of the plan will also be discussed along with successes and lessons learned.

Company history and previous experience

Parsons Brinkerhoff has offices around the world, with 19 offices in the United States alone. Some of these offices have been purchased, so they have different operating standards. The challenge is to put all these offices on one platform. This has historically been done with a network of CAD/BIM managers and a working group called the BIM Process Group of users tasked with defining standards. A national level of BIM development documents and implementation plans creates from managers. The BIM Process group created a common national parameter file and project template, but it is slow to create. The members lost their power after two years.

Global strategic plan

A global strategic plan developed through a brainstorming session of senior executives. The following five objectives were set as priorities:

Objective A - Training of program staff

Objective B - Promote the use of Revit and BIM internally and externally

Objective C - Content development for Revit and other applications

Objective D - to improve the quality of documents

Objective E - Management and upstream staff to provide support for the strategic plan

By revising the global strategic plan, the goals were in line with what we wanted to accomplish as a company, but the defined tasks were behind where our local office operated. A revised strategic plan with a local office focus needs, one where training, development and quality were the main focus.

Brainstorming and writing a plan

Two days were devoted to brainstorming the revised plan. This consisted of three hours a day involving users from all businesses along with some senior staff. At the beginning of the effort, an inspirational symbol needes to help maintain momentum and energy in the group.

Whenever I talk about Revit standards or Revit process improvement, I describe it as a "black hole that pulls everything and everyone into it." Light from a neutron star appears to be fast enough to escape from a black hole. So we used the neutron star as our mascot.

Day 1

This committee divided into three groups that were assigned to one of the three objectives, education, development and quality. Subgroups added content in its post notes that should have been included. The basic rule of thumb is only one idea per post, no more allowed. Brainstorming followed the discussion along with probing questions. They were then organized and prioritized into overall tasks. Some of its posts were moved to different purposes and duplicates were removed. Once each subgroup done, we presented it to the group as a whole to provide validation and consensus.

Day 2

The content of the first day typed on large poster paper. The second day devoted to setting a time frame for completion with six-month, one-year, and three-year milestones. Some edits were also made by re-prioritizing some content and shifting tasks between objectives. The result is the outline of our strategic plan, which then presentes to senior managers and department heads in the form of meeting minutes for review.

Write a plan

Each committee was assigned a champion to formally write the content of the final strategic plan. Tasks were presented in a spreadsheet format with time slots assigned for easier future tracking. Writing the executive summary and the introduction of the strategic plan was assigned to the chairman of the committee. An action plan template was created for each task to organize specific steps to completion. In addition, subcommittee chairs were instructed to observe overlap between different groups. Content can go from development to quality for education, and we didn't want to work on the same thing.

There were review sessions between select Revit-proficient staff and department heads. All comments were documented and formally responded to. A common theme was to complete cases early, the three-year milestone was too long for some cases.

Implementation and maintenance

After the design was completed, the document was presented to the staff via email and presentation. In addition, this plan was given to the National Committee. Regular emails are scheduled for employees with revised/updated content with training sessions scheduled to emphasize the information. In addition, the developed content is included in a published BIM database for maintenance. Biweekly meetings are held with the committee, alternating between the subcommittee work session and the all-member reporting session. It is presented to department managers every three weeks. Meeting minutes are important for following up on decisions.

After a year of operation, progress was slower than initially reported. Not all tasks can be completed in six-month-one-year time groups. New members are added to the committee every year to keep new blood and excitement in the group. We have also reassigned committee members and placed greater emphasis on training based on feedback from bureau and department heads. The overall goal is to keep the content entertaining.

Educational platforms and corporate communication

Employee training requires multiple platforms to deliver content. We have an online training assessment that creates a list of training video modules based on your specific knowledge. Regular meetings with staff regarding administrative processes are required. In addition, a week-long training group of upcoming new features and topics will stress the use of the program. We must continually emphasize to employees and supervisors to take the time to train. It is not easy to do it with a deadline.

One-week training session "BIMco de Mayo"

The first week of May (during Cinco de Mayo) is dedicated to teaching specific software content. One-hour lunchtime sessions were devoted to analyzing content and features that are new to the app that employees may not already be using. The atmosphere was fun with the theme. Below is the general schedule of our office:

Day 1: Smart planning

Day 2: Mechanical conduit pressure drop analysis

Day 3: Analysis of piping equipment

Day 4: Electrical panel programs

Day 5: Business coordination

The sessions were very successful and there was standing room for attendance at the back. Staff feedback was that it was useful and that some of the material presented was implemented in their daily operations.

Corporate communication

The content created so far has been locally focused and reporting nationally on our activities. Our company has a national BIM champion who organizes different groups in each office with regular meetings. The goal is to coordinate the content developed between offices. Leadership support is essential for any progress in the strategic plan.

Autodesk review

After a year of committee work, Autodesk presented a Revit MEP evaluation to our office. A report interpretation was created with the same outline as our strategic plan.

The evaluation determined that more emphasis should be placed on the implementation of the strategic plan. The priority list provided by Autodesk was in a different order than the one created by the users.

More emphasis was placed on workflow diagrams and official documents. For example, the level of development and BIM implementation plans should be revised. This was a useful exercise and added credibility to the strategic plan.

Project audit

Project audits were conducted for three large-scale projects. The models were compared with our administrative standards and industry standards. A list of improvements was created.

Next steps and lessons learned

next levels

Our office's next steps are to update the strategic plan with revised timelines and to outline completed items. We will be adding new content that has been discussed throughout the year's operations. In addition, new employees were also included and assigned to different purposes. More emphasis will be placed on the educational objective. We initially had only four team members, which has changed to six. We will have a monthly staff meeting to report on committee activities. Each member of the committee will have a one-day presentation task and some of the plan will be discussed. Maintaining the project template with the latest contents of the committee. We will continue a regular email schedule for each subcommittee.

In order to confirm that staff are using the new features and content developed by the committee, we will create a checklist for project audits similar to Autodesk's review audits. We will schedule regular internal audits of the project. We are looking to add it as an ISO QA process as part of our certification.

Lessons learned

Regular presentations to department managers are key to maintaining momentum

The project template is a living item and should be updated continuously

Each office will operate slightly differently, starting with a basic project template and allowing content to be reviewed by each office.

Continuous software training is required for all employees

Set a more realistic time frame to complete each task

Revit in 2001 and hasn't stopped, working on projects ranging from university work to lab design.

companion class

This class provides real-world experience writing a strategic BIM building information modeling plan for an office. A strategic BIM plan organizes a 3-year plan for everything related to BIM and evit software, from drafting to analysis. The plan identifies areas of office operations that need improvement and identifies new software avenues to explore.

Chapter Seven

LEED

Leadership in Energy and Environmental Design (LEED) is a green building certification program used worldwide. Developed by the nonprofit United States Green Building Council (USGBC), it includes a set of rating systems for the design, construction, operation, and maintenance of green buildings, homes, and neighborhoods that aim to help building owners and operators be environmentally responsible and use resources efficiently. As of 2015, there were more than 80,000 LEED-certified buildings and more than 100,000 LEED-accredited professionals. Most LEED-certified buildings are located in large metropolitan areas in the United States. LEED Canada has developed a separate rating system that is compatible with Canadian climate conditions and regulations.

Washington DC is the first LEED Platinum city in the world. [1] Image 1225 Connecticut Avenue is the first renovated office building on the East Coast of the United States to receive LEED Platinum status.

Some US federal agencies, state and local governments require or reward LEED certification. This can include tax credits, zoning grants, fee reductions and expedited permits. Studies have shown that LEED leased office spaces generally have higher rents and occupancy rates and lower capitalization rates.

LEED is a design tool rather than a performance measurement tool and focuses on energy modeling rather than actual energy consumption. It lacks climate features and has been criticized for a point system that can encourage poor design choices and rate energy conservation as the weakest part. It has also been criticized for the LEED brain phenomenon, in which the public relations value of LEED certification drives the development of buildings.

History

Arlington County, Virginia, is the first LEED Platinum community in the world. [4] Pictured is 1812 N Moore, the tallest LEED Platinum building in the Washington metropolitan area and other towers with various LEED statuses.

Phipps Conservatory and Botanical Garden in Pittsburgh has multiple LEED certifications, including the world's only platinum-certified greenhouse and a platinum-certified, net-zero energy center for sustainable landscapes.

The University of Texas at Dallas Student Services Building is the first campus building in Texas to receive LEED Platinum status.

Shearer's Foods plant in Massillon, Ohio, is the first food manufacturing plant to receive LEED Platinum status

Development of the Leadership in Energy and Environmental Design (LEED) certification program began in 1993 under the leadership of Natural Resources Defense Council (NRDC) Chief Scientist Robert K. Watson and with the support of the United States Green Building Council (USGBC). Contributors to the initial guidelines included JD Polk, co-founder of Solar Cells, Inc. (now First Solar) and solar energy advocate Lawton Chiles.

Governor of Florida at the time. Watson led an extensive consensus process spanning two decades, bringing together nonprofit organizations, government agencies, architects, engineers, developers, builders, product manufacturers, and other industry leaders. The USGBC Board of Directors was chaired by Steven Winter from 1999 to 2003.

From 1994 to 2015, LEED evolved from a standard for new construction to a comprehensive system of interrelated standards covering aspects from design and construction to maintenance and operation of buildings. LEED also grew from six volunteer committees to an organization of 119,924 employees, volunteers and professionals. [10] LEED standards have been applied to approximately 83,452 LEED registered and certified projects worldwide, covering approximately 13.8 billion square feet (1.28 billion m2).

Many US federal, state and local government agencies require or reward LEED certification. However, four states (Alabama, Georgia, Maine, and Mississippi) have banned the use of LEED in new public buildings, preferring other industry standards that the USGBC considers too lax.

Unlike model building codes, such as the International Building Code, only USGBC members and certain "internal" committees can add to, subtract from, or edit the standard, subject to an internal review process. Proposals to modify the LEED standards are submitted and publicly reviewed by the USGBC's approximately 6,660 member organizations.

Performance

Research papers provide more of what is known about LEED performance and effectiveness in two credit areas: Energy and Indoor Environmental Quality (IEQ). In a study of 953 New York City office buildings, 21 LEED-certified buildings showed no overall energy savings compared to non-LEED buildings, although LEED Gold buildings "performed 20 percent better than all other New York City office buildings." IEQ-related studies provide two contrasting results: the first used surveys of occupants in 65 LEED buildings and 79 non-LEED buildings, concluding that occupants in both groups were equally satisfied with the overall building and work environment. The second IEQ study used occupant interviews and physical site measurements in 12 LEED buildings to report superior indoor environmental performance compared to 12 similar non-certified buildings.

LEED-certified buildings do not need to demonstrate energy or water efficiency in practice to earn LEED certification points, but instead LEED uses modeling software to predict future energy use based on intended use. This has led to criticism of LEED's ability to accurately determine the efficiency of buildings. The USGBC notes that "buildings have a poor record of performance as predicted during design."

Energy performance research

In 2009, architectural scientist Guy Newsham (et al) of the National Research Council of Canada (NRC) analyzed a database of 100 LEED-certified buildings (Version 3 or earlier). In the study, each building was paired with a typical "twin" building in the CBECS Commercial Building Energy Survey database (CBECS) by building type and occupancy. On average, LEED buildings used 18 to 39 percent less energy than conventional buildings. by area, although 28-35% of LEED-certified buildings use more energy.

The Empire State Building in New York City is one of the tallest and most recognizable LEED-certified buildings in existence.

Hostal Empúries was the first LEED certified hotel (LEED Gold) in Europe

In 2009, physicist John Scofield published a paper responding to Newsham et al. that analyzed the same database of LEED buildings and reached different conclusions. Scofield criticized the previous analysis for focusing on energy per floor level rather than total energy use. Scofield considered source energy (the integration of energy during generation and transmission) as well as site energy and area-weighted energy intensity (EUI) when comparing buildings to account for the fact that larger buildings tend to have larger EUIs. Scofield concluded that, overall, LEED-certified buildings did not show any significant savings in source energy consumption compared to non-LEED buildings, although they used 10 to 17 percent less energy.

In 2013 Scofield analyzed 21 LEED-certified buildings in New York City. He found that LEED-Gold 20 buildings consumed less source energy, while Silver-certified buildings consumed an average of 11-15% more source energy than their conventional counterparts.

In 2014, architect Gwen Fuertes and engineer Stefano Schiavon developed the first study to analyze fork loads using documented LEED data from certified projects. This study compared plug load assumptions made by 92 energy modeling professionals against ASHRAE and Title 24 requirements and evaluated the plug load calculation method used by 660 LEED-CI and 429 LEED-NC. Their verified projects found that energy modelers only considered the energy consumption of predictable plug-in loads such as refrigerators, computers and monitors. Overall, the results indicated a disconnection between the assumptions in the models and the actual performance of the buildings.

Energy modeling may be a source of error in the LEED design phase. Engineers Christopher Stoppel and Fernanda Leet evaluated the predicted and actual energy consumption of the twin buildings using the LEED design-stage energy model and city meter data after one year of occupancy. The results of this study show that the circulation and occupancy assumptions of mechanical systems are significantly different from the predicted to actual values.

Most of the flow [when? The analysis of LEED buildings focuses on LEED v3 (2009) or earlier versions rather than LEED v4 (2014) certification. According to Newsham et al., these analyzes should be considered preliminary and should be replicated with longer data histories and larger building samples, including LEED v4 certified new buildings. Newsham et al also noted that more work needs to be done to define green building rating schemes to ensure more sustainable and significant long-term reductions in energy consumption at the level of individual buildings.

Published by Schiavon and architectural physicist Sergio Altamonte, IEQ examined occupant satisfaction in LEED and non-LEED buildings. Using resident surveys from the Berkeley Built Environment Center database, 65 LEED-certified buildings and 79 non-LEED buildings were analyzed for 15 IEQ-related factors. These factors include: ease of interaction, building cleanliness, furniture comfort, light level, building maintenance, colors and textures, workplace cleanliness, space level, furniture adjustability, visual comfort, air quality, visual privacy, noise, temperature, and sound privacy. The results showed that residents in LEED buildings are a little more satisfied with the air quality and a little less dissatisfied with the amount of light. The overall finding was that there was no significant effect of LEED certification on occupant satisfaction considering overall building and workspace ratings.

Based on a similar dataset (21,477 people) in 2013, Schiavon and Altomonte found that occupants had similar levels of satisfaction in LEED and non-LEED buildings when assessed independently of the following factors: office type, spatial layout, distance from windows, building. Size, gender, age, type of work, time at work and weekly working hours. LEED-certified buildings may provide greater satisfaction in open spaces than in closed offices, in smaller buildings than in larger buildings, and for occupants who have spent less than a year in their workplace than those who have used their workspace longer. The study also notes that the positive value of LEED certification in terms of occupant satisfaction may decrease over time.

In 2015, a study on the indoor environmental quality and potential health benefits of green-certified buildings was conducted by environmental health scientist Joseph Allen (et al.), showing that green buildings provide better indoor environmental quality with direct benefits to human health. The number of occupants of those buildings compared to non-green buildings. One of the limitations of the study was the use of subjective health performance indicators, because there is no definition of these indicators in current studies.

Newsham et al published a detailed study of IEQ and LEED buildings in August 2013. Field studies and post-occupancy evaluations (POE) were conducted in 12 green buildings and 12 conventional buildings across Canada and the northern United States. On site, 974 workstations were measured for thermal conditions, air quality, acoustics, lighting, workstation size, ceiling height, window access and shading, and surface finish. The responses were positive in the fields of environmental satisfaction, thermal conditions satisfaction, exterior views satisfaction, aesthetic appearance, reduction of disturbance caused by HVAC noise, workplace image, night sleep quality, mood, physical symptoms and reduction of the number of airborne particles. The results showed that green buildings show better performance compared to similar conventional buildings.

A 2017 study by Altomonte, Schiavon et al. It was investigated whether the green rating by itself leads to greater satisfaction of occupants with IEQ or not. Based on a subset analysis of the CBE Occupant IEQ comprising 11,243 responses from 93 LEED-certified office buildings, this study found that achieving a specific IEQ credential did not increase satisfaction with the corresponding IEQ quotient. Additionally, rating level and certification version had no effect on job satisfaction. There are some possible explanations. Many intervening factors in the time between design and occupancy can alter the existence or performance of LEED-awarded strategies. IEQ certification criteria are also challenged by fundamental differences that characterize the modern workplace in terms of spatial requirements, task requirements, user characteristics, and product design and marketing disciplines.

IEQ performance research

The Centers for Disease Control and Prevention (CDC) defines indoor environmental quality (IEQ) as "the quality of a building's environment as it relates to the health and well-being of its occupants."

The USGBC includes the following considerations for achieving IEQ credits: indoor air quality, volatile organic compound (VOC) levels, lighting, thermal comfort, and daylighting, and views regarding the indoor environmental quality of the building. Published studies also include factors such as acoustics, building cleanliness and maintenance, colors and textures, workstation size, ceiling height, window access and shading, surface finish, furniture compatibility, and comfort.

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Daylight validation in LEED version 4 was updated to include a simulation option for daylighting analysis that uses daylighting spatial independence (SDA) and annual solar exposure (ASE) criteria to evaluate daylighting quality in LEED projects. SDA is a standard that measures the annual adequacy of daylight levels in indoor spaces, and ASE describes the potential for visual discomfort caused by direct sunlight and glare. These standards are approved by the North American Lighting Engineering Society (IES) and compiled in the LM-83-12 standard. LEED recommends a minimum of 300 lux for at least 50% of the total occupancy hours of the year for at least 55% of the occupied floor area. The LEED-recommended threshold for ASE is that no more than 10% of the regularly occupied floor area can be exposed to more than 1,000 lux of direct sunlight for more than 250 hours per year. Additionally, LEED requires that window shades be closed when more than 2 percent of the space is exposed to direct sunlight above 1,000 lux. According to building scientist Christopher Reinhart, requiring direct sunlight is too restrictive an approach that can inhibit good daylighting design. Reinhart suggested using the direct sunlight criterion only in spaces that require precise control of sunlight (such as desks, whiteboards, ...).

Innovation in design research

Innovation in LEED architecture is associated with new designs and high quality construction.

An example is the use of nanoparticle technology for stabilization and conservation effects in cultural heritage buildings. This process started with the use of calcium hydroxide nanoparticles in porous structures to improve mechanical strength. It is also possible to use compounds based on titanium, silicon and aluminum.

Material technology and construction techniques can be one of the first issues to be considered in building design. For tall building facades, such as the Empire State Building, surface area provides opportunities for design innovation. New York City has five other tall green buildings.

In Milan, an academic-corporate partnership sought to produce translucent solar panels to replace conventional windows in glass-fronted tall buildings. Similar concepts are being developed elsewhere, with significant market potential.

The Manzara Adalar skyscraper project in Istanbul, designed by Zaha Hadid, saw significant innovation as part of the Ben der Kartal district's urban transformation project.

A 2003 analysis of green building savings in a review of 60 LEED buildings found that the buildings were, on average, 25 to 30 percent more energy efficient. It also attributed significant benefits to increased productivity due to better ventilation, temperature control, lighting control and reduction of indoor air pollution.

From a financial perspective, several studies in 2008 found that LEED leased office spaces generally charge higher rents and have higher occupancy rates. An analysis of GroCoStar property data estimated an additional cost to minimum profit of 3% and an additional 2.5% for Silver-certified buildings. More recent studies have confirmed earlier findings that certified buildings achieve significantly higher rents, sales prices and occupancy rates, as well as lower capital rates, potentially reflecting lower investment risk.

LEED focuses on the design of the building and not on its actual energy consumption, so it has been suggested that LEED buildings should be tracked to discover whether the potential energy savings from the design are being used in practice.

Directory of LEED certified projects

The USGBC and the Canadian Green Building Council maintain online directories of US LEED-certified projects and LEED Canada-certified projects. In 2012 the USGBC launched the Green Building Information Gateway (GBIG) to connect green building efforts and projects around the world. Provides searchable access to a database of green building activities, buildings, locations, and data sets from many sources and programs, including LEED projects.

Advantages and Disadvantages

Real estate developers are beginning to use LEED certification and a building's green status as selling points.

LEED-certified buildings are intended to use resources more efficiently than conventional structures that are only inspected by mandatory building codes. However, an analysis of energy and water consumption data from New York City shows that LEED certification does not necessarily make a building more energy or water efficient.

Often, when LEED ratings are pursued, the cost of initial design and construction increases. There may be widespread unavailability of manufactured building components that meet LEED specifications. There are also additional costs in USGBC correspondence, LEED design assistant consultants, and the hiring of a required commissioning authority, which are not in themselves necessary for an environmentally responsible project.

Proponents argue that these higher upfront costs can be offset by savings realized over time due to lower projected operating costs than typical industry standards for a LEED-certified building. This life cycle costing is a method of evaluating the total cost of ownership, taking into account all the costs of acquiring, owning and operating and the final disposal of a building. Additional economic payback may come in the form of increased employee productivity resulting from working in a healthier environment. Studies show that an initial investment of 2% more returns more than ten times the initial investment over the life cycle of the building.

The USGBC has supported Architecture 2030, an effort that has set a goal for a zero-emission building by 2030. The Living Building Challenge (LBC) is currently the most rigorous sustainable design protocol. It sets out 20 requirements that compel building owners, designers, operators and tenants to go beyond current LEED rating levels.

LEED is a design tool, not a performance measurement tool. It's also not yet weather-specific, although the latest version hopes to address that to some extent. Because of this, designers may be encouraged to make design choices to achieve LEED points, even if the choice is not optimal for the particular project. Additionally, LEED is not energy specific. It only measures overall performance and allows creators to choose how they achieve points in different categories. A USA Today review found that 7,100 approved commercial building projects targeted cheap and easy green spots, such as creating healthy spaces and providing in-building educational displays Few builders used renewable energy because of the upfront cost. Manufacturers game the rating system, using certain functions to compensate for others, and energy saving becomes the weakest part of the overall evaluation.

LEED and BIM

The synergy between Building Information Modeling (BIM) and LEED Leadership in Energy and Environmental Design was recognized early on, as the industry began to adopt BIM. However, current practices of implementing BIM in LEED projects remain ad hoc, resulting in job successes that are difficult to replicate.

Building information modeling (BIM) and green building are currently two main trends in the architecture, engineering and construction (AEC) industry. This research recognizes the market demand for better solutions to achieve green building certification such as LEED in the United States. It proposes a new strategy based on the integration of BIM and green building rating systems. Based on the matching of LEED certification requirements with the functional list of popular BIM software solutions, then a framework to prepare the theoretical foundations Practical solutions were developed to support this integration. The BIM LEED application model was developed to address practical problems at the credit level that may occur in real LEED projects. It consisted of two modules: "Design Assistance" and "Certificate Management". The "Design Assistance" module used the Autodesk Revit API to provide designers with LEED knowledge contained in BIM software to ensure that the design was LEED-centric. The "Certificate Management" module was a web application based on the Apache platform. /MySQL/PHP was built that focused on managing project information, LEED documentation and submissions for certification purposes.

Finally, the LEED materials and resources use case was developed for initial validation of the program model by simulating the LEED project delivery process. Overall, this research suggested and showed that BIM-LEED integration is possible with significant limitations. Integration must meet the needs of different team members with specialized assistance at different stages of the project delivery process. New functions of BIM software solutions and better support for information exchange at the database level facilitate a more accurate implementation of BIM in green building certification.

Legal challenges and contractual bottlenecks

BIM's unique features of building information modeling have made designers and builders have very good facilities for project design and implementation. However, due to the new working conditions in the BIM environment, issues and challenges arise in the implementation and use of building information modeling, which must be thoroughly understood in order to provide solutions to solve future problems. Despite the many advantages and attractions of using information modeling in the construction industry, the contractual and legal challenges around it can prevent the expansion and widespread use of this technology. Legal issues related to building information modeling is always one of the most important challenges, and the need to regulate contractual relationships and special agreements that can guarantee the goals and results of building information modeling is emphasized. Understanding how to apply BIM and use it in a project provides the necessary foundation for preparing a potential contract text. In this context, there are two distinctive features compared to traditional construction methods, which are:

BIM can be a source of information for a project (as a single data set or a set of integrated or related data),

(2) Contracting parties may contribute to the production of an integrated or multiple virtual model as part of the BIM process. Engineers aren't the only people learning how to work in building information modeling. As much as designers can create their own BIM models, lawyers and other professionals are also trying to create BIM legal relationships and participate in this debate.

"GIS"

A geographic information system (GIS) is a database containing geographic data (descriptions of phenomena to which a location relates), along with software tools for managing, analyzing, and visualizing that data.

In a broader sense, such a system can be considered to include human users and support staff, procedures and workflows, knowledge sets of related concepts and methods, and institutional organizations.

Basic concept of GIS

Geographic information systems, also called GIS for short, is the most common term for the industry and profession related to these systems. It is almost synonymous with geoinformatics and part of the broader field of geospatial, which also includes GPS, remote sensing, ... GIS science is definitely more popular.

Geographic information systems are used in many technologies, processes, techniques and methods. They are related to various operations and multiple applications related to: engineering, planning, management, transportation/logistics, insurance, telecommunications, and commerce. For this reason, GIS and location information applications are at the base of active location services that rely on geographic analysis and visualization.

GIS provides the ability to link previously unrelated information through the use of location as a "key indicator variable".

Locations and extents found in Earth's space-time can be recorded through the date and time of occurrence, along with x, y, and z coordinates. Indicating, longitude (x), latitude (y) and elevation (z), all ground-based, spatio-temporal, location and extent references must be related to each other and ultimately to a "real" physical location or extent. This key feature of GIS has opened up new avenues for scientific research and study.

BIM project

Building Information Modeling (BIM) is one of the most promising recent developments in the architecture, engineering and construction (AEC) industry. With BIM technology, a detailed virtual model of a building is created digitally. This model, known as a building information model, can be used to plan, design, build and operate facilities. It helps architects, engineers and builders to visualize what is to be built in a simulated environment so that any identify potential design, construction, or operational issues.BIM represents a new paradigm in AEC that encourages the integration of the roles of all stakeholders in a project.

The architecture, engineering and construction industry (AEC) has long sought techniques to reduce project cost, increase productivity and quality, and reduce project delivery time. Building Information Modeling (BIM) offers the potential to achieve these goals (Azhar, Nadim et al. 2008). BIM simulates a construction project in a virtual environment. With BIM technology, an accurate virtual model of a building, known as a building information model, is created digitally. Once completed, the building information model contains the detailed geometry and relevant data needed to support the design, procurement, construction, and construction activities required to realize the building. Once completed, the model can be used for operational and maintenance purposes.

A building information model specifies geometry, spatial relationships, geographic information, quantities and properties of building elements, cost estimates, material inventory, and the project schedule. This model can be used to represent the entire life cycle of a building, as a result, the values and common properties of materials can be easily extracted. The scope of work can be easily separated and defined. Systems, sets, and sequences can be represented on a relative scale across an entire facility or a group of facilities. Construction documents such as drawings, procurement details, delivery processes and other specifications can be easily linked together (Khamlani et al. 2006).

BIM can be thought of as a virtual process that captures all aspects, disciplines, and systems of a facility in a virtual model, allowing all members of the design team (owner, architects, engineers, contractors, subcontractors, and suppliers) to collaborate more accurately; And it is more efficient than using traditional processes. As the model is being created, team members are continuously refining and adjusting their parts according to project specifications and design changes to ensure that the model is as accurate as possible before the project physically fails (Carmona and Irwin 2007).

It is important to note that BIM is not just software. It is a process and software. BIM not only means the use of intelligent 3D models, but also brings about significant changes in workflow and project delivery processes. BIM represents a new paradigm in AEC that encourages the integration of the role of all stakeholders in a project. This has the potential to promote greater efficiency and coordination among players who previously saw themselves as enemies (Azhar, Hein et al. 2008). BIM also supports the concept of integrated project delivery, which is a new project delivery approach to integrate people, systems and structures and business practices into a common process to reduce waste and optimize efficiency at all stages of the project life cycle.

Future challenges of BIM

The productivity and economic benefits of BIM for the AEC industry are widely acknowledged and increasingly well understood. In addition, BIM implementation technology is readily available and growing rapidly. However, the adoption of BIM has been much slower than expected.

Management issues revolve around the implementation and use of BIM. Currently, there is no clear agreement on how to implement or use BIM. Unlike many other construction methods, there is no single BIM document that provides guidelines for its application and use (Associated General Contractors of America 2005). Furthermore, little progress has been made in creating BIM model contract documents. Several software companies are cashing in on the BIM "bell" and have programs to address specific quantitative aspects of it, but not the process as a whole. There is a need to standardize the BIM process and define guidelines for its implementation. Another contentious issue among AEC industry stakeholders (owners, designers, and builders) is who should develop and implement building information models and how development and operation costs should be distributed.

To optimize BIM performance, companies or vendors, or both, must find a way to lower the learning curve for BIM practitioners. Software vendors have a bigger hurdle to produce a quality product that customers can trust and manage, and that meet the expectations set by advertising. Additionally, the industry must develop acceptable processes and policies that promote the use of BIM and govern today's ownership and risk management issues.

Researchers and practitioners need to develop appropriate solutions to overcome these challenges and other related risks. The use of BIM in the AEC industry is expected to continue to grow as a number of researchers, practitioners, software vendors and professional organizations work hard to meet these challenges.

In the past, facility managers have been very limitedly involved in the building planning process and implemented maintenance strategies based on the condition of the building at the time of owner occupancy. In the future, BIM modeling may allow facility managers to enter the picture at much earlier stages where they can influence design and construction. The visual nature of BIM allows all stakeholders, including tenants, service representatives and maintenance personnel, to obtain critical information before the building is completed. Finding the right time to include these people will undoubtedly be a challenge for owners.

Building Information Modeling is emerging as an innovative way to design and manage projects virtually. The predictability of building performance and performance is greatly improved with the adoption of BIM. As the use of BIM accelerates, collaboration within project teams should increase, leading to improved profitability, reduced costs, better time management, and improved client-client relationships. The average ROI of BIM for the projects under study was 634%, which clearly shows its potential economic benefits. At the same time, teams implementing BIM must be very careful about legal issues involving data ownership and related proprietary issues and risk sharing. Such issues should be raised in advance in the contract documents.

BIM represents a new paradigm in AEC that encourages the integration of the role of all stakeholders in a project. This merger has the potential to create greater efficiency and coordination among players who have often seen themselves as enemies in the past. As with most paradigm shifts, there will undoubtedly be risks. Perhaps one of the greatest dangers is the potential removal of an important check and balance mechanism inherent in the current paradigm. An adversarial stance often entails a more critical review of the project as a kind of mutual protection of each participant's own interests. In the early stages of BIM, builders worked from architectural drawings because digital models were not shared by architects with contractors. Construction modelers inevitably discover errors and inconsistencies in drawings when creating building information models. This created a natural redundancy because the design-build model placed the virtual building in this experiment. With the more reliable sharing of architectural drawings that can be easily imported and serve as the basis for a building information model, this critical review step may be eliminated. In other words, when all players see themselves on the same team, they may stop looking for and finding faults in each other's work. In the past, lack of critical review has been at least one component of building failure. With the more reliable sharing of architectural drawings that can be easily imported and serve as the basis for a building information model, this critical review step may be eliminated. In other words, when all players see themselves on the same team, they may stop looking for and finding faults in each other's work. In the past, lack of critical review has been at least one component of building failure. With the more reliable sharing of architectural drawings that can be easily imported and serve as the basis for a building information model, this critical review step may be eliminated. In other words, when all players see themselves on the same team, they may stop looking for and finding faults in each other's work. In the past, lack of critical review has been at least one component of building failure.

BIM project specifications

The customer is the highest organizational level of an organizational structure in a construction project. As he defines the project objectives, i.e. the requirements of the building to be built, he also defines the BIM objectives and orders all related services.

Duties overview:

The client transfers the information required by the company and the property operator to the person responsible for BIM (also known as the information manager) so that he can compile and communicate them in the appropriate way in the project; And so that the requirements are actually considered and implemented.

The client can also specify internal standards, for example, define compliance with process specifications, require the use of templates and checklists, and many more, request that they be used or implemented as part of the project.

This often involves defining the required interface binding in the existing software architecture.

A key aspect here is particularly the software used in the completed building, for example asset management, facility management, building control technology, or smart building software.

Ideally, the software itself, as well as the use cases for mapping, are defined before planning begins.

In larger companies, it is not unusual to provide the CDE environmental data collaboration platform and prescribe its use to the customer. In this context, the customer can also define the exact usage of the collaboration platform.

The client is usually involved in the execution phase to make quick on-site decisions (such as change requirements, reordering, payment processing, ...) and is responsible for subsequent acceptance and final invoice negotiations after the construction project is completed.

BIM Accountable organizes the BIM project for the client. He is the digital equivalent of a project manager. The BIM accountant is responsible for ensuring that the data and information provided by the project participants are in line with the client's interests. The purpose of the duties is specifically focused on meeting the employer's information requirements (EIR).

Duties overview:

BIM accountant duties are organizational in nature. He organizes the BIM project on the client side. Here, the role is specifically responsible for defining the client's information needs with respect to digital project implementation and outcomes. The BIM Accountant, together with the project managers (eg, project management and steering committee), is responsible for formulating the BIM objectives and drafting the project-specific Employer Information Requirements (EIR). Milestones for the information cloud also emerge from this.

In this context, he also evaluates project progress for the client with respect to the implementation of BIM objectives and prepares review reports and makes recommendations for the release of milestones to the client.

BIM Accountable defines the service profiles of BIM Manager and Total BIM Coordinator. In addition, the BIM Accountable, in coordination with the BIM Manager, is also responsible for the requirement profiles of other BIM participants. In this way, the BIM accountant has a continuous influence on the scope of the participants' services and can therefore determine the required qualifications of the participants in the project.

His duties also include communicating BIM or EIR goals to contractors and coordinating with them. This relates to the objectives, programs, quality and depth of the model. Therefore, he is also involved in defining the LOG and LOI requirements for the respective project phases. The most important contact in this regard is the BIM manager. In consultation with the BIM Manager, the BIM Accountant can also help determine the data exchange organization and data exchange formats.

He publishes the implementation of BIM objectives, which must be explained by the BIM manager or contractors in the framework of a BIM implementation plan BEP. In this framework, it controls the processes and specifications specified by the client to execute the digital project for the benefit of the client.

His area of responsibility also includes the organization and control of information exchange between project participants within the framework of the cooperation platform, which may be already specified by the client in the EIR or defined between the participants in the framework. BAP Thus, all internal standards and guidelines of the client can be organized and integrated by BIM Accountable.

In addition, there are interfaces for BIM quality management, as he provides specifications for BIM quality management and quality assurance, and makes all arrangements and guidelines for quality features with BIM quality management.

In this context, it provides the employer with all the evaluations he needs for his decisions in the project and informs him of what happens during the implementation of the project.

BIM quality management works on behalf of the client and is responsible for the overall quality management of the BIM method in the project.

Duties overview:

The quality of the BIM method in the project, taking into account the contractually agreed costs and schedule goals, is always considered by the BIM quality management.

BIM Quality Management together with Accountable BIM participates in the definition of BIM objectives in the project as well as the performance profiles of the BIM Manager and the overall BIM Coordinator.

He participates in all project contracts and especially in the BIM Implementation Plan (BEP). He places special emphasis on BIM KPIs and performance parameters, as well as inspection KPIs used in routine inspections to effectively monitor the scope and quality of services. These can be, for example, specifications and handling of the types and number of encounters and their removal rate, as well as specifications and regulations related to the performance of the document management system. Quality management can classify service quality only based on these specifications.

BIM Quality Management ensures the implementation of the specifications created for the BIM method by monitoring the quality of work of the BIM Manager and BIM Total Coordinator.

Participation in BIM Total-coordinator courses is also not excluded, because the possibility of conflict is revealed during the meetings.

BIM quality management is also used as an inspection reference when accepting BIM models with partial models between service phases. Oversees awarding of contracts and delivery of BIM to contractors. BIM quality management is also responsible for monitoring the review and acceptance of the BIM model and its delivery to the operator.

Risks of BIM

BIM risks can be divided into two general categories: legal (contractual) and technical. In the following paragraphs, the key risks in each category are briefly discussed.

The first risk is the lack of ownership of BIM data and the need to protect it through copyright laws and other legal channels. For example, if the owner pays for the design, the owner may feel entitled to ownership of it, but if team members provide proprietary information for use in the project, their proprietary information should also be protected. Therefore, there is no simple answer to the question of data ownership. Each project requires a unique response depending on the needs of the participants. The goal is to avoid inhibitions or deterrents that prevent participants from fully realizing the model's potential. To avoid disputes over copyright issues, the best solution is to specify ownership rights and responsibilities in the contract documents.

Authorization issues may arise when project team members other than the owner and architect/engineer provide data that is integrated into the building information model. For example, vendors of equipment and materials provide designs associated with their products for the convenience of the original designer in hopes of getting the designer to specify the vendor's equipment. While this practice may be good for business, licensing issues may arise if the designs are not produced by a licensed designer on the project site.

Another contractual issue that needs to be addressed is who controls the input of data into the model and who is responsible for any inaccuracies. The responsibility of updating BIM data and ensuring its accuracy involves a lot of risk. Complex indemnification requests by BIM users and the provision of limited warranties and disclaimers by designers are essential negotiation points that must be resolved prior to using BIM technology. It also requires more time to enter and review BIM data, which is a new cost in the design and project management process. Although these new costs may be dramatically offset by productivity and planning gains, they are still a cost incurred by a project team member. Therefore, before BIM technology can be fully utilized,

The integrated concept of BIM blurs the level of responsibility so that there is a possibility of increased risk and liability. Consider a scenario where a building owner encounters a design error. Architects, engineers, and other participants in the BIM process look to each other in an effort to determine responsibility for this issue. In the event of a dispute, the lead expert will not only be liable to the claimant as a matter of law, but may also have difficulty proving fault with others such as engineers.

As cost and schedule dimensions are layered on top of the building information model, responsibility for the appropriate technology interface among different applications becomes an issue. Many complex contracting teams require subcontractors to provide detailed critical path method plans and cost breakdowns by work item before the project begins. The general contractor then collects the data and creates a master schedule and cost breakdown for the entire project. When subcontractors and the prime contractor use the same software, integration can be fluid. In cases where data is incomplete or submitted in different scheduling and costing schedules, a team member—typically a general contractor or construction manager—must re-enter and update the original schedule and costing schedule. That application may be a BIM module or another application that is integrated with the building information model. Currently, most of these project management tools are developed separately. Responsibility for the accuracy and coordination of cost and schedule data should be contractually considered.

Collaborative and integrated project delivery contracts where the risks of using BIM along with the rewards are shared among the project participants. Recently, the American Institute of Architects published an exhibit on BIM to help project participants define their BIM development plan for integrated project delivery (Building Design and Construction 2008). This exhibit may assist project participants in defining model management arrangements as well as authorship, ownership, and development level requirements at various stages of the project.

BIM represents a new paradigm in AEC that encourages the integration of the role of all stakeholders in a project. This merger has the potential to create greater efficiency and coordination among players who have often seen themselves as enemies in the past. As with most paradigm shifts, there will undoubtedly be risks. Perhaps one of the biggest risks is the potential removal of an important check and balance mechanism inherent in the current paradigm.

An adversarial stance often entails a more critical review of the project as a kind of mutual protection of each participant's own interests. In the early stages of BIM, builders worked from architectural drawings because digital models were not shared by architects with contractors. Construction modelers inevitably discover errors and inconsistencies in drawings when creating building information models. This created a natural redundancy because the design-build model placed the virtual building in this experiment. With the more reliable sharing of architectural drawings that can be easily imported and serve as the basis for a building information model, this critical review step may be eliminated. In other words, when all players see themselves on the same team, they may stop looking for and finding faults in each other's work. In the past, lack of critical review has been at least one component of building failure. With the more reliable sharing of architectural drawings that can be easily imported and serve as the basis for a building information model, this critical review step may be eliminated. In other words, when all players see themselves on the same team, they may stop looking for and finding faults in each other's work. In the past, lack of critical review has been at least one component of building failure. With the more reliable sharing of architectural drawings that can be easily imported and serve as the basis for a building information model, this critical review step may be eliminated. In other words, when all players see themselves on the same team, they may stop looking for and finding faults in each other's work. In the past, lack of critical review has been at least one component of building failure.

The future of BIM is both exciting and challenging. It is hoped that the increasing use of BIM will increase collaboration and reduce fragmentation in the AEC industry, ultimately leading to improved performance and reduced project costs.

BIM project models

Federal BIM models can be considered as a combination of various specialized digital models of the project (structural model, MEP systems, architectural model, interior design, ...). They also aim to provide a complete model of the entire project to facilitate information sharing, coordination between design disciplines, but above all, interference checks and validation of any design-related problems.

A federated BIM model means a set of 3D models related to specific disciplines (architectural, structural, engineering, MEP, ...) that are integrated into a single view to create a complete digital twin model of the building that is multidisciplinary and comprehensive.

In a federated model, all information related to building geometry, structure, electrical system, plumbing, heating, renewable resources, ... are converged.

The federated model consists of interconnected but distinct components that do not lose their identity or integrity. This means that any change to a single component of the federated model does not mean a change to other components of the same federated model.

The components of the federated model can be created by the same professional or by individual members of a team or by professionals working separately, each for their own discipline.

Generally, the process starts with the architecture modeling phase, where other professionals, for example structural designer, plant engineer, ..., develop the relevant competency areas by importing the architectural model in IFC format. The individual pieces are then integrated into the federated model, which once completed forms the complete digital twin of the project.

Federation between models can be managed through the use of BIM tools that can coordinate the different disciplines involved and create a common knowledge base for the different professionals involved. The goal is to investigate and manage any problems, conflicts and inconsistencies that arise from comparing and overlapping different models.

The coordination of these processes also allows for the control, management and monitoring of any conflicts between the separate parts of the federated model. This obviously means that other specific professional roles may also be required. The UNI 11337 standard, in the section related to these aspects, defines two different management roles, the BIM manager and the BIM coordinator, and one with more operational training, the BIM specialist.

Advantages of the federal model

The availability of a federated model capable of integrating all data from different disciplines has an important impact on many management aspects of a BIM project.

For example, it has a very positive effect on:

coordination

It improves the understanding of the project in all its different parts

It ensures everyone's access to information

Informed decision-making facilitates coordinated planning.

Prevents interference detection

Improves project approval processes

It is a repository of information that can be consulted and implemented by anyone over time

Interference detection

This allows for early detection of cross-threading conflicts that might otherwise be missed during the verification phase. For example, by processing the structural model and the plant engineering model separately, in certain cases you may not be able to highlight the collision between an air conditioning duct and an emerging structural beam. If the models were not federated, this interdisciplinary encounter between the structural model and the MEP model would not have emerged. All the missing information, design inconsistencies, wrong decisions and insufficient use of resources in the design phase appear before the project starts. This method allows professionals to easily intervene, introduce corrective actions, and continue the design and construction process.

This saves time and resources that would otherwise be spent reviewing new design solutions, revisions, and project changes at advanced design stages or even during construction.

Accurate and realistic estimates

Provides consolidated and accurate data

It contains all graphical, metric, geometric data and information about individual components

It allows to obtain accurate estimates on quantities, costs and realization schedules and, based on the data in IFC files, enables construction cost estimation resulting from the parametric design workflow with planning and approval of execution time and tasks.

Where does a federated model fit in a project workflow?

A collaborative 3D BIM project places requirements on a network of project participants to develop a wide range of project-related data and data in electronic form.

Work on BIM level 2 will see the creation of a managed environment for data (including 3D models). At this level of BIM maturity, these are created in separate discrete models that originate from a range of construction disciplines – architects, structural engineers, building services engineers, contractors, subcontractors and suppliers.

These models are uploaded to a common data environment, known as the CDE Common Data Environment, where they can be accessed and combined.

When individual models are entered into a software, they are usually referred to as 'federated models' although BS 1192 (Joint Production of Architectural, Engineering and Construction Information – Code of Practice) refers to them as 'composite models'.

How are federated models managed?

The CIC BIM protocol requires the client to designate an information manager responsible for managing the federated model in the shared data environment.

The information manager must ensure that the relevant procedures are followed and that the provisions of the BIM protocol are followed. The role of the information manager is not a design function – model coordination and collision detection should be addressed elsewhere.

The journey to increasing BIM maturity and Level 3 BIM requires the creation of a single, online project model that can support (and be accessible to) a range of project participants.

What are the contractual implications?

The copyright and liability issues surrounding increased collaboration are numerous.

At BIM level 2, each federated model exists as a completely distinct and separate entity. The individual models themselves do not interact – they only provide data that is used to build the federated model. This means that the liabilities of those offering individual models are virtually unchanged.

In practice, this means that adding conflicting documents to a BIM protocol, such as the CIC BIM protocol, should be sufficient to address any contractual concerns.

The journey to increasing BIM maturity and level 3BIM requires the creation of a single, online project model that can support (and be accessible to) a range of project participants. How to deal with this contractually requires careful thought and is likely to raise significant barriers to copyright and liability issues.

What are the advantages of the federal model?

The process of combining models has many advantages, including that all models can be visualized in one tool. Other benefits include:

Early coordination and design development **-** the ability to solve problems and make design decisions before work begins on site; moreover, missing information, inconsistencies, poor decisions and inadequate resource allocation should all be exposed early on. Scene.

Collision prevention and advanced detection – through early and regular data supply and integration.

Improved estimates – Schedule and cost estimates are made easier by providing more data and early integration and approval and sharing of specification decisions.

EIR

Information requirements of the employer (EIR) information that the employer from its internal team and suppliers defines what is needed for project development and exploitation of completed constructed data.

Relevant extracts from the employer's information requirements in the procurement documents for the appointment

Any supplier appointed directly by the employer is included. which may include; Consultants, contractors, ...

Prospective suppliers respond to the client's information needs with a pre-contract BIM implementation plan against which their proposed approach, capability and capacity can be assessed.

Developing employer information requirements is likely to be an iterative process:

Initially, it may take the form of a simple information requirements process map that identifies the key decisions that must be made during the project to ensure that the developed solution meets the business need, and defines the information requirements very broadly.

To make those decisions to identify required materials, operational and functional information about facilities, floors and spaces is developed.

As the design progresses, it identifies more specific requirements regarding the proposed systems and building components to support logistics.

At the end of the project, the need for information to support the maintenance and operation of the systems and defines the components that are actually installed.

Information requirements The employer must clearly state the information requirements of each supplier and describe the expected information in terms of documents, model files and structured information.

It should also specify how and when to exchange information in the project life cycle.

However, the exact nature of the client's information needs depends on the complexity of the project and the client's experience and requirements.

Experienced employers may establish very detailed employer information requirements, while others may set only high-level requirements and some ground rules and allow the supplier to suggest how these requirements can be met.

BIM audit

In any project, it is very important for the BIM manager or BIM coordinators to conduct a series of audits to ensure that the BIM models created by BIM Modeller meet the desired quality and standards. These standards are usually specified in the BIM Implementation Plan (BEP) prepared by the BIM Manager at the start of each project before any BIM modeling work begins.

Types of audits

Checks There are different types of checks that can be performed by BIM managers and BIM coordinators. This includes visual checks, standard checks and conflict checks.

Due to the many years of experience of our team of BIM managers and BIM coordinators, they are able to perform visual checks to identify any errors in the BIM model.

BIM managers in our company are also equipped with the knowledge of preparing quality control checklists. This checklist ensures that reviews of BIM models are carried out thoroughly so that BIM deliverables meet the required delivery standards set by the authorities.

The BIM manager and BIM coordinators are also equipped with a set of skills to perform collision checks through the software adopted by the project. They should then prepare a conflict report that can be generated through the software to be used as a reference in BIM coordination meetings for conflict resolution.

Often, some construction companies choose to build an in-house BIM model with their own in-house engineers. While not undermining the abilities of other engineers, a third-party BIM model audit from an engineering firm with extensive experience is critical to objectively validating the model's accuracy.

New York Engineers is armed with extensive experience in BIM models. We have provided model designs and audits for a large number of companies in various fields of construction.

A third-party firm provides an objective analysis of the model and all its features to ensure that the design intent is met. Such an unbiased view will bring great results to your model.

BIM modeling is a complex subject and not all professionals are well versed with it. Developing 3D digital models that represent the components of your project requires in-depth knowledge.

In addition, you need to ensure that the model builds efficiently from one dimension to another while intelligently adding specific information to components depending on the scope of the project. For example, you must master the art of data planning, cost estimating, and facility management. All these aspects are very important for the accuracy and consistency of the BIM model, thus the need for the model to be audited by a third-party company.

Why audit a BIM model?

BIM modeling requires deep knowledge about the technological operations of building information modeling. Any incorrect representation of your building may result in incorrect output data and incorrect reports.

In summary, the following can occur as a result of your BIM model being misrepresented:

Failure to identify conflicts: With a poorly designed digital model, the team may not be able to anticipate conflicts and resolve them in advance. This can be costly for the project with rework requests. Too many change orders: While change orders are common in construction projects, a smart design model can eliminate them altogether. On the other hand, a poor design mode may result in too many change orders after construction. Inaccurate addition of critical information: BIM encompasses various dimensions such as 4D planning, 5D cost estimation and 6D facility management. Improperly adding these layers of information to BIM can compromise the validity and consistency of the model. Compromised Details: An incorrect model compromises the details of your project. Other team members may find it difficult to interpret the model and ultimately the entire project may be compromised. Furthermore, an incorrect model may compromise the scope of the design. Failure to comply with building codes: Finally, all buildings must comply with local building codes and relevant standards. An incorrect model may fail to comply with building standards and other good building practices. This includes standard naming conventions.

By auditing the advanced BIM model, the above failures can be avoided. What you get will be an accurate and consistent digital representation of your project, with fully functional, accurate Levels of Development (LOD).

Our MEP engineers have been in the industry for decades using BIM to maneuver construction projects. This extensive experience gives us the technical skills to master the art of using this technology.

How is BIM model audit done?

To perform a BIM model audit, there are a series of steps that our professional engineers follow. This includes ticking off a checklist customized to the scope of your construction project.

Typically, our audit process includes the following:

Document review: Typically, a digital model follows the designs made on the documents. From initial documents and reviews, our engineers review them to see if the model covers everything. Early documents give us an indication of the scope of the work. Usually, 2D maps are converted into 3D BIM models. We review such designs to ensure that the digital model has no missing or inconsistent items. Compliance with industry best practices and standards: The construction industry is highly regulated by existing building standards and best practices. To ensure that your model produces excellent results, our engineers review relevant standards and practices to ensure that your BIM model complies with them. Building Code Compliance: Local building codes are also a consideration when auditing your digital building model. Our engineers are familiar with a wide range of building codes in the United States. For each location, we study the relevant codes and apply them to your model.

Design Validation: We perform a series of calculations, check the plans to confirm the validity of the design in the BIM model. As we review the model, we check for omissions and errors. Development level review: Our engineers will review the development of BIM model dimensions to ensure that it matches the original design and scope of work. Model accuracy: We check the 2D maps from which the 3D BIM model is extracted. This helps us determine if the model matches the original design in 2D or CAD drawings.

The aforementioned services do not include what we offer in model auditing. Construction projects vary in scope and we customize our services for each client. We can extend our services to structural analysis, energy analysis and performance analysis. Our engineers can confirm whether the model is effective in all BIM dimensions such as 4D, 5D and 6D.

Benefits of BIM Model Auditing for Contractors

Contractors often rely on models given to them by architects and engineers and proceed with the construction work. They rarely care about approving designs and may be hit with change orders. With our audit model, contractors can survive the change orders that are common in many construction projects.

Making a change order after the structure is built can be disastrous and costly. The best way to avoid them is to have the model audited by reputable professional engineers who validate the model against the design intent. We do an in-depth review of the original designs and compare them to the model. This helps us detect omissions and errors.

Conflicts are common in constructions and can only be avoided by rechecking the model with professional engineers. Unlike traditional 2D designs, 3D BIM models help us visualize designs in real time and detect errors in advance. If the model is poorly performed, it cannot detect such collisions in time. This will then lead to costly requests to rebuild your project.

What happens after BIM model audit?

After conducting a model audit, we document the findings to relevant stakeholders. Our review process considers all dimensions and dynamics of the model. When providing feedback, we comment on features that conform to best practices, building codes, and standards. We applaud the designers for the great work they have done on the functional features.

However, when we encounter some model inconsistencies and compromises, we recommend changes to owners. We will identify errors and omissions that designers should address. Our experience in BIM has equipped us with the ability to detect errors in BIM models.

What can we do to correct faulty BIM models?

New York Engineers is a multi-disciplinary MEP engineering firm in New York. As such, our engineers are multi-skilled in multiple fields.

BIM modeling has become our forte since its inception in the construction industry. In fact, many customers can attest to our expertise and excellence in this model. This makes us the leading provider of BIM models in the United States.

After we find errors, inaccuracies and inconsistencies in your BIM model, we suggest changes to the model to make it complete. This means we will strategically work with your design team to correct any issues our team finds in the model. From designing to adding critical information to components, we can help you achieve them.

What happens if the in-house design team fails to correct the BIM model issues?

We understand that BIM modeling is a highly specialized technology in the construction industry. However, not everyone is well versed with it and that is the case with some interior designers. New York engineers can partner with your team or do the work on your behalf. Our engineers are highly specialized in BIM coordination and management. No BIM job is too big for us.

BIM engineer

Building Information Modeling is a technological advancement that helps construction professionals in the industry to virtually understand the design and performance of a building prior to the actual physical construction process. BIM has provided a different lens to all construction actors and has given them a lot of energy to understand the details of their project compared to the traditional method. This process has really helped construction professionals to save time and think of every economic aspect.

The term Building Information Model really has a lot for its users, but its operational process is not easy. This is where our BIM engineers step in to explain their role in this spectrum. BIM engineers work with a team of engineers who have knowledge and training in BIM functionality. This allows them to make an important decision with the right knowledge to access the full benefits of the software.

Roles and Responsibilities of a BIM Engineer:

They have the ability to work in a variety of construction environments including commercial, educational, industrial and healthcare related projects. They have a strong network with their clients for 3D modeling, 2D shop design and design submissions, necessary to work with clients during pre-construction. They maintain and coordinate project delivery with the offshore production team. They are also trying to champion the advancement of BIM.

BIM engineers follow a different pattern compared to what a typical civil engineer follows, and their sophisticated knowledge of this software is what makes their job so challenging and different from other construction professionals. If you aspire to become a BIM engineer one day, make sure you are aware of the important qualification requirements to become a professional BIM engineer.

The influence of a BIM specialist is huge and the decisions made by a BIM engineer must be approved by the architect so that the operations are carried out accordingly. A BIM engineer is in a position to analyze all the details of the mock-up before the actual physical construction process takes place, and leading a team allows him to work collaboratively and efficiently, because the benefits of BIM look so nice, but the implementation is what gets lost somewhat.

Technostuct has truly proven its worth in this construction spectrum by providing our clients with expertise and wisdom in approaching their projects from the right lens and their impact has truly shown in the industry.

BIM manager

The BIM Manager is the gatekeeper of how a company implements its BIM workflow. They are often the key decision makers regarding the BIM applications, workflows, and standards used throughout an enterprise. This makes them an essential part of any modern architecture or design firm.

The BIM manager generally ensures the full performance of the BIM method in the project.

He supports the client and BIM Accountable regarding BIM strategy and project management.

His activity should be separated from the BIM Accountable activity in the sense that he has a deeper knowledge of BIM request forms and model development documentation. Finally, he is responsible for defining and determining these areas in coordination with the BIM Total-Coordinator.

Duties overview:

His main duties are in the field of BIM application management and strategy. He receives technical support from the overall BIM coordinator and is supervised by BIM quality management.

He determines the BIM maturity level in consultation with the client. A distinction must be made between the following levels:

BIM level 0 which is exclusively about the joint collaboration of project participants.

Level 1 BIM, which involves collaborative work and the creation of 3D models,

Level 2 BIM, where various degrees of information enrichment with more dimensions are already added and

Level 3 BIM where only non-proprietary data formats are used and, for example, a cloud-based platform and building model are used throughout the life cycle.

This role defines and updates the required content and level of detail in terms of geometry and information (LOG and LOI requirements, as well as coordination and procurement) in each cost group and project phase. This is done in collaboration with BIM quality management and its predefined specifications.

The BIM Manager defines and helps coordinate the use of software and the import and export interfaces and data exchange formats used.

Provides technical guidelines for storing, creating, and presenting data. He/she is also responsible for managing access rights in the CDE project platform or shared data environment – this role can also set up workflows for this purpose. Together with BIM coordinators, he documents all other specifications in a BIM Execution Plan (BEP).

The BIM Manager is generally responsible for organizing and coordinating processes in BIM planning by defining processes and time intervals for data integration, quality review, data transfer and reporting.

He analyzes the communication, coordination and information requirements related to BIM in the specialized areas of the project and ensures proper implementation and modifications.

In this context, the BIM manager can also play a supporting role for the project manager and the BIM Total coordinator. In this context, he coordinates BIM processes with stakeholders, moderates model coordination meetings, and participates in the creation of CAD modeling guidelines.

Implementation of BIM quality review in the project is also part of the tasks. For this purpose, it can define and prescribe rules and procedures. He can define regulations to ensure data quality and BIM implementation. In the scope of the report to evaluate the implementation of BIM, he transfers the results to the BIM quality management and reviews them.

He is still responsible for communicating the required BIM methods and supports contractors through training or directly assisting with implementation if problems arise. If the contractor decides to obtain certification in this area, the BIM manager can assist in the development of the relevant BIM certification and training program and support the employer in the certification process.

What does a BIM manager do?

BIM managers play a very key role in an architecture or design firm as the gatekeepers of how companies implement BIM workflows.

Once again, a BIM manager acts as the gatekeeper for how a company executes its BIM workflow.

Assuming a company is committed to an existing software package (such as Autodesk Revit), it will likely hire a BIM manager with expert-level experience in that particular platform, in addition to any other technology that touches that universe.

This person will often be the key decision maker on programs and tours throughout the company.

Ideally, these decisions are made based on experience, research, and testing, along with discussions with other stakeholders in the company, such as project architects. BIM managers enforce quality and standards. The next role of the BIM manager is to be the "guardian of the standards".

Construction drawings require careful communication. In this case, communication is done through text and graphics.

What kind of standards are there with BIM?

Each company has its own standards for how maps should be visualized. Everything from font and line weight to "how should we draw a toilet?" It will be discussed in the discussion about standards. BIM standards can be drawn from any number of authorities, but each company determines exactly what standards it wants to implement.

Do BIM managers need certification?

There is no requirement for BIM managers to obtain specific certifications for employment. Some companies may require certain years of experience or familiarity with a certain industry, but there is no formal certification process for BIM managers. Becoming an Autodesk Certified Revit Expert can be a good start.

coordinator

To make it easier to understand, I have divided the BIM Coordinator's work into 4 main roles, which are somewhat defined depending on the progress of the project and the nature of the workflow. The initial letters of these BIM Coordinator roles are arranged in the form of EPIC abbreviation, which is easy to remember.

the coach

Since BIM technology is developing at a very high speed, it is not easy to keep up with new methods and tools. It is necessary to have a person who takes the role of coach in the project and is a technical support for others. BIM Coordinator is exactly one of them.

The main task of the trainer is to ensure that the project team and management are properly trained in the use of the tools used in the project or company.

I want to emphasize here that they don't have to be experts in modeling software, although knowing at least one of them helps a lot. A key task in this role is to understand what BIM competencies project participants have and to organize the training process and workshops so that they receive the appropriate knowledge and technical support.

The role of the BIM Coordinator as a trainer is a very responsible function that includes a list of responsibilities. Some of them are as follows:

Support the tender team and clarify the client's BIM requirements - tender stage,

Explaining how to implement BIM in the project for the project team - preliminary stage,

Coordination of training courses for the project group:

Confirmation of the competence level of the project team.

Providing more training courses to employees if necessary.

Joint creation of knowledge exchange places about tools and methods of working with BIM in the company:

Creating additional webinars using the tools used in the company.

Create "best practice" documents that describe how to use specific tools in the most effective way - e.g. "Best Practices for Working with ArchiCAD".

Organizing meetings to exchange experiences in working with technology between project team members,

Personal support for designers in working with models.

Teaching designers new work methods and automation of repetitive tasks.

Programmer

Planning, analysis of requirements and development of strategy for applying BIM is the key responsibility of BIM Coordinator. Its related tasks are mainly related to the bidding stage or the preliminary design stage, where the BIM implementation plan has not yet been created. The prepared documents, knowing the terms of the tender, explain in detail how the client's ambitions are to be met. One of these documents is BEP-BIM implementation plan.

Here the role of the BIM coordinator plays the fiddle first and adjusts the strategy and finds the best solutions that do not disturb the work of the designers and provides the documents required by the client.

Below I have outlined the tasks of the BIM coordinator where the role of the PLANNER is particularly evident, these tasks are as follows:

Planning a proposal that meets the client's BIM Ambition (EIR) with a tender team Establishing internal BIM standards used in the office/organization:

standards for the use of modeling tools,

standards for creating object libraries,

Office Information Exchange Standards

Co-creating a BIM implementation plan for a project – creating a BIM implementation plan

Planning procedures:

related to the implementation of coordination programs,

To conduct industrial and multidisciplinary investigations,

To hold coordination meetings

the innovator

Although the construction industry is still one of the least innovative in terms of technology, the area related to the application of building information modeling is no exception. I have observed the ongoing changes in BIM quite closely and I have seen how quickly it is developing. New workflow methods and new approaches to modeling, orchestrating and managing modeled information tools are emerging.

As you work on a project, you don't always have time to "understand" it all. And this is where the BIM Coordinator comes to the rescue. They are one of the main catalysts of innovation in the project. By keeping up-to-date with the latest developments, they can tailor their BIM implementation strategy to best utilize existing technology. Innovations may support project teams in their work, accelerate the design process, or add entirely new value.

A BIM coordinator's duties as a technology pioneer in a company may include the following:

Choosing and implementing solutions to automate repetitive tasks:

Using tools like Dynamo and Grasshopper

New plugins for existing programs, for example the RVT tool to automate the export of IFC files

Using robot processing automation technology - RPA

Participating in industrial conferences and events for educational purposes and getting familiar with the latest developments in the industry.

Testing new solutions/methods/concepts in pilot projects:

design without design,

Using VDC, ICE, Last Planner,

Using Huddle Walls for project needs

Using Huddle Wall for Coordination Meetings - Hospital Project in Tønsberg (Norway)

Using models for completely new purposes:

visualization of a project with virtual reality or augmented reality,

Presentation of the project as a computer game

coordinator

Among all four roles, this role is bolder and the name of the position itself also comes from this role. Coordination duties may include many tasks, often depending on the type of project you are working on. The most common ones are checking the model geometry, searching for collisions and reporting to the relevant team members.

However, this is only a small part of the overall picture. The BIM Coordinator is also responsible for:

assigning the discovered geometric encounters to the appropriate people responsible for a given model,

Logical grouping and naming of encounters for easier identification.

View reports of dealings with the relevant project team members.

Update encounter reports and send them to project management.

Creating a 4D simulation of the workflow on the site,

Checking the correctness of the information entered in the model,

Check if all the data exported from the model are complete and accurate.

Ensure that the model parameters match the BEP,

Initial configuration of 3D models in modeling programs (Revit, Tekla, ArchiCAD, Allplan, ...),

Configure models for all disciplines to ensure correct use of coordinate system and matching models.

Creating and adjusting design templates in modeling tools,

Create solutions to improve workflow with models,

Creating a family of elements or a library of internal elements in the project,

Attend kick-off meetings to ensure everyone understands the BIM process.

Participate in meetings with clients and others as the "BIM expert" in the organization.

Creating an agenda for regular coordination meetings,

Migration of models to new software versions (previously agreed with the whole project)

Compliance verification, checking if any data was deleted during transfer.

BIM Levels of Implementation (LOI)

With BIM, you can use as much technology as you want and can. I have seen MEP engineering companies use Revit as a modeling tool for coordination, others use it for its programmability, but few use Revit to its full computational capability. There is no right or wrong way to use Revit, but each level of implementation (LOI) in an MEP engineering firm has advantages.

The easiest and fastest way to implement Revit in an MEP firm is to use it only for its 3D modeling and smart tagging capabilities. This low LOI is acceptable in the construction industry because most architects who mandate the use of Revit only use your model to coordinate 3D elements for spatial planning.

Modeling on the same platform as the architect makes it easy to launch the project.

Modifications to the architectural model can be tracked with coordination tools built into Revit.

Creating designs (sheets and views) is hard work. Designers have the ability to create large plans, sections, and elevations with almost no effort.

Since the elements are controlled by categories and filters, it's simple to display any value or less than any view, and it's easy to edit these views during subsequent revisions.

In general, 3D element modeling helps to facilitate the coordinated design of the building at every stage, from pre-construction to pre-construction.

Scheduling in Revit is simple because it collects data that is already in your model. A scheduler is simply a way to view your model in a table. If Revit is used correctly and the information is already in the model, why not use a timeline to display that information?

You no longer have to worry about counting equipment or devices. The programmed elements will always match what is shown in your programs because it technically pulls the same information from the same model.

Data is always synchronized between threads. As long as your multi-disciplinary models are set up to exchange data correctly, there will never be a disconnect between engineering disciplines.

Calculations in Revit are easily created as schedules. The real challenge is getting your team to ditch their Excel spreadsheets and trust a new software enough to develop computational models in Revit.

Using Revit to calculate pressure drop and electrical loads is ideal in a perfect world. If it can automate the calculation of data already in the model, why shouldn't it?

Revit eliminates the human error factor of counting and calculation. As long as your model is accurate, your calc will be accurate.

By using a single source for your model, drawings and calculations, you ensure that your data is always in sync and there is never a discrepancy between the three critical elements of building design.

As a result, every level of Revit implementation is improved over using 2D CAD for building design. Even if only used as a 3D coordination tool, regardless of size, the benefits of Revit will become apparent in the early design stages of your first project.

We don't expect LOI to become an industry standard term, but we think you don't need to use "full BIM" when working on your first Revit project. Start small, then gradually use BIM as much as possible.

Understanding the need for change and innovation

The construction industry has been widely criticized as a fragmented industry. There are increasing calls for industry change. Supported change requires collaboration as well as embracing innovation in the design process, construction and throughout the supply chain. Innovation and the use of emerging technologies are seen as enablers for the integration of "team integration" processes such as Building Information Modeling (BIM). A questionnaire survey was conducted to determine the shift in construction with regard to design management, innovation and the use of BIM as advanced pathways for collaboration. sets and architectural surveyors. Most respondents were in general agreement that the design team is responsible for design management in their organization. There is a perception that the design manager and the client are the catalysts for driving innovation. The current state of the industry in terms of incorporating BIM technologies presents a challenge as well as an opportunity to achieve it. BIM technologies are creating a new paradigm shift in how buildings are designed, constructed and maintained. This paradigm shift requires a review of the curriculum for education. Building professionals collectively believe that the design manager and the client are the catalysts for driving innovation. The current state of the industry in terms of incorporating BIM technologies presents a challenge as well as an opportunity to achieve it. BIM technologies create a new paradigm shift in how buildings are designed, constructed and maintained. This paradigm shift requires a revision of the curriculum for the education of building professionals collectively. There is a perception that the design manager and the client are the catalysts for driving innovation. The current state of the industry in terms of incorporating BIM technologies presents a challenge as well as an opportunity to achieve it. BIM technologies create a new paradigm shift in the way buildings are designed, constructed and maintained. This paradigm shift requires a revision of the curriculum for the education of building professionals collectively.

SMEs

Small and medium-sized enterprises (SMEs) or small and medium-sized businesses (SMBs) are businesses whose number of employees is less than certain limits. The abbreviation SMES is used by international organizations such as the World Bank, the European Union, the United Nations, ... The World Trade Organization (WTO) is used.

In any national economy, SMEs sometimes outnumber large firms by a large margin and also employ more people. For example, Australian SMEs account for 98% of all Australian jobs, generate a third of total GDP and employ 4.7 million people. In Chile in the 2014 business year, 98.5% of companies were classified as SMEs. In Tunisia, self-employed workers alone account for about 28 percent of total non-agricultural employment, and firms with fewer than 100 employees account for about 62 percent of total employment. US SMEs create half of all US jobs, but only 40% of GDP. In 2014, 170,000 US SMEs exported nearly $180 billion in goods to TPP countries.

However, while 98 percent of U.S. exporters are small businesses, less than 5 percent of all U.S. businesses export goods. This means there is enormous untapped potential for small businesses to increase revenue and support businesses by selling US goods and services to the 95 percent of the world's consumers who live outside the US.

Developing countries tend to have a higher share of SMEs. SMEs are also responsible for creating innovation and competitiveness in many sectors of the economy. Although they create more new jobs than large companies, SMEs also suffer the majority of job destruction/attrition.

Considering the role of this sector in employment, SMEs are important for economic and social reasons. Due to their size, SMEs are highly influenced by their chief executive officer, or CEO. CEOs of SMEs are often the founders, owners and managers of SMEs. The duties of a CEO in an SMES are difficult and mirror those of a CEO of a large company: the CEO must allocate time, energy, and assets strategically to steer SMEs. Typically, the CEO is the strategist, champion and leader of SMES development or the root cause of business failure.

This definition is provided in Section 7 of the Micro, Small and Medium Enterprises Development Act, 2006 (MSMESD Act) and was promulgated in September 2006. This law provides for the classification of companies based on the size of their investment and the nature of the activity performed by them. Under the MSMESD Act, companies are divided into two categories – manufacturing companies and service companies. For each of these categories, a definition is provided to explain what constitutes a micro-enterprise, a small enterprise, or a medium-sized enterprise. What does not fall under the above three categories is considered as a large scale enterprise in India.

At the employee level, Petrakis and Kostis (2012) examine the role of interpersonal trust and knowledge in a number of SMEs. They conclude that knowledge positively affects the number of SMEs, which in turn positively affects interpersonal trust. Note that the empirical results show that interpersonal trust does not affect the number of SMES. Therefore, although the development of knowledge can strengthen SMEs, the trust in the community expands when there are more SMEs.

Legal frontier for SMEs worldwide

Multilateral organizations have been criticized for using a one-size-fits-all approach. Legal boundaries for SMEs vary around the world and below is a list of upper limits for SMEs in some countries.

Africa

Results of the European Investment Bank survey on banking in Africa, 2021. Expected change in credit demand from SMEs in South Africa in 2021.

Small African businesses often struggle to get the cash they need to thrive. According to the SME Finance Association, the official financing gap for African SMEs averaged 17% of GDP in the 43 countries assessed in 2017.

According to the World Bank, women own 58% of all small and medium enterprises in Africa.

The European Investment Bank's 2021 African Banking Survey shows that most of the responding banks had a non-performing loan ratio of at least 5%. NPLs account for at least 10% of the SMES portfolio in almost one-third of African banks. Additionally, 50% of banks had at least 5% of their SMES portfolio under suspension and 40% had at least 5% of their SMES loans under some form of restructuring.

Egypt

Most businesses in Egypt are small, with 97 percent employing fewer than 10 workers, according to census data released by the state statistics agency CAPMAS.

Medium-sized companies with 10 to 50 employees account for about 2.7 percent of all jobs. However, large businesses with more than 50 employees make up 0.4 percent of all businesses nationwide.

This data is part of the 2012/13 Egyptian economic census on various establishments from small stalls to large companies. Economic activity outside of institutions—such as street vendors and farmers, for example—was excluded from the census.

The results of the European Investment Bank survey on banking in Africa, 2021, for the expected change in credit demand from small and medium-sized enterprises in East Africa. The results show that Egypt has a large shortage of medium-sized businesses.

70% of the country's 24 million businesses have only one or two employees. But less than 0.1 percent—just 784 businesses—employ between 45 and 49 people.

Kenya

In Kenya, the term was changed to MSMES, which stands for "Small, Small and Medium Enterprises". For small companies, the minimum number of employees is up to 10 people. For small companies it is from 10 to 50. For medium companies, it is from 50 to 100.

Nigeria

The Central Bank of Nigeria defines SMEs in Nigeria based on their asset base and the number of employees employed. The criteria are asset base between N5 and N500 million and employee strength between 11 and 100 employees.

Somali

In Somalia, this term is SMES (for "small, medium and micro enterprises"). Elsewhere in Africa, MSMES stands for Micro, Small and Medium Enterprises. An SME is defined as a small business with more than 30 employees but fewer than 250 employees.

South Africa

In the National Small Business Reform Law of 2004, [18] micro businesses are defined in various sectors, from manufacturing to retail, as businesses with five or fewer employees and a turnover of up to 100,000 Rials. Very small businesses have between 6 and 20 employees, while small businesses have between 21 and 50 employees. The upper limit for turnover in a small business ranges from 1 million rupees in the agriculture sector to 13 million rupees in the hospitality, accommodation and other business sectors as well as in the manufacturing sector, with a maximum of 32 million rupees in the wholesale business sector.

Medium-sized businesses typically employ up to 200 people (100 in the agricultural sector) and the maximum turnover ranges from 5 million rand in the agricultural sector to 51 million rand in the manufacturing sector and 64 million rials in wholesale trade, commercial agencies and related services.

BIM

To achieve its full potential, building information modeling (BIM) needs to be implemented throughout the supply chain. The purpose of this study is to investigate the implementation and adoption of BIM among small and medium-sized enterprises (SMEs) in the UK architecture, engineering and construction (AEC) sector.

Although SMEs have some understanding of BIM-related concepts, their familiarity with existing BIM software support systems is particularly low. Limited financial capacity has been identified as the main barrier to BIM adoption, while knowledge exchange initiatives are the most useful measure in facilitating further implementation. SMEs' changes in BIM adoption and implementation are mostly influenced by company size, professional discipline and services provided.

The AECO industry is rapidly digitizing and Building Information Modeling (BIM) has become an essential part of it. The adoption of BIM is seeing an expanding trend as more and more stakeholders in the construction sector can realize how by realistically prototyping the building to be built, they can more efficiently review the design, gain more accuracy in construction and, if needed, evaluate alternatives related to cost and other components. In this regard. , small and medium-sized enterprises (SMEs) constitute a significant part of this sector. Therefore, their innovative practices are very important in the implementation of BIM in the integrated design (ID) scheme. Many governments support the adoption of BIM-based ID approaches in their national markets, however, the participation of small enterprises in the common adoption of BIM is considered insufficient. Also, there is a common BIM gap, which negatively affects the overall speed of adopting innovative technologies in construction. Inspiring SMEs to adopt BIM can help the AECO industry, including each individual company, to increase their productivity as well as their economic profit and reduce risks. The sooner SMEs decide to make the BIM shift and leave the traditional construction process as the only choice, the better the stakeholder vote. Based on this underlying hypothesis, the purpose of the current research is to firstly identify the issues that are the cause of the BIM gap, and secondly, to examine what actions can be taken by trying to resolve it. The research method used in this study includes data collection from the hands of various experienced workers, including site engineers. Construction managers, planners, cost estimators, BIM coordinators, consultants and designers with an understanding of BIM implementation on site. In order to collect the right amount of timely data that can help further inference, a mixed method called triangulation is used, including telephone interviews. extensive literature review; Non-interactive interviews in the form of online forum discussions, including online surveys and reviews of relevant physicians. Data collection is then followed by analyzing the collected data and extracting further relevant facts. It is the conclusion of this study that the costly adoption of BIM does not seem attractive to many SMEs due to various barriers including lack of motivation and the need for change.

BIM tends to be thought of as an approach used only by larger public sector businesses or government projects. And while those larger companies are often seen as BIM's guinea pigs, the benefits it provides mean SMEs don't have to sit back and wait for others to adopt it first. Instead, small and medium-sized businesses can benefit from fully investing in BIM to reap its benefits.

What are the benefits of BIM for SMEs?

In general, the benefits of BIM for SMEs are the same as those for larger businesses and government projects.

Advanced communication

Communicating with customers also becomes easier. Architects, engineers or designers may be used to talking to others in their field, but for non-professionals, their concepts and language may be difficult for a client to fully understand. BIM accelerates communication by providing technical information in an interactive format. And since everything is updated in real-time, everyone stays up-to-date on even the smallest changes.

More affordable

Some SMEs may be concerned about the cost of BIM, but in the long run, it is a very cost-effective approach that avoids mistakes during the construction phase. This error, known as collision detection, is invaluable if a problem occurs later on. Since each stage is recorded, users have a record of each stage in the life cycle of a structure. As a result, the amount of documentation is reduced, as there is no need to worry about duplicating or redesigning certain things, saving a lot of time as the process progresses.

more cooperation

Even for SMEs, BIM enables greater collaboration between all team members. Thanks to the cloud functionality of BIM, smoother and simpler communication is easily possible. Designs can be viewed and reviewed and there is no need to worry about files disappearing or getting corrupted because all the history or evolution of the project is safely saved.

Better continuity

At the heart of BIM is the idea of a simple workflow. As this process supports the entire building life cycle process, from inception to construction to future demolition, all aspects of the project life cycle can be documented and updated. This means no data is ever lost, providing a clearer and smoother journey to project completion.

Improved visualization

In the design phase, 3D modeling allows for the real-world imagination of a project. From detailed floor plans to its overall energy performance, the entire design can be viewed before the construction phase begins.

How should SMEs get started with BIM?

Weigh your purchasing options

There are many options for SMEs when purchasing a BIM solution. Now more than ever, you'll find purchase models with lower upfront costs. These purchasing models, such as desktop software leasing and cloud solution licenses, are a smart decision for smaller companies.

If your business falls into a fallow period after a business boom, these are temporary measures that reduce cost risks. If work really starts to dry up, they can hold off on leasing or licensing until business recovers. This keeps upfront costs low and allows businesses to adjust their budgets to inbound opportunities. Find solutions that encourage cloud and mobile access.

Finding a BIM solution, look for those with cloud capabilities. Access to models, maps and other business data is essential in this day and age. Cloud and mobile access in connection with BIM shows the great flexibility of the latter, which is essential for modern businesses.

Take it step by step

BIM has so many features that it may seem overwhelming at first. The important thing is that for SMEs trying to implement BIM, they should not worry about using all these features from the beginning. Instead, they should focus on learning the process that solves an individual problem, then look at solving subsequent problems one at a time.

Support senior team members

Although BIM promotes collaboration, it is important that those in the highest positions are convinced of its potential. Without this support, BIM implementation will not be successful. Whoever takes this idea forward will see rapid changes in day-to-day operations as a result. And since smaller businesses have fewer established workflows and policies, it can actually be easier to make these changes than larger businesses.

Are there any major challenges that SMEs may face?

Implementation cost

The cost of implementing BIM is something of a myth that can be confusing to those unfamiliar with the process. While the upfront costs can be expensive (if you're not looking in the right areas), the long-term benefits are well worth the upfront cost.

Technical barriers

Following on from the above, who is responsible for generating data when everyone is doing their daily tasks and managers and executives are unlikely to get their hands dirty? If everyone is too busy, they may need to bring in someone from the outside, which can be problematic for businesses looking to keep costs down.

There is no time to change the old system

In addition to high-level employee resistance, BIM adoption may face barriers simply due to time constraints. If you are used to doing one thing and the business is booming, changing the system when time is of the essence can be a challenge.

Strategy and plan

Over the past few years, Building Information Modeling (BIM) has evolved from a shiny new toy in architecture and engineering to a critical component in building success. A more comprehensive modeling alternative to CAD and other types of architectural drawings, it allows everyone involved in the process to get a complete picture of the project.

However, buying into the concept is only part of the equation. Any stakeholder looking to use it needs to understand the variables involved, especially for companies and individuals relatively new to the concept. Specifically, the following seven factors are critical to a successful BIM implementation project.

1) The right perspective

The variables that go into a successful building information model are complex. That's the concept that allows companies to use this kind of comprehensive model to get started. Consequently, a strategic framework is absolutely critical to ensure accurate, coherent and strategic implementation of BIM.

As noted by Autodesk in a recent white paper, this framework should start with a vision. In the context of this project, the vision is more than a statement. This is a narrative of the results of the BIM concept.

For a successful BIM implementation, a concise and well-articulated vision from executive leadership of what BIM business transformation will achieve for the organization, what the key elements of the transformation are, and what this transformation will look like at different stages is essential.

This vision must be both inspiring and aspirational and can be easily communicated throughout the organization. It must answer the five WBIMs: Who, What, When, Where and Why.

2) Strategic goals

From a fairly general perspective, an organization that embraces BIM needs to articulate exactly what it looks like to do, not only in terms of the technical concept, but also the philosophy of the building and its underlying planning. Setting strategic goals can be challenging, especially considering the need to be both idealistic and realistic.

Implementing BIM will create major changes in your organization, and being realistic about that change is critical to success. Strategic objectives should identify the benefits as well as the challenges of reaching the end point of an implementation project. It also makes sense to include an individual that allows you to track your overall progress towards the larger end game.

Building information modeling is not as simple as flipping a switch. This requires careful planning. Without strategic macro goals and individual milestones to get there, successful BIM implementation will be challenging.

3) Buy leadership

BIM requires buy-in throughout your organization, especially when viewed as an organizational philosophy that demands process sophistication. To gather the resources necessary for long-term and sustainable success, leadership must be on hand.

It is likely that your employees who are directly affected by the BIM approach will readily see the benefits. However, leadership may recognize potential challenges such as resource constraints and prioritize them. However, even small challenges are difficult to overcome without buy-in at that level.

Architects, engineers, planners, builders, surveyors should all be behind this concept. But so are the higher levels of the organization, which you can only reach through strategic messaging and engagement. A realistic overview of the long-term benefits, along with a detailed plan for success, is an important step in securing this purchase.

4) Data input

Perhaps the biggest advantage of BIM is the complexity of a building or infrastructure model, which is the result of its successful implementation. The range of variables available for evaluation and the actual building process is far beyond the previous methods of planning and implementing any type of building and construction project.

This complexity, of course, requires accurate data input from a wide variety of sources. In their landmark theoretical model for implementing BIM, published in the International Journal of Information Systems and Project Management, three Canadian researchers outline eight distinct variables that can lead you to achieve this kind of accuracy:

Legal data

Financial data

Geographic data

Designer data

Identifying data

Owner data

Environmental data

Retention data

Researchers treat these data points as individual dimensions that would normally have existed in isolation to build various models that inform the building process. On the other hand, the successful implementation of BIM requires their convergence to build a more comprehensive and accurate model.

5) Necessity of cooperation

Make no mistake: BIM cannot be successful as an isolated process developed by an engineer behind a desk. Collaboration is absolutely essential to success, nowhere more evident than in the data needs outlined in the previous section.

No single person can collect data from such a wide range of sources. Even the traditional relationship between architect and engineer is not enough to do this. Success requires that all levels of the organization come together and collaborate on a single model that captures all the variables involved in the process.

This means bridging the gap between professionals who might not otherwise interact. It also means assembling a team with representatives from each region involved. But most importantly, it means continuous and strategic communication between all stakeholders to ensure successful implementation.

6) Human factor

It's tempting to think of BIM as a linear process that moves from strategic planning and goal setting to execution. But in reality, the process is much more complex thanks in large part to the people involved to ensure that the implementation is successful.

In other words, success requires more than the technical cooperation mentioned above. This requires a team that works well together, can understand and overcome initial resistance to change, and can leverage their individual strengths to create a more consistent modeling process.

In other words, the human factor is an important part of any BIM implementation. Understanding the strengths and weaknesses of the team members involved can be the key to success. Meanwhile, a strategic process designed to train and develop individual staff directly involved in implementation can help improve confidence and technical skills for all stakeholders and participants.

7) The right partner

Finally, successful BIM implementation is difficult without a trusted partner on your side. If nothing else, even with all the above variables considered, you still need to have deep knowledge and expertise in actual model building.

Depending on the size of your operation, BIM can be a completely in-house process. But in most cases, it makes sense to look for an external partner who can take care of the technical aspects and develop the process while you design and implement the more strategic elements mentioned above.

Of course, the right BIM implementation partner should have both experience and expertise in the concept as it applies to your industry and application types. They should also help you navigate through some of the strategic elements listed above, especially as they relate to communication and goal setting. Add software knowledge to the equation and your BIM implementation process will be on the right track for long-term sustainable success.

BIM periodic table

Stephen Mord's periodic table of BIM and in this introduction to the BIM periodic table published in the National BIM Report 2016, it is introduced in Dmitri Mendeleev's classic table of elements about an introduction to the BIM periodic table.

Inspired by the periodic table of elements, NBS recently designed a visual guide to possible collision conditions and concepts that run along the BIM path.

In the BIM periodic table, we outline the necessary steps for close collaboration (process and people) using technology, standards and proactive tools based on your efforts.

The original table, published by Russian chemist Dmitri Mendeleev in 1869, managed to organize the names of 112 elements (and confirm several nominations) using strict rules and hierarchies.

The periodic table of BIM is classified into 9 groups with the number of each element.

The table is designed as a handy reference, ideal for printing and hanging on a wall or sharing digitally, and should give some thought to areas of BIM readiness that may need your attention.

Table grouping

Strategy:

At the top of the strategy grouping table is the BIM strategy elements.

With strategy at the heart of any successful BIM implementation, it's no surprise to find this at the top of the table.

Thinking about what you want to achieve from BIM and how and why you might implement a strategy (and in turn the foundation, processes, technology, tools and people) is fundamental to your success.

Your strategy is likely to be unique, highly dependent on your key drivers, whether they're designed to improve decision-making, better deliver coordinated information, or actually reduce the use of paper.

Basics:

The strategy is in position, the time to implement the basis, the establishment of efficient systems for communication, information exchange and data transfer, which provide advanced BIM processes.

To build strong foundations, you also need to measure your skills in managing production, distribution and how building information in a common data environment (CDE) ensures that everyone can access the same data.

Also consider appropriate provisioning paths to create the best environment for collaboration, on what skills you will acquire in the management model, intellectual property rights and data management, responsibility for errors (given the dependency on the data provided), liabilities and ownership.

A common BIM capability and capacity assessment (CA) allows you to determine your BIM readiness status and take action.

Cooperation:

The BIM periodic table is collaborative and hands-on, and the collaborative group is about developing more efficient methods.

You need to consider the digital tools (Di) that allow you to communicate effectively (and how data flows between them without loss) as well as people's attitudes that may require cultural and behavioral changes (Cu).

Make sure you can also use outputs that someone else on the project team has created with an understanding of interoperability (St.

Process:

Understanding current processes allows you to determine which improvements can be made.

This grouping suggests a best-practice workflow is possible.

This idea is through understanding the information needed during the entire project cycle, from measuring and needing (As and providing (De) to the end of output and use (Ma), so that the best value is obtained during the project time.

The Common Data Environment (Cde) is at the center and provides the tools to collect, store and distribute information across the entire project team, ensuring that everyone is working with the same information.

Using tools:

The tools that can help us a lot in design, these tools can be called: development and presentation and asset maintenance.

You may need a number of different tools for specific tasks and functions that no single piece of software meets your needs, so think carefully, make sure the tools you use are compatible and allow you to exchange information with existing or new systems and flow from one category to another. Some tools require human thought.

References

Before making any investment, you should consider the free tools available. The

final grouping in the table confirms the sources that are available to you
and have access to the information. In addition to paying for books (Bo)), blog posts (Bl)), videos (Vi) as well as surveys and reports (Su)) such as the NBS Annual National BIM Report are free, you can use these resources to get started easily.

The Internet and social media have created a valuable online community of support. There are many online forums and user groups, all of which share useful tips and advice, as well as a range of face-to-face events.

Consider the information exchange (In), how, when and in what form does the customer request it?

People:

People are often overlooked when it comes to BIM strategy.

As with any change management process, you need to coordinate with your colleagues to clarify why and how you want to implement BIM.

You will need the help of senior management and the advantage of the BIM support field will probably be used to improve the workflow on the project.

Ideally BIM should be embedded into existing workflows and not as a separate entity, your communications should be clear and timely regarding the impact on the "business".

You should be aware of the impact of any change and not ignore the best bits of the current process and method.

Make sure you share success across the team and keep people in mind with the support and training they may need.

Technology:

Make sure you have the right technology to support your BIM goals and objectives.

However, an important factor for successful implementation is to consider, in addition to hardware and software considerations, as you navigate a digital environment, how and where data is stored and how best to share and disseminate information in a secure manner.

standards:

Access to standards, methodologies and complementary documents available to you that will work with your strategy and contribute to collaborative BIM.

Today, developing countries are increasing day by day in the interface with BIM, which can be followed by a successful strategy according to the periodic table of BIM.

Try to start with the end result in mind and consider the needs of the customer and the facilities management (Fm) team. The Briefing Element (Br) addresses BS 8536-1:2015 and describes the subject of projects to provide assets and facilities based on defined operational requirements. BS 1192:4 defines a methodology for the transfer of COBie information, for example between different parties involved in a project.

Benefits of BIM collaboration in construction projects

The construction industry has historically struggled to adopt collaboration as a way of working. A combination of the need for cultural change, better education, improved awareness and enabling technologies has caused stagnant productivity.

When BIM is understood as an enabling technology that supports modeling and management, significant productivity gains will be achieved.

Today, it is possible to achieve an overall productivity increase of 40 to 60 percent.

But be careful, BIM collaboration, to bring benefits, must express leadership especially from the client and not be seen as an imposition, but as a collaborative working practice. The goals and benefits of the collaboration must be clear, accepted, shared and measurable from the very beginning.

BIM as a collaborative method

Understanding BIM requires more entry into the organization as well as project management activities.

A measurable and structured approach to project workflow and information flow, based on the availability of up-to-date and shared information, should be supported to reengineer digital processes and procedures. The ultimate goal is to allow all project participants and stakeholders to understand the expected results as well as their specific roles and responsibilities. Full availability and transparency of information guides expected schedule, costs and quality, thereby providing the ability to introduce corrective actions to bring the project back in line with expectations.

Key tools required for project success include the BIM Implementation Plan, a document that should clearly include specific roles, responsibilities, process and outcomes, and a Common Data Environment (CDE). Both are shared in a common digital environment and supported by mandatory initial and ongoing training.

Building in Cloud provides these facilities, manages the team, structures information, models, also controls and digitally manages procedures and processes throughout the work life cycle.

If you want to know how all this can become a reality for your organization, simply contact us to get all the necessary information and explanations.

BIM collaboration process

The collaborative BIM process can be described as the process of identifying different construction phases for a single project. Another part of this definition is understanding the process of sharing data and information between different stages of construction. In this context, a boundary can also be drawn between the definitions of "data" and "information":

The first is the actual data generated by the software during the different phases of the project.

The second case represents the process of notifying different users about specific events in the context of different phases of the project.

It's fair to say that the BIM collaboration process is quite complex, with different parts that need to interact with each other to make everything work properly (permissions, data creation, information sharing, data replication, software tools, ...). To streamline this complex process, several specific components can be defined that strongly influence the revenue of the BIM collaboration process:

Data Interoperability This is primarily about exploring ways to bring different data formats into a hybrid project. It may also work with data transfer if needed.

Create and share data. Develop data management solutions, data sharing workflows, and other processes that deal with defining and organizing different types of data.

Communication and interaction. This refers to interacting with the communication process, providing relevant information to users, such as project status, design data artifacts, ... Works with email notifications, social media tools, dashboards, and more.

Information sharing. It defines the various steps by which information is shared with the same design thread or with other threads, as well as status information, version information, and more.

Evaluating BIM collaboration

Figuring out if you have a collaboration problem isn't as complicated as it seems. There is a list of general problems that occur when you have complex teams, multiple model types, or other problems with BIM collaboration in general, including problems with:

Stability

standards

Structures within the workflow

Project teams and quick access

Timely release of information, ...

If you don't have any of these issues, your collaboration solution may be considered great, and you may not need to invest in improving your BIM collaboration efforts. On the other hand, having these issues means you need a proper BIM collaboration solution, or you may want to invest in upgrading your current solution.

The use of BIM by the architecture, engineering and construction industry

In recent years, many public and private sector owners have begun to require a Building Information Modeling (BIM) component in new construction projects. Although there has been a significant increase in the adoption of BIM at the industry level, it is still not a standard practice in the educational facilities sector. This research was conducted with the aim of investigating the use of BIM in educational facilities projects by the fields of architecture, engineering and construction (AEC). A survey examining firm-wide adoption of BIM, implementation of BIM in projects, benefits of BIM use, and barriers to BIM use was distributed to architects, site engineers, structural engineers, mechanical engineers, and contractors throughout the United States. The results of the survey showed that most of the respondents used BIM in all five disciplines. BIM was mostly used for 3D visualization, documentation automation and collision detection. The most important benefits of BIM included better marketing and a clearer understanding of projects, which are very important for customers such as school students, teachers and administrators. The lack of expertise and the need for training seemed to be the main obstacle to using BIM. This research contributes to the body of knowledge by showing the prevalence of BIM use in educational facility projects and showing how BIM can help improve shared knowledge sharing between designers, contractors, and clients, resulting in better quality educational buildings. These research findings can be used to assist AEC firms interested in implementing BIM in educational facility projects. The most important benefits of BIM included better marketing and a clearer understanding of projects, which are very important for customers such as school students, teachers and administrators. The lack of expertise and the need for training seemed to be the main obstacle to using BIM.

The AEC industry uses BIM for 3D visualization, collision detection, feasibility analysis, feasibility studies, quantity and cost estimation, 4D/planning, LEED environmental analysis, creation of shop drawings, and facility management. The use of BIM has the potential to improve construction efficiency, increase collaboration and knowledge sharing among team members, and support construction-related tasks. Using BIM throughout a project reduces risk by improving efficiency, by minimizing errors or misinterpretations between designers, engineers, and contractors, and by requiring collaboration and knowledge sharing among all parties involved to ensure accuracy and reliability.

In Integrated Project Delivery (IPD), the owner, design team, construction, and O&M professionals are involved in decision-making at all stages of the project, starting with project planning/pre-design and ending with the O&M phase. However, in a typical office building, the owner and client are not necessarily the same entity, and therefore, clients may be excluded from the design and construction process. Conversely, in the case of educational buildings, it is important that the employer (for example, students, teachers, administrators and supervisors) participate in the process of designing, constructing and maintaining the buildings in order to achieve a high quality. A quality project that meets customer needs. Previous studies also showed that IPD creates a project environment that enables the full use of the BIM process. As a result, a client involved in IPD can also benefit from the use of BIM in an educational project.

For example, BIM can be used for 3D visual communication, which is much more user-friendly for elementary school students compared to verbal communication. During the design phase, school students can participate in building design decisions using 3D methods of a school. In addition, BIM can assist in the design phase by simulating the evacuation of school residents in an emergency (e.g. fire), students can also participate in the analysis of a real- world project using 3D BIM tools. It is important that students evaluate the design of daylight because daylight is very beneficial for student well-being and their learning of clay material. Another example is the use of BIM to monitor the energy performance of a building. This process can be incorporated into a high school curriculum (for example, a physics course) where students can use their school building as a living laboratory.

BIM is used as a term to provide a building information model and a collaborative method used by various project stakeholders. The National Institute of Building Sciences (NIBS) has defined building information models as "a digital representation of the physical and functional characteristics of a facility ... [that] serves as a common knowledge source for information about a facility." BIM interprets and communicates the characteristics of each building system simultaneously through a common data-rich model that helps all parties involved in the project. This automated model provides easier data transfer, interference checking, documentation, and exchange of ideas between different disciplines. Furthermore, Building Information Modeling is defined as a collaborative method that produces data for use in different phases of the building life cycle such as design, construction, operation and maintenance.

BIM adoption has been steadily increasing since 2007. In 2007, 28 percent of the industry used BIM, nearly half (49 percent) in 2009, and 71 percent in 2012. In 2012, 70 percent of architects, 67 percent of engineers, and 74 percent of contractors used BIM. Another survey by [McGraw Hill Construction] of contractors worldwide reported that half of contractors in the United States and Canada had been using BIM for 3 to 5 years, and 8% had been using BIM for more than 11 years. Demand for BIM from public and private owners has also been a factor that has encouraged this rapid adoption rate among design and construction firms. In 2014, a quarter of owners in the United States required the use of BIM, while 43% encouraged, but did not require, the use of BIM.

How software algorithms and robotics are drastically changing the design/build process. With advances in generative design, software algorithms, and robotic manufacturing, our current processes will change little over the next three to ten years. More and more of what we have ever seen is done by computers and machines.

Instead of Building Information Modeling (BIM) we are seeing Building Information Optimization. Instead of manually drawing walls, doors, and columns for what we think is a good design, we give the computer "rules" that instruct it to give us the optimal footprint, structural load capacity, and thermal performance of the building. Things that took months are done in one day. What does this mean for you? How do you play a role in these changing processes?

where are we now?

Most companies currently using BIM software are focused on data collection. We design the buildings by hand, enter the data by hand, and then print the data by hand. This system works in most cases. However, it is not very efficient. However, most companies don't even implement this process well. Most companies use their BIM software like a CAD program.

In his book, Rise of the Robots: Technology and the Threat of a Jobless Future, Martin Ford discusses how software algorithms and robots will replace low-paying jobs such as fast-food waitresses as well as high-paying jobs such as writers and legal professionals. What patterns do you see in your industry? In the end, what is the place of robots and algorithms in the administration and the field?

The film I, Robot poses the question: "Can a robot write a symphony?" Can a robot turn a canvas into a beautiful masterpiece? "Coop has been writing software to help him make music for 30 years, and he long ago got to the point where most people couldn't tell the difference between the real Bach and the

Bach-like," Chris Wilson wrote in an article on Slate.com. Combinations that his computer can produce. Audiences have been moved to tears by melodies created by algorithms."

Pindar van Arman, a technology artist and software engineer, has created a robot that can paint art. An avid painter himself, Van Arman first built the robot as an assistant for his personal projects. Now this robot can create beautiful portraits and landscapes either with human help or completely alone.

Here's another question for you: Can an algorithm design a building? Can a robot build a structure? If a tool doesn't exist or is limited in an application, we can now create our own. This feature has existed in cases such as Lisp routines in AutoCAD and Dynamo for Revit. If you haven't jumped on the dynamo engine yet, you should.

Static modeling versus parametrism and algorithmic thinking

How does design happen in your office? Is the design usually modeled in a static design software such as Sketchup? Of course, the nice thing about conceptual modeling software is that you don't have to think about collections, materiality,......

What if we could do multiple designs in a concept tool without having to rebuild our buildings every time we changed? The most obvious advantage is the efficiency of not requiring frequent reconstruction. We can create multiple iterations very efficiently.

FormI is another conceptual modeling tool. A nice perk about FormI is the ability to plug and play with Dynamo (pun intended). Below is a personal building in our team modeled using FormI.

In the future, instead of collecting data and reporting on that data, we will use data to inform our designs. We can use Parametricism plus BIM to help solve the problem. One of the challenges I had with this particular design was rationalizing the radius so that the panels would be evenly spaced and lay flat for the builder. The way I solved this was rational form thinking = rational panels. Using data and mathematics, I was able to achieve this goal. However, the family was rigid and not intuitive to edit.

Later I started getting into algorithmic editors like Grasshopper and Dynamo. Here is the same example; However, notice how easy it is to edit the geometry and I can constrain the panels and keep them flat! As the tools become easier to use, we will see a wider adoption rate.

The cost of machines versus humans

In the past, if we asked a human to cut these beams, the price would be more expensive due to the complexity of the mold and form. However, if we use CNC to cut straight or curved beams, the price is the same. But what happens to the work of the traditional builder? Will the device replace him? No. He now operates and maintains machinery. The machine and the craftsman become a unified team.

Data loss and interoperability:

Data loss

Everyone has heard of construction waste. This is basically the result of excess material being shed during the construction of a building, where the waste is basically demolished or placed in a landfill. What is data loss? Data loss is the process of not using data or re-creating data during the life cycle of a building. We do this all the time. What happens when you get a spatial program done in Excel with all program information including required area, dependencies, segment adjacencies, ...? If you're like most companies, you'll either print out the Excel form or have it on your second monitor when designing in Sketchup up or Revit.

There are many Revit Excel import/export plugins and there is no reason for us to recreate the same data in Revit as in Excel. These tools can and should talk to each other.

Interoperability

What design tools do you use? If you're like most companies, you probably design in Sketchup and maybe a little FormIt or Rhino. What happens when you get to design development? Are you now rebuilding a model that was in Sketchup in Revit? Notice the data drop? What if you could push a button and translate your model from Sketchup/Rhino to Revit?

In the future, we will not spend months translating information from one software to another. I imagine that in the future, the cloud will be software agnostic and we will be able to create, manipulate and record data regardless of the software in which the geometry was created.

AI (artificial intelligence) BIM

This is where it gets exciting... Computers can be fed a set of tasks, rules and processes and can execute them independently and more efficiently than humans.

AI BIM Plus Task Automation

Today we are looking at some AI BIM tips. Do you enjoy manually creating PDFs, exporting DWG files, and dissecting Revit models? In the near future, you won't. It is available now. IMAGINIT product resolution automates tasks such as printing, publishing to Navisworks, and creating room data sheets. The ROI is ridiculous.

Imagine if the computer knew when the milestones were, when the model changed, and could react by sending information to advisors. Go one step further. What if all the modeling was done in the cloud and you had live PDF collections. Every time a change happens, your PDF will update in real time. Considering the situation we are in today, it is not so hard to imagine.

3D Coordination AI BIM Plus

The traditional 3D collision detection/coordination process is about to be revamped. Building System Planning, Inc. One tool has an auto-route feature called "GenMEP" (genuine design mapper). Imagine a tool that routes ducts and piping while being object-aware and loses the beams and other MEP information. Currently, the user tells the tool which parts to connect and it loses the MEP structural information. Instead, imagine that the computer is fed load requirements, room types, ..., and the computer algorithm independently designs, routes, and maps the MEP information. It models. When GC is involved, there are savings in the 3D coordination process? What happens when subassemblies have the same technology? I think we will see this technology within the next three years.

AI BIM Plus analysis and design

Manual analysis and modeling is eliminated. GRAITEC Advance BIM Designer Collection has already developed a tool that is a design-based reinforcement calculation program for 3D cage modeling and automates the generation of documents for reinforced concrete columns, beams and footings. It's only a matter of time before this tool becomes mainstream.

Imagine that in the next five to ten years, structural analysis will have a more direct impact on architectural design. This is done today, but with advances in materials science, biomaterials, and algorithmic modeling, we can see highly efficient structural buildings with half the materials.

AI BIM Plus Architecture

My good friend Nate Holland at NBBJ ran an incredible process as part of his college thesis. He created an algorithm that optimized his building to increase revenue at a higher rate than cost by maximizing retail space, ocean views, and floor plans. The assumption is to create an integrated team, designer and computer. Together, the designer can feed the computer a set of rules, requirements, and parameters. The computer can then return a list of options that match the parameters set by the designer.

With the chart below, we can see that each plan is placed in relation to costs more than benefits and benefits more than costs.

The Nate algorithm uses a tool called Galapagos that helps optimize the building. There is a tool built for Dynamo with similar functionality called Optimio. It's in the early stages of design, but with more and more tools like this, we can expect to see more, not less, optimization. In the future, I envision a tool, or possibly a series of tools, that takes all the international codes, the rules set by the designer and the engineer, and creates a series of optimal options based on the given constraints.

Likewise, these design tools consider other factors such as daylight analysis, heating and cooling loads, glazing percentage, ... and help us design more sustainable buildings.

What is the process we now use for sustainability? We manually design a building using our software of choice, "gather the data and adjust accordingly using a manual modeling process. Repeat. What if we fed the computer our model and asked the algorithm to optimize daylighting? It could analyze, refine, analyze, refine, analyze until it found its optimal shape to maximize the building's daylight in relation to the coordinates and the sun. There are already algorithms that It's just a matter of time before they are intuitive enough for the majority of design professionals in our industry to use.

Option engineering

Personally, I believe the reason Option Engineering hasn't taken off is because the software isn't as intuitive as design tools like Sketchup, so designers don't want to use it. I believe teams like the Fractal Project will help overcome this.

AR/VR

You can't talk about the future of our industry without touching on VR/AR. In the future, we will no longer have to choose between virtual reality and mixed reality headsets. Future headsets will have lenses that can accommodate both virtual reality and mixed reality.

Plus, as hardware gets lighter and more comfortable, we'll be wearing them all day, not just when we want to see a render. Expect to see hybrid VR/AR headsets within two years. With additional accessories that allow us to experience pressure, temperature and smell, the virtual will be much more difficult to decipher than the real.

How will robots drastically change the construction industry?

Will construction industry robots be similar to food industry robots? I believe that the robots of the future will be more like machines than people.

Surely robots can't do many of the same things humans do, like navigating a construction site, right? Uber has invested heavily in its cars, which navigate city streets with pedestrians and civilians in their own vehicles. These self-driving cars have object avoidance algorithms that feed information from vehicle-mounted sensors. It's only a matter of time before robots work alongside construction workers.

Robots are already appearing in construction. Below is a robot that helps cobblers sleep more efficiently (and save their backs and knees).

The workers put the bricks on top of the robot and the machine robot arranges the bricks in the desired pattern. Arch_Tec_Lab is an experimental facility for robotics in architecture located in Zurich, Switzerland. The center is currently prototyping robots and using them in construction. The idea behind this facility is to not be constrained by a two-way path similar to automated manufacturing, but to be completely free to assemble complex forms using the 40-axis motion of the robotic array.

Sam (Semi-Automated Mason) is a robot designed to make construction work a more efficient process. At a cost of half a million dollars, its creators claim that the SAM can lay between 800 and 1,200 bricks in a day - a skilled mason can lay 500. Lines of brick-making robots claim that their robot can lay 1000 bricks per hour!

3D printers are now leaving the office and on-site construction to scale. With the advent of 3D printing and materials science, we will see more unique buildings instead of traditional boxes. This is because, in terms of labor, it will not cost more to make a rectangle than an oval.

Drones are quickly finding their place in the world of construction. This is nothing new. They contribute to more efficient walking, less injured workers, ... A team from Gensler in Los Angeles has launched a 3D-printed drone prototype. Their goal was to solve the traditional problem of 3D printers, the size of the print bed. It also helps in places where a construction site may be difficult to get materials to.

Architect Ammar Mirjan programmed a small set of drones together to send hundreds of blocks into a shape to build a tower six meters high. This was a first for drones. Overall, robots are vastly faster than humans and never get tired or injured. They never file a workers' compensation claim. Construction accounts for one-fifth of all on-the-job fatalities in the United States. This is in the US only! In 2014, the government killed 870 construction workers.

Internet of Things

If you combine robotics, construction and the Internet of Things (IoT), this is where it gets exciting. Like the Uber car that never collides with other objects, imagine drones and machines being aware of objects and unable to collide with humans.

Our team is currently using a technology called photogrammetry. We have a camera that is connected to the Internet of Things. Based on the WiFi signal given from the camera, we can control the camera using iPad. This is a very interesting technology and general contractors especially like it. Imagine being able to send a team of tiny drones to scan a property instead of a human having to lug around a heavy camera? I predict that we will see this technology in the next three to five years.

How CAD and BIM changed the construction industry?

Over the past few decades, few technologies have influenced building design and construction as much as computer-aided design (CAD) and building information management (BIM).

First came CAD, which replaced manual drafting with digital drafting. Now, architects and engineers can create designs more quickly to exact specifications. They can make changes without starting over. They can check that the components fit together.

This reduced the risk of human error, allowed the exploration of unusual designs that would have been too difficult to create by hand – and led to a wave of other trends and technologies, such as 3D printing, that were not previously possible.

But while digitization was certainly a step up from manual designs, it did little to address the downstream workflow.

Key information, models, maps, and timelines remain siloed. Different teams and stakeholders had no way to keep up to date on progress or share project knowledge with each other. Once work began on a real-world project, the CAD drawings faded into the background.

From CAD to BIM

As the name suggests, BIM is about information and management rather than design per se. BIM is not intended to replace or enhance CAD workflows, but to make these drawings part of a centralized project management ecosystem. A model that places the building model at the core and is updated along with the project.

However, this technology has had a significant impact on the way buildings are designed. For example:

Generative design

BIM opens possibilities for generative and parametric design based on artificial intelligence. Using generative design tools, architects and engineers can set parameters such as physical constraints and automatically generate hundreds of potential solutions, inspiring innovative starting points for their work.

Typically, this happens at the beginning of a project, but it can also be used to deal with problems that arise later. Because BIM works with a "live" model, you can update your models and design iterations without having to start over.

Modular design

Combining CAD with BIM also facilitates a modular approach to construction that also informs the design process. Architects and engineers can take sophisticated approaches to prefabrication, including 3D printing unique shapes and parts.

Since the construction process is no longer separated from the design phase, you approach the whole process holistically, first testing ideas and solving problems in virtual space. Ultimately, this means architects can be bolder with their ideas – without increasing risk.

virtual reality

BIM is also used to make CAD models interactive, helping stakeholders visualize the project. Using virtual reality headsets, you can walk around the site and see the future building as it is meant to be, feel how it will fit together, understand where certain systems and features should be located, and even check for potential safety hazards.

Benefits of BIM in construction

Here are 8 key ways the BIM boom has shaped the modern construction site:

1. You have better information to work with

With BIM, all key information about the project and the building is collected in one place. This information is much more comprehensive and valuable than that contained in traditional schematic drawings or CAD designs. It also develops throughout the project, so it's always relevant and accurate, no matter how much the building design changes along the way.

2. Keeps everyone informed

A BIM-based tool not only gives you a complete overview of the project that is completely up-to-date, but also means that all your stakeholders have a way to access it. You don't have to worry about getting everything done quickly, or worry that some of your colleagues may still be working from previous iterations. (Provided, of course, that the BIM system you're using provides real-time updates!)

3. Increases productivity

From architect to GC to individual crew managers, everyone in the chain can work faster with fewer obstacles. Workflow becomes simpler and potential problems are easier to identify and predict, reducing the risk of work stoppages and delays. Once you have a bird's-eye view of the project, with all relevant data in one place, automated supply chain management becomes even simpler.

4. It is easier to adapt to changes

Making changes is also much faster. In the past, if the prospective owner wanted to request a relatively simple change in the plan, such as moving a wall back a few feet, the architect would have to painstakingly redraw everything from scratch. Doing this with CAD may be a bit faster than drawing by hand, but it boils down to the same time-consuming process. With BIM, the system is smart enough to know that, for example, moving a wall means moving the roof grid, so your roof plan is automatically updated as well. This cuts a lot of steps out of your workflow and makes it easier to respond to change requests on the fly.

5. It helps with your other considerations

BIM is much more than a simple building plan. This will help you collect and organize the data you need for other on-site considerations. It includes solar energy and energy analysis. Urban planning requirements permits, licenses, project codes. Conflict protection and conflict resolution. It is a living document that matures with the project. In the long term, it may even be used as an operational digital twin by building owners.

6. You prevent data loss

During a typical project, a lot of useful data leaks out that is never put to good use. But with BIM, when the model is delivered to the contractor, it is not replaced, but refined. It is continuously developed and enriched. Information is continuously added to the model – and this information flows throughout the project. Nothing is wasted.

7. Improves workplace safety

With BIM, you combine all your models in one place and you can see the condition of the building as it is now, at the current point of construction, as well as what it will look like when it is built. It helps you track safety hazards, exit points, fall hazards, ...

8. Keeps costs down

The more oversight you have, the more effectively and efficiently you can plan and manage your resources. You run a tighter ship with fewer avoidable costs, making it easier to stay on schedule and on budget throughout the project lifecycle. Ultimately, this is good news for your income.

What is the future of BIM in construction?

Basically, the exciting thing about BIM technology is that it produces higher quality data than construction teams previously imagined. By generating and collecting this data, more opportunities are created for the future of construction management.

We are now seeing more technology on job sites, including drones, scanners, sensors and other devices used to map the area, assess safety risks, track progress and monitor other factors critical to project success. In the future, this could even mean tracking the vital signs of construction workers, building sensors into PPE that detect health and safety hazards and help you prevent workplace accidents.

For example, imagine if schedulers and GCs had a simple and reliable way to factor in the impact of extreme weather such as heat waves. A system that was accurate enough to alert their crew as soon as they showed the first warning signs of heatstroke. How much safer and better managed could your job site be thanks to this information? How accurate and realistic will your plans become? And what about the impact it could have on your premiums?

Data is an incredibly valuable and powerful resource. It opens up many ways to improve and save. Not just for the project you're currently working on, but for all your future projects as well, BIM makes it easier to retain and share knowledge and insights gathered during one project so you can transfer it to the next. It's not just the technology that's constantly learning and improving—so is your team.

LCA

Life cycle assessment or LCA (also known as life cycle analysis) is a method of assessing the environmental impacts associated with all stages of the life cycle of a commercial product, process or service. For example, in the case of a manufactured product, the environmental effects are evaluated from the extraction and processing of raw materials (cradle), through the manufacture, distribution and use of the product to the recycling or final disposal of its constituent materials (grave).

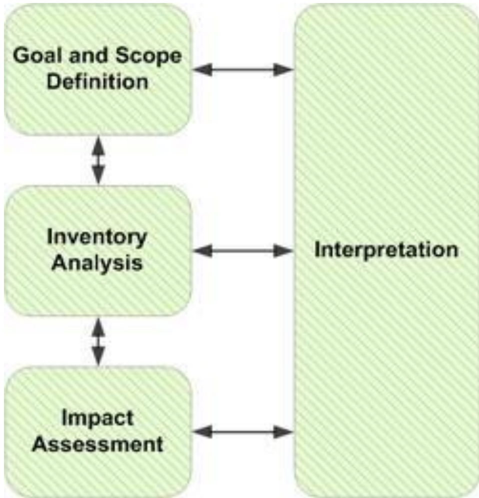

Illustration of the general stages of life cycle assessment, as described by ISO 14040.

An LCA study includes a complete inventory of the energy and materials required in the value chain of the product, process or service industry and calculates the relevant emissions to the environment. Therefore, LCA evaluates potential cumulative environmental impacts. The goal is to document and improve the general environmental characteristics of the product

Widely recognized procedures for performing LCA are included in the 14000 series of environmental management standards of the International Organization for Standardization (ISO), particularly ISO 14040 and ISO 14044. ISO 14040 provides the "principles and framework" of the standard, while ISO 14044 provides an outline of "requirements and guidelines".

In general, ISO 14040 is written for a managerial audience and ISO 14044 for professionals.As part of the introductory part of ISO 14040, LCA is defined as follows:

LCA studies the environmental aspects and potential impacts throughout the product life cycle (cradle to grave) from raw material acquisition through production, use and disposal. General categories of environmental impacts that require consideration include resource use, human health, and ecological consequences.

Criticisms have been leveled against the LCA approach, both in general and with respect to specific cases (e.g., in methodological consistency, particularly with respect to system boundaries and the sensitivity of specific LCAs to the orientations of professionals with respect to the decisions they make. Seeking to inform). Without a formal set of requirements and guidelines, LCA can be completed based on a practitioner's views and belief methods. In turn, an LCA completed by 10 different parties can have 10 different results. ISO LCA standard aims to normalize this. However, the instructions are not overly restrictive and 10 different answers may still be generated.

Goals

Life cycle assessment (LCA) is sometimes referred to synonymously as life cycle analysis in the scientific and agency reporting literature. Also, due to the general nature of an LCA study to examine life cycle impacts from raw material extraction (cradle) through disposal (grave), it is sometimes referred to as a "cradle-to-grave analysis".

As defined by EPA's National Risk Management Research Laboratory, LCA is a technique for evaluating the environmental aspects and potential impacts associated with a product, process, or service by:

Compile an inventory of energy and related inputs and environmental emissions Assess potential environmental impacts associated with identified inputs and emissions Interpret results to assist in more informed decision-making. [2]

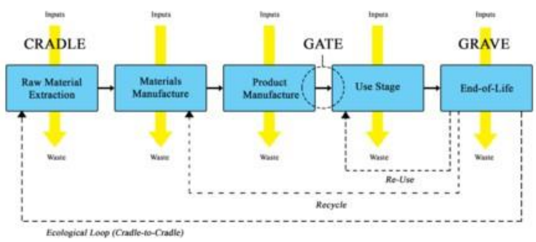

Diagram of life cycle assessment (LCA) stages

Hence, it is a technique for assessing the environmental impacts associated with all stages of a product's life, from the extraction of raw materials through material processing, manufacturing, distribution, use, maintenance and disposal or recycling. The results are used to help decision makers choose products or processes that have the least impact on the environment, taking into account the entire product system and avoiding the sub-optimization that may occur if a single process is used.

Therefore, LCA aims to compare the full range of environmental impacts attributable to products and services by quantifying all inputs and outputs of material flows and assessing how these material flows affect the environment. This information is used to improve processes, support policy and provide a sound basis for informed decision-making.

The term life cycle refers to the concept that a fair and holistic assessment requires an assessment of the production, manufacture, distribution, use and disposal of raw materials, including all intervening transportation steps necessary or resulting from the existence of the product.

Despite efforts to standardize LCA, the assumption that LCAs provide a unique and objective result is not realistic. Consequently, it should not be considered a single and unique method, but a family of methods that try to quantify results from a different perspective. Among these methods, there are two main types: Attributional LCA and Consequential LCA.

Documentary LCAs seek to attribute the burdens associated with the production and use of a product, or with a specific service or process, for a specified period of time. Consequential LCAs seek to identify the environmental consequences of a decision or a proposed change in a system under study and are therefore future-oriented and require that market and economic consequences must be considered. In other words, Attributional LCA "attempts to answer how things (e.g., pollutants, resources, and trade-offs between processes) flow in a selected time window? Whereas Consequential LCA attempts to answer" How will currents flow beyond the immediate?” System change in response to decisions?

A third type of LCA, called social LCA, is also under development and is a distinct approach for assessing potential social and socioeconomic outcomes and impacts. Social Life Cycle Assessment (SLCA) is a useful tool for companies to identify and evaluate the potential social impacts during the life cycle of a product or service on different stakeholders (eg: workers, local communities, consumers) SLCA. It is regulated by the UNEP/SETAC Guidelines for Social Life Cycle Assessment of Products published in 2009 in Quebec. This tool is based on the ISO 26000:2010 guidelines for social responsibility and the Global Reporting Initiative (GRI) guidelines.

The limitations of LCA to focus solely on ecological aspects of sustainability and not economic or social aspects distinguish it from production line analysis (PLA) and similar methods. This limitation is intentionally created to avoid method overload, but recognizes that these factors should not be ignored when making product decisions.

The main steps of ISO LCA

According to ISO14040 and 14044 standards, an LCA is performed in four separate steps.

As shown in the figure shown on the upper right (in the opening). Phases are often interdependent, so that the results of one phase indicate how the other phases are completed. Therefore, none of the steps should be considered final until the entire study is completed.

Purpose and scope

The ISO LCA standard requires a series of parameters for quantitative and qualitative expression, sometimes referred to as study design parameters (SPDs). The two main SPDs for LCA are the objective and the scope, both of which must be clearly stated. It is recommended that a study use the key words provided in the standard when documenting these details (e.g. the purpose of the study is...) to ensure that there is no confusion and to ensure that the study is interpreted for its intended use.

In general, an LCA study begins with a clear statement of purpose that defines the context of the study and explains how and to whom the results should be communicated.

According to ISO guidelines, the objective should clearly state the following:

The desired program

Reasons for conducting the study

Audiences

Whether the results are used in a comparative claim that is published publicly or not.

Also, the purpose should be specified with the commissioner of the study and it is recommended to provide a detailed explanation of why the study is being conducted from the commissioner.

Following the objective, the scope should be defined by describing the quantitative and qualitative information available in the study. Unlike the objective, which may consist of only a few sentences, the scope often requires multiple pages to describe the detail and depth of the study and demonstrate that the objective can be achieved within the stated limitations. Under the ISO LCA standard guidelines, the scope of the study should specify the following:

The product system is a set of processes (activities that convert inputs into outputs) that are required to perform a specific function and are within the scope of the study system. It represents all the life cycle processes of a product or process.

A functional unit that defines exactly what is being studied, quantifies the services provided by the system, provides a reference to which inputs and outputs can be related, and provides a basis for comparative analysis of alternative goods or services. Functional unit is a very important component of LCA and should be clearly defined. It is used as a basis for selecting one or more product systems that can deliver performance. Therefore, the functional unit enables different systems to be functionally equivalent. The defined performance unit should be measurable, contain units, consider time coverage and not contain inputs and outputs of the product system (e.g. kg of CO 2 emissions). Another way to check it is by considering the following questions:

what

How many?

For how long / how often?

Where?

How good?

Reference flow, which is the amount of product or energy required to realize a functional unit.

Typically, the reference flow is qualitatively and quantitatively different for different products or systems in the same reference flow. However, there are some things that can be the same.

A system boundary that specifies which processes should be included in the analysis of a product system, including whether the system produces common products that should be considered when extending or appropriating the system. The boundary of the system should be in accordance with the stated purpose of the study.

Assumptions and limitations, which include any assumptions or decisions made during the study that may affect the final results. It is important that these items are reported as omission may lead to misinterpretation of results. Additional assumptions and constraints necessary to carry out the project are often made throughout the project and should be recorded as appropriate.

Data quality requirements that specify the types of data to be included and limitations. According to ISO14044, the following data quality considerations should be documented within:

Time coverage

Geographic coverage

Technological coverage

Accuracy, completeness and representativeness of data

Compatibility and reproducibility of the methods used in the study

Data sources

Information uncertainty and any identified data gaps

The allocation procedure used to divide the inputs and outputs of a product and is necessary for processes that produce multiple products or co-products. This is also known as multipurpose product system. ISO 14044 provides a hierarchy of solutions to deal with multi-function issues, as the choice of allocation method for common products can significantly affect the results of an LCA. Hierarchical methods are as follows:

Avoiding Allocation by Subdivision - This method attempts to separate the single process into smaller sub-processes to separate the production of the product from the production of the common product.

Avoiding allocation through system expansion (substitution) - This method attempts to expand the joint product process in the most likely way to provide the secondary function of the determining product (reference product). In other words, by expanding the joint product system in the most probable alternative method for the independent production of the joint product (system 2). Then the effects from the alternative method of producing the joint product (system 2) are subtracted from the determining product to isolate the effects in system 1.

Allocation (partition) based on physical relationship - this method tries to partition inputs and outputs and allocate them based on physical relationships between products (such as mass, energy consumption, ...).

Allocation (Partition) Based on Other (Non-Physical) Relationships – This method attempts to partition inputs and outputs and allocate them based on non-physical relationships (e.g. economic value).

An impact assessment that includes an outline of the identified impact categories of interest for the study and the selected methodology used to calculate the respective impacts.

Specifically, life cycle inventory data is translated into environmental impact scores, which may include categories such as anthropogenic toxicity, smog, global warming, and eutrophication, as part of the scope, only an overview should be given, as the main analysis on impact categories is discussed in the Life Cycle Impact Assessment (LCA A) phase.

Data documentation, which is explicit documentation of inputs/outputs (individual flows) used in the study. This is necessary because most analyzes do not consider all inputs and outputs of a product system, thus providing a clear representation of selected data to the audience. It also provides clarity as to why the system boundary, product system, functional unit, ..., is chosen.

Life cycle assessment (LCA)

Life cycle assessment (LCA) analysis involves creating an inventory of nature (ecosphere) flows for a product system. It is the process of quantifying raw material and energy requirements, atmospheric emissions, land emissions, water emissions, resource use and other emissions during the life cycle of a product or process. In other words, it is the aggregation of all the elementary flows related to each single process in a product system.

For inventory development, it is often recommended to start with a technical system flow model using product system input and output data. The flow model is usually represented by a flow chart that includes the activities to be evaluated in the respective supply chain and provides a clear picture of the boundaries of the technical system. In general, the more detailed and complex the flow chart, the more accurate the study and the results.

According to ISO 14044, an LCA should be documented using the following steps:

Preparation of data collection based on purpose and scope

Collecting data

Data validation (even if data from another work is used)

Data allocation (if needed)

Data communication with the unit process

Data connection with the functional unit

Data aggregation

As mentioned in the ISO 14044 standard, the data should be related to the functional unit as well as the purpose and scope. However, since the LCA phases are iterative in nature, the data collection phase may change the objective or scope. Conversely, a change in purpose or scope during the study period may require the collection of additional information or the deletion or data previously collected in LCA.

The output of an LCA is a compiled list of elementary flows from all the processes involved in the product system(s) under study. Data is usually presented in detail in graphs and requires a structured approach due to its complex nature.

When collecting data for each process within the system scope, the ISO LCA standard requires the study to measure or estimate data in order to quantitatively represent each process in the product system. Ideally, when collecting data, a practitioner should seek to collect data from primary sources (eg, measuring the inputs and outputs of a process in situ or other physical instruments). Questionnaires are often used to collect data on site and can even be issued to the manufacturer or company concerned for completion. Items that must be recorded in the questionnaire may include the following:

Product for data collection

Data and history collector

Data collection period

Detailed explanation of the process

Inputs (raw materials, auxiliary materials, energy, transportation)

Outputs (emissions in air, water and land)

The quantity and quality of each input and output

Oftentimes, primary data may be difficult to collect and may be considered proprietary or confidential by the owner. An alternative to primary data is secondary data, which is data obtained from LCA databases, literature sources, and other past studies. With secondary sources, you will often find data that is similar to the same process, but not exact (eg data from a different country, slightly different process, similar but different machines, ...) so it is important to clearly document the differences in such data. However, secondary data is not always inferior to primary data. For example, referencing data from another work where the author used very detailed primary data. Along with primary data, secondary data should document the source, reliability, and temporal, geographic, and technological representativeness.

When identifying the inputs and outputs to document for each single process in the product system of an LCA, a practitioner may encounter an instance where a process has multiple input streams or produces multiple output streams. In such a case, the doctor should allocate the flows according to the "allocation procedure".

One area where data is difficult to access is monosphere flows. The technosphere is more simply defined as the human-made world. Considered by geologists as secondary resources, these resources are in theory 100% recyclable. However, in practical terms, the primary goal is salvation. For an LCA, these technosphere products (supply chain products) are those produced by humans, and unfortunately those completing a questionnaire about a process that uses a man-made product as a means to an end cannot determine how much of a specific input they use. Typically, they will not have access to data about the inputs and outputs of the product's previous manufacturing processes. If the institution conducting the LCA, it should refer to secondary sources if it does not already have that data from its previous studies. National databases or datasets provided with, or readily accessible by, LCA-practitioner tools are typical sources for that information. Care should then be taken to ensure that the secondary data source accurately reflects regional or national conditions

LCA methods include "process-based LCAs", economic input-output LCA (EIOLCA) and hybrid approaches. Process-based LCA is a bottom-up LCA approach that constructs an LCA using knowledge about industrial processes in a product's life cycle and their associated physical flows. EIOLCA is a top- down approach to LCA and uses information on the primary flows associated with a unit of economic activity in different sectors.

This information is usually extracted from national statistics, a government agency that tracks trade and services between sectors. Hybrid LCA is a combination of process-based LCA and EIOLCA.

The quality of LCA data is usually assessed using a pedigree matrix. Different pedigree matrices are available, but they all include a number of data quality indicators and a set of quality measures within each indicator. There is another hybrid approach that integrates the widely used semi-quantitative approach that uses a pedigree matrix into a qualitative analysis to better demonstrate the quality of LCA data to a non-technical audience, in particular.

Life Cycle Impact Assessment (LCA)

Life cycle inventory analysis is followed by life cycle impact assessment (LCA). This stage of LCA aims to assess the potential environmental and human health impacts resulting from the primary flows determined in the LCA. ISO 14040 and 14044 standards require the following mandatory steps to complete an LCA:

Selection of hit categories, category indices and characterization models. The ISO standard requires that a study select multiple impacts that cover a "comprehensive set of environmental issues". Impacts should be relevant to the geographic area of study and the justification of any selected impact should be discussed. Often in practice, this is completed by selecting an existing LCA method (such as TRACI, ReCiPe, AWARE, ...).

Classification of inventory results In this step, the LCA results are assigned to selected impact categories based on known environmental impacts. In practice, this is often completed using LCA databases or LCA software. Common impact categories include global warming, ozone depletion, acidification, anthropogenic toxicity, ...

Characterization, which quantitatively modifies the LCA results in each impact category through characterization factors (also referred to as equivalence factors) to create impact classification indices. In other words, this step aims to answer the question, how much does each result contribute to the impact category? The main purpose of this step is to convert all streams classified for impact into common units for comparison. For example, for global warming potential the unit is generally defined as CO 2 -equiv or CO 2 -e 2CO equivalent, where CO 2 is given a value of 1 and all other units are converted to their respective effect.

optional

Normalizing Results The goal of this step is to answer the "Is it too much?" By expressing LCA results in relation to a selected reference system, a separate reference value is often chosen for each impact category, and the rationale for this step is to provide a temporal and spatial perspective and help validate LCA results. Standard references are the typical impacts in each impact category in each: geographic area, resident of geographic area (per capita), industrial sector, or other product system or baseline reference scenario.

Grouping of LCA results This step is done by sorting or ranking the LCA results (specified or normalized depending on the previously selected steps) in one group or several groups as defined in the objective and scope. However, grouping is subjective and may be inconsistent across studies.

Weighting of influence categories. The purpose of this step is to determine the importance of each category and its importance relative to others. This allows studies to aggregate impact scores into a single index for comparison. Weighting is highly subjective and, as is often the case, decided on the ethics of those interested. There are three main categories of weighting methods: panel method, monetization method and target method ISO 14044 advises on weighting in general and states that "weighting should not be used in LCA studies used in comparative claims that are to be disclosed to the public".

Life cycle impacts can be classified into several stages of development, production, use and disposal of a product. In general, these effects can be divided into first effects, use effects, and end-of-life effects. The first impacts include extraction of raw materials, manufacturing (transformation of raw materials into product), transportation of product to market or site, construction/installation, and commencement of use or occupation. Impacts of use include the physical impacts of the product or facility's operation (such as energy, water, ...) and any maintenance, renovation, or repairs required to continue using the product or facility. (source required) End-of-life impacts include destruction and processing of waste or recyclable materials.

interpretation

Life cycle interpretation is a systematic technique for identifying, quantifying, reviewing and evaluating information from life cycle inventory results and life cycle impact assessment. The results of inventory analysis and impact assessment are summarized in the interpretation stage. The result of the interpretation stage is a set of conclusions and recommendations for study. According to ISO 14043, this interpretation should include:

Identifying important issues based on the results of the LCA and LCA phases of an LCA

Study evaluation considering completeness, sensitivity and consistency checks

Integrating BIM and LCA

This work integrates Building Information Modeling (BIM) with Life Cycle Assessment (LCA) and presents the result of this integration in the environmental impact assessment of building materials in the construction sector. A case study of a multi-story office building is used to validate the development of design concepts and discuss the results produced by BIM and LCA tools.

Using Autodesk Revit as a BIM program and Green Building Studio and Tally programs in Revit as a tool to achieve the objectives, this research evaluates the case study LCA method based on ISO 14040 and 14044 guidelines in the existing database.

This study shows that BIM-LCA integration is an optimal method for achieving sustainable development and environmental protection and empowering the decision-making process in the construction sector. This highlights the current limitations facing the integration process. Furthermore, this work shows that most of the negative environmental impacts occur during the construction and operation phases. Therefore, it encourages the review of the use of construction materials in order to reduce the passive contribution to the environment.

The world is witnessing an increasing concern in the field of energy consumption and natural resources and environmental effects. Environmentally intensive human activities such as fossil fuel burning, deforestation, and land use change produce harmful emissions that passively affect the environment. The United States Energy Information Agency (US) predicts that by 2025, global energy consumption will increase by 33% in developed countries and

91% in developing countries. The International Energy Agency (IEA) predicts that between 2003 and 2030, the annual growth rate of energy consumption in the countries participating in the Organization for Economic Co-operation and Development (OECD) will reach 1-3%... The construction industry is one of the activities that It affects energy, resources and the environment, therefore, increasing innovations and solutions to achieve sustainability standards in this field, especially in critical conditions such as increased competition, lack of resources and lack of environmental protection standards, is important. Factors play a fundamental role in influencing the built environment and energy consumption during the entire life cycle assessment (LCA) of building materials, i.e. extraction of raw materials, manufacturing, packaging and transportation to site, construction and installation, operation until demolition and recycling.

New strategies such as green building approaches, sustainable material practices, and renewable energy systems are widely needed to reduce energy consumption, greenhouse gas (GHG) emissions, and environmental impacts of building materials in the construction sector. The relationship between building materials and energy has evolved in a complex manner in recent decades. This goes back to modern technologies that explored the various properties and capabilities of these materials. In addition, the type of building, climatic region and level of economic development are prominent factors that play a role in determining the pattern of energy consumption in the construction sector. LCA is one of the many management tools used to assess environmental impacts in the construction sector. The performance of LCA appears as an environmentally friendly method for calculating the environmental effects of building materials. Despite the aim of the LCA method is to evaluate the concept of sustainability in the construction sector, there are various challenges facing the application of LCA in this field. Examples of these challenges are the potential changes in the form and performance of buildings during their entire lifetime, mostly over 50 years, and the challenges of predicting the entire life cycle and reducing environmental loads of buildings. In this context, the role of Building Information Modeling (BIM) appears as a construction tool that facilitates the application of LCA in the construction sector. The use of BIM in the early stages of designing construction projects empowers the decision-making process in the construction sector, BIM provides designers, architects and engineers with the data needed to evaluate energy consumption and environmental effects in the construction sector throughout the life cycle of construction materials. It can be considered that BIM coordinates both the information of building materials and their environmental impact assessment.

The number of publications in the field of environmental LCA studies has increased rapidly since the publication of the ISO 14040 series. According to Anand and Amore, the number of publications found in Scopus by 2011 was only 88. This number increased to 264 publications in 2015. In this field, several articles discussed the LCA methodology from a building perspective, while many other publications refined the methodology in analytical works and case studies. In addition, several publications investigated the application of BIM method in the construction sector. Some authors defined strategies that demonstrate the power of BIM. Other authors reviewed several BIM publications in order to determine the objectives and potential of green BIM tools in the construction sector. However, there is a growing concern regarding the integration of BIM and LCA. Some authors considered this phase as a promising opportunity in the architecture, engineering and construction (AEC) industry. Other authors evaluated this integration as the three pillars of environmental, social and economic sustainable development in the early stages of design. cover In addition, some authors analyzed the ability of such integration to evaluate the sustainability standards and energy performance of the building, while others tried to maximize the benefits of this integration and achieve the most sustainable construction standards. Despite these publications, one can perceive a gap in the field of BIM and LCA integration. This gap is insufficient in the methodological details covered in this section of the study. In fact, the need for a defined systematic framework of BIM and LCA goes beyond research and knowledge organization. This area should be considered in order to support the decision-making process in the construction sector and protection of the built environment.

This work analyzes the LCA methodology from the perspective of the building and presents the role of BIM and LCA integration in assessing the environmental effects of building materials in order to enable the decision- making process and sustainable design method in the construction sector. Therefore, empowering the decision-making process aims to achieve more efficient, cost-effective and sustainable design standards, especially in the early stages of construction project design. The purpose of this work is to motivate the integration of BIM and LCA methods in the initial design phase of construction projects and to provide the ability of such integration in evaluating the environmental effects of building materials. In addition, BIM-LCA integration shows the important role of sustainable construction in reducing the environmental effects of building materials such as global warming potential, acidification potential, ozone depletion potential, eutrophication potential, smog formation potential and non-renewable energies.

Integration process tools

Sustainable construction is a practice that aims to improve the quality of life of residents by maintaining a balanced relationship between the different demands of people and affordable facilities. Agenda 21 on Sustainable Construction for Developing Countries defines sustainable construction as a holistic approach that aims to preserve the relationship between the natural and built environment and build settlements that protect human dignity and create justice.

BIM-LCA integration methodological framework

The integration of BIM and LCA attracts designers, engineers, architects and experts interested in sustainability and environmental engineering. On the one hand, BIM models generate integrated design and support information management and collaboration between stakeholders throughout the life cycle of construction projects. It gives the opportunity to present design alternatives in all possible variations and design parameters in the early design stages of construction projects.

IPD

One of the most important decisions when starting a project is defining how to deliver the project, specifically how to design and build a project. Design-Bid-Build (DBB) and Construction Management at Risk (CMAR) represent the majority of project delivery systems in use today. Design-build is an alternative approach to DBB that can successfully deliver horizontal and vertical construction projects regardless of project type.

However, there is a fourth delivery approach known as Integrated Project Delivery (IPD).

IPD is a project delivery approach that integrates people, systems, business structures and practices into a process that harnesses the talents and insights of all participants collaboratively. This approach was created to optimize project results, increase property value, reduce waste and maximize efficiency in all stages of design, construction. In the 1990s, various groups began to focus on project collaboration due to declining productivity in the construction industry. Due to this focus, the IPD model began to develop in the early 2000s.

At its core, the IPD consists of a tripartite agreement. It is a contractual agreement between the owner/project manager, the builder and the design professional that aligns the business interests of all parties. IPD is more than a contractual vehicle, but a collaborative approach to delivery where there is mutual trust between team members and inefficiencies are avoided.

Many delivery models can create silos and chaotic deliverables from different stakeholders that can become more focused on individual goals than overall project goals. Instead, IPD seeks to build better partnerships and create an environment focused on common goals.

It has been recognized for many years that conventional procurement routes in construction projects, such as the traditional or design-build route, can result in under-delivering on a project-by-project (and therefore international) basis. The construction industry as a whole) often suffers from deficiencies in satisfying the “triple constraints” of construction projects (time, cost, and quality) due to their inherent cultural values (Darrington & Lichtig, 2018).

While in recent years there has been a lot of focus on the technology and information aspects of project delivery, it is felt that if the construction industry needs industry collaboration, there should be an equal amount of industry collaboration to rethink these common procurement pathways. to reach the desired pure ideal.

One alternative procurement route that has gained international attention is Integrated Project Delivery (IPD), which is most widely cited by AIA (2007) in its original guidance, describing it as follows:

A project delivery approach that integrates people, systems, structures, and business practices into a process that harnesses the talents and insights of all participants to collaboratively optimize project outcomes, increase owner value, reduce waste, and maximize efficiency throughout all design phases. . IPD construction stands in stark contrast to the traditional procurement model, which is notoriously fragmented and adversarial in nature, instead offering an approach that emphasizes close and genuine collaboration between project participants in a spirit of trust, common goals and mutual benefits.

Perhaps the most fundamental quality of IPD implementation is the equal sharing of risk and reward. By participating in a project that uses IPD, the participant forfeits the opportunity to manage his or her share of the project work in a way that maximizes individual profit, opting instead for an equal share of the net budget savings generated by the integrated team. .

The result of this is that the company's focus can be directed towards effective and value-added collaboration in the early stages of the project, with the perspective of maximizing individual profit through total shared profit, perhaps as an incentive for all participants to optimize their contribution to the project. as far as practically possible (Moylan and Arafa, 2017; Kent, 2010).

With this in mind, the potential importance of the IPD philosophy in an industry striving for higher levels of efficiency, collaboration, transparency and accountability needs no explanation and industry-wide progress in BIM adoption and innovation means the industry is halfway there.

At a high level, BIM and IPD can appear to be very similar concepts, with both advocating close collaboration between cross-parties with a "collective mind" of information as a tool to enable more efficient and effective interdisciplinary problem solving. However, an important distinction to make is that BIM is largely concerned with the various information management processes that occur throughout the asset lifecycle, while IPD is more concerned with the project team – both from a logistical and cultural perspective.

Together, their symbiotic relationship allows all participants to maximize project outcomes for the common good. AIA's (2007, p.10) view of BIM is a platform for collaboration "that helps enable IPD in practice: "BIM is a tool, not a method of project delivery, but the methods of the IPD process work hand in hand. Use BIM and take advantage of the tool's capabilities.

Simply put, BIM provides the technological platform and robust information management protocols that enable collaborative work and also provide a "common source of truth" While IPD provides a strong cultural backbone that can often be missing from projects (to their detriment).

The available data confirms that IPD (implemented in conjunction with BIM and strictly following lean principles) provides a highly effective alternative to traditional delivery projects. Despite these developments, there has been little comment on the issue in the UK so far and there are apparently no plans for future adoption.

Therefore, it appears that there is still much work to be done to positively influence the cultural landscape of the UK construction industry and to create the spirit of trust and genuine partnership that is essential for its successful implementation. However, as industry awareness of IPD spreads enough to eventually be introduced in the first critical projects, we can expect our industry's overall performance to improve over time and then progress toward a sustainable lean ideal in construction.

Strengths of IPD

While owners may prefer a collaborative team focused on project-level goals over individual goals, a complete IPD model is not appropriate for every project. This system is best suited for complex projects that span more than 12 months and have multi-million dollar budgets. Historically, IPD has been successfully implemented in the healthcare, higher education, manufacturing, and infrastructure and critical project sectors.

Current trends include organizations looking for ways to align process improvement and team health with capital improvement projects. IPD enables organizations to use collaborative delivery methods to create value through innovative approaches and improvement actions driven by teamwork with shared risk and reward for successful delivery.

IPD projects share a common theme of collaboration, which focuses on a team mentality underpinned by consensus. IPD contracts are designed to bring teams together through the challenges they face. Although there are ways to succeed through experimentation in the shared delivery model, the IPD contract is designed to prevent a team from slipping off track. The IPD structure creates an environment of open communication and establishes a chain of command.

This process eliminates waste by using a template that moves decisions and conversations through a defined reporting structure of core teams. Core teams provide opportunities to break down barriers between traditional roles and expectations of team members. Different groups in this delivery model may develop strong relationships and want to work together again to strengthen their partnership and success.

Studies have shown that project results using the IPD model are more successful compared to other models. A University of Minnesota School of Architecture IPD case study found that IPD "provided a remarkable uniformity of success for all teams in this study, regardless of project type, scope, geographic location, or prior experience with IPD." This is a testament to the nature of the expectations set using this team approach with a contract model that replicates the value created with an advanced team environment.

Challenges of IPD

Although there are many advantages to using IPD, there are also disadvantages. This delivery method requires teams to (give and take) to improve the overall project. This type of ebb and flow can lead to challenges for teams that carry the heavy workload to contribute to the overall success of the project.

It is essential that each team member realizes their own results for the benefit of the project, even when they may be asked to delegate mundane tasks to other responsible individuals on the team. When you're pushing for innovative ideas, high-performing teams need strong partners. This requires team members to be flexible, knowledgeable, and always available. This process reveals the strengths and weaknesses of team members and pushes stronger members to work harder. Unfortunately, IPD is not always considered a lean delivery model in terms of personnel time.

Ensuring easy access to documents and information through an open environment can require more work and time from key parties. For example, given the reduction in change orders due to open communication, the team is likely to be fully engaged in development, conversation, and documentation versus the traditional delivery method where it bounces back and forth for design and pricing exercises.

The best types of projects

IPD works well with three types of projects:

Repetitive projects, complex projects and large projects.

An iterative project is similar to an assembly line in that it achieves better results by maintaining a consistent team motivated to increase results from project to project.

Complex projects, regardless of size, require a highly focused team effort focused on proper planning, innovation, and results. The final type of project that has been successful using IPD is large projects.

Large projects benefit from strong team alliances and processes, as teams work together over long periods of time.

On a final note, IPD will continue to gain momentum in the world of complex projects, but trying to implement a full IPD model on projects with a budget of less than $5 million may create an excessive administrative burden. Logistics issues alone may be a stumbling block for many organizations. IPD projects require intensive time and work investments of team members, especially in the early stages of the project. Owners should first look to hire a professional project management team to help determine the right delivery system for their projects.

What is the integrated project delivery method?

Integrated Project Delivery (IPD) is a method of organizing construction projects so that all responsible parties, from the design team to the general contractors, are involved in every phase of the construction process. It creates multilateral agreements, meaning everyone is contractually bound to complete the project. Team members agree on delivery terms and all parties are in the same contract. This means that everyone shares the same level of risk, reward and responsibility.

IPD vs. Design Proposal Build

IPD differs from traditional project delivery methods such as design proposal construction due to the contract structure and construction process:

Contract structure: In creating a design proposal, an owner first hires a design team, and both parties sign a single contract that outlines the design team's responsibilities, timelines, and costs. After the design is complete, builders bid on the project and the owner hires a general contractor based on cost and terms. Then the owner and the general contractor conclude their separate contract and start the construction. In this method of project delivery, the design team and the general contractor are not contractually bound, so they do not share the same level of risk, reward, or responsibility.

Construction Process: A design-build proposal moves through each of its project phases separately, meaning that once the design team completes an approved design, the contract is executed and their work is complete. The project can then proceed to the bidding stage for general contractors and then construction. In the integrated project delivery method, the design team remains involved until the project is actually built. At IPD, there is much more overlap between the design team and the general contractor, as everyone works together to complete a single contract.

How does IPD work?

The integrated project delivery method offers greater collaboration between different parties in a construction project.

While all project delivery methods are tailored to each project, there are common steps for IPD: The project owner hires a full team.

The project owner works to quickly hire a full team of contractors, usually including a design team, general contractor, engineers, a project management team, ...

Most project owners implementing an IPD often use a lean construction method that aims to reduce costs and delays. This can mean reduced materials, crews and waiting time between construction stages. Each team member must agree on common goals before doing anything.

The team signs a contract. This contract specifies the project timeline, schedule, obligations, payments, and risk/reward terms. In an IPD contract, everyone has the same responsibilities, so if one team drops out and loses, everyone loses. If one team member is ahead of schedule, everyone benefits. After signing the multilateral contract, the project enters the design phase.

The team approves the plan. Owners, architects, and engineers work with other stakeholders in a project during the design phase to ensure that the building meets contract requirements. This keeps everyone on the same page from the start and can help reduce potential delays. The design team benefits from feedback from engineers, general contractors, and other professionals.

After the building permits are issued, construction begins. Day-to-day construction may only involve the general contractor and the project management team, but all members of the IPD team are kept informed of any issues or delays in the schedule.

Benefits of IPD

An IPD encourages all project team members to work together because everyone is financially responsible for the project's success. When team members work together, it reduces misunderstandings.

Promotes transparent communication Given the nature of an IPD construction project where all stakeholders are accountable, the delivery method also promotes frequent inter-team communication and reviews.

It encourages quality. Shared accountability encourages team members to perform at their best and improves project quality.

Increases Productivity IDP reduces the waiting time between different phases of a construction project because every team is involved in every phase. For example, the general contractor can begin to order materials and equipment because they are involved in the design phase of the project and know the needs of the project.

Disadvantages of IPD

Some of the advantages of IPD make it a risky proposition for project owners.

Individual performance affects the entire project. Poor performance by one team member jeopardizes the entire timeline and other stakeholders.

Group decision-making can slow down the process. In IPD projects, the entire group must reach consensus on all parts of the project, which is not as time-efficient as other project delivery methods, such as design, bid, build. IDP contracts usually specify a form of group consensus for project decisions that can also guide the overall construction process.

High project costs Although IPD projects often implement lean construction, meaning they emphasize efficiency, waste-free materials, and crossover between the design and construction phases, it is generally a higher-cost project delivery method because of the risk involved. In IDP contracts, all parties are contractually bound to each other, meaning that one team's delay has ripple effects throughout the entire construction project. Because of the increased responsibility inherent in this project delivery method, owners often pay teams more than they would normally pay for other traditional project delivery methods.

Principles of integrated project delivery method

Allison is a co-developer of the American Institute of Architects' Integrated Project Delivery: A Guide, known as the IPD "Bible." This guide sets the following standards for successful IPD implementation:

Mutual respect and trust: All parties involved—owner, designer, contractor, consultants, subcontractors, and suppliers—understand the value of collaboration and are committed to working as a team in the best interests of the project.

Reciprocal Benefits and Rewards: IPD compensation recognizes and rewards early engagement. Compensation is value-based and rewards positive behavior, often by providing incentives tied to project goal achievement.

Collaborative innovation and decision-making innovation: The free exchange of ideas is encouraged and ideas are evaluated on merit rather than position or role. Major decisions are weighed by the team and, if possible, made by unanimous decision.

Early Involvement of Key Participants: Key participants are involved as early as possible. Decision-making is enhanced by the influx of expertise from key participants, and this shared knowledge is most profound in the early stages of a project, when informed judgments have the greatest impact.

Initial goal definition: Project goals are developed and agreed upon in the early stages and are supported by all participants. Each participant's insight is valuable in supporting innovation and superior performance.

Intensified Planning: The goal of IPD is not to reduce design effort, but rather to advance design outcomes in order to simplify and shorten costly construction efforts.

Open Communication: Direct and honest communication between team members is essential. In a no-blame culture, the goal is to identify and solve problems rather than assign responsibility or blame. When differences arise, they are acknowledged as such and resolved quickly.

Appropriate technology: IPD often relies on advanced technologies. Specifying the technologies you will use at the start of the project maximizes interoperability, and technologies that support mutual data exchange are essential to project support.

Organization and leadership: All team members must be committed to the goals and values of the project team. Leadership is given to the most capable team member based on specific situations. Clearly define roles, but remember that creating artificial barriers can reduce open communication and risk-taking.

Integrated project delivery steps

Once the stage is set, contracts are written, and the team is in place, it's time to implement the IPD project. Here are the steps involved in submitting an IPD project and some free templates to use to facilitate the IPD process:

Build a cohesive team: IPD succeeds in assembling a dedicated team for collaborative collaboration.

Conceptualization: Stakeholders gather early in the process and analyze multiple solutions. The goal is to reduce waste and errors, minimize problems, and avoid rework or redesign.

For commercial construction projects, this template can help you stay on track. This template is broken down into separate sections for each phase of construction, so you and your IPD team can use it to ensure that essential tasks are properly planned and completed, from conceptualization to project closeout. Keep all stakeholders informed with this easy-to-use template. Check out other free tools for new homes, renovations, and schools in our Complete Construction Timeline Templates collection.

Design Criteria: In this phase, team members review and test different design options. In a project using Building Information Modeling (BIM) software, you can use the model to test potential scenarios and determine what the IPD team will achieve.

Detailed Design: Finalize key design decisions at this stage with respect to waste reduction and savings. Building code regulations and sustainability goals are incorporated into the design process.

Implementation Documentation: Once the design is set, implementation begins with design data analysis and computer modeling. Often IPD integrates BIM and CAD modeling to visualize the project. During this phase, analyze and virtually test the proposed systems to ensure design performance. Contractors, subcontractors, and suppliers document how systems and structure are created. At this stage, documents are produced to be used for licensing, financial and regulatory needs.

Agency Review: Review and licensing of agencies usually requires traditional delivery. However, BIM can provide information directly or through links to check the design for regulatory or building code criteria. You can use analytics software for data modeling to generate metrics or performance analysis for design validation.

Procurement: Procurement means obtaining price commitments for all project work packages. In IPD, these promises are typically developed on an ongoing basis by subcontractors and suppliers participating in the design and then revise pricing based on current information. This means that in IPD the procurement phase is usually limited to obtaining price commitments from other suppliers and subcontractors who were not directly involved during the two design phases.

Construction: Architects usually consider building at the final stage of design, when issues are addressed and solutions are provided to solve real-life problems. But in IPD, this work is completed in the detailed design stages and implementation documentation. This means that construction management is about quality monitoring and cost control.

When problems do occur (although the use of IPD is likely to be much less), teams can use the PDCA Deming cycle approach to process-related problems to understand the underlying causes, identified as root causes, which then need to be improved. The IPD team can use this template to perform their own root cause analysis and then take appropriate action.

Closeout: The exact nature of the closeout of an integrated project depends on the commercial terms of the contract. For example, if the contract includes incentives or compensatory penalties, the package will include the calculation of appropriate credits and bonuses.

Facility Management: Coordination of physical work space with people and tasks of an organization is the responsibility of facility management. This role integrates architecture, business management and engineering, and the behavioral sciences. In the most basic terms, facilities management covers all the activities that keep an occupied structure operational. The practical management of the facility after the building is completed may or may not be included in an IPD commitment unless it is in the contract.

This easily modifiable template simplifies any inspections your IPD contract requires. In addition to the type of inspection, you can add details of the property and area to be inspected along with any necessary details in the dedicated space.

Advantages and disadvantages of integrated product delivery

All of our experts associate IPD with lean practices and note that their pairing has multiple benefits. Heinemeier strives to transform the built environment through the use of lean principles, tools and research. "The benefits of IPD and lean construction include safer work environments, more efficiently completed projects, increased productivity and satisfied stakeholders," he says.

The right tools are essential for the success of IPD projects. Zandy recommends:

“It's important to use tools and processes that allow supervisors and foremen to communicate quickly. "The jobs with the best connections are the most successful."

Here are just some of the many benefits of IPD for every team member:

Improved planning and management: Collaborative management that leverages the expertise of multiple team members helps achieve optimal solutions. Decision-making timelines are shorter because key players are usually in the same space and available for the duration of the project. When challenges arise, a democratically structured workflow supports optimal solutions, fast turnaround, and fast execution.

Risk Reduction: When all parties are equally involved in a project based on the IPD philosophy, resolving issues quickly is in everyone's best interests. This process removes the usual "blame game" and accountability and replaces it with a work environment where everyone is looking for project coordination and ultimate prosperity.

Transparency: When all team members meet regularly to share ideas and experiences or use common software, everyone is up to speed and aware of all aspects of the project. There are no hidden plans, cost surprises, or delays.

Save time and money: Adopting an integrated approach can speed up project delivery, and incentivizing everyone to share in the savings motivates everyone to work profitably.

Teamwork and collaboration: As all parties involved act as one entity (due to multilateral contracts or partnership agreements), both project transparency and integrated financial benefits increase, while fostering mutual support. Contracts also give team members the freedom to share documents without the legal or proprietary risks found in other forms of project delivery.

Shared responsibility and shared risk: IPD spreads project responsibility among all team members, while traditional models can force contractors and subcontractors to take on too much risk. Since IPD involves a shared overall risk, you must have high levels of owner involvement and trust between all parties.

Better Business Continuity: There is complete alignment with the owner's goals, which results in the project being successfully delivered on time and within budget more than traditional delivery methods.

Higher standards: When everyone has a stake in the project, potential financial incentives or responsibility, and a sense of unity with their colleagues, they tend to work for the benefit of the project, their team members, and themselves.

Customization: One size fits all is not part of the equation at IPD. By its very nature, IPD creates an environment that provides customized solutions to design and manufacturing challenges. While there is continuous learning that you can apply to future projects, each interaction provides an opportunity to learn and provide unique solutions.

Increasing stakeholder satisfaction: In essence, this is the goal of IPD, in addition to maximizing value and minimizing waste.

A big pro for the environment: IPD and green building are a natural fit. "IPD and the use of Lean all go well together in green, high-performance LEED-rated structures, and we need to do more to build sustainably," says Barnes. The United States Green Building Council (USGBC) tells us that buildings are responsible for most of the world's energy use—an average of 41 percent. The next largest energy consumers don't even come close: “Buildings are responsible for 73 percent of electricity use in the United States, and our building construction is responsible for many of the greenhouse gas emissions that contribute to climate change. Buildings are responsible for 38% of all CO2 emissions.

It makes sense to use collaboration to reduce these numbers. It makes sense to design and plan to reduce these numbers. Barnes adds, "It's important to eliminate all potential risks up front and to be in close communication with other stakeholders from start to finish, especially at the beginning."

Any company can use IPD, Barnes says. This method can be scaled to small projects - it's not just for large commercial projects. Everyone wants to save money and waste less. As an architect and someone interested in sustainability, it is important for me to adopt a lean approach and use a continuous process of rethinking and improving the methodology. IPD is a critical process for all green or LEED projects.

Disadvantages of IPD

"There is now a strong methodology and growing industry understanding of Lean in construction, but not in delayed design. Lean design is in danger of being seen as just another step toward applying robust lean construction processes and tools," says Cheng. In fact, lean design needs a different approach and method and needs to change its own culture. Until we spend some time working on what lean means for design steps, we are in danger of trying to apply lean methods developed for construction throughout the design.

In a recent post about his IPD research study, Cheng writes: “IPD is sometimes seen as difficult and complicated because it requires project owners and teams to negotiate contract terms such as joint reward risk pools and financial transparency terms. Our research team found that the time and energy spent on negotiations is an investment that pays off in forming the foundations of trust and mutual respect, key elements of successful collaboration.

"You need to have an engaged client who provides strong leadership, with well-defined project goals and deep knowledge of the construction process," says Zandi. "It's a different set of owner responsibilities compared to other delivery methods that can lead to resistance."

Resistance to change and training: As Heinmeier says, "Cultural change can be difficult to implement." Industry professionals sell their services based on past projects and can tend to be devalued by new practice.

The idea that learning and improving performance is a necessity may appear as a threat rather than an exciting opportunity. Training requires a significant investment of time and resources. Applying IPD and Lean principles and tools requires time and energy to educate customers, designers, manufacturers and business partners. Care is required:

In order to achieve outstanding results, IPD requires the use of criteria. Design criteria must be balanced with other criteria (engineering, costs, budget) to meet stated objectives. In fact, the entire team should initially identify the metrics and track them throughout the IPD process, as well as monitor the associated costs. The project team is responsible for successfully managing benchmarks at milestones throughout the design and construction phases.

Difficulty finding IPD experts: Despite the growing interest and positive results of IPD, there are currently not many experienced practitioners. For owners, there are not many experienced practitioners who have completed projects as a company, individually or as a member of a multidisciplinary team.

Contract Challenges: “The shared risk and reward (we all sink or swim together) and the idea that one team member can hurt the entire team's bottom line is a big incentive or challenge for those new to IPD. Several new contract models have been created as legal and insurance entities regarding IPD. When the risk is clearly defined, legal entities and insurers can provide the necessary protection. The application for an integrated RFIT team is an IPD-based agreement. Here you can find examples of multi-party agreements, RFITs, more contracts and health care providers with shared risk and lean IPD construction.

Funding and insurance barriers: "Integrated project delivery as a delivery method can sometimes have insurance issues if professional consultants are introduced early." To clarify issues and obtain coverage to protect an IPD project, insurers need to understand how the parties work together and how to mitigate the risk of joint claims. It is important that insurers draw up constructive risk as well as professional and general liability policies to meet the project objective.”

The essential (hardest) element of IPD is trust: "Cultivating a positive environment of mutual respect and trust is critical to team cohesion," explains Zandi. Participating parties must become strong teams to succeed.

Technology in IPD and the growing importance of BIM

Building Information Modeling (BIM) is essentially shared data software that provides non-graphical process information based on 3D models which gives architects, engineers and builders the ability to more effectively share information and concept, design, build and manage structures. BIM complexity of all kinds is increasing: in addition to 3D modeling, 4D BIM provides scheduling data, 5D provides cost and calculation information, and 6D provides project life cycle information for data extrapolation.

BIM helps computer simulation in our projects, says Pease.

Generally, we use it for collision detection, collision detection is finding where elements of separate models occupy the same space. For example, when a beam and conduit collide. Conflicts can also occur over sequences or changes that didn't make it into the schematic.

Careers in Construction: What Does a BIM Professional Do?

Building Information Modeling (BIM) is a type of digital technology used in construction projects. The 1960s was when engineers first envisioned how 3D models could be used to help architects conceptualize their designs. These days, computer technology is advanced enough to produce virtual spaces previously only dreamed of in science fiction novels.

Pen-and-paper sketches, blueprints, computer-aided design (CAD) programs were all points on the way to building information modeling technology, but when we use the term, they're not what we're referring to. CAD, for example, is a very useful drafting tool, but it is much more static and less flexible in comparison. BIM differs from CAD and its other technological predecessors in that it can render entire structures in their full complexity as immersive, data-heavy, interactive graphical layer cakes that respond to a dynamic range of inputs.

It is the job of a BIM professional to understand all of this.

However, it is important to understand that when we use the term BIM, we are actually talking about several different things. For starters, there's the technology itself: the entire suite of electronic software and digital tools responsible for producing 3D models. Of these, Revit Autodesk is widely considered the industry gold standard in the US, but there are many others.

Then there are BIM models themselves, electronic 3D representations of a structure's spatial layout.

What makes BIM models unique is that they also include a large amount of information about the physical materials, functional components, and related systems that make up a built structure.

Everything from the chemical composition of a building's steel beams to electrical wiring and HVAC systems is included in BIM.

Furthermore, each of these design elements can be isolated and optimized in the model. The big picture automatically updates to stay consistent over time and show how changes to one element affect the rest. When BIM is described as multi-dimensional and "intelligent", it means something. Intelligent BIM models can not only show the geometric design of a building (3D), but also how much time (4D) it will take to complete each stage of that design. Some versions of BIM can also make advanced cost predictions (5D), while others are able to generate data on a building's energy consumption (6D).

So this is the technology in a nutshell. But BIM is also a process. The collaborative digital space provided by BIM has changed how construction is done, facilitating an unprecedented level of collaboration between architects, engineers, contractors and clients throughout the project lifecycle.

BIM allows for a high degree of input from each of the project stakeholders during the design process. Therefore, this workflow helps guide contractors through the construction phase. And even after completion, a BIM model can be delivered to the client, who can then continue to use it to monitor the system's critical systems, perform analysis, and map out future changes to the building.

This multifaceted definition of BIM should give you an idea of the core competencies involved in this career path. In short, a BIM professional must be as adept at creating a collaborative environment with teammates as they are at using advanced digital technology in building information modeling.

What is a BIMS specialist?

Just like the definition of BIM itself, the career path of a BIM professional is best understood when broken down into individual rate segments. Depending on the company and its level of BIM adoption, the term BIM specialist may refer to a specific occupation or an entire category of occupations.

When used as a specific job title, BIM specialist likely describes a person within a company who is responsible for handling any and all matters related to building information modeling. When used as an umbrella term, it refers to a variety of branching roles within the BIM career path. For example, some companies employ a wide range of BIM titles, including BIM modelers, BIM analysts, and BIM managers to form an entire BIM team or department. All of these positions are considered a type of BIM specialist.

BIM is still a very new and growing field that accounts for some of the diversity in the career landscape. A 2017 report by the University of Auckland identified 20 different roles currently on the BIM specialist career path. Other studies have identified 40 cases, the report notes.

BIM titles

Here's a rough breakdown of just a few of these roles (salary estimates are based on checking several different job boards and job websites):

BIM modeller or BIM technician

This is the person who makes the 3D models. An expert in drafting and design, a BIM technician modeler is highly skilled in using a suite of BIM software and digital tools to create complex geometric representations of structures and the built environment. It is their job to work with architects and engineers to combine data on the properties of various materials and building systems to build each piece of the 3D model together to their exact specifications. A BIM modeler in the United States can expect to make an annual salary of around $50,000 to $70,000.

BIM Analyst

Once the model is built, someone must be able to understand it. This is where the BIM Analyst comes in. This person searches, collects, organizes, and synthesizes data in a thin model following simulation and creation of archival databases. Experts in statistical analysis are also tasked with creating presentations and recommending methods based on their analysis. A BIM analyst can expect to earn around $70,000 per year.

BIM coordinator or manager

Some companies separate these two roles—coordinator and manager—into separate positions. Others do not. Regardless, their functions overlap enough to warrant a single explanation. The BIM Manager Coordinator is responsible for coordinating efforts between BIM team members and other project stakeholders. Their role is to guide the BIM workflow, establish procedures, create BIM training programs, troubleshoot bottlenecks, identify opportunities to increase efficiency, and lead the execution of BIM projects. Another important task is to stay up-to-date on developments in the BIM technology landscape and strategically introduce upgrades as needed. A BIM manager can expect to earn $60,000 to $95,000 annually.

A BIM professional may then be expected to perform all of these roles simultaneously. Some companies are in the early stages of implementing Building Information Modeling or may have limited budgets and therefore are more likely to hire only one BIM specialist. Other companies are more advanced in their implementation or may simply be able to allocate the resources to hire a BIM team comprised of separate subspecialties. Remember, this is still a relatively new field, so job titles and duties are still in the early stages of being changed from company to company.

How does a D o I B become a BIMS expert?

It is clear that a BIM specialist must be skilled in many different things. Whatever their specific role, a successful BIM professional must have a solid understanding of architectural and engineering principles. For this reason, a degree in any of these fields is an excellent starting point for a career in BIM.

At the same time, BIM professionals also need a high degree of competence with the related software and digital technology involved in producing BIM models. Therefore, the background in computer science is also a suitable angle for the approach.

However, the truth is that while some BIM-specific degrees and certification programs have grown in recent years, there is no single training path that you must complete before you are eligible to work in the field. Many people currently working in BIM careers created their own paths, although it's also true that many were originally architects or mechanical engineers (both of which require a master's degree) before switching to BIM. . They also spent a lot of time exploring and honing their drafting and computing skills along the way. That is, having experience in construction, a higher level of specialized training and computer skills is not harmful.

However, there really is no set path to becoming a BIM specialist, which is both an exciting and daunting proposition for someone taking their first step. Obviously, those looking to break into this profession have options to explore, but they will benefit greatly by playing to whatever strengths they bring to the table. After all, let's not forget that in addition to technical skills, another core competency of a BIM specialist is the ability to foster collaboration and high levels of communication between teammates. So whatever your background, the best thing you can do is stay curious and willing to throw yourself into whatever skills you need to succeed in a career as a BIM professional.

Is BIM a good goal to pursue?

With something as new and fluid as BIM, it's understandable to ask if it's good professional practice to be in the first place.

It's true that despite its many benefits, BIM adoption among construction companies has historically been slower than expected. Part of this is due to COVID-19 in recent times, which has had a negative impact on construction in general. A reduction in projects in 2020 due to the pandemic also meant a reduction in the use of BIM. Of course, there are other reasons for the slow adoption rate, not the least of which is the construction industry's reluctance to be slow to adopt any type of digital technology.

However, there is good reason to believe that the slow tide of BIM adopt ion is turning. A growing number of countries are beginning to issue mandates requiring the use of BIM in all large-scale construction projects. The United States has yet to follow suit, but some states, such as Wisconsin and Texas, have made the leap themselves.

In the end, the simple fact is that BIM dramatically improves all aspects of construction. For this reason, companies that use BIM have a distinct advantage in the competition. This edge becomes ever sharper with each addition of a BIM specialist to their teams. Small and medium-sized construction companies may be slow to adopt, but many of the biggest construction companies on the scene are already well aware of this fact: BIM is on the rise, and so is the demand for people with the skills to use it.

GIS software

A distinction must be made between a single geographic information system, which is an installation of software and data for a specific application, along with associated hardware, staff, and institutions (such as a GIS for a specific city-state).

GIS software is a general-purpose application that is intended for use in many individual geographic information systems in various fields of application. : 16Since the late 1970s, many software packages have been developed specifically for GIS applications, including commercial ones such as Esri, ArcGIS, Autodesk, and MapInfo Professional; and open source programs such as QGIS, GRASS GIS, and MapGuide These and other desktop GIS applications include a full set of capabilities for importing, managing, analyzing, and visualizing geographic data and are designed for stand-alone use.

Since the late 1990s, with the advent of the Internet, GIS Server has been developed as another mechanism for providing GIS capabilities. It is standalone software that is installed on the server, similar to other server software such as HTTP servers and relational database management systems, which enables clients to access GIS data and processing tools without the need to install specialized desktop software. Access to the server through a web browser This strategy has been extended through the development of cloud-based GIS platforms such as ArcGIS Online and specialized GIS software as a service

An alternative approach is to integrate some or all of these capabilities into other software or IT architectures. An example is a spatial extension for the Object-Rational database software, which defines a geometric data type so that spatial data can be stored in relational tables, and SQL extensions for spatial analysis operations such as overlay. Another example is the extension of geospatial libraries and APIs (eg, GDAL, Leaflet, D3.js) that extends programming languages to allow integration of GIS data and processing into custom software, including web mapping sites and location-based services on smartphones.

Integration of GIS and BIM in infrastructure design and construction

Introducing location services to infrastructure design and construction will lead to much safer and smarter transportation methods, roads, and buildings. Integrating BIM and GIS data provides a spatial element that can be used in infrastructure design, enabling more efficient workflows and consistent data.

This initiative was born out of the awareness that the AEC industry was facing a real challenge. How to solve the puzzle of missing data between construction steps? From planning to operation and construction, critical pieces of information are lost.

Since the latest technology used in this industry relies solely on static data and software systems, such a problem has caused more problems than the industry can handle. Every time data is moved between phases of a particular project, the entire data set is lost.

The problem appears the moment a project stakeholder needs data from an early stage of the process. Engineers, designers, and planners must retrieve that data, sometimes manually, which causes more problems. The GIS industry took a step forward to solve this problem by moving towards 3D modeling.

Building information modeling in construction and design

The rapid evolution of the BIM industry has created a real disruption in both the design and construction industries. This evolution includes a digital transformation from 2D to 3D building information modeling. The emergence of BIM and GIS integration brings a completely new approach to construction and planning.

This approach allows introducing a geographic element to BIM design. This means that construction and infrastructure design companies can plan and place their new objects in contexts that match their surroundings.

Integration and benefits of BIM and GIS

GIS data is essential for planning all operations regarding any infrastructure such as rail networks, airports, bridges, roads, ... This helps place this infrastructure in the context of the surrounding environment.

While GIS helps to understand how to place infrastructure in that context, BIM information is the critical element that allows the design and construction process of that infrastructure to take place.

Integrating BIM and GIS is the process of integrating the BIM model into spatial texture layers. Therefore, designers can use GIS to get the most accurate information about some of the areas where the construction is going to take place. If the area is prone to flooding, designers learn about it and influence building materials, orientation, location, ...

The reason for the importance of this issue is that GIS information can be used in national, regional and urban scales. On the other hand, BIM data is closely related to the design and construction of a particular object, structure or shape. By combining the two, you gain the ability to build any structure at the object level.

Adding GIS enlarges the whole picture by adding a smarter and larger environmental context, meaning that the object becomes part of the roads, utilities and land in that environment.

Integrating GIS and BIM data allows design and construction firms to collect accurate and valuable data that leads to more effective and efficient design and project management.

Here are some of the benefits of integrating GIS and BIM:

Long-term savings and efficient design

Regardless of what the contractors' goal is, converting some objects to an open-air construction site or reducing the entire process to factory-level prefab, minimizing data loss and time, as well as improving logistics planning, becomes a top priority.

The use of BIM and GIS introduces a whole new spatial element to this intelligent and innovative industrial construction process with one simple goal in mind – to increase the efficiency of the entire design and construction process.

Companies that provide location services use geographic information systems and BIM modeling to better design and make every process, operation, and construction project much more efficient in terms of effort, time, and resources.

The integration and combination of these advanced technologies can be applied to any design and construction project at hand. The digital work that comes as a direct result of integration is a highly effective way of retrieving, storing, cataloging and recording critical data. The necessary information can be used to support any project and see it through to a successful conclusion.

Post-construction and GIS/BIM integration

In addition to being useful in pre-construction, geographic services, BIM modeling and geographic information systems can also be used in post-construction. Since facilities management also requires data, the flexible GIS/BIM model ensures that operations receive all the information they need.

The integration is particularly useful for customers as well. They can use integrated GIS/BIM solutions to retrieve and reuse critical data at every stage of a structure's life cycle.

The need for GIS/BIM integration stems from the initiative to adopt the most innovative approach to infrastructure design and construction in building smart cities. To be able to do this, space companies need to decide, plan and do everything else much smarter than ever before.

The best way to do this is to connect and integrate GIS and BIM. Such integrated systems are the basis of future evolution. This evolution may include cutting-edge infrastructure from self-driving vehicles to entire smart cities.

About the Author: John Victor has been an avid blogger for 5 years, with a special interest in CAD and related technologies. He is now associated with IndiaCADworks. Among his other interests are blogging, film and photography.

References

- Eastman, C. Tiecholz, P. Sacks, R. Liston, K. 2008, "BIM Handbook: a Guide to Building Information Modeling for owners, managers, designers, engineers, and contractors"
- 2.0 2.1 buildingSMART Finland 2012, “Common BIM Requirements 2012: Management of BIM projects"
- 3.0 3.1 3.2 Wiig, O. J. 2014. "BIM’s influence in construction project management"
- 4.0 4.1 4.2 Bips, Digital Constructions 2006, “3D Working Method 2006”
- Alashwal, A. and Fong, P. 2015, ”Empirical Study to Determine Fragmentation of Construction Projects.”
- 6.0 6.1 6.2 The computer integrated construction research program at the Pennsylvania State University 2010, “BIM Project Execution Planning Guide”
- 7.0 7.1 ISO21500, 2012, Guidance on Project Management. International Organization for Standardization.
- 8.0 8.1 Andersson, N. 2015, “BIM-based Management of Construction presentation”, June 2015, DTU
- 9.0 9.1 9.2 9.3 Winch, Graham, M. 2010, Managing Construction projects, second edition
- 10.0 10.1 Smith, D. P. 2014 (27th IPMA World Congress), BIM & 5D Project Cost Manager.
- Chen, L. and Luo, H. 2014, "A BIM-based construction quality management model"
- Smith, D. K. 2009, "Building Information Modelling: A strategic implementation guide"
- Attrup, M. L. Olsson, J. R. 2008, Power I Projekter Og Portefølje.
- 14.0 14.1 14.2 Hauch, P. 2014, "Measuring profit by using Open BIM – tools from Digital Constructions(Det Digitale Byggeri) Presentation" 2014, DTU
- Jørgensen, E. F. 2014, "Standards and classification of building objects, SfB and CCS presentation, 2014, DTU."
- Compare: Fischer, Eileen; Reuber, Rebecca (2000).
- Industrial Clusters and SME Promotion in Developing Countries. Issue 3 of Commonwealth trade and enterprise paper, ISSN 2310-1369. London: Commonwealth Secretariat. P. 1. ISBN 9780850926484.
- Retrieved 18 November 2020. In most countries, small and medium-sized enterprises (SMEs) make up the majority of businesses and account for the highest proportion of employment.

- ^ "Chile", Financing SMEs and Entrepreneurs 2016, Financing SMEs and Entrepreneurs, OECD Publishing, 2016-04-14, pp. 155–173, doi:10.1787/fin_sme_ent-2016-11-en, ISBN 9789264249462, retrieved 2018-10-01^ Rijkers et al (2014): "Which firms create the most jobs in developing countries?", Labour Economics, Volume 31, December 2014, pp.84–102^
- United States. Commission for Assistance to a Free Cuba (2004). Report to the President. Department of State publication, volume 11164. Colin L. Powell. U.S. Department of State. P. 233. Retrieved 18 November 2020. In the United States, small business accounts for 50 percent of jobs, 40 percent of GDP, 30 percent of exports, and one-half of technological innovations.
- ^ "Small and Medium-Sized Enterprises". USTR.gov. United States Trade Representative. Retrieved 2021-11-29.
- ^ Compare: Antoldi, Fabio; Cerrato, Daniele; Depperu, Donatella (5 January 2012). Export Consortia in Developing Countries: Successful Management of Cooperation Among SMEs. Berlin: Springer Science & Business Media (published 2012). P. v. ISBN 9783642248788. Retrieved 18 November 2020. Small and medium-sized enterprises (SMEs) are highly significant in both developed and developing countries as a proportion of the totl number of firms, for the contribution they make to employment, and for their ability to develop innovation.
- ^ a b Cueto, L. J. Frisnedi, A. F. D. Collera, R. B. Batac, K. I. T. Agaton, C. B. (2022). "Digital Innovations in MSMEs during Economic Disruptions: Experiences and Challenges of Young Entrepreneurs". Administrative Sciences. 12 (1): 8. Doi:10.3390/admsci12010008. ISSN 2076-3387.^ Aga et al. (2015): SMEs, Age, and Jobs: A Review of the Literature, Metrics, and Evidence, World Bank Group, November 2015.
- ^ P.E. Petrakis, P.C. Kostis (2012), "The Role of Knowledge and Trust in SMEs", Journal of the Knowledge Economy, DOI: 10.1007/s13132-012-0115-6.
- ^ Kushnir (2010) A Universal Definition of Small Enterprise: A Procrustean bed for SMEs? World Bank
- ^ Gibson, T. van der Vaart, H.J. (2008): Defining SMEs: A Less Imperfect Way of Defining Small and Medium Enterprises in Developing Countries", Brookings Institution website, September 2008
- ^ a b Bank, European Investment (2021-11-18). Finance in Africa: for green, smart and inclusive private sector development. European Investment Bank. ISBN 978-92-861-5063-0.
- ^ a b c "Finance in Africa: for green, smart and inclusive private sector development". European Investment Bank. Retrieved 2021-12-06.
- ^ "MSME Finance Gap". SME Finance Forum. Retrieved 2021-12-20.^ "Eliminating Gender Disparities in Business Performance in Africa: Supporting Women-Owned Firms". World Bank. Retrieved 2021-12-20.
- ^ "World Bank SME Finance: Development news, research, data". World Bank. Retrieved 2021-12-20.
- ^ Central Bank Of Nigeria (March 30, 2010). "N200 BILLION SMALL AND MEDIUM ENTERPRISES CREDIT GUARANTEE

SCHEME(SMECGS)" (PDF). Central Bank of Nigeria. Retrieved December 9, 2017.
- ^ "Republic of South Africa, National Small Business Amendment Act" (PDF). www.thedti.gov.za. Retrieved 10 October 2015.^ Du Toit.Erasmus.& Strydom "Definition of small business" Introduction to business management, 7th Edition Oxford University Press,2009, p. 49
- ^ "Micro, Small and Medium Enterprises". Reserve Bank of India. Retrieved 9 May 2015.
- ^ "Indonesian Government Law No. 20 of 2008" (PDF). Commission for the Supervision of Business Competition. Retrieved 2 November 2017.
- ^ "Fact Sheet on New SME Anonymous (2016-07-05). "Entrepreneurship and Small and medium-sized enterprises (SMEs)". Internal Market, Industry, Entrepreneurship and SMEs – European Commission. Retrieved 2021-07-15.
- ^ Bank, European Investment (2022-01-27). EIB Activity Report 2021. European Investment Bank. ISBN 978-92-861-5108-8.
- ^ "Small and medium-sized enterprises | Fact Sheets on the European Union | European Parliament". www.europarl.europa.eu. Retrieved 2022-05-12.
- ^ "Two companies empower small businesses and grow together". European Investment Bank. Retrieved 2022-05-12.
- ^ "Europe's Small and Medium-sized Enterprises, Start-ups…". Renew Europe. Retrieved 2022-05-12.
- ^ "What is an SME? - Small and medium sized enterprises (SME) – Enterprise and Industry". Ec.europa.eu. Archived from the original on February 8, 2015. Retrieved 2015-06-12.
- ^ European Commission, Public consultation on the review of the SME definition, accessed 22 November 2019
- ^ European Commission (2003-05-06). "Recommendation 2003/361/EC: SME Definition". Archived from the original on 2015-02-08. Retrieved 2012-09-28.
- ^ Enterprise and Industry Publications: The new SME definition, user guide and model declaration, Extract of Article 2 of the Annex of Recommendation 2003/361/EC
- ^ "Consultations". European Commission – European Commission. Retrieved 2018-02-19.
- ^ Sommer, Lutz (28 November 2015). "Industrial revolution – industry 4.0: Are German manufacturing SMEs the first victims of this revolution?". Journal of Industrial Engineering and Management. 8 (5). Doi:10.3926/jiem.1470.
- ^ Hans-Heinrich Bass: KMU in der deutschen Volkswirtschaft: Vergangenheit, Gegenwart, Zukunft, Berichte aus dem Weltwirtschaftlichen Colloquium der Universität Bremen Nr. 101, Bremen 2006 Archived 2017-12-15 at the Wayback Machine (PDF; 96 kB)
- ^ "Small and medium-sized enterprises: an overview". Ec.europa.eu. Retrieved 2021-07-15.^ "Small and medium-sized enterprises: an overview". Ec.europa.eu. Retrieved 2021-07-15.
- ^ "Coronavirus (COVID-19): SME policy responses". OECD. Retrieved 2021-07-15.

- ^ D. Walczak, G. Voss, New Possibilities of Supporting Polish SMEs within the Jeremie Initiative Managed by BGK, Mediterranean Journal of Social Sciences, Vol 4, No 9, p. 760-761.
- ^ “Mid-sized businesses”. Gov.uk. Department of Business, Innovation and Skills. Retrieved 11 June 2015.
- ^ “Micro-entities, small and dormant companies”. GOV.UK.^ Groom, Brian (1 October 2015). “Brittelstand stymied by lack of growth and skills”. Financial Times. Retrieved 11 September 2020
- .^ “Bridging loans UK can be used for many purposes”. www.konnectfinancial.co.uk. Konnect Financial. Archived from the original on 11 October 2015. Retrieved 10 October 2015.
- ^ “Statistical Release: Business Population Estimates for the UK and Regions 2014” (PDF). Department for Business Innovation and Skills. 26 November 2014. Retrieved 9 May 2015.
- ^ “2010 to 2015 government policy: government buying”. 20 February 2013. Retrieved 9 May 2015.
- ^ a b (in French) Taille, forme juridique, secteurs, répartition régionale, Swiss Federal Statistical Office (page visited on 24 October 2017).
- ^ “T2 Corporation – Income Tax Guide – Chapter 4: Page 4 of the T2 return”. Canada Revenue Agency. Retrieved 27 April 2014.
- ^ “Equicapita May 2014 – Who Will Buy Baby Boomer Businesses?” (PDF).
- ^ United States Small Business Administration. “Size Standards”. Retrieved 2011-08-21.
- ^ “1321.0 – Small Business in Australia, 2001”. 23 October 2002. Retrieved 30 September 2015.
- ^ “AN INTRODUCTION TO FTAs (FREE TRADE AGREEMENTS)” (PDF). Small Business Association of Australia, 2015. Retrieved 29 March 2016. [permanent dead link]
- "Industry Foundation Classes (IFC)". buildingSMART. Retrieved 2021-12-21.
- ^ "Digital client demands scheme", Archived from the original.
- ^ "Sivua ei löydy". Senaatti.fi. 2015-10-23. Retrieved 2017-03-19.
- ^ Stephen Hamil (2012-07-02). "BIM, Construction and NBS: The End Of Babel - IFC promotional video". Constructioncode.blogspot.co.uk. Retrieved 2017-03-19.
- ^ "IFC Specifications Database". buildingSMART. Retrieved 2021-12-21.
- ^ "Welcome to". Buildingsmart-tech.org. Archived from the original on 2013-03-17. Retrieved 2017-03-19.
- ^ "IFC Formats". buildingSMART. Retrieved 2021-12-21.
- ^ a b c Grabowki, Ralf. "The Future of IFC: Enabling Partial BIM Model Exchange (June 8, 2020)". Upfront E-zine. Retrieved 8 June 2020.
- ^ "Start Page of IFC2x3 Final Documentation". Iai-tech.org. Archived from the original on 2011-03-24. Retrieved 2017-03-19.
- D. Asprone, A. Salzano, E. Cosenza, and G. Manfredi, “Building information modeling: nuove frontiere per l’ingegneria strutturale,” in Proceedings of Italian Concrete Days Gionate AICAP 2016 Congresso CTE, Rome, Italy, October 2016.View at: Google Scholar

- Z. Liu, F. Zhang, and J. Zhang, “The building information modeling and its use for data transformation in the structural design stage,” Journal of Applied Science and Engineering, vol. 19, no. 13, pp. 273–284, 2016.View at: Google Scholar
- C. Robinson, “Structural BIM: discussion, case studies and latest developments,” Structural Design of Tall and Special Buildings, vol. 16, no. 4, pp. 519–533, 2007.View at: Publisher Site | Google Scholar
- P. Smith, “BIM implementation—global strategies,” Procedia Engineering, vol. 85, pp. 482–492, 2014.View at: Publisher Site | Google Scholar
- S. Eleftheriadis, P. Duffour, P. Greening, J. James, B. Stephenson, and D. Mumovic, “Investigating relationships between cost and CO2 emissions in reinforced concrete structures using a BIM-based design optimisation approach,” Energy and Buildings, vol. 166, pp. 330–346, 2018.View at: Publisher Site | Google Scholar
- P. Sanguinetti, S. Abdelmohsen, J. Lee, J. Lee, H. Sheward, and C. Eastman, “General system architecture for BIM: an integrated approach for design and analysis,” Advanced Engineering Informatics, vol. 26, no. 2, pp. 317–333, 2012.View at: Publisher Site | Google Scholar
- U. Vitiello, V. Ciotta, A. Salzan, D. Asprone, G. Manfredi, and E. Consenza, “BIM-based approach for the cost-optimization of seismic retrofit strategies on existing buildings,” Automation in Construction, vol. 98, pp. 90–101, 2019.View at: Publisher Site | Google Scholar
- D. Zuppa, R. R. A. Issa, and P. C. Suermann, “BIM’s impact on the success measures of construction projects,” in Proceedings of International Workshop on Computing in Civil Engineering 2009, pp. 503–512, Austin, TX, USA, June 2009.View at: Publisher Site | Google Scholar
- BIM Forum Chile, Initial Guide to Implement BIM in Organizations, BIM Forum Chile, Santiago de Chile, Chile, 2017.
- R. F. Herrera, F. Muñoz, C. Vargas, and M. Antio, “Use and impact of nD models as a tool for project management in the architecture, engineering and construction industry,” Información Tecnológica, vol. 28, no. 4, pp. 169–178, 2017, in Spanish.View at: Publisher Site | Google Scholar
- C. M. Eastman, Y. Jeong, R. Sacks, and I. Kaner, “Exchange model and exchange object concepts for implementation of national BIM standards,” Journal of Computing in Civil Engineering, vol. 24, no. 1, pp. 25–34, 2010.View at: Publisher Site | Google Scholar
- S. P. Ho, H. P. Tserng, and S. H. Jan, “Enhancing knowledge sharing management using BIM technology in construction,” The Scientific World Journal, vol. 2013, Article ID 170498, 10 pages, 2013.View at: Publisher Site | Google Scholar
- D. J. Harrington, “BIM implementation standards at the firm level,” in Proeedings of Structural Congress ASCE, pp. 1645–1651, EEUU, Orlando, FL, USA, May 2010.View at: Google Scholar
- Z. Pezeshki and S. A. S. Ivari, “Applications of BIM: a brief review and future outline,” Archives of Computational Methods in Engineering, vol. 25, no. 2, pp. 273–312, 2016.View at: Publisher Site | Google Scholar

- Z. Xu, T. Huang, B. Li, H. Li, and Q. Li, "Developing an IFC-based database for construction quality evaluation," Advances in Civil Engineering, vol. 2018, Article ID 3946051, 22 pages, 2018.View at: Publisher Site | Google Scholar
- BIM committee UK, AEC (UK) BIM Technology Protocol, BIM committee UK, High Wycombe, UK, 2015.
- Penn State University, Project Execution Planning guide, Penn State University, State College, PA, USA, 2011.
- C. Eastman, P. Teicholz, R. Sacks, and K. Liston, BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, John Wiley & Sons, Hoboken, NJ, USA, 2nd edition, 2011.
- P. Coates, Y. Arayici, K. Koskela, M. Kagioglou, C. Usher, and O. Reilly, "The key performance indicators of the BIM implementation process," in Proceedings of the International Conference on Computing in Civil and Building Engineering (ICCCBE'10), Nottingham, UK, June-July 2010.View at: Google Scholar
- T. Hartmann, H. van Meerveld, N. Vossebeld, and A. Adriaanse, "Aligning building information model tools and construction management methods," Automation in Construction, vol. 22, pp. 605–613, 2012.View at: Publisher Site | Google Scholar
- D. Migilinskas, V. Popov, V. Juocevicius, and L. Ustinovichius, "The benefits, obstacles and problems of practical BIM implementation," Procedia Engineering, vol. 57, pp. 767–774, 2013.View at: Publisher Site | Google Scholar
- Tomek and P. Matějka, "The impact of BIM on risk management as an argument for its implementation in a construction Company," Procedia Engineering, vol. 85, pp. 501–509, 2014.View at: Publisher Site | Google Scholar
- M. Tveit and K. Gjerde, "Using building information modelling for planning a high-speed rail project in Norway," Proceedings of the Institution of Civil Engineers-Civil Engineering, vol. 171, no. 3, pp. 121–128, 2018.View at: Publisher Site | Google Scholar
- F. Meng, T. Shi, and B. Liu, "Research on BIM application in high-speed railway OSC operation maintenance management," in Proceedings of the 3rd International Conference on Electrical and Information Technologies for Rail Transportation (EITRT 2017), vol. 483, pp. 853–860, Changsha, China, October 2017.View at: Google Scholar
- Building Information Council–BIR, BIR Leaflet Number 3 BIM Roles and Competences, Building Information Council, Rotterdam, Netherlands, 2015, https://www.bouwinformatieraad.nl/main.php?mode=download_cat&cat_id=9.
- S. Eleftheriadis, D. Mumovic, P. Greening, and A. Chronis, "BIM enabled optimisation optimisation framework for environmentally responsible and structurally efficient design systems," in Proceedings of the 32nd International Symposium on Automation and Robotics in Construction and Mining: Connected to the Future, Oulu, Finland, June 2015.View at: Google Scholar
- F. Hevia, "Required hardware for revit," 2012, in Spanish, https://bimchile.wordpress.com.View at: Google Scholar
- Sánchez, "System requirements and recommendations for REVIT®," 2016, in Spanish, https://www.espaciobim.com.View at: Google Scholar

- D. Wang, J. Fan, H. Fu, and B. Zhang, "Research on optimization of big data construction engineering quality management based on RNN-LSTM," Complexity, vol. 2018, Article ID 9691868, 16 pages, 2018.View at: Publisher Site | Google Scholar
- R. A. Kivits and C. Furneaux, "BIM: enabling sustainability and asset management through knowledge management," The Scientific World Journal, vol. 2013, Article ID 983721, 14 pages, 2013.View at: Publisher Site | Google Scholar
- E. Focael, "Optimization of the bidding process of public constructions, through the use of discreet events simulation and building information modeling, under an environment of extreme collaboration," Proyecto FONDECIT Regular, 2017, in Spanish.View at: Google Scholar
- Plan BIM Comité de transformación Digital CORFO, BIM Roles and BIM Roles Matrix, CORFO, Santiago, Chile, 2017.
- Bazjanac, V. and Crawley, D.B. (1997) The implementation of Industry Foundation Classes in simulation tools for the building industry – http://www.inive.org/members_area/medias/pdf/Inive/IBPSA/UFSC585.pdf (accessed: 6 February 2012)
- ^ a b A/E/C Industry Alliance for Interoperability Links Building Industry Professions AT&T, Carrier Corp. Honeywell, Inc. and HOK Among Founding Members. 17 April 1995. http://www.thefreelibrary.com/A%2FE%2FC+Industry+Alliance+for+Interoperability+Links+Building+Industry...-a016817760 (accessed: 6 February 2012; archived)
- ^ Amor, Robert (1997) Product Models in Design and Engineering, Building Research Establishment, UK
- ^ Graphisoft joins industry alliance for interoperability, 6 August 1996 – http://www.graphisoft.com/community/press_zone/iai.html.html (accessed: 6 February 2012)
- ^ Drogemuller, Robin (2009) Can B.I.M be civil? Queensland Roads(7). Pp. 47-55 – http://eprints.qut.edu.au/27991/1/27991.pdf (accessed: 6 February 2012)
- ^ a b Eastman, Charles M. and Eastman, Chuck (2008) BIM handbook: a guide to building information modeling for owners, managers, designers, engineers, and contractors John Wiley & Sons, pp.72-73
- BuildingSMART chapters
- "Stowarzyszenie buildingSMART Polska oddziałem międzynarodowej organizacji buildingSMART buildingSMART Polska". 7 June 2019.^
- "BIM Alliance & buildingSMART UK&I Chapter announce a merger". BIM Today. 30 October 2017. Retrieved 8 February 2018.^
- "UK BIM Alliance releases FAQs on merger with buildingSMART UK&I". BIM Today. 11 January 2018. Retrieved 8 February 2018
- ^ "Hiroshi Watanabe". Waseda University. Retrieved 3 May 2022.
- ^ "Kohtaro Asai". IEEE Xplore. Retrieved 3 May 2022.
- ^ "Two Sony Engineers Honored with METI's Industrial Standardization Awards". Sony. 1 October 2020. Retrieved 3 May 2022.

- ^ a b "MPEG Systems Wins Two More Technology & Engineering Emmy Awards". MPEG. 21 January 2022.
- ^ a b Gasiorowski-Denis, Elizabeth (27 April 2022). "Record-Breaking MPEG Takes Two Emmy Awards". International Organization for Standardization.
- ^ ISO (2012), "ISO/IEC JTC 1/SC 27 Security Techniques", ISO/IEC JTC1 Standing Document N 2
- ^ Karmasin, Matthias (2013). Diehl, Sandra (ed). Media Convergence and Management. New York. p. 208. ISBN 9783642361630.
- ^ "ISO/IEC Awarded Emmy for JPEG, MPEG-1 and MPEG-2". 2000-04-03. Archived from the original on 2013-12-31. Retrieved 2013-10-11.
- ^ a b "Outstanding Achievement in Technical/Engineering Development Awards" (PDF). National Academy of Television Arts & Sciences. 2011-01-19. Archived from the original (PDF) on 2013-10-08. Retrieved 2013-10-17.
- ^ "Second Emmy Award for ISO/IEC MPEG-4 AVC Standard". ISO. 2009-03-18. Retrieved 2013-10-17.
- ^ "IEC and ISO Win Emmy for MPEG Standards". ANSI. 1 April 2009. Retrieved 2013-10-17.
- ^ ISO (26 August 2008). "Revolutionary Video Standard Receives Emmy Award". Quality Digest. Retrieved 2013-10-17.
- ^ "MPEGIF Congratulates JVT on Its 2008 Primetime Emmy Engineering Award and Announces Inclusion of MPEG-4 AVC/H.264 High Profile in the MPEGIF Logo Qualification Program". Business Wire. 2008-09-11. Retrieved 2013-10-17.
- ^ Tribbey, Chris (2008-08-13). "Joint Video Team to Receive Emmy". Home Media Magazine. Retrieved 2013-10-18.
- ^ "Emmy for MPEG-2 Transport Stream Standard". Fraunhofer HHI. 7 February 2014.
- ^ "69th Engineering Emmy Awards Recipients Announced". Academy of Television Arts & Sciences. 27 September 2017.
- ^ Naden, Clare (24 October 2019). "ISO, IEC and ITU's Committee for JPEG Receives Emmy Award". ISO.
- ^ "ISO and IEC Experts Win Prestigious Emmy Award". ISO. 1 February 2021.
- ^ "73rd Award Recipients". National Academy of Television Arts & Sciences. 26 January 2022.
- ^ "ISO/IEC JTC 1/SC 29". ISO. Retrieved 2021-05-15.
- ^ "Future of SC 29 with JPEG and MPEG". ISO/IEC JTC 1. 24 June 2020. Retrieved 3 May 2022.
- ^ ISO. "ISO/IEC JTC 1/SC 29". Retrieved 2013-10-11.
- ^ a b Asai, Kohtaro; Watanabe, Shinji (10 October 2012). Business Plan for JTC 1/SC 29 (PDF) (Business Plan). Retrieved 11 October 2013.
- ^ ISO/IEC JTC 1/SC 29 (17 September 2013). "L-Members". Archived from the original on 31 December 2013. Retrieved 11 October 2013.
- ^ "ISO/IEC JTC 1/SC 29 Liaisons". ISO. Retrieved 15 July 2015.
- ^ ISO. "III. What Help Can I Get from the ISO Central Secretariat?". ISO Membership Manual (PDF). ISO. pp. 17–18. Retrieved 2013-07-12.
- ^ ISO. "Standards Catalogue: ISO/IEC JTC 1/SC 29". Retrieved 2013-10-11.

- ^ ISO/IEC. "Freely Available Standards". Retrieved 2013-10-11.
- ^ ISO/IEC JTC 1/SC 29 (2013-10-02). "Programme of Work Allocated to SC 29/WG 1". Archived from the original on 2013-12-31. Retrieved 2013-10-11.
- ^ ISO/IEC JTC 1/SC 29 (2013-10-10). "Programme of Work Allocated to SC 29/WG 11". Archived from the original on 2013-12-31. Retrieved 2013-10-11.
- ^ ISO (2011-09-22). "ISO/IEC 10918-1". Retrieved 2013-10-11.
- ^ ISO (2013-04-26). "ISO/IEC 10918-5:2013". Retrieved 2013-10-11.
- ^ ISO (2010-06-17). "ISO/IEC 11544:1993". Retrieved 2013-10-18.
- ^ ISO (2009-12-17). "ISO
- Top of Form
- AIA (2007). Integrated Project Delivery: A Guide. [ebook] Available at: https://www.aia.org/resources/64146-integrated-project-delivery-a-guide [Accessed 2 Apr. 2019].
- Darrington, J. and Lichtig, W. (2018). Integrated Project Delivery: Aligning Project Organization, Operating System and Commercial Terms. [ebook] Available at: Construction Management https://www.dpr.com/assets/case-studies/IPD-Whitepaper_2018-2.pdf [Accessed 3 Apr. 2019].
- Laurent, J. (2017). Cross-Functional Project Teams in Construction: A Case Study. Masters. Pennsylvania State University.
- MacLeamy, P. (2004) Collaboration, integrated information and the project lifecycle in building design, construction and operation.
- Moylan, W. & Arafah, N (2017) Integrated Project Delivery: Complicated Collaboration or Improbable Panacea.
- Kent, David, C., & Burcin Becerik-Gerber Understanding Construction Industry Experienceand Attitudes Toward Integrated Project Delivery. ASCE Journal of Construction, Engineering and Management 136, no.8 (2010):815-825.
- Pelberg, Brian E. (2009). Contracting for Integrated Project Delivery: ConsensusDocs, presented to The 48th Annual Meeting of Invited Attorneys, Victor O. Schinnerer & Company, Inc.
- AIA (2007). Integrated Project Delivery: A Guide. [ebook] Available at: https://www.aia.org/resources/64146-integrated-project-delivery-a-guide [Accessed 2 Apr. 2019].
- Darrington, J. and Lichtig, W. (2018). Integrated Project Delivery: Aligning Project Organization, Operating System and Commercial Terms. [ebook] Available at: Construction Management https://www.dpr.com/assets/case-studies/IPD-Whitepaper_2018-2.pdf [Accessed 3 Apr. 2019].
- Laurent, J. (2017). Cross-Functional Project Teams in Construction: A Case Study. Masters. Pennsylvania State University.
- MacLeamy, P. (2004) Collaboration, integrated information and the project lifecycle in building design, construction and operation.
- Moylan, W. & ArafaAIA (2007). Integrated Project Delivery: A Guide. [ebook]
- Available at: https://www.aia.org/resources/64146-integrated-project-delivery-a-guide [Accessed 2 Apr. 2019].
- Darrington, J. and Lichtig, W. (2018). Integrated Project Delivery: Aligning Project Organization, Operating System and Commercial Terms. [ebook]

Available at: Construction Management https://www.dpr.com/assets/case-studies/IPD-Whitepaper_2018-2.pdf [Accessed 3 Apr. 2019].
- Laurent, J. (2017).
- Cross-Functional Project Teams in Construction: A Case Study. Masters. Pennsylvania State University.MacLeamy, P. (2004)
- Collaboration, integrated information and the project lifecycle in building design, construction and operation.
- Moylan, W. & Arafah, N (2017) Integrated Project Delivery: Complicated Collaboration or Improbable Panacea.Kent, David, C., & Burcin Becerik-Gerber Understanding Construction Industry Experienceand Attitudes Toward Integrated Project Delivery.
- ASCE Journal of Construction, Engineering and Management 136, no.8 (2010):815-825.Pelberg, Brian E. (2009). Contracting for Integrated Project Delivery: ConsensusDocs, presented to The 48th Annual Meeting of Invited Attorneys, Victor O. Schinnerer & Company, Inc.
- Kent, David, C., & Burcin Becerik-Gerber Understanding Construction Industry Experienceand Attitudes Toward Integrate
- Pelberg, Brian E. (2009). Contracting for Integrated Project Delivery: ConsensusDocs, presented to The 48th Annual Meeting of Invited Attorneys, Victor O. Schinnerer & Company, Inc.
- Eastman, Charles; Fisher, David; Lafue, Gilles; Lividini, Joseph; Stoker, Douglas; Yessios, Christos (September 1974). An Outline of the Building Description System. Institute of Physical Planning, Carnegie-Mellon University. Archived from the original on 13 December 2013. Retrieved 13 December 2013.
- ^ a b Eastman, Chuck; Tiecholz, Paul; Sacks, Rafael; Liston, Kathleen (2008). BIM Handbook: a Guide to Building Information Modeling for owners, managers, designers, engineers, and contractors (1st ed.). Hoboken, New Jersey: John Wiley. pp. xi–xii. ISBN 9780470185285.
- ^ Eastman, Chuck; Tiecholz, Paul; Sacks, Rafael; Liston, Kathleen (2011). BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors (2nd ed.). Hoboken, New Jersey: John Wiley. pp. 36–37.
- ^ a b Miller, Kasper (January–February 2022). "Exploring BIM's hidden past". AEC Magazine. Retrieved 9 February 2022.
- ^ Laiserin, J. (2003) "LaiserinLetterLetters Archived 2017-08-02 at the Wayback Machine" (see Laiserin's comment to letter from John Mullan), The Laiserin Letter, 6 January 2003.
- ^ "Prince Philip Medal for engineer behind revolution in Building Information Modelling (22 June 2016)". Royal Academy of Engineering. RAEng. Archived from the original on 25 June 2016. Retrieved 22 July 2016.
- ^ Laiserin, J. (2003) "Graphisoft on BIM Archived 2017-07-04 at the Wayback Machine", The Laiserin Letter, 20 January 2003.
- ^ a b Lincoln H. Forbes, Syed M. Ahmed, (2010) Modern Construction: Lean Project Delivery and Integrated Practices, CRC Press.

- ^ Cinti Luciani, S. Garagnani, R. Mingucci (2012) "BIM tools and design intent. Limitations and opportunities", in K. Kensek, J. Peng, Practical BIM 2012 - Management, Implementation, Coordination and Evaluation, Los Angeles
- ^ Quirk, Vanessa (7 December 2012). "A Brief History of BIM". Arch Daily. Archived from the original on 14 October 2017. Retrieved 14 July 2015.
- ^ M. Dobelis (2013), "Drawbacks of BIM concept adoption", in the 12th International Conference on Engineering Graphics, BALTGRAF 2013, 5–7 June 2013, Riga, Latvia
- ^ In Appendix 6: Letter to the author, p. 281, Ingram, Jonathan (2020). Understanding BIM: The Past, Present and Future. Abingdon: Routledge. ISBN 9780367244187...
- ^ Ruffle S. (1986) "Architectural design exposed: from computer-aided-drawing to computer-aided-design" Environments and Planning B: Planning and Design 1986 March 7 pp 385-389. Abstract
- ^ Aish, R. (1986) "Building Modelling: The Key to Integrated Construction CAD" CIB 5th International Symposium on the Use of Computers for Environmental Engineering related to Building, 7–9 July.
- ^ cited by Laiserin, Jerry (2008), Foreword to Eastman, C., et al (2008), op cit, p.xii
- ^ Van Nederveen, G.A.; Tolman, F.P. (1992). "Modelling multiple views on buildings". Automation in Construction. 1 (3): 215–24. doi:10.1016/0926-5805(92)90014-B.
- ^ a b Day, Martyn (February 2022). "What next for AEC software?". AEC Magazine. Retrieved 25 February 2022.
- ^ "Autodesk (2002). Building Information Modeling. San Rafael, CA, Autodesk, Inc" (PDF). laiserin.com. Archived (PDF) from the original on 14 July 2015. Retrieved 8 April 2014.
- ^ Laiserin, J. (2002) "Comparing Pommes and Naranjas Archived 2017-07-29 at the Wayback Machine", The Laiserin Letter, 16 December 2002.
- ^ Laiserin, J. (2003) "The BIM Page Archived 2015-07-08 at the Wayback Machine", The Laiserin Letter.
- ^ Laiserin, in his foreword to Eastman, et al (2008, op cit) disclaimed he had coined the term, adding "it is my opinion that the historical record ... shows that Building Information Modeling was not an innovation attributable solely to any individual or entity." (p.xiii)
- ^ Gallaher, Michael P.; O'Connor, Alan C.; Dettbarn, John L.; Gilday, Linda T. (August 2004). Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry. National Institute of Standards and Technology. p. iv. doi:10.6028/NIST.GCR.04-867.
- ^ "SteelVis (aka CIS/2 Viewer)". NIST. NIST. Archived from the original on 19 June 2020. Retrieved 25 May 2020.
- ^ "IFC4 poised for wider reach as ISO 16739 launched" (PDF). IFC4 Special. BuildingSmart International. March 2013. Archived (PDF) from the original on 15 September 2020. Retrieved 25 May 2020.

- ^ East, E. William. "Construction Operation Building Information Exchange". USACE ERDC. Archived from the original on 8 April 2013. Retrieved 8 October 2012.
- ^ East, William. "Corps of Engineers Pilots COBie". Building Sciences Monthly e-Newsletter. NIBS. Archived from the original on 9 June 2015. Retrieved 8 October 2012.
- ^ "CERL's COBie is National Institute of Building Sciences Approved". Engineer Research & Development Center. ERDC. Archived from the original on 12 December 2012. Retrieved 8 October 2012.
- ^ East, Bill. "COBieLite: A lightweight XML format for COBie data". National Institute of Building Sciences. Archived from the original on 6 May 2013. Retrieved 27 April 2013.
- ^ "BS 1192-4:2014 Collaborative production of information. Fulfilling
- "BS 1192-4:2014 Collaborative production of information. Fulfilling employer's information exchange requirements using COBie. Code of practice". Archived from the original on 15 September 2020. Retrieved 26 May 2020.
- ^ "ISO releases new set of standards for BIM". Geospatial World. 23 January 2019. Archived from the original on 15 September 2020. Retrieved 25 May 2020.
- ^ "IEC 81346-12:2018 Abstract". Archived from the original on 15 September 2020. Retrieved 25 August 2020.
- ^ "ISO Standards under Development". Archived from the original on 10 August 2020. Retrieved 25 August 2020.
- ^ British Standards Institution (2019) BS EN ISO 19650: Organisation and digitisation of information about buildings and civil engineering works, including building information modelling - Information management using building information modelling, London: BSI
- ^ "Frequently Asked Questions About the National BIM Standard-United States - National BIM Standard - United States". Nationalbimstandard.org. Archived from the original on 16 October 2014. Retrieved 17 October 2014.
- ^ a b "4DBIM or Simulation-Based Modeling". structuremag.org. Archived from the original on 30 May 2012. Retrieved 9 January 2016.
- ^ a b "ASHRAE Introduction to BIM, 4Dand 5D". cadsoft-consult.com. Archived from the original on 3 April 2013. Retrieved 29 May 2012.
- ^ a b c Eastman, Chuck (August 2009). "What is BIM?". Archived from the original on 26 October 2019. Retrieved 24 January 2008.
- ^ a b McPartland, Richard (11 September 2017). "What is a federated Building Information Model?". NBS: Knowledge. NBS. Archived from the original on 15 September 2020. Retrieved 26 May 2020.
- ^ "Understanding BIM Wash". BIM Thinkspace. 6 June 2011. Retrieved 25 February 2012.
- ^ "Green-Washing and Cloud-Washing – Terms you must know relative to BIM – Not to mention BIM-Washing". buildinginformationmanagement.wordpress.com. 12 December 2011. Retrieved 25 February 2012.

- ^ *Will we have to get used to "BIM Washing"?
- ^ ISO 19650-1:2018, p. 3.3.15.
- ^ Archived 12 November 2009 at the Wayback Machine
- ^ "Senate Properties modeling guidelines". Gsa.gov. Archived from the original on 26 February 2012. Retrieved 17 October 2014.
- ^ Leite, Fernanda; Akcamete, Asli; Akinci, Burcu; Atasoy, Guzide; Kiziltas, Semiha (2011). "Analysis of modeling effort and impact of different levels of detail in building information models". Automation in Construction. 20 (5): 601–9. doi:10.1016/j.autcon.2010.11.027.
- ^ a b Smith, Deke (2007). "An Introduction to Building Information Modeling (BIM)" (PDF). Journal of Building Information Modeling: 12–4. Archived from the original (PDF) on 13 October 2011. Retrieved 25 January 2012.
- ^ Leite, Fernanda; Akinci, Burcu (2012). "Formalized Representation for Supporting Automated Identification of Critical Assets in Facilities during Emergencies Triggered by Failures in Building Systems". Journal of Computing in Civil Engineering. 26 (4): 519. doi:10.1061/(ASCE)CP.1943-5487.0000171.
- ^ Liu, Xuesong; Akinci, Burcu (2009). "Requirements and Evaluation of Standards for Integration of Sensor Data with Building Information Models". In Caldas, Carlos H.; O'Brien, William J. (eds.). Computing in Civil Engineering. pp. 95–104. doi:10.1061/41052(346)10. ISBN 978-0-7844-1052-3.
- ^ Maltese, Sebastiano; Tagliabue, Lavinia C.; Cecconi, Fulvio Re; Pasini, Daniela; Manfren, Massimiliano; Ciribini, Angelo L.C. (1 January 2017). "Sustainability Assessment through Green BIM for Environmental, Social and Economic Efficiency". Procedia Engineering. 180: 520–530. doi:10.1016/j.proeng.2017.04.211. ISSN 1877-7058.
- ^ "Ministry of Construction -- china.org.cn". www.china.org.cn. Archived from the original on 29 March 2018. Retrieved 9 December 2018.
- ^ "Ministry of Science and Technology of the People's Republic of China". www.most.gov.cn. Archived from the original on 6 December 2018. Retrieved 9 December 2018.
- ^ "Building Information Modelling | Hong Kong Housing Authority and Housing Department". Hong Kong Housing Authority. Retrieved 25 January 2022.
- ^ "About bSHK". Archived from the original on 29 January 2019. Retrieved 28 January 2019.
- ^ Government of the Hong Kong SAR (2017). "Adoption of Building Information Modelling for Capital Works Projects in Hong Kong" (PDF). Development Bureau. Archived (PDF) from the original on 8 November 2018. Retrieved 8 November 2018.
- ^ "Sawhney, Anil et al. (2014). State of BIM Adoption and Outlook in India (English). RICS School of the Built Environment, Amity University. Noida, Uttar Pradesh" (PDF). Archived (PDF) from the original on 15 December 2014. Retrieved 17 October 2014.
- ^ Haidar, Faizan (27 December 2019). "Government backs new tech to speed up infra work". The Economic Times. Archived from the original on 17 October 2020. Retrieved 15 October 2020.

- ^ "IRAN Building Information Modeling Association (IBIMA), Tehran, IRAN". Ibima.ir. Archived from the original on 21 October 2014. Retrieved 17 October 2014.
- ^ Hosseini, Reza; Azari, Ehsan; Tivendale, Linda; Chileshe, Nicholas. "Building Information Modeling (BIM) in Iran: An Exploratory Study (April 2016)". Researchgate. Retrieved 4 December 2016.
- ^ Hosseini, Reza; Azari, Ehsan; Tivendale, Linda; Chileshe, Nicholas. "Barriers to adoption of building information modeling (BIM) in Iran: Preliminary results (September 2016)". Researchgate. Retrieved 4 December 2016.
- ^ CITP. "CITP". www.citp.my. Archived from the original on 11 March 2016. Retrieved 12 February 2016.
- ^ BuildSmart Archived 2013-11-02 at the Wayback Machine (BCA magazine), December 2011.
- ^ "Ministry of Land, Infrastructure, Transport and Tourism". www.mlit.go.jp. Archived from
- Scheer D. The Death of Drawing. Architecture in the Age of Simulation. 1st ed. New York: Imprint Routledge; 2014. p. 258. DOI: 10.4324/9781315813950
- 2.Bernstein PG, Pittman JH. Barriers to the adoption of building information modeling in the building industry. In: Autodesk Building Solutions Whitepaper. San Rafael, CA: Autodesk Inc.; 2005
- 3.Carmona J, Irwin K. BIM: Who, what, how and why. Building Operating Management. 2009. Available from: http://www.facilitiesnet.com/software/article/BIM-Who-What-How-and-Why–7546 [Accessed: August 21, 2009]
- 4.Azhar S. Building information Modeling (BIM): Trends, benefits, risks and challenges for the AEC. Leadership and Management in Engineering. 2011;11(3):241-252. DOI: 10.1061/(ASCE)LM.1943-5630.0000127
- 5.Pavan A, Giani M, Mirarchi C. BIM: metodi e strumenti Progettare, costruire e gestire nell'era digitale. 1st ed. Milan: Tecniche Nuove; 2017. p. 328
- 6.Osello A. Il futuro del disegno con il BIM per ingegneri e architetti. 1st ed. Palermo: Dario Falccovio Editore; 2012. p. 324
- 7.Dimyadi P, Parsanezhad J. Effective facility management and operations via a BIM-based integrated information system. In: CIB Facility Management Conference: CIB W070, W111 & W118: 21-23 May 2014. Copenhagen, Denmark; 2014. DOI: 10.13140/2122989764
- 8.Ashworth S, Carbonari G, Stravoravdis S. How Facility Management Can Use Buidling Information Modelling (BIM) to Improve the Decision Making Process. Technische Universität Wien Published; 2015. pp. 55-69. DOI: 10.34749/JFM20152120
- 9.Pavan A, Rota A, Mirarchi C, Romano A. I capitolati informativi con metodologia BIM. 1st ed. Milan: Tecniche Nuove; 2021. p. 232
- 10.Charef R, Alaka H, Emmitt S. Beyond the third dimension of BIM: A systematic review of literature and assessment of professional views. Journal of Building Engineering. 2018;19:242-257. DOI: 10.1016/j.jobe.2018.04.028
- 11.Mirarchi C, Spagnolo SL, Daniotti B, Pavan A. Structuring general information specifications for contracts in accordance with the UNI 11337:2017

standard. Digital Transformation of the Design, Construction and Management Processes of the Built Environment. 2019:103-112. DOI: 10.1007/9783030335700-0_10
- 12.Borin P, Zanchetta C. IFC–Processi e modelli digitali openBIM per l'ambiente costruito. 1nd ed. Vol. 194. Palermo: Milan: Maggioli Editore; 2020
- 13.Lupica Spagnolo S, Amosso G, Pavan A, Daniotti B. In: Daniotti B, Gianinetto M, Della Torre S, editors. BIMReL: The Interoperable BIM Library for Construction Products Data Sharing, in Digital Transformation of the Design, Construction and Management Processes of the Built Environment. Cham: Springer; 2020. pp. 37-47
- 14.Build up, Digitalization in the construction industry. 2019. Available from: https://www.buildup.eu/en/news/overview-digitalisation-construction-industry
- 15.Lupica Spagnolo S. Information integration for asset and maintenance management. In: Integrating Information in Built Environments. From Concept to Practice. Routledge: Taylor& Francis Group; 2017. pp. 133-149
- Boje C, Guerriero A, Kubicki S, Rezgui Y. Towards a semantic construction digital twin: Directions for future research. Automation in Construction. 2020;114:103179
- 17.Centre of Digital Built Britain. The Gemini Principles. 2018
- 18.Batty M. Digital twins. Environment and Planning B: Urban Analytics and City Science. 2018;45:817-820
- 19.El Jazzar M, Piskernik M, Nassereddine H. Digital twin in construction: An empirical analysis. In: EG-ICE 2020 Workshop on Intelligent Computing in Engineering, Proceedings. 2020. pp. 501-510
- 20.Camposano JC, Smolander K, Ruippo T. Seven metaphors to understand digital twins of built assets. IEEE Access. 2021;9:27167-27181
- 21.Mathupriya S, Saira Banu S, Sridhar S, Arthi B. Digital twin technology on IoT, industries & other smart environments: A survey. Materials Today: Proceedings. In press
- 22.Sacks R, Brilakis I, Pikas E, Xie HS, Girolami M. Construction with digital twin information systems. Data-Centric Engineering. 2020;1:e14
- 23.Errandonea I, Beltrán S, Arrizabalaga S. Digital twin for maintenance: A literature review. Computers in Industry. 2020;123:103316
- 24.Fuller A, Fan Z, Day C, Barlow C. Digital twin: Enabling technologies, challenges and open research. IEEE Access. 2020;8:108952-108971
- 25.Jafari MA, Zaidan E, Ghofrani A, Mahani K, Farzan F. Improving building energy footprint and asset performance using digital twin technology. IFAC-PapersOnLine. 2020;53(3):386-391
- 26.European Commission, Renovation Wave: Doubling the Renovation Rate to Cut Emissions, Boost Recovery and Reduce Energy Poverty, 2020
- 27.BPIE. The European renovation wave: From words to action. 2020
- 28.European Commission, A Renovation Wave for Europe–greening our buildings, creating jobs, improving lives. 2020
- 29.IET and NTU. Scaling Up Retrofit 2050. 2018

- 30.S. D'Oca, A. Ferrante, C. Ferrer, R. Pernetti, A. Gralka, R. Sebastian, P. o. t. Veld, Technical, Financial, and Social Barriers and Challenges in Deep Building Renovation: Integration of Lessons Learned from the H2020 Cluster Projects. Buildings, MDPI, Switzerland; 2018. pp. 1-25
- 31.ECSO, Digitalisation in the Construction Sector. 2021
- 32.European Commission. Building information modelling adapted to efficient renovation (RIA). 2018
- 33.Daniotti B, Bolognesi CM, Spagnolo SL, Pavan A, Signorini M, Ciuffreda S, et al. An Interoperable BIM-Based Toolkit for Efficient Renovation in Buildings. Buildings, MDPI, Switzerland; 2021. pp. 1-16
- 34.Building Information Modelling based tools & technologies for fast and efficient RENovation of residential buildings|BIM4REN Project. 2018. 1-9
- 35.Harmonised Building Information Speedway for Energy-Efficient Renovation|BIM-SPEED Project. 2018. 1-8
- 36.BIM-based holistic tools for Energy driven Renovation of existing Residences|BIMERR
- ENergy aware BIM Cloud Platform in a COst-effective Building REnovation Context|ENCORE Project. 2019. 1-6
- 38.Service Platform to Host and SharE REsidential data|SPHERE Project. 2018. 1-9
- 39.Alonso R, Borras M, Koppelaar RHEM, Lodigiani A, Loscos E, Yöntem E. SPHERE: BIM digital twin platform. Proceedings. 2019;20:9
- Max J. Egenhofer (2002). Geographic Information Science: Second International Conference, GIScience 2002, Boulder, CO, USA, September 25–28, 2002. Proceedings. Springer Science & Business Media. p. 110. ISBN 978-3-540-44253-0.
- ^ Building def. 2. Whitney, William Dwight, and Benjamin E. Smith. The Century dictionary and cyclopedia. vol. 1. New York: Century Co., 1901. 712. Print.
- ^ Structure. def. 2. Merriam-Webster's dictionary of synonyms: a dictionary of discriminated synonyms with antonyms and analogous and contrasted words... Springfield, Mass: Merriam-Webster, 1984. 787. Print.
- ^ Building. def 1. Sturgis, Russell. A dictionary of architecture and building: biographical, historical, and descriptive. vol. 1. New York: The Macmillan Co.; 1901. 2236. Print.
- ^ Paul Francis Wendt and Alan Robert Cerf (1979), Real estate investment analysis and taxation, McGraw-Hill, p. 210
- ^ Rob Dunn (Aug 23, 2014). "Meet the lodgers: Wildlife in the great indoors". New Scientist: 34–37. Archived from the original on 2014-11-29.
- ^ Pace, Anthony (2004). "Tarxien". In Daniel Cilia (ed.). Malta before History – The World's Oldest Free Standing Stone Architecture. Miranda Publishers. ISBN 978-9990985085.
- ^ "plans to convert housing complex". Archived from the original on 2017-01-10. Retrieved 2017-02-23.
- ^ "isye building complex". Archived from the original on 2017-01-03.

- ^ "Building Damage". Pb.unimelb.edu.au. Archived from the original on 2014-02-14. Retrieved 2014-08-22.
- ^ Bru, G.; Herrera, G.; Tomás, R.; Duro, J.; Vega, R. De la; Mulas, J. (2013-02-01). "Control of deformation of buildings affected by subsidence using persistent scatterer interferometry". Structure and Infrastructure Engineering. 9 (2): 188–200. doi:10.1080/15732479.2010.519710. ISSN 1573-2479. S2CID 110521863.
- ^ Soldato, Matteo Del; Bianchini, Silvia; Calcaterra, Domenico; Vita, Pantaleone De; Martire, Diego Di; Tomás, Roberto; Casagli, Nicola (2017-07-12). "A new approach for landslide-induced damage assessment" (PDF). Geomatics, Natural Hazards and Risk. 8 (2): 1524–1537. doi:10.1080/19475705.2017.1347896. ISSN 1947-5705. S2CID 73697187.
- ^ Brotóns, V.; Tomás, R.; Ivorra, S.; Alarcón, J. C. (2013-12-17). "Temperature influence on the physical and mechanical properties of a porous rock: San Julian's calcarenite". Engineering Geology. 167 (Supplement C): 117–127. doi:10.1016/j.enggeo.2013.10.012.
- Webster, Fredrick (1991) „Industrial Marketing Strategy“, Third Edition, John Wiley & Sons
- ^ Bonoma & Shapiro (1984) Segmenting Industrial Markets, Lexington Books.
- ^ Kalafatis, Stavros & Cheston, Vicki (1997), „Normative Models and Practical Applications of Segmentation in Business Markets“, Industrial Marketing Management 26, Elsevier
- ^ Parasuraman, A., 1980. Vendor segmentation: An additional level of market segmentation. Industrial Marketing Management, 9, 59-62.
- ^ Kraljic, P., 1983. Purchasing must become supply management. Harvard Business Review, (September/October), 109-117.
- ^ Dyer, J.H., Cho, D.S. and Chu, W., 1998. Strategic supplier segmentation: the next 'best practice' in supply chain management. California Management Review, 40 (2), 57-77.
- ^ Olsen, R.F. and Ellram, L.M., 1997. A portfolio approach to supplier relationships. Industrial Marketing Management, 26 (2), 101-13.
- ^ Bensaou, B.M., 1999. Portfolios of buyer-supplier relationships. Sloan Management Review, summer, 35-44.
- ^ Kaufman, A., Wood, C.H. and Theyel, G., 2000. Collaboration and technology linkages: a strategic supplier typology. Strategic Management Journal, 21, 649-663.
- ^ van Weele, A.J., 2000. Purchasing and Supply Chain Management, Business Press, Thomson Learning, London.
- ^ Hallikas, J., Puumalainen, K., Vesterinen, T. and Virolainen, V.M., 2005. Risk-based classification of supplier relationships. Journal of Purchasing & Supply Management, 11, 72–82.
- ^ Rezaei, J., and Ortt, R. (2012). A multi-variable approach to supplier segmentation. International Journal of Production Research, 50(16), 4593-4611
- R. E. Chapman, D. T. Butry, and A. L. Huang, "Measuring and improving U.S. construction productivity," 2010, https://www.nist.gov/publications/measuring-and-improving-us-construction-productivity.View at: Google ScholarM.

- R. Miller, Ed.in The Commercial Real Estate Revolution: Nine Transforming Keys to Lowering Costs, Cutting Waste, and Driving Change In a Broken Industry, Wiley, Hoboken, NJ, USA, 2009
- P. Teicholz, "Labor productivity declines in the construction industry: causes and remedies," AECbytes Viewpoint, vol. 4, no. 14, 2004.View at: Publisher Site | Google ScholarS.
- Seyis, "Pros and cons of using building information modeling in the AEC industry," Journal of Construction Engineering and Management, vol. 145, no. 8, Article ID 04019046, 2019.View at: Publisher Site | Google ScholarGeneral Services Administration, GSA Building Information Modeling Guide Series 01—Overview, General Services Administration, Washington, DC, USA, 2007.S.
- Alizadehsalehi, A. Hadavi, and J. C. Huang, "From BIM to extended reality in AEC industry," Automation in Construction, vol. 116, Article ID 103254, 2020.View at: Publisher Site | Google ScholarR.
- Ayman, Z. Alwan, and L. McIntyre, "BIM for sustainable project delivery: review paper and future development areas," Architectural Science Review, vol. 63, no. 1, pp. 15–33, 2020.View at: Publisher Site | Google Scholar
- J. Wu and J. Zhang, "New automated BIM object classification method to support BIM interoperability," Journal of Computing in Civil Engineering, vol. 33, no. 5, Article ID 04019033, 2019.View at: Publisher Site | Google Scholar
- Autodesk, Inc., Autodesk Building Industry Solutions: Building Information Modeling (White Paper), Autodesk, Inc, San Rafael, CA, USA, 2002.
- S. Azhar, M. Hein, and B. Sketo, in Building Information Modeling (BIM): Benefits, Risks and Challenges, Auburn Univercity, Auburn, Alabama, 2007.
- C. M. Eastman, Ed.in BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors, Wiley, Hoboken, NJ, USA, 2008.T. L. McCuen, P. C. Suermann, and M. J. Krogulecki, "Evaluating award-winning BIM projects using the national building information model standard capability maturity model," Journal of Management in Engineering, vol. 28, no. 2, pp. 224–230, 2012.
- View at: Publisher Site | Google ScholarNIBS, United States National Building Information Modeling Standard Version 1—Part1: Overview, Principles, and Methodologies, National Institute of Building Sciences, Washington, DC, USA, 2007.Indiana University, Building Information Modeling Guidelines and Standards Forarchitects Engineers and Contractors, University Architect's Office, Bloomington, IN, USA, 2009
- .B. Succar, "Building information modelling framework: a research and delivery foundation for industry stakeholders," Automation in Construction, vol. 18, no. 3, pp. 357–375, 2009.View at: Publisher Site | Google Scholar
- R. Sebastian and L. van Berlo, "Tool for benchmarking BIM performance of design, engineering and construction firms in The Netherlands," Architectural Engineering and Design Management, vol. 6, no. 4, pp. 254–263, 2010.View at: Publisher Site | Google Scholar

- J. Messner, "BIM planning guide for facility owners," in Computer Integrated Construction Research Program, The Pennsylvania State University, University Park, PA, USA, 2013.View at: Google Scholar
- B. Giel and R. R. A. Issa, "Framework for evaluating the BIM competencies of facility owners," Journal of Management in Engineering, vol. 32, no. 1, Article ID 04015024, 2016.View at: Publisher Site | Google Scholar
- J. Du, R. Liu, and R. R. A. Issa, "BIM Cloud score: benchmarking BIM performance," Journal of Construction Engineering and Management, vol. 140, no. 11, Article ID 04014054, 2014.View at: Publisher Site | Google Scholar
- C. Liang, W. Lu, S. Rowlinson, and X. Zhang, "Development of a multifunctional BIM maturity model," Journal of Construction Engineering and Management, vol. 142, no. 11, Article ID 06016003, 2016.View at: Publisher Site | Google Scholar
- Y. Chen, H. Dib, R. F. Cox, M. Shaurette, and M. Vorvoreanu, "Structural equation model of building information modeling maturity," Journal of Construction Engineering and Management, vol. 142, no. 9, Article ID 04016032, 2016.View at: Publisher Site | Google Scholar
- S. Siebelink, J. T. Voordijk, and A. Adriaanse, "Developing and testing a tool to evaluate BIM maturity: sectoral analysis in the Dutch construction industry," Journal of Construction Engineering and Management, vol. 144, no. 8, Article ID 05018007, 2018.View at: Publisher Site | Google Scholar
- H. Solli-Sæther and P. Gottschalk, "The modeling process for stage models," Journal of Organizational Computing & Electronic Commerce, vol. 20, no. 3, pp. 279–293, 2010.View at: Publisher Site | Google Scholar
- R. L. Nolan, "Managing the computer resource," Communications of the ACM, vol. 16, no. 7, pp. 399–405, 1973.View at: Publisher Site | Google ScholarR. L. Nolan, "Managing the crisis In data processing," Harvard Business Review, vol. 57, 1979.View at: Google Scholar
- J. V. de Carvalho, Á. Rocha, and J. B. de Vasconcelos, "Maturity models for hospital information systems management: are they mature?" in Innovation in Medicine and Healthcare 2015, Y.-W. Chen, C. Torro, S. Tanaka, R. J. Howlett, and L. C. Jain, Eds., Springer, New York, NY, USA, 2016.View at: Google Scholar
- P. Gottschalk, "Toward a model of growth stages for knowledge management technology in law firms," Informing Science: The International Journal of an Emerging Transdiscipline, vol. 5, pp. 079–093, 2002.View at: Publisher Site | Google Scholar
- W. Dai, M. Zhang, K. Wu, and Y. Hu, "Improved chaotic particle swarm optimization algorithm and valuation based on Nolan model thinking," Control and Decision, vol. 30, no. 12, pp. 2121–2128, 2015.View at: Publisher Site | Google Scholar
- o Duane and P. O'Reilly, "A conceptual stages of growth model for managing an organisation,s social media business profile (SMBP)," in
- Proceedings of the the Thirty Third International Conference on Information Systems (ICIS) "Digital Innovation in the Service Economy, Orlando, FL, USA, December 2012.View at: Google Scholar

- CMMI Product Team, Capability Maturity Model Integration (CMMI) Version 1.2 Overview, Software Engineering Institute, Los Angles, CA, USA, 2007.J. David Patón-Romero, M. T. Baldassarre, M. Rodríguez, and M. Piattini, “Maturity model based on CMMI for governance and management of Green IT,” IET Software, vol. 13, no. 6, pp. 555–563, 2019.View at: Publisher Site | Google Scholar
- CMMI Product Team, CMMI for Services, Version 1.3, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA, USA, 2010.D. Tilson, K. Lyytinen, and C. Sørensen, “Research commentary-digital infrastructures: the missing IS research agenda,” Information Systems Research, vol. 21, no. 4, pp. 748–759, 2010.View at: Publisher Site | Google Scholar
- P. Wang, S. Ge, N. Wang, Y. Pan, and N. Ren, “MIS 4.0 research for industrie 4.0,” Computer Integrated Manufacturing Systems, vol. 22, no. 07, pp. 1812–1820, 2016.View at: Publisher Site | Google Scholar
- J. Holmström, V. Singh, and K. Främling, “BIM as infrastructure in a Finnish HVAC actor network: enabling adoption, reuse, and recombination over a building life cycle and between projects,” Journal of Management in Engineering, vol. 31, no. 1, Article ID A4014006, 2015.View at: Publisher Site | Google Scholar
- o Succar, “Building information modelling maturity matrix,” Handbook of Research on Building Information Modeling and Construction Informatics, pp. 65–103, 2010.View at: Publisher Site | Google Scholar
- G. Yilmaz, A. Akcamete, and O. Demirors, “A reference model for BIM capability assessments,” Automation in Construction, vol. 101, pp. 245–263, 2019.View at: Publisher Site | Google Scholar
- ANDY K. D. WONG, FRANCIS K.W. WONG, and ABID NADEEM, COMPARATIVE ROLES OF MAJOR STAKEHOLDERS FOR THE IMPLEMENTATION OF BIM IN VARIOUS COUNTRIES. 2009, The Hong Kong Polytechnic University.
- Wong A.K.D., Wong F.K.W., and Nadeem A. Attributes of Building Information Modelling and its Development in Hong Kong. 2009.
- Chelson D, The effects of building information modeling on construction site productivity., inUniversity of Maryland. 2010, University of Maryland: Maryland.
- Chuck eastman, et al., BIM Handbook (A guide to building information modeling ...). 2011: Wiley & sons,Inc.
- Willem Kymmell, Building information modeling (planning and managing construction projects with 4D CAD and simulations). 2008: McGrow Hill.
- John Messner, et al., BIM Project Execution Planning Guide. 1'th edition ed. 2010: Pennsylvania State University.
- Hergunsel, M.F., BENEFITS OF BUILDING INFORMATION MODELING FOR CONSTRUCTION MANAGERS AND BIM BASED SCHEDULING. 2011, WORCESTER POLYTECHNIC INSTITUTE.

- Brad Hardin, BIM and Construction Management (Proven tools, methods, and workflows). 2009: Wiley.
- ANDY K. D. WONG, FRANCIS K.W. WONG, and ABID NADEEM, COMPARATIVE ROLES OF MAJOR STAKEHOLDERS FOR THE IMPLEMENTATION OF BIM IN VARIOUS COUNTRIES. 2009, The Hong Kong Polytechnic University.
- Wong A.K.D., Wong F.K.W., and Nadeem A. Attributes of Building Information Modelling and its Development in Hong Kong. 2009.
- Chelson D, The effects of building information modeling on construction site productivity., inUniversity of Maryland. 2010, University of Maryland: Maryland.
- Chuck eastman, et al., BIM Handbook (A guide to building information modeling ...). 2011: Wiley & sons,Inc.
- Willem Kymmell, Building information modeling (planning and managing construction projects with 4D CAD and simulations). 2008: McGrow Hill.
- John Messner, et al., BIM Project Execution Planning Guide. 1'th edition ed. 2010: Pennsylvania State University.
- Hergunsel, M.F., BENEFITS OF BUILDING INFORMATION MODELING FOR CONSTRUCTION MANAGERS AND BIM BASED SCHEDULING. 2011, WORCESTER POLYTECHNIC INSTITUTE.
- Brad Hardin, BIM and Construction Management (Proven tools, methods, and workflows). 2009: Wiley.
- Azhar.S,Michael Hein and B.Sketo. Mc Whorter School of Building Science,Auburn University.Building Information Modeling(BIM): Benefits, Risks and Challenges
- Azhar.S, Nadeem.A, Mok.N, Leung.Y, (2008), Building Information Modeling: A New Paradigm for Visual Interactive Modeling and Simulation for Construction Projects, First International Conference on Construction in Developing Countries (ICCIDC-I), Karachi, Pakistan
- Smith.D, (2007), An Introduction to Building Information Modeling (BIM), Journal of Building Information Modeling.
- Yonghong Chen, GuangbinWang. School of Economics and Management,Tongji University,Shanghai. 2013. Integrationof Construction Investment and Progress Control Based on BIM. Third International Conference on Intelligent System Design and Engineering Applications.
- Karen M. Kensek, Editor. July ٢٠١٢, Practical BIM ٢٠١٢, The Sixth Annual USC Symposium on Management, Implementation, Coordination, And Evaluation. School of Architecture University of Southern California.

With the aim of updating and upgrading the syllabus of engineering knowledge to advanced technical sciences and monitoring needs assessment, for the first time in the country, by writing a BIM reference book, we have opened a new perspective to the civilized engineering community and through this way to scientific and social purposes. Let's do it ourselves, the present book is the first brick of this magnificent building.

Dr. Abozar Shahpari

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