Applied Computing in Civil Engineering

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Another specific subset, infrastructure design, relies heavily on estimates of load, pressure, drainage and flow. Some software houses have attempted to provide design software catering for the variety of infrastructure design fields in an integrated manner. However, general-purpose software may be used in the same manner at a fraction of the cost of design software. When planning the construction phase, various project management methods are used to estimate factors such as cost, schedule and resourcing.

Different software packages rely on different formulas and theories as the basis for these calculations. Consulting engineers also take advantage of the insight software can provide as far as crossing services are concerned. A road design may have to accommodate the presence of underground pipes for example. Civil designer is an example of a design package which forms an integrated data gathering, drawing, surface modeling and design system for civil engineering infrastructure.

Computer-aided design (CAD)

Computer-aided design (CAD) is the use of computer systems to assist in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations.

Computer-aided design is used in many fields. Its use in designing electronic systems is known as electronic design automation, or EDA. In mechanical design it is known as mechanical design automation (MDA) or computer-aided drafting (CAD), which includes the process of creating a technical drawing with the use of computer software. CAD may be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) space. *4D or BIM is a type of virtual construction engineering simulation incorporating time or schedule related information for project management.*

AutoCAD

AutoCAD is a computer-aided drafting software program used for creating blueprints for buildings, bridges and computer chips. AutoCAD is used mainly by drafters, although engineers, surveyors and architects may need to use the software from time to time. It is available since 1982 as a desktop application and since 2010 as a mobile-web and cloud-based application marketed as AutoCAD 360. AutoCAD is developed and marketed by Autodesk, Inc. AutoCAD is used across a wide range of industries, by architects, project managers, engineers, graphic designers, and other professionals.

AutoCAD is a 2D and 3D computer-aided drafting software application used in architecture, construction and manufacturing to assist in the preparation of blueprints and other engineering plans. Professionals who use AutoCAD are often referred to as drafters. While drafters work in a number of specialties, the six most common specialization areas are mechanical drafting, architectural drafting, civil drafting, electrical drafting, electronics drafting and aeronautical drafting.

Building Information Modelling (BIM)

Building Information Modelling (BIM) is a very broad term that describes the process of creating a digital model of a building or other facility (such as a bridge, highway, tunnel and so on). The range of 'BIM maturity levels' that this form of modelling can take are categorised as:

- Level 0: Unmanaged CAD;
- Level 1: Managed CAD in 2D or 3D;
- Level 2: Managed 3D environment with data attached, but created in separate discipline models, and;
- Level 3: Single, online, project model with construction sequencing, cost and lifecycle management information.

At level 2, BIM is likely to comprise a series of federated building information models prepared by different design teams, and including non-graphical data and associated documentation.

Characteristics of BIM

Fundamentally, the purpose of BIM is to ensure that appropriate information is created in a suitable format at the right time so that better decisions can be made throughout the design, construction and operation of built assets. It is not about creating a 3D model for its own sake, and it is not an add-on process. BIM is fundamental to the way a project is set up and run.

It centres around the creation of employer's information requirements (EIR), which define the information that the employer wishes to procure, along with the actual building itself, in order to be able to develop and operate that building. Setting this out in a contract document ensures that appropriate information is created in a suitable format at the right time. The employer's information requirements is vital to the successful adoption of building information modelling.

The required information is then produced collaboratively by the supply chain of designers, contractors, and specialist suppliers in a common data environment using standard methods and procedures.

Very broadly, building information that might be required is categorised as:

- 2D;
- 3D;
- 4D (including time / programme information);
- 5D (including cost information), and;
- 6D (including facilities management information).

The common data environment (CDE), is the single source of information for the project, used to collect, manage and disseminate documentation, the graphical model and non-graphical data for the whole project team. Creating this single source of information facilitates

collaboration between project team members and helps avoid duplication and mistakes.

The creation of a geometric model as part of this process allows buildings to be conceived collaboratively and tested virtually, before they are built and operated for real. This should reduce the problems that are encountered in construction and occupation. These models are created from a series of objects. Each object is defined only once and then placed in the model in multiple locations as required. If the object is then changed, these changes will appear throughout the model. This makes models automatically consistent and reduces errors.

The Role of BIM in Facilities Management (FM) for BIM 6 (6D)

FM is concerned with the management of facilities in the built environment at both a strategic and a day-to day level to deliver operational objectives and to maintain a safe and efficient environment. Whilst there has always been a need for facilities management, it has emerged, developed and grown as a profession in recent years, partly as a result of the increasing rate of change required in thebuilt environment, but also due the trend for outsourcing services, and the introduction

of procurement routs that include operation and maintenance in integrated supply contracts.

However it is provided, it is vital that facilities management is seen as an integral part of the strategic thinking and day-to-day operation of businesses, and not as an add on. Even where facilities management is out-sourced, FM contractors must be embedded in the client organisation with their service provision aligned to the client's strategic objectives.

Facilities management is an interdisciplinary activity that can include:

- Estates strategies;
- Asset management;
- Space management;
- Masterplanning;
- Acquisitions and sales;
- Maintenance, cleaning, testing and inspection;
- Refurbishment, retrofitting and renovation;
- Enabling changes in working practices;
- Delivering new technology;
- Brand management;
- Rationalisation of services and assets;
- Ensuring safety and security and establishing emergency procedures;
- Traffic, transport and parking;
- Budget management;
- Asset exploitation and income generation;
- Performance and usage assessment, optimisation and improvement;

〉 Sustainability;
〉 Procurement and project management;
〉 Contract management;
〉 Quality assessment;
〉 Help desk and other support services, and;
〉 Mechanical electrical and plumbing (MEP) and technical services.

The recent emergence of Building Information Modellings (BIM) requires FM input during inception to ensure that the information generated during the design and construction phases is appropriate for operational needs and asset management (that is the development of the project information model into an appropriate asset information model that can be used to assist facilities management).

Green BIM

The emergence of Building Information Modeling (BIM) has transformed the construction industry and is reshaping how engineers deliver projects. It has been implemented during every phase of the project life cycle, from conceptual design through facility management. Using BIM along with sustainable design and construction techniques is referred to as "Green BIM". Green BIM helps the project stakeholders make informed decisions early in the design process and enables a

greater impact on the efficiency and performance of a construction project.

Energy

Using BIM in the design process helps us evaluate energy efficiency and make recommendations for design alternatives that will enhance a building's performance. By combining BIM with specialized energy modeling software, every part of a building, from MEP (Mechanical, Electrical & Plumbing) systems to interior climate, can be simulated and optimized for energy efficiency.

Carbon

Carbon footprinting with BIM helps to test conceptual designs so designers can specify solutions with the lowest carbon impact. This allows us to identify low carbon options that have the potential to drive down carbon emissions during the design and construction phases, as well as options that lead to carbon savings during a building's operation.

Materials

Tying BIM to materials can significantly reduce construction waste and streamline the supply chain through more accurate procurement.

Like carbon footprinting, it also helps designers select design solutions that can reduce the overall environmental impact of a building throughout its operation. BIM has the potential to reduce waste on all construction projects, it is highly beneficial to large complex projects, which tend to generate significant waste if they are not carefully managed.

Water

BIM helps to quantify the amount of water used in a building by calculating the number of fixtures (sinks, toilets, etc.) and their related water usage. This also helps us measure the potential for greywater reuse, which is highly beneficial for reducing demand on local water supplies. The amount of water available for harvesting can be calculated using BIM, based on the site, harvesting system, and the size of building.

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