# BIM Curriculum for Geomatics Engineering

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## SUMMARY

Building Information Modelling (BIM) and digital engineering have begun to shift the way the architecture, engineering and construction industry operates. The geospatial professionals have the opportunity to take a more prominent position in this paradigm shift. The shift is expected to take place exponentially soon. The silo-based engineering approaches will no longer address the needs of this shift. Instead, the need for competencies in collaboration and digital principles are becoming more prominent. This need will make the data management and sharing skills of geospatial professionals critical for the future of engineering. This study presents the current state of the infrastructure engineering curriculum at the University of Melbourne concerning this shift. This paper provides a review of the contemporary AEC challenges and recommends an approach to cater for them in a blended curriculum design.

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## 1. How BIM is transforming Architecture Engineering, construction industry

Architecture Engineering, Construction (AEC) industry has been long criticised for inefficiencies. There are broadly five challenges that the industry faces (Eastman *et al.* 2011).

The industry uses an increasing amount of material raw material. In fact, 40% of the material of the world is used by this industry. With population growth, we will need more accommodation. It is estimated that the raw material we have for construction is enough for a population of 10 billion people. By 2050 the world will have a population of 9 billion. The first challenge for the industry is how to optimise the use of limited material.

The uniqueness of each AEC project, in terms of intent, size, resources, regulatory environment, geographic location, has also challenged the industry. Such that AEC has not benefited from technologies as other industries have. By adopting digital technologies such as 3D modelling, the manufacturing industry has seen a 1.7% annual increase in productivity based considering hourly labour cost. At the same period, AEC has faced a 0.6% decrease in its productivity.

Building performance is another challenge that is faced by the industry. For example, non-industrial buildings, in the U.S. in 2005, used 40 % of all energy and 70 per cent of electricity. In 2030, we will observe a 30 per cent increase in energy use in the U.S. and buildings will use slightly more energy around 40.5%.

57 % of the activities of the AEC industry is non-value add and result in waste. The non-value add is around 26 per cent. 90 per cent of the car pieces can be recycled in depo; this is for a mobile object they can be bought in a location and end up some faraway location. The AEC industry is challenged to learn from other industries how to reduce waste at the same time recycle the material for new constructions.

The industry is also considered a fragmented business in which there are many groups and individuals are involved. For a 10 million dollar project, which is a modest cost, there might be 420 companies, 850 individuals 5600 pages of documents involved. On top of that, the industry faces challenges in terms of documentation, data integration and process continuity (Systèmes, 2014).

With these challenges in mind, BIM enables easier design visualisation, low-level errors and collaborative design. It helps with smoother verification of design intent and extraction of cost estimates. The models can be used as a basis for fabricated components and facilitate quicker reaction to design change and discovery of errors before construction . it helps with synchronisation of design and construction planning and synchronisation of procurement with

design. Finally, BIM improves handover of facility information and better management and operation of facilities

## 2. Geospatial competencies are core to BIM

BIM can be observed from two views. From one perspective, BIM is a process by which the design, construction and operation of a building are streamlined through the use of shared information. From, another perspective, BIM is seen as a product used for managing information about the building, time and cost of the construction. Spatial data is the anchor in BIM. The geometry of the building is modelled, and other information is linked to it in the data model.

For surveying and spatial professional, the immediate contribution is in modelling buildings and infrastructure. This contribution is well underway and well recognised by the AEC. However, BIM is more than only representing buildings and infrastructures using spatial information. BIM is about collaborative data environments (CDE) and a solution for the fragmented AEC business model.

The SDI philosophy and our expertise in spatial data management, standards can be adopted in developing CDE to facilitate the operation of buildings and infrastructures. Geospatial industry's longstanding expertise in generalising large-scale spatial data to create a small-scale map.

BIM provides opportunities to evolve GIS technologies that are focused primarily on outdoor environments into technologies that can be used for indoors spatial analysis. Buildings require different geospatial skills: creating BIM, creating CDE, maintaining and analysing the BIM data and converting it to city models. The AEC industry is not fully aware of these capacities in the surveying and spatial industry.

## 3. What AEC expects from geospatial industry?

With the increasing availability of laser scanning technologies, Scan-to-BIM has become the major pathway for the surveying and spatial professional to contribute to digital engineering of buildings and infrastructures. While there is a growing demand for the Scan-to-BIM service within the AEC industry, it is essential to note that this service, which effectively is a 3D surveying and mapping service, is a small part of the broader BIM economy.

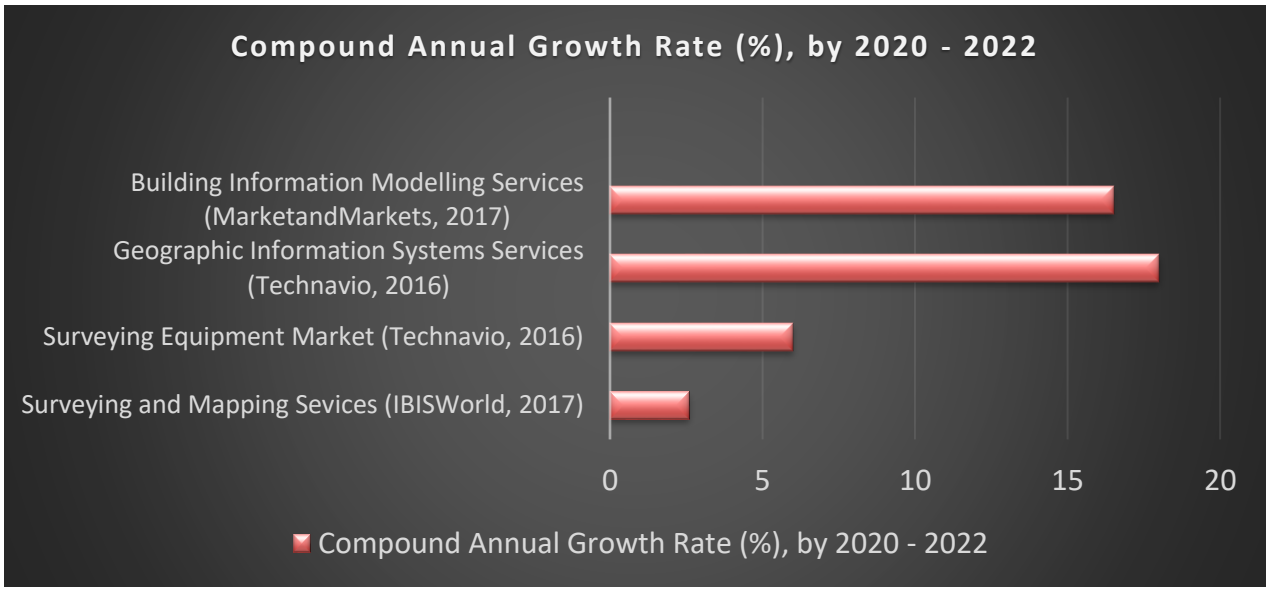

Figure 1: A comparison of growth in BIM, GIS and Surveying industries (Kalantari, 2017)

Analysing various facets of surveying and geospatial market, it imperative that the growth in surveying and mapping services and survey equipment is marginal. There is one clear message from the analysis, the cost of collecting geospatial data will be increasing declined, and there will not be much growth in services related to surveying and mapping. Instead, what is fast growing is GIS, and what we can do with the spatial data.

We can draw similarities between BIM and GIS. BIM will be no different to surveying and mapping if we only focus on preparing data and information. However, if we go beyond modelling building information; we can discover a continuum of opportunities.

## 4. Blend engineering curriculum through BIM

In the past few years, the AEC industry has observed the evolution of simple 2D drafting programs into integrated BIM based on 3D spatial technologies. The geospatial industry is expected to contribute to collecting and managing and analysing building information in the connect of AEC. Geomatics graduates must be educated in a broader context and get the fundamental knowledge about AEC.

In the University of Melbourne, we have developed a subject on BIM, through which students learn how BIM is used to model, store and visualise architectural, structural, and facilities components of infrastructure in 3D. Students learn how adding time and cost information to BIM allows AEC to foster collaboration in designing infrastructures, minimise the risk of construction errors and optimise the maintenance of them.

The intended learning outcomes are to for students to

- Explain the function of BIM in the Architecture, Engineering and Construction industry
- Apply BIM in designing, visualising and maintaining components of infrastructures
- Analyse how collaborative techniques in BIM increase productivity and reduce the risk of construction and usage errors
- Design infrastructures and plan for their construction and maintenance using BIM

The students are exposed to topics including spatial modelling and visualisation, infrastructure design, structural analysis, energy modelling, collaborating in BIM, costing using BIM and procurement through BIM. An essential part of the curriculum is the industry lectures that are delivered by

The subject is being offered as an elective to a range of disciplines civil engineering, mechanical engineering, electrical engineering, property management, geomatics, spatial information and urban planning. This mixed cohort enables real-world collaboration and knowledge sharing challenges for the students in the processing of learning.

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## BIOGRAPHICAL NOTES

Mohsen Kalantari is Associate Professor of Geomatics Engineering. He brings a wealth of experience in developing successful research grant applications, engaging with the industry and profession, building strong research teams, conducting research in Australia and overseas, and leading a research centre. His area of research land administration, spatial data infrastructures and BIM. He brings in-depth and rich skills in university teaching, developing teaching grants, coordinating degrees, inter/cross-disciplinary curriculum development, accreditation, and assisting students to progress in their studies.

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