



Building Information Modelling in Australia, Lessons from the UK

Christopher Byrne

2014 Higher Education and Skills Group Overseas Fellowship Report

An ISS Institute Fellowship sponsored by

Higher Education and Skills Group



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i. EXECUTIVE SUMMARY

Building information modelling (BIM) has emerged in Australia, particularly over the last four years, as the future of designing, constructing and operating buildings and infrastructure. In 2011, the UK Government recognised the tangible benefits of using BIM and announced a mandate that requires all central government-funded projects from 2016 to use a BIM framework.

While the private sector in Australia is experiencing significant growth of BIM projects, there is still some way to go to take advantage of BIM's time, cost and other efficiency benefits. BIM reports and case studies reviewed by the Fellow show that it can result in efficiencies of four to 20 per cent. Given the billions of dollars spent on the built environment, plus ongoing maintenance costs, it is clear that BIM offers the potential for massive savings.

Australia is now at a turning point. The time has come to decide if we want to be leaders, or followers, in this proven methodology.

There is a worldwide shortage of people with experience and knowledge of BIM.

The Fellow's experiences in the UK highlighted the opportunity to act by taking a national approach to BIM implementation involving industries, governments and educational institutions. Just as the success of a BIM project comes from effective collaboration between building professionals, so too do we need collaboration between our national stakeholders.

The Fellow interviewed key representatives of the UK Government, businesses and academics.

From this valuable experience he found the following:

- BIM projects reduce risk and deliver cost, resource, quality and time efficiencies
- Collaboration is the key to success when implementing BIM
- Education innovation will come from methods that teach how to collaborate. Simulated projects from the real world in real time are vital to learning the true power of BIM
- The collaborative nature of BIM means that it needs a range of occupations to come together in a training environment. The contractor works with the architect, engineer and client, all 'in the room'
- Linking educators with industry through knowledge transfer partnerships will create training programs targeted to industry needs
- The UK Government's BIM mandate has been the motivator for industry to adopt this technology and methodology. However it is the innovative (early adopter) organisations that have embraced BIM and actively encouraged its use
- The UK Government has instigated the creation of networks based on regional areas throughout the UK and across building professionals. This promotes the collaborative nature of BIM and knowledge sharing
- Government direction to identify champions, structure collaboration and develop BIM tools for implementation (including networks, Australian standards and units of competency) is paramount
- A BIM government mandate alone is not enough to implement BIM. Finland is an example: although it was the first country to mandate BIM, there has not been significant take up by the private sector
- A learning framework must sequentially educate the client, teachers, the existing workforce and finally new entrants.

i. EXECUTIVE SUMMARY

The Fellow is now in a position to link Australian stakeholders with governments, academics and businesses that have an international reputation for implementing BIM and educating BIM practitioners. The Fellow also has the skills, knowledge and attributes required to work on BIM projects.

The Fellow aims to share these valuable lessons with students, industries, businesses and governments: from the micro level of teaching his own students, through to being a source of knowledge on BIM projects for industries and governments.

The recommendations that have emerged from this Fellowship will challenge industry, government and training providers. They focus on the key stakeholders ability to capitalise on the lessons learnt from the UK government mandate and implement BIM using a coordinated, collaborative approach that will allow Australia to take full advantage of the boundless opportunities right here right now.

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ii. ABBREVIATIONS/ACRONYMS

AIB	Australian Institute of Building
AIBS	Australian Institute of Building Surveyors
AMCA	Air Conditioning and Mechanical Contractors Association
BA	BIM Academy
BDAV	Building Designers Association of Victoria
BIM	Building Information Modelling
BLSC	Building Leadership Simulation Centre
CPSISC	Construction and Property Services Industry Skills Council
HESG	Higher Education and Skills Group
HIA	Housing Industry Association
ISS	International Specialised Skills Institute
MBAV	Master Builders Association of Victoria
Revit	Commercial 3D building design software specifically built for BIM
NFIA	National Fire Industry Association
NU	Northumbria University
RFI	Request for Information

iii. DEFINITIONS

Building Information Modelling

BIM is a process for creating and managing all of the information on a project – before, during and after construction. The output of this process is the Building Information Model, a digital description of every aspect of the built asset.

Efficient design, visualisations, simulation and collaboration provide greater clarity for all stakeholders across the project lifecycle making it easier to achieve project goals.

Navisworks and Revit

Simulation computer software programs that enable architects, designers, engineers and construction professionals to visually communicate project details to clients and the project team. There are other software programs with similar capabilities in the market. These include ArchiCAD and AECOSim (similar to Revit) and Solibri and Vico (similar to Navisworks).

Skills enhancement

Enhancement and improvement in skills, knowledge and practice not currently available or implemented in Australia and the subsequent dissemination and sharing of those skills and recommendations throughout the relevant Australian industry, education, government bodies and the community.

1. ACKNOWLEDGEMENTS

Christopher Byrne thanks the following individuals and organisations that have generously given their time and their expertise to assist, advise and guide him through this Fellowship program.

Awarding Body – International Specialised Skills Institute (ISS Institute)

The International Specialised Skills Institute (ISS Institute) is an independent, national organisation. In 2015 it is celebrating twenty-five (25) years working with Australian governments, industry education institutions and individuals to enable them to gain enhanced skills, knowledge and experience in traditional trades, professions and leading edge technologies.

At the heart of the ISS Institute are our individual Fellows. Under the Overseas Applied Research Fellowship Program the Fellows travel overseas. Upon their return, they are required to pass on what they have learnt by:

- Preparing a detailed report for distribution to government departments, industry and educational institutions
- Recommending improvements to accredited educational courses
- Delivering training activities including workshops, conferences and forums.

Over 300 Australians have received Fellowships, across many industry sectors. In addition, recognised experts from overseas conduct training activities and events. To date, 25 leaders in their field have shared their expertise in Australia.

According to Skills Australia's 'Australian Workforce Futures: A National Workforce Development Strategy 2010'.

Australia requires a highly skilled population to maintain and improve our economic position in the face of increasing global competition, and to have the skills to adapt to the introduction of new technology and rapid change. International and Australian research indicates we need a deeper level of skills than currently exists in the Australian labour market to lift productivity. We need a workforce in which more people have skills and knowledge, but also multiple and higher level skills and qualifications. Deepening skills and knowledge across all occupations is crucial to achieving long-term productivity growth. It also reflects the recent trend for jobs to become more complex and the consequent increased demand for higher-level skills. This trend is projected to continue regardless of whether we experience strong or weak economic growth in the future. Future environmental challenges will also create demand for more sustainability related skills and knowledge across a range of industries and occupations.

In this context, the ISS Institute works with our Fellows, industry and government to identify specific skills and knowledge in Australia that require enhancing, where accredited courses are not available through Australian higher education institutions or other Registered Training Organisations. The Fellows' overseas experience sees them broadening and deepening their own professional knowledge, which they then share with their peers, industry and government upon their return. This is the focus of the ISS Institute's work.

For further information on our Fellows and our work see <http://www.issinstitute.org.au>.

Christopher Byrne also thanks the CEO (Bella Irlight AO) and staff (Ken Greenhill and Paul Sumner) of ISS Institute for their assistance in planning and development of the Fellowship and completion of this report.

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1. ACKNOWLEDGEMENTS

Fellowship Sponsor - The Higher Educations Skills Group, Department of Education and Training

The Higher Education and Skills Group of the Department of Education and Training, Victorian Government, is responsible for the administration and coordination of programs for the provision of training and further education, adult community education and employment services in Victoria and is a valued sponsor of the ISS Institute. Christopher Byrne thanks them for providing funding for this Fellowship.

Supporters

The following organisations/ individuals were involved in and supported the Fellowship application and submission:

- Joan Whelan - Project Manager, Construction and Property Services Industry Skills Council (CPSISC)
- Mark Lyons, General Manager, Building Leadership Simulation Centre, Master Builders.

Employer support

Swinburne University of Technology has generously supported this Fellowship by providing time to travel to undertake the Fellowship and additional mentoring as required. The Fellow particularly acknowledges:

- Coralie Morrissey, Director of Learning (now of Seek Learning)
- Terese McAlesse, Director of Learning
- Ron Bronson, Senior Educator, Advanced Building Studies.

Organisations and individuals that participated in this Fellowship

- Peter Barker, Managing Director, BIM Academy, UK.
- Sam Collard, Construction Engineer, Ryder Architecture, Newcastle upon Tyne, UK, Hong Kong, Australia.
- Barry Gledson, Senior Lecturer in Construction Management, Northumbria University, UK.
- Professor David Greenwood, Professor of Construction Management, Northumbria University, UK.
- Will Joske, BIM Development Manager, Architect, i2C, UK and Australia.
- Dr Mohammad Kassem, Senior Lecturer in Engineering Project Management, Teesside University, UK.
- Graham Kelly, Senior Project Manager, BIM Academy, UK.
- Richard Lane, Director and Lead Consultant at Creonova Consulting, Reading, UK.
- Professor John Lorimer, Chair of the UK Government BIM Task Group.
- Bilal Succar, Director of Change Agents and www.bimexcellence.net.

2. ABOUT THE FELLOW

Name: Christopher Byrne

Employment: Teacher, Built Environment, Swinburne University

Qualifications

- Diploma of Building and Construction (Building), Swinburne, 2013
- Certificate IV in Training and Assessment, Swinburne, 2013
- Certificate IV in Building and Construction, Swinburne, 2012
- Diploma of OHS, Swinburne University, 2011
- Diploma of Building and Construction (Management), MBAV, 2010
- Certificate IV in Building and Construction (Environmental Management), MBAV, 2009
- Advanced Diploma of VET, Box Hill TAFE, 2005
- Certificate III in Building and Construction (Painting), Holmesglen, 1989

Membership

Master Builders Association of Victoria

Short biography

After completing secondary school, Byrne commenced a painting and decorating apprenticeship. He stayed in the industry for 10 years, until he saw an opportunity to work with young people, providing them with career advice.

After working with various organisations (such as schools and industry associations) and running his own construction business, he started working in the Built Environment Department of Swinburne University.

The Fellow was determined to find out more about BIM after realising his students (who were current and future project managers/ builders on commercial and domestic sites) needed to be part of successfully implementing BIM on site.

3. AIM OF THE FELLOWSHIP PROGRAM

The aim of this fellowship research program was to examine international best practice, to identify innovative, simulated learning strategies and to foster BIM in building and construction education in Australia.

This will be done by:

- Interviewing international BIM experts to develop recommendations for industry, education and government leaders about what is required to keep Australia at the forefront of BIM education
- Becoming a source of knowledge for Australian education providers that are implementing BIM
- Identifying international innovations in simulated training in building and construction
- Identifying skills, knowledge and attributes that could be integrated into training packages
- Making recommendations to training providers about potential areas for implementing innovative BIM training
- Sharing research findings and recommendations with:
 - » Building design and construction management students
 - » Industry (Master Builders Association of Victoria, Building Designers Association of Victoria, Housing Industry Association, Air Conditioning & Mechanical Contractors' Association, National Fire Industry Association, Australian Institute of Building and Australian Institute of Building Surveyors)
 - » Construction and Property Services Industry Skills Council
 - » Victorian Advanced Building Studies Teacher Network Group
 - » Swinburne colleagues
 - » Building Leadership Simulation Centre.

4. THE AUSTRALIAN CONTEXT

The next transformation for the building industry will be the wider implementation of BIM. BIM is about collaboration: about harnessing technology with a 3D object database that can be easily visualised and that provides rich data and structured information. From July 2016, all UK government-funded construction projects will be required to use BIM as part of the design, construction, operation, maintenance and recycling of the building. According to the AECOM Blue Book 2013 ¹, globally, the BIM market is expected to grow from AU\$1.8 billion in 2012 to \$6.5 billion by 2020.

A recent BIM survey by McGraw Hill ² predicted there would be a strong increase in implementation over the next few years:

- Half (51 per cent) of all users were engaged with BIM on more than 30 per cent of their projects, predicted to grow to three-quarters (74 per cent) of users by 2015
- Over half (56 per cent) of design professionals will be very heavy users (more than 60 per cent of projects) in just two years
- Design professionals led contractors as users, with six out of 10 (61 per cent) currently using BIM on 30 per cent or more of their work, versus only one-third (33 per cent) of contractors.

The benefits of BIM are largely cited as: reducing errors, promoting an industry leader image, reducing rework, improving collaboration and offering new services. With the barriers to BIM not being adopted including: lack of demand from clients (including government), expense of upgrading software/hardware, insufficient training available and difficulty of software to use.

The Australian industry is preparing itself by investing resources into developing data modelling standards through the international construction advisory group BuildingSMART and the National Building Information Modelling Initiative (NBI) previously funded by the Federal Government. BuildingSMART Chair John Mitchell states, "Our national competitiveness is at stake if nothing is done to address the issues that are the focus of the strategy outlined in the NBI".³

Integrating innovative learning models with major advances in collaborative construction methods will help keep Australia abreast of this massive technological development. BIM will unlock new and more efficient ways of working, putting the world in a new digital construction era.

It is vital that the Australian vocational education sector implement BIM for its students. Given that BIM is particularly important for construction project managers, it is timely that training providers understand this innovative approach and are able to teach it to current and future construction project managers.

Training providers must do this, while acknowledging the need to connect accredited training with new, innovative methods of design simulation, to engage a wider component of the building and construction workforce in training. We must also ensure we remain market leaders in design and virtual reality.

The BIM technology is available; we now need to foster the people side of this new technology, to ensure it is successfully integrated into the construction process. Education that fosters the cultural change required (through increased collaboration) will greatly assist this process.

Being more than just project management software, BIM involves all levels and occupations in the industry. The Fellowship examined the skills needs of project managers and site supervisors and how ready Australia is to truly embrace BIM.

¹ AECOM, Davis Langdon, The Blue Book, Accessible Knowledge for the Property and Construction Industry, 2013

² McGraw Hill Construction, The Business Value of BIM for Owners Smartmarket Report, 14 October 2014

³ BuildingSmart Australasia, viewed 12 April 2014 <<http://buildingsmart.org.au>>

4. THE AUSTRALIAN CONTEXT

BIM Components

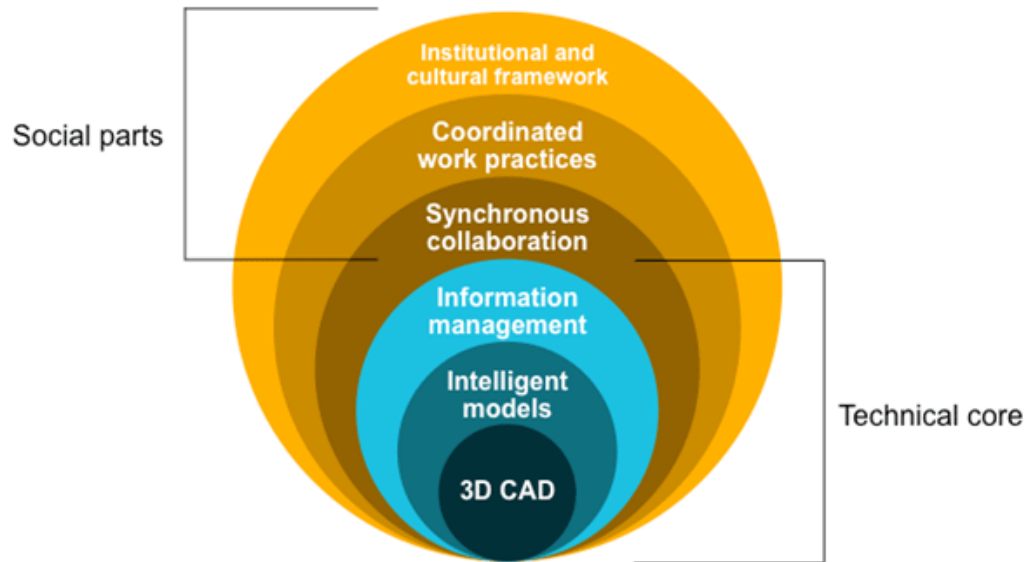


Image 1: BIM viewed as a sociotechnical system with a technological base and layers of social components.
Source: <http://wspgroup.com>

SWOT analysis of BIM in Australia

<p>Strengths</p> <ul style="list-style-type: none">» Saves time and money (reduces waste, gets it right the first time)» Improves 3D design capacity» Simulates construction sequences» Reduces risks and errors» Reduces energy use over a building's lifecycle» Can engage the smallest of companies» Is universally applicable across many industries, including construction, engineering, civil, mining and facility management	<p>Weaknesses</p> <ul style="list-style-type: none">» There is no culture of collaboration across occupations» The focus has been on building, rather than on information» Governments need to take the lead» Companies must work together» There is no one universal software platform» There are initial software and training costs
<p>Opportunities</p> <ul style="list-style-type: none">» Linking with international BIM leaders in education» Integrating with simulated training innovations» BIM will be the DNA of future construction» Developing new skills and knowledge for Australian qualifications» Australia can emerge as an international leader in BIM education	<p>Threats</p> <ul style="list-style-type: none">» BIM will destabilise traditional ways of working in the construction industry» New types of construction contracts will be needed» There is limited understanding of BIM» There may be fewer suppliers (as fewer companies work together)» Resistance to change

5. IDENTIFYING THE SKILLS AND KNOWLEDGE ENHANCEMENTS REQUIRED

There are examples of areas in Australian industries where there are weaknesses in innovation, skills, knowledge, experience, policies and/ or formal organisational structures to support the ongoing successful development and recognition of individuals and the particular sector.

The focus of all ISS Institute Fellowships is on applied research and investigation overseas by Australians. The main objective is to enable enhancement and improvement in skills, knowledge and practice not currently available or implemented in Australia and the subsequent dissemination and sharing of those skills and recommendations throughout the relevant Australian industry, education, government bodies and the community

The Fellowship provided the Fellow, Christopher Byrne, with an opportunity to examine the ways in which construction will change by implementing BIM. Specifically, it allowed him to examine:

- The skills required of site managers working with BIM
- How training providers are responding to the increasing awareness of BIM
- How the industry is linking with training providers
- The benefits BIM industry leaders have identified from using it
- The real or perceived barriers to implementing BIM
- How to make BIM more widely known in Australia
- How to identify the skills and knowledge that should be included in Australian building and construction qualifications (that is, in the CPC08 training package).

The Fellow researched affordable and wider market opportunities for BIM-simulated building and construction training, and how to link it with accredited training. He identified:

- Recent innovations in simulated training in building and construction
- How simulated training is linked with accredited training
- How industry professionals are networking to foster BIM implementation and sharing resources
- How the acquisition of soft skills (largely as the result of simulated training) is delivered and assessed as part of accredited training.

The Fellow examined experiences in the United Kingdom, to identify and explore the approach taken by the government, industry and training providers to providing BIM training for site supervisors.

Byrne's fellowship enabled him to:

- Meet with prominent representatives involved in the UK Government mandate
- Interview university personnel working at the forefront of BIM
- Attended the BIM Academy's Virtual Project, a structured course based on a real project using a collaborative multidisciplinary approach.

6. THE INTERNATIONAL EXPERIENCE

Visit one: BIM Academy, Northumbria University, Newcastle upon Tyne, UK

The Fellow participated in the BIM Academy's Virtual Project, delivered over three days at Northumbria University. The course takes place in a controlled environment with advice and support from the team leaders.

Contacts

- Peter Barker, Managing Director
- Will Joske, Consultant
- Justine Gray, Senior Project Manager

Objective

There are no courses such as this available in Australia. The objective was therefore to learn how leaders in BIM education provide innovative short-course training to existing workers from a variety of disciplines.

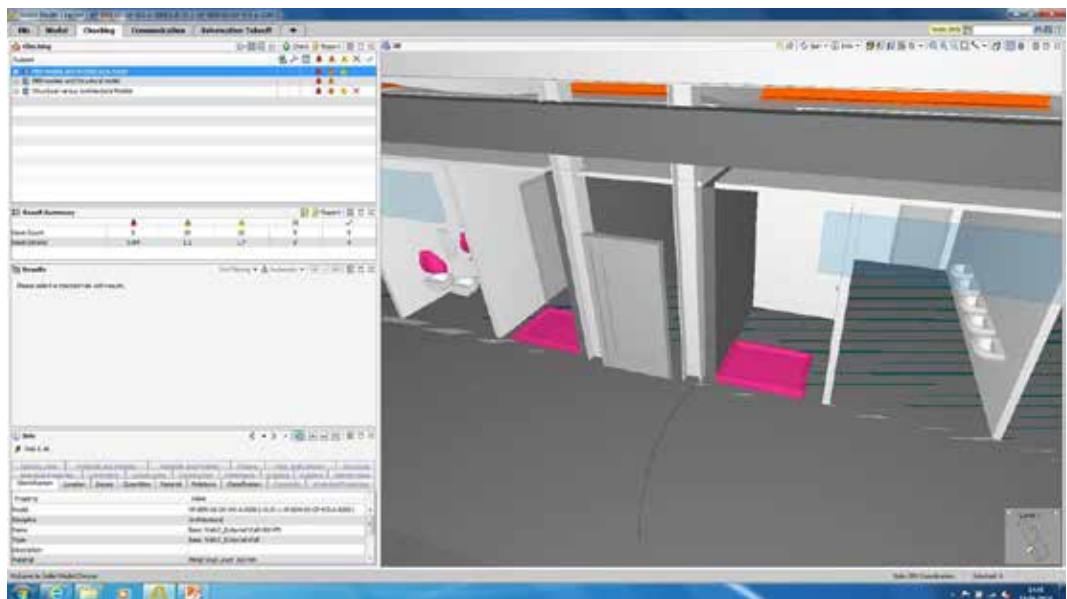


Image 2: An example of the software used in the BIM Academy's Virtual Project short course

Outcomes

- First-hand experience of the benefits of using BIM tools for design, construction and operation.
- Better understanding of the collaborative work processes required to effectively implement BIM in a workplace, or for a new construction, refurbishment or infrastructure project.
- Better understanding of which methods of training delivery are best suited to people new to BIM and which are best suited to people who now use BIM in their workplace.

6. THE INTERNATIONAL EXPERIENCE



Image 3: Will Joske (i2C Design), Christopher Byrne (Fellow), Barry Gledson (NU)

The course brought together project managers, contractors, engineers, architects and facility managers in a real-time, collaborative environment. We were given a task that required us to work as a team to deliver a project to a hypothetical client. The structure of the course allowed us to explore the BIM process and quickly assess our own capabilities and responsibilities. We did this with the safety of knowing there was none of the risk or cost to our organisations that can occur on a real project when a new system is introduced.

Key lessons from the BIM Academy's Virtual Workshop

- Collaboration is the key to success when implementing BIM. It can only be achieved through good communication skills.
- Education innovation will come from methods that teach how to collaborate. Simulated projects from the real world, in real time, are vital to learning the true power of BIM.
- Put in the right environment, all construction stakeholders can get along.
- This method of training (a simulated, real-time project) works and can be modified for an Australian audience.
- BIM works.

6. THE INTERNATIONAL EXPERIENCE



Image 4: Graduates of the BIM Academy's Virtual Project (June 2014) with facilitator Justine Gray

6. THE INTERNATIONAL EXPERIENCE

Visit two: Northumbria University, Newcastle upon Tyne, UK

Northumbria University is a research-rich, business-focused, professional university with a global reputation for academic excellence. It is based in the heart of Newcastle upon Tyne, which is regularly voted the best place in the UK for students.

The university has its origins in the Rutherford College, founded in 1880. Northumbria is in the top ten UK universities for the number of graduates entering professional employment, and nine of every ten graduates are working or studying six months after graduation. It was ranked 21 of 111 universities in the 2014 Times Higher Education Student Satisfaction Survey.¹

Northumbria University works with major employers including Nike, IBM, Nissan, Proctor & Gamble, the BBC and the NHS. More than 560 employers and 60 professional bodies sponsor or accredit the university's programs.



Image 5: Northumbria University Newcastle campus

Contacts

- Barry Gledson, Senior Lecturer in Construction Project Management
- David Greenwood, Professor of Construction Management
- Graham Kelly, Senior Project Manager
- Peter Barker, Managing Director, BIM Academy

¹ www.northumbria.ac.uk/about-us (accessed 25 October 2014)

6. THE INTERNATIONAL EXPERIENCE

Objective

To identify how Northumbria University engages with industry to ensure the training it delivers is relevant and meets current and future needs.

Outcomes

Northumbria University and Ryder Architecture cofounded BIM Academy in 2010. Its vision is to create an international centre of excellence for BIM through the complementary activities of research, education and consultancy.

Both organisations are leaders in the field that recognise the benefits for industry that can flow from independent and evidence-based innovation, research and learning. These ultimately increase the value and growth of enterprises and industries.

The concept of delivering training using a real-life, virtual project emerged from the success of the organisations' collaborative approach to multidisciplinary competitions such as Build London Live, Build Qatar Live and Build Sydney Live.

A Build Live event is open to teams from around the world. They must work together to design a multiuse development in 48 hours. The event demonstrates how working in a public, collaborative manner using the 'cloud' can harness the world of BIM in architecture, engineering, planning, construction and operation.

This 48-hour virtual design collaboration has been deconstructed and used as a new model of training. BIM requires a multidisciplinary approach and such approaches are often not often evident in traditional construction projects.

The same approach to BIM training can be made by all sectors of the industry. For example, irrespective of whether an organisation is a Tier 1 construction company or a spec home builder, it should still follow the path of:

- Getting buy-in from senior managers
- Developing its BIM champions
- Piloting a project
- Developing training programs
- Measuring success.

However, at this stage, it is the Tier 1 architects, governments and large and small design consultants that see BIM as a differentiator.

“The type of person who is attracted to BIM is one who sees within it the potential for excellence in what they deliver, whether design, construction or operational efficiency.”

Interview with Peter Barker, BIM Academy

6. THE INTERNATIONAL EXPERIENCE

Key lessons from the people at Northumbria University

- Bringing together a range of occupations in a training environment reflects the exact needs of the collaborative nature of BIM. The contractor works together with the architect and engineers with the client and all are in the room.
- Linking educators with industry through knowledge transfer partnerships will create training programs that specifically address industry needs.
- The UK Government BIM mandate has been the motivator for industry to adopt this technology and methodology. However, it is the innovative (early adopting) organisations that have embraced BIM and actively encouraged its use.
- The benefits of BIM include reduced capital costs, optimised programs and efficient design processes. A successful BIM project is one that exceeds the client's objectives and expectations.
- Challenges for site managers are to understand BIM and where they fit in the process and to overcome the idea that it is just about technology.
- To increase the uptake of BIM in Australia, it should be made a requirement for delivering government projects.
- To improve collaboration among diverse but allied occupations, regional/ distinct BIM networks need to be formed and linked back to an international network and supported by collaboration between professional associations.
- Australian universities can learn from this industry partnering approach to education that can also work effectively internationally.

6. THE INTERNATIONAL EXPERIENCE

Visit three: UK Government Department of Business, Innovation and Skills BIM Steering Group

Contact

- John Lorimer, Chair, Constructing Excellence BIM Task Group, JLO Innovation Ltd.

In May 2011, the UK Cabinet Office published the Government Construction Strategy. The strategy announced the government's intention to require 3D BIM on its projects by 2016. Since then, the government has embarked with industry on a program to modernise the construction industry, aiming to reduce capital costs and the carbon burden from building and operating the built environment by 20 per cent.

The UK BIM Task Group brings together expertise from industry, government, the public sector, institutes and academia. The task group, of which Lorimer was a founding member, addresses the practicalities of how industry can prepare for the step change BIM requires.

Lorimer is also Chair of the BIM Academy, a Board member of the UK Construction Industry Training Board, Visiting Professor at Salford University, and a member of the UK Government Department for Business, Innovation & Skills BIM Steering Group.

"The level of interest and investment (in BIM) is not a function of size – it is more one of seeing the light."

Interview with John Lorimer, JLO Innovation Ltd

Objective

To identify how the government interacted with industry, suppliers and clients to adopt a BIM regulatory framework.



Image 6: BIM Task Group - Source: www.bimtaskgroup.org

6. THE INTERNATIONAL EXPERIENCE

Outcomes

The Fellow met with John Lorimer, who provided valuable insights into the UK experience of mandating BIM on government projects. They discussed the following:

- When embarking on a BIM project, all involved must have an idea about how the supply chain works. Most people have previously gone through a sequential construction process concentrating on their own individual input. Now, everyone is in the same room and involved in the entire lifecycle of a built asset
- The client also needs education about BIM and champions across all stakeholders to support them. Who is the right person in the supply chain to do that? The best chance a client has is to procure the right provider and determine how they want to work in with the supply chain
- Lorimer's involvement in BIM projects has shown that those who are approaching the end of their career and new entrants seem to be the ones most interested in taking on the BIM challenge. Experienced and respected people within organisations across the supply chain can become effective BIM champions. The most successful strategy is to use coaching or mentoring, rather than traditional education
- Cultural change is something that must be implemented over years. Even with great desire, change requires peer pressure, so it's the construction manager who is motivated to use BIM who will help the site supervisors. The lesson for contractors is to find a champion and foster the idea
- Lorimer makes a compelling argument that suggests Australian governments should mandate BIM. Without it, UK companies will enter the market with experienced and results-driven BIM methodologies
- If it's not mandated, smart businesses will implement it anyway
- As a way of improving collaboration across occupations involved in the supply chain, professional associations and major contractors need to take the lead. They need to engage with BIM and help their clients
- The education system's clients—students and potential students—will drive change. UK universities are being quizzed by undergraduates about the BIM content in their courses.

Lorimer has been involved in several high-profile construction projects, one of which is the £73 million renovation of the Manchester Central Library. The case study of this amazing building follows the key lessons below.

Key lessons

- The UK Government's mandate has moved procurement towards a more efficient and productive system.
- The BIM Task Group has been instrumental in implementing BIM across the supply chain.
- The UK Government has invested in creating networks based on regional areas throughout the UK and across building professionals. This promotes the collaborative nature of BIM.
- Australian governments would do well to make BIM a condition of public infrastructure development as a starting point.
- Government strategies that underpin BIM's success include the BIM Object Library, developing PAS1192 (equivalent to an Australian standard) and a soft-landing approach (by implementing the mandate over four years).
- All government resources are available for free. The UK Government has taken the implementation of BIM seriously and is committed to the BIM process.
- The importance of education cannot be understated.

6. THE INTERNATIONAL EXPERIENCE

Case study: Manchester Central Library

Client: Manchester City Council

Contractor: Laing O'Rourke

Architect: Ryder Architecture

Project cost: About \$73 million

A core team of 120 people (including the client and key suppliers) worked in an open-plan project office, opposite the site. The library has undergone many changes since its construction, and now has to accommodate services very different to those envisaged when the building was opened in 1934. The library was completely refurbished.

The team used BIM to generate detailed information in the form of 2D and 3D outputs, enabling greater cooperation between the client and design team.

The benefits included:

- Reduced construction programme and associated risk and contingency funds
- A reduced volume of concrete, through design efficiencies
- Costly remedial works avoided, with early clash detection providing cost and time savings
- Reduced transport mileage, through local employment and procurement
- An onsite energy efficiency measure reducing the embodied carbon
- 90 per cent of waste being diverted from landfill
- 75 per cent of waste being recycled or reused
- 50 per cent of construction spending with Manchester-based suppliers
- Recruitment of local labour
- Early connection to the grid (with overall onsite CO2 emission reduced by 15 per cent).

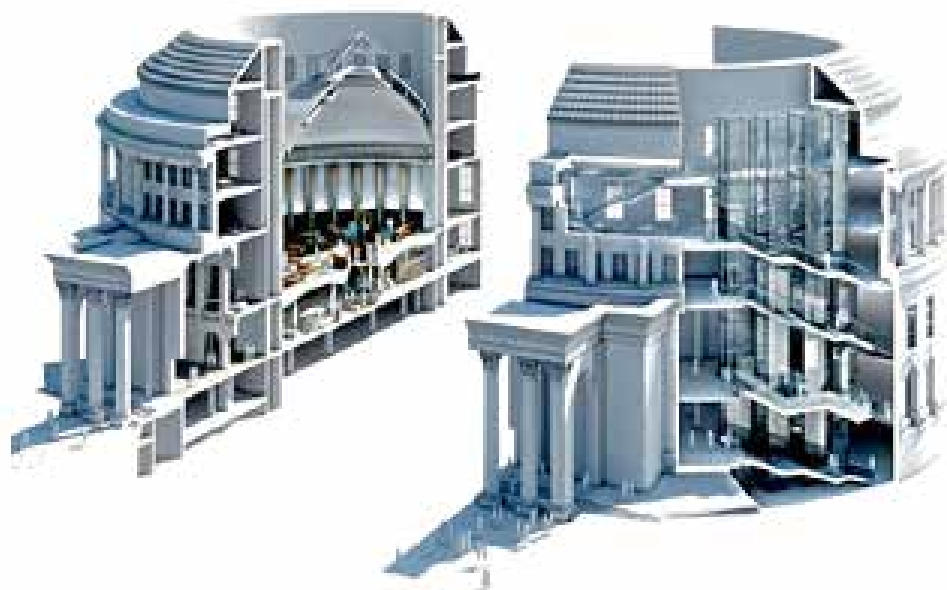


Image 7: Manchester Central Library, cross sectional 3D model. Source: www.wrap.org.uk

6. THE INTERNATIONAL EXPERIENCE

Visit four: Ryder Architecture, Newcastle upon Tyne, UK

Contact

- Sam Collard, Technical Director, Ryder Architecture.

Sam Collard is an accomplished mechanical, electrical and plumbing (MEP) design leader with a track record of achievement in large organisations and across a portfolio of major projects. Collard has worked as a building services design team leader and as a project team MEP leader. His career experience includes private finance initiatives, public-private partnerships and Procure 21 projects in healthcare and education. He is a chartered engineer with over 35 years experience in the building services industry. He is a Fellow of the Chartered Institution of Building Services and is an enthusiastic supporter of BIM.

Objective

To identify what motivates an architecture firm to form a partnership with a university to supply BIM training.

Outcomes

The Fellow met with Sam Collard and they discussed the following:

- Site supervisors need skills such as Navisworks and basic computer skills. They must be positive about BIM, acknowledge the communication required to make it work and have the tools to make it work
- BIM needs to be integrated into existing courses rather than be a simple add-on. It is a method to design, construct, maintain and demolish a built asset
- Innovation can come through web-based training, with reinforcement through YouTube videos. However, classroom learning is still essential. Access to guest speakers who work within a BIM framework is key
- Site managers want to learn on-site. They are practical people who want to be handed BIM. But this is not going to happen: they need to have the gravitas of the content reinforced when offsite. Navisworks can be taught in one day in the classroom, but when back in the workplace they must have access to the technology and support from management (to buy the software)
- It is the more enlightened people who are seeing the benefits of BIM and promoting its use
- The divide between organisations that use and don't use BIM is going to become greater. The UK is reaping the rewards of a head start of two to five years along with the decision to acknowledge the importance of data integration
- Some organisations are reluctant to work with companies that have been told to use BIM, but are resisting
- Australia has increasingly outsourced a range of skills to Asia because of value-for-money; but the market for BIM in Asia is truly untapped. BIM engineers in Asia are very expensive because there is a limited skills base. Australia has an opportunity to be a hotspot for educational services for Asia
- The UK has seen a 28 per cent increase in the cost of competent Revit drafters due to scarcity. Revit is a software program that allows draftspeople to design collaboratively using 3D modeling. When the 'good drafters' are snapped up the less skilled drafters will be employed. Demand is currently exceeding supply capability

6. THE INTERNATIONAL EXPERIENCE

- Mechanical, electrical and plumbing engineers are taking the lead, along with contractors and architects/ designers with an international presence
- The benefits of BIM include client engagement, dynamic management of costs, less requests for information (RFIs), better work practice management, more detail, less conflict on site, better integrated teams, safer and enriched records management
- It is difficult to promote the 'wins'. There is no single measure of what a good BIM project is. However, the UK are now trying to find improved ways of measuring performance, so there should be a big return in the next few years. A simple way of measuring BIM is to set performance indicators, centrally locate data, then measure performance on completion
- It is a challenge for site supervisors who have a manager who is unwilling to support or implement BIM. Early adopters are not frightened of new technology and are willing to learn
- Australia can foster BIM by understanding the UK strategy. The government wanted a better way to procure buildings (for example, five new schools). BIM is ideal, because it reduces risks and errors. The UK Government realised that education projects could be procured 20 per cent cheaper internationally. This was a driver for the UK businesses to adopt BIM and its efficiencies leading to the 2016 mandate. Costs increased in the first and second years with the additional staff and expertise required, but by years three and four, efficiencies are realised; and there were also immediate productivity increases. Companies who use BIM are simply getting more work: companies who are not, are buying work. Coordination of projects is truly global, with efficiencies in design and prefabrication. Savings are initially invested back into people and quality assurance processes.
- Education is still mostly offered by software suppliers. However BIM needs to be in the context of the bigger picture, which these suppliers are not doing.

"If Australia does nothing, the ability to engage in the overseas market will be lost."

"A successful BIM project for a site manager can be measured by the number of RFIs, or lack of them."

Interview with Sam Collard, Ryder Architecture

Key lessons learned from Collard

- One organisation needs to take the lead and establish itself as the preeminent source of information for industry and educators and provide guidance and structure on implementing BIM in Australia. It could also coordinate BIM knowledge transfer and ensure consistency across education and industry at a national level. The Australian Construction Industry Forum has started doing this. It is a reputable organisation and should be supported by government to continue in this role.
- Education is the key factor that will ensure the ongoing successful implementation of BIM in Australia.
- An ideal partnership between educators and industry is from middle management out – promote it through the BIM champions who can influence across the organisation.
- A national educational framework is required (similar to Attachment 1: UK Task Group BIM Learning Outcomes Framework), with support at the local level for BIM champions.

6. THE INTERNATIONAL EXPERIENCE



Image 8: Sam Collard (Ryder Architecture), Will Joske (i2C), Christopher Byrne (Fellow)

Visit five: BIM Regional Hub meeting, North East, United Kingdom

Contact

- Dr Mohamad Kassem, Technology Futures Institute, Teesside University, Middlesbrough, North-east England.



Image 9: Dr Mohamad Kassem (Teesside University) presenting to the Brazilian Government

Dr Kassem is a Senior Lecturer in Engineering Project Management. His research interests are in BIM, information technology and virtual reality applications in architectural, engineering and construction projects and processes. He has an international reputation in BIM.

Dr Kassem is the European Union BIM consultant to the Brazilian Ministry of Development, Industry and Foreign Trade and the Ministry of Planning, Budget and Management. He is advising about policy to overhaul the Brazilian Government's approach to major building projects. The new policy will aim to prescribe, incentivise and enforce BIM on construction projects to improve the predictability and certainty of their outcomes. Given the massive amount of construction work in Brazil, BIM efficiencies, even small ones, have the potential to save the Brazilian economy billions of reals.

Other research that Dr Kassem is involved, as a member of the Technology Futures Institute and the Centre for Construction Innovation and Research at Teesside University, includes four knowledge transfer partnerships and a three-year project in Qatar to make it a centre for BIM excellence in the Gulf, in the lead-up to the 2022 FIFA World Cup.

Objective

Interview Dr Kassem to determine educational priorities for effective BIM adoption and discover how governments are supporting industry and academics to work together.

6. THE INTERNATIONAL EXPERIENCE

Outcomes

Dr Kassem has significant knowledge and expertise about BIM and about what governments, educationalists and industry need to do next.

Considering the amount of research and consultancy conducted in the UK and Brazil, it is concerning that BIM education and skills are not better investigated. Dr Kassem believes that government BIM mandates and the expected benefits from BIM adoption are unlikely to be achieved without enough people with the skills to implement it, skills that come with education, learning and experience. With a severe skills shortage in BIM, experienced practitioners can earn three to four times their current income by moving to countries that have realised the significant benefits that BIM can bring.

In the area of education and learning, Dr Kassem provides the following advice to governments that are considering implementing BIM. As part of an educational and learning framework, the following categories in the supply chain must have structured education and learning opportunities:

1. **Government:** as the principal client, it is vital that everyone exposed to a BIM project has the knowledge and skills to understand how to procure projects using BIM. Government departments' individuals, required to procure using BIM, can be trained by innovative contractors, consultants and users of BIM to achieve this goal.
2. **Existing workforce:** There is a massive backlog of people now working in the industry who need BIM skills, delivered using strategies that suit them. This demand for BIM skills is accentuated in countries where there is a BIM mandate in place. Following a BIM mandate, a market size comparable to the UK construction industry size, would require about four to five years at least to clear this backlog. Vocational training providers are currently leading this market. It would be beneficial to organise this market through accredited/ certified training but this would be challenging due to several reasons: lack of BIM training accreditation/certification frameworks, limited input from professional bodies, and the significant and urgent demand on BIM training.
3. **Educators and Teachers:** they have the paramount task of equipping future new entrants with BIM knowledge and skills. Most higher education institutions consider the limited BIM understanding by academics and staff a key barrier to embedding BIM in the curriculum. There is a need to invest in educating existing academics and teachers. Currently, in every institution, there are a few academics with a research background in BIM, helping other teaching staff to gain BIM understanding through the delivery of continuing professional development.
4. **New entrants:** there is a need to urgently embed BIM in existing qualifications across all qualification levels and develop new ones. With the absence of noteworthy guidelines or frameworks and the limited participation of professional bodies, the current incorporation of BIM is sporadic across tertiary education especially at undergraduate levels. Academics, in collaboration with professional bodies, should develop guidelines or a framework to guide this process at collective level.

This framework can be supported through initiatives such as partnerships between educational providers, policy makers and professional bodies and incentives to attend training. Governments must actively encourage and monitor the development and implementation of this framework.

“When all working groups are voluntary... with no one in charge, things will move slowly. With no guidance, you may not always get what you want or necessarily the best outcome... BIM designated champions, shared responsibilities and an understanding of BIM adoption dynamics are needed.”

Interview with Dr Mohamad Kassem, Teesside University

6. THE INTERNATIONAL EXPERIENCE

The UK Government provides guidance and support to various components of the building supply chain (ie cradle to grave), including the following initiatives.

Knowledge Transfer Partnerships

The UK government's Department of Business, Innovation and Skills funds Innovate UK to support and connect innovative businesses to accelerate sustainable economic growth. In practice, Knowledge Transfer Partnerships is used on many BIM adoption projects in the UK when businesses wanting to adopt BIM collaborate with a university on a specific project. A university graduate is recruited and co-funded to work in the business as a cross-transfer of knowledge and skills between the university and the business. Dr Kassem is involved in four knowledge transfer partnerships.

BIM Academic Forum

Realising the need for an informed and equipped workforce, academics from all Built Environment Schools throughout the UK, established the BIM Academic Forum in late 2011. The forum comprises 60 representatives from more than 30 teaching centres in the UK and Ireland that are developing an academic framework for BIM. This framework will be a roadmap to embed BIM learning at the appropriate levels of discipline-specific qualifications. They work closely with the UK Government's BIM Task Group.

British Standards Institution PAS1192

There are a number of standards published by the British Standards Institution, equivalent to Standards Australia. These important documents include:

- PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling
- PAS 1192-3:2014 Specification for information management for the operational phase of assets using building information modelling
- BS 1192-4 Collaborative production of information. Part 4: Fulfilling employer's information exchange requirements using COBie – Code of practice.

The Construction Industry Council sponsors the specifications. The UK government has also supported the development of protocols and classifications to assist defining BIM in the progress to regulation.

The standards are available for free. The UK Government funds research, tools and data collection that is freely available to increase understanding and implementation of BIM.

BIM regional hubs

BIM regional hubs allow for grass-roots collaboration (including feedback to the government) and for dissemination of accurate and up-to-date information. They are a point of contact in a region for anyone in the supply chain that wants to know more about BIM.

Other strategies that governments and industry can support include fostering collaboration between professional associations, linking BIM skills with professional accreditation and membership requirements and licensing practitioners.

6. THE INTERNATIONAL EXPERIENCE

Key lessons learnt from Dr Kassem

- BIM is by nature collaborative and learning and training methods and environments should reflect this by bringing together a range of occupations to learn about collaboration.
- Government engagement is essential to identify champions, structure collaboration and develop BIM guides, protocols and tools (including Australian standards and inclusion of BIM in training packages).
- A BIM government mandate alone is not sufficient for ensuring a successful BIM uptake across the whole industry especially in the private sector. For example, Finland was the first country to mandate BIM, but there has not been much take-up of it by the private sector.
- Education institutes can spread awareness and knowledge of BIM by partnering with industry to use practical learning methods. For example, together they can design and deliver industry-sponsored modules in the curriculum. The participation of professional bodies in this process is also the key.
- National education guidelines based on a learning framework such as the BIM Learning Outcomes (Attachment 1) can be modified for Australian conditions and endorsed by industry.
- Relevant Australian standards should be updated to incorporate BIM and new ones may need to be developed.

7. KNOWLEDGE TRANSFER: APPLYING THE OUTCOMES

The Fellow proposed three ways to promote the findings and recommendations contained in this report:

- Present the outcomes to stakeholders, such as professional associations, Federal and State governments and training providers
- Promote the integration of the technical information into current course delivery through promoting BIM at education forums and informal networking / mentoring of teachers
- Send the report to relevant organisations, with summary information tailored to each organisation's interests.

Presentations

- Swinburne Vice Chancellor, vice presidents and faculty heads (November 2014)
- Construction and Property Services Industry Skills Council networking event
- Building Leadership Simulation Centre networking event
- Australian Construction Industry Forum (Sydney, 11 March 2015)
- Planning Minister, Victorian Government

Education integration

Assist teachers integrate key aspects of BIM into the following qualifications through attending teacher network group meetings and informally through promoting the application of BIM to specific qualifications:

- Certificate III in (trades) (for example, carpentry, bricklaying and plastering)
- Certificate IV in Building and Construction
- Diploma of Building
- Advanced Diploma of Building Design (Architectural).

Report synopsis

Report synopsis sent to:

- Master Builders Association of Victoria
- Building Designers Association of Victoria
- Housing Industry Association
- Air Conditioning & Mechanical Contractors' Association
- National Fire Industry Association
- Australian Institute of Building
- Australian Institute of Building Surveyors
- Australian Construction Industry Forum
- BuildSmart
- Victorian Advanced Building Studies Teacher Network Group.

The Fellow proposes to take up opportunities as they arise to promote the findings of the report to industry, government and educational stakeholders.

8. RECOMMENDATIONS

Industry

- Industry to promote that relevant Australian Standards (CAD/design/construct) be amended to incorporate BIM.
- A specific Australian Standard be developed to provide guidance on BIM in Australia, similar to the British Information Standard, PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modeling.
- Professional associations support a national BIM learning framework.

Education

- Construction and Property Services Industry Skills Council integrate BIM into relevant units of competency and qualification. Specific BIM units should be developed and then included in the qualifications listed below.
 - » In addition to the above, training providers who offer these qualifications should review their learning and assessment methods to include BIM as a method of project delivery. Qualifications that may benefit from this include:
 - » All Certificate III trade qualifications in CPC08
 - » CPC40508 Certificate IV in Building and Construction (Site Management)
 - » CPC40110 Certificate IV in Building and Construction (Building)
 - » CPC40912 Certificate IV in Plumbing and Services
 - » CPC50210 Diploma of Building and Construction (Building)
 - » CPC50308 Diploma of Building and Construction (Management)
 - » CPC50412 Diploma of Plumbing and Services
 - » CPC60212 Advanced Diploma of Building and Construction (Management)
 - » CPP30311 Certificate III in Property Services (Operations)
 - » CPP40611 Certificate IV in Property Services (Operations)
 - » CPP50911 Diploma of Building Design
 - » CPP50511 Diploma of Property Services (Asset and Facility Management)
 - » CPP60211 Advanced Diploma of Property Services (Asset and Facility Management).
 - The Victorian accredited course
 - » 22268VIC Advanced Diploma of Building Design (Architectural).

Government

- Governments provide leadership by:
 - » adopting a structured approach to collaboration, by identifying and funding an appropriate and respected industry organisation to perform a lead role for BIM
 - » facilitating BIM partnerships between industry and educational institutions for construction projects and research
 - » developing a BIM learning framework for clients, educators, the existing workforce and new entrants.
- The Victorian Government acts as a pilot state for implementing a mandatory BIM framework for government-funded infrastructure projects.

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Consult Australia & Australian Institute of Architects, BIM Education, BIM in Practice, August 2012

McGraw Hill Construction, The Business Value of BIM in Australia and New Zealand: How Building Information Modeling is Transforming the Design and Construction Industry, Smartmarket Report, 27 March 2014.

Succar B and Sher W, A Competency knowledge-base for BIM learning, 2013.

UK BIM Task Group, Initial BIM learning outcomes framework, July 2012.

10. ATTACHMENTS

Attachment 1 – UK BIM Learning Outcomes Framework

This is the Preliminary BIM Learning Outcomes Framework (July 2012) developed by the UK BIM Task Group. It describes the potential outcomes for learning programmes and relates to functions performed by practitioners in the industry that are facilitated or enhanced by BIM. The learning outcomes are recommended for consideration by education and training providers when developing built environment courses. The framework is delineated to focus separately on the following roles:

- Strategic
- Management
- Technical.

It is important to note that learning outcomes have also been developed in Australia, such as 'A Competency knowledge-base for BIM learning' developed by Bilal Succar.

The full framework is available at <http://www.bimtaskgroup.org/education-and-training/>

Strategic	
Overview	
O1	What is BIM
O2	BIM Value proposition (context relevant, e.g. client and contractor)
O3	What is the Government requirement from BIM
O4	Industry context of BIM adoption (e.g. peer firms)
O5	Impact to client and supply chain relationships (collaborative and coordinated)
Strategic Considerations	
S1	Strategic issues associated with starting BIM
S2	The role of Executive leadership
S3	Information deliverables; impact to procurement conditions and skills demands
S4	Developing the business case
S5	Investment model (up-skilling, systems and process management)
S6	Organisation stakeholder engagement

10. ATTACHMENTS

Management	
O1	What is BIM
A1	Developing the business case, investment and return model
A2	Organisation and Project applications, and benefits of BIM
A3	Visualisation benefits and spatial coordination
A4	Productivity/Efficiency improvements
A5	Sustainable design
A6	Scheduling, Estimating
A7	De-risking projects
A8	Facilities management
Developing Organisational Business Plan	
D1	Engaging business stakeholders
D2	Developing business goals and plans
D3	Gaining commitment
D4	Execution of plans; referencing examples
Managing external requirements	
E1	Legal implications and requirements – FOC's, agreements, appointments, SLA's etc
E2	Ownership, IP, copyright, design rights, insurances, PII, etc
E3	Risk – identifying and managing (risk registers, etc)
E4	Data deliverables to supply chain; and to clients

Managing people	
P1	Impact to internal and external roles
P2	Internal stakeholder engagement - strategic, management and technical
P3	Collaboration – management of people, communication skills, team working, etc
P4	Communicating the impact and relevance of BIM
P5	Compare examples of successful BIM organisation implementation
P6	Discuss issues associated with starting BIM
Managing process	
R1	Defining common language; BIM terminology
R2	Governance of information and process management
R3	Standards (data and process) – knowledge of and implementation
R4	Developing BIM Execution Plan – frameworks and guidance
Managing technical infrastructure	
T1	Interoperability – adherence to standards, managing compliance
T2	Hardware, Software, Network infrastructure requirements (organisation specific)
T3	Software/technology evaluation and selection process

10. ATTACHMENTS

Technical	
O1	What is BIM
Tech 1	Identifying project requirements
Tech 2	Assessing contextual data affecting potential developments
Tech 3	Developing design solutions
Tech 4	Managing design information
Tech 5	Implementing procurement processes
Tech 6	Analysing and planning construction and installation work processes and resources
Tech 7	Coordinating and controlling construction and installation operations
Tech 8	Managing project handover and facilities information
Tech 9	Assessing the condition of existing assets
Tech 10	Assessing the energy performance of buildings
Tech 11	Managing the use and maintenance of facilities
Tech 12	Managing and operating technical information systems

