BIM Education

E Education

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BIM IN PRACTICE

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BIM Education

E Education

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E Education [Version 1 – August 2012]

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PREFACE

Bilal Succar (Change Agents)
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Working Group

Building Information Modelling (BIM) is a transformative approach to designing, constructing and operating the built environment. BIM includes a wide range of concepts, tools and workflows which need to be learned and applied by industry stakeholders. BIM Education represents the process of acquiring the necessary knowledge and the required skills to generate BIM deliverables and satisfy their respective requirements.

The documents gathered here stem from the efforts of the BIM Education Working Group (EWG). The EWG started its six month mandate back in December 2011 and included 11 members, equally split between industry (practicing professionals) and academia (university/TAFE lecturers and researchers).

There are three documents in the BIM Education section. Read together, they represent the position of the EWG, an invitation for an open discussion, and a foundation for further work. Read separately, each document covers a specific aspect of our work:

- **Document E1** introduces BIM Education, the group's objectives and the structure underlying this effort. It also identifies BIM Learners and their varied requirements
- **Document E2** identifies BIM Learning providers and the current status of BIM Education
- **Document E3** introduces the BIM Learning Spectrum and a draft Collaborative BIM Education Framework

At the conclusion of each document, a summary set of BIM Educational Principles (EP)s is provided. These 20 principles highlight the group's position and provide opportunities for future discussions covering:

- **why** BIM Education is the shared responsibility of industry and academia
- **what** needs to be done to identify the BIM learning requirements of all construction industry stakeholders
- **where** best to start in a suitably comprehensive BIM learning approach
- **who** needs to participate in defining, developing and delivering BIM education
- **how** best to convert BIM educational principles into BIM learning opportunities
- **when** a BIM education mechanism can be instigated to deliver BIM learning dividends

The BIM Education working group hopes this effort resonates well with all those who stand to benefit from a collaborative approach to BIM Education. We also hope the three documents, the framework and the embedded principles instigate a fruitful discussion between - and within - industry and academia.

BIM Education

E1 BIM Education & BIM Learners

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E.1 BIM Education & BIM Learners [Version 1 – August 2012]

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INTRODUCTION

BIM is a wide array of evolving technologies, processes and policies. Identifying how to best teach or learn about BIM is still being explored by a great number of industry stakeholders. After much discussion, the BIM Education Working Group (EWG) adopted two complementary objectives. The first objective is to deliver a **Collaborative BIM Education Framework**. The second is to deliver a **BIM Education Position Paper** (this document) which describes the working group's position. Both objectives aim to:

- instigate an in-depth discussion with both academia and industry
- connect with other groups, both in Australia and internationally, engaged in developing complementary educational deliverables
- lay foundations for further work by AIA/Consult Australia and their future BIM Education partners

With the limited time and resources available to this Group, we've chosen to focus on identifying a foundational part of the Collaborative BIM Education Framework – defining the BIM Learning Spectrum (refer to **E3 – BIM Learning Spectrum** as part of this series of documents).

UNDERSTANDING BIM EDUCATION

BIM Education is the process of learning[1] the sum of conceptual and practical knowledge relating to BIM technologies, workflows and protocols. Underlying BIM Education are many technical (eg, data management), procedural (eg, team collaboration) and regulatory topics (eg, risk management). These topics need to be:

- integrated within educational curricula
- made readily available to practicing professionals

Such a broad **BIM Learning Spectrum** would serve current professionals, future professionals (current students) and the teachers/trainers who educate them (collectively referred to as **BIM Learners**).

WHY IS BIM EDUCATION IMPORTANT?

BIM Education is an effort that ranges from spreading basic awareness about BIM risks and benefits to solidifying specialist BIM knowledge and skills. BIM Education facilitates collaboration between project participants of all disciplines – and across all project lifecycle phases. BIM Education is the main communication method to spread technology-enabled, process-driven and policy-encouraged advances in design, construction and operation of facilities. It empowers current and future generations of industry practitioners to achieve increases in productivity, reduction in waste and fulfilment of an aesthetic and sustainable future.

As discussed in several national reports and international guides – refer to the *National BIM Initiative*[2], *BIM in Australia Report*[3] and *Impacts of Building Information Models*[4] – BIM Education is a foundational activity, a critical need for both industry and academia, and a priority due to the apparent skill shortage in this sector in Australia.

BIM plays a key role in facilitating more effective collaboration across disciplines during the full lifecycle of a building project. This relies on accurate exchange of 3D model data and associated information, either through the use of compatible proprietary software applications or the use of an open BIM standard like Industry Foundation Classes (IFC). At present this is based on file exchange, but in the future it is clear that shared BIM database servers will play a more significant role in supporting collaborative processes. This leads to a growing need for industry practitioners to be educated about collaborative work practices and processes that make use of BIM technologies. This should become a core component of professional design and construction education. It follows that Collaborative BIM Education is best developed in a cooperative manner involving all stakeholders, whether universities, TAFE, professional training associations, accreditation bodies and AEC organisations (referred to collectively as the BIM Learning Providers).

The BIM Education Working Group strongly believes that there is a great opportunity for academia and industry to work together to develop BIM curricula that reinforce the value of BIM within the collaborative work practices. We see that a cooperative approach to developing and delivering BIM Education to students and professionals would be a great benefit to the industry.

1 Refer to Bloom's Taxonomy (http://en.wikipedia.org/wiki/Bloom's_Taxonomy) for a wide definition of learning and learning objectives.

2 The National Building Information Modelling Initiative: *Volume 1 Strategy - A report for the Department of Innovation, Industry, Science, Research and Tertiary Education*, (2012) prepared by buildingSMART Australasia, but at the time of writing, not yet released publicly.

3 BIM in Australia, a report prepared by Star Monde on behalf of AIA/Consult Australia who conducted a number of BIM/IPD forums across Australia in October/November 2010

4 *Productivity in the Buildings Network: Assessing the Impacts of Building Information Models* prepared by the Allen Consulting Group and submitted to the Built Environment Industry Innovation Council (BEIIC) in October 2010

WHO IS A BIM LEARNER?

BIM technologies and workflows affect all those involved in the design, construction and operation of facilities, ranging across design professionals, managers and tradespeople. In this position paper, we refer to all those who want to learn about Building Information Modelling – in its widest definition – as BIM Learners.

BIM Education focuses on individual learning as opposed to organisational learning. This distinction is important as most BIM guides and national workshops focus on standards, legal implications and success stories. With the exception of training focused on technical tasks, the learning needs of individual users in the midst of this BIM-led industry transformation are not well supported. This is specifically true for a great number of individuals within both industry and academia.

Within industry

- Employees of small organisations with small training budgets – these individuals will have to depend on unstructured learning from ad-hoc sources (eg, learning from internet postings, attending user-led groups, etc).
- Employees of single-discipline organisations – these individuals will need structured guidance to develop and extend their collaborative BIM skills.
- Team managers and project leaders who require – due to the nature of their roles – adequate BIM knowledge in how to manage the deliverables of staff under their guidance.
- Managers and senior managers who are tasked with leading their organisations through the ever-changing BIM landscape.

Within academia

- Students of universities/TAFE institutions who are yet to embrace BIM Education – these students may want to prepare themselves for a working environment where data-rich models and multidisciplinary collaboration is fast becoming the norm rather than the exception.
- Lecturers within universities/TAFE institutions who are yet to embrace BIM Education – these lecturers may wish to expose themselves and then their students to BIM tools and workflows.
- Deans, heads of schools and directors who are tasked with leading their schools and departments – in response to industry's requirements – to keep abreast of collaboration technologies and workflows.
- Accreditation boards which are tasked with reviewing and accrediting universities/TAFE courses and programs.

The above simplified list highlights the varied nature of BIM Learners and their equally varied requirements. In essence, every individual who needs BIM technologies, workflows and protocols within any construction sector, at any position or role, or within a university, TAFE or AEC organisation, is a potential BIM Learner.

CONCLUSION

The accelerating proliferation of BIM within the Construction Industry prompts current and future professionals to continuously learn new technologies, workflows, and protocols. Industry stakeholders – whether they are professionals, academics or tradespeople – need to unceasingly match their knowledge and skills with evolving market requirements. All need to learn and all need to educate others.

BIM Learning includes all those affected by BIM concepts and tools; whether they are students or teachers within tertiary institutions; professionals within AEC organisations; or tradespeople on the job site. BIM Education is the sum of all these individual learners, the BIM topics they need to learn and the learning materials they require.

Summary

EP1. *BIM Education is the shared responsibility of academia and industry*

EP2. BIM Education addresses the requirements of current professionals (irrespective of formal qualification), future professionals (students) and their teachers/ trainers

EP3. BIM Education encompasses all modes of BIM Learning (tertiary courses, industry workshops, online media and on-the-job training)

EP4. BIM Education ranges from spreading awareness to developing highly specialised skills

EP5. BIM Education should be made available to all those who need it in formats which are mindful of their respective disciplines, specialities, roles, education and experience levels

EP6. Collaborative BIM Education should be developed and delivered collaboratively

EP7. Every individual within the construction industry is a potential BIM Learner, and every BIM Learner is a potential BIM Learning Provider

BIM Education

E2 BIM Learning Providers

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E2 BIM Learning Providers [Version 1 – August 2012]

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INTRODUCTION

BIM Learning Providers are all those who provide BIM Education, training and development: universities, TAFE, professional associations, Architecture, Engineering, Construction (AEC) organisations, registered training organisations, etc. The working group conducted an initial investigation into the current status of BIM Education within academia and across professional associations. Below is a summary of the findings which influenced this position paper:

BIM EDUCATION WITHIN ACADEMIA – UNIVERSITIES

A recent study – coupled with a literature review and international interviews[1] – indicated that most universities are yet to run fully collaborative BIM courses between students of the three AEC disciplines. However, there is an increasing number of universities around the world who are (a) either currently investigating BIM Education or (b) have actively initiated a BIM-focused, multidisciplinary educational curriculum at undergraduate and/or graduate levels.

In recent months and years, BIM concepts and tools have gradually started appearing within tertiary institutions (especially within graduate programs[2]). In Australia, three universities (the University of Technology in Sydney, the University of South Australia, and the University of Newcastle) are currently involved in Code BIM: Collaborative Design Education using BIM[3] – an Office of Learning and Teaching (OLT) project that aims to develop collaborative programs between AEC disciplines using BIM technologies and processes.

Introducing BIM Education into academia is a difficult change process and – like any major change process – it is likely to encounter resistance. Some of the reported difficulties include:

1. The difficulty of introducing new topics into an already crowded curriculum.
2. Unfamiliarity of lecturers with BIM and other fast-paced technologies and workflows.
3. Reluctance of some lecturers to alter established teaching methods coupled with an unwillingness by some to retrain in new topics.
4. Inability to bridge the traditional educational silos of architecture, engineering and construction and deliver collaborative courses and programs.

BIM EDUCATION WITHIN ACADEMIA – VOCATIONAL EDUCATION AND TRAINING

BIM has a potentially significant impact on the vocational education and training (VET) sector[4] – the sector responsible for training and retraining construction industry's tradespeople (carpentry, plumbing, painting, electrical, etc) and para-professionals (architectural technology, building design, surveying, etc). VET covers a range of qualifications from Certificate II (AQF 2)[5]up to Advanced Diploma (AQF 6). All of these VET qualifications, the industry roles they represent and the education they require, are significantly affected by BIM technologies and workflows.

First, para-professional qualifications (AQF 4-6) have traditionally generated technician level graduates within a wide range of discipline areas. With the advent of BIM technologies, many have taken the opportunity to develop into BIM specialists within their respective fields and currently play diverse and increasingly important roles. A great number of modellers, model managers, BIM project coordinators and BIM managers have their roots in para-professional education. Also, in addition to the knowledge and skills para-professionals need to operate within their chosen specialities, VET trainees must now learn how to use data-rich models and other technologies to collaborate with their peers, tradespeople, and AEC professionals. New BIM-focused courses now need to be developed to ensure para-professionals are 'industry ready' at graduation – courses which necessarily include hands-on, collaborative and multidisciplinary project work.

Second, at trade qualification levels (AQF 2-3), the increasing availability of accurate, information-rich models is starting to impact the construction site. While many in the steel detailing and mechanical ducting professions have been using 3D CAD for many years (especially for offsite prefabrication), BIM has highlighted the need for a tighter coordination between many trades and specialties. This in turn has dramatically increased the need for highly trained technicians with additional experience in model interrogation, clash detection, construction sequencing and quantity take-off. These skills should now be included in trade certificate courses so trainees benefit from available BIM technologies and can collaborate efficiently with professionals, para-professionals, product suppliers and others within the construction supply chain.

1 This is based on a recent investigation conducted by Jennifer Macdonald, an EWG member and PhD candidate at the University of Technology, Sydney.

2 For example, refer to BIM Education programmes in the UK: MSc/Dip/Cert *BIM and Integrated Design* (University of Salford - http://bit.ly/LHIetA), and the recently announced *MSc Building Design Management with BIM* (Northumbria University - http://bit.ly/LHIbhe).

3 For more information, refer to University of South Australia, *Code BIM* project page - http://bit.ly/sZFArR.

4 The VET sector includes Training and Further Education (TAFE) institutions, Registered Training Organisations (RTO)s, Continuing Professional Development (CPD) providers.

5 The Australian Qualifications Framework (AQF) is 'the national policy for regulated qualifications in Australian education and training. It incorporates the qualifications from each education and training sector into a single comprehensive national qualifications framework.' For more information about the Australian Qualification Framework, please visit http://www.aqf.edu.au/.

BIM EDUCATION WITHIN INDUSTRY – PROFESSIONAL ASSOCIATIONS

Professional associations can play an important role in promoting BIM Education within both academia and industry. Some of these associations provide course accreditation, certification and/or Continuing Professional Development (CPD) programs.

To develop a better understanding of the attention professional associations give to BIM Education, the EWG conducted an introductory investigation (online and phone interviews) covering 12 associations. From this initial investigation – which focused on CPD programs - we learned the following:

1. Eleven of the 12 associations offer Continuing Professional Development (CPD) courses to their members. Of these, most indicated an awareness of BIM, three indicated that they include BIM in their learning activities (presentations by guest professionals), and one association reported that they currently offer BIM-specific training as part of their CPD program.
2. Most professional associations seem to have adopted a wait-and-see approach. Some are learning from each other – especially from those who have recently developed a BIM-focused set of deliverables and most indicated a keen interest in learning more about BIM Education.

BIM EDUCATION WITHIN INDUSTRY – ORGANISATIONAL TRAINING

BIM training within organisations is another important aspect of BIM Education. Driven by immediate business benefit, many design, construction and operation companies offer their staff the necessary training to generate and share data-rich models with their project partners. Training offered – whether on-the-job or through registered training organisations – is mainly technical, focused on cultivating the skills necessary to use BIM's ever expanding repertoire of tools and workflows. However, other types of training are less frequently provided-training which targets the soft skills necessary to manage multidisciplinary teams and deliver collaborative BIM projects (eg, team management skills, meeting facilitation, conflict resolution).

While some organisations prefer to offer their own customised, in-house BIM training, many would argue (especially those with limited training budgets) for integrating BIM Education/training within universities so students are industry-ready by the time they enter the employment market. Others would also argue that professional associations should make available non-technical BIM training for managers and senior staff (eg, project leaders, team managers). Such training is not available on demand but through irregular BIM-focused conferences and workshops.

CONCLUSION

There are many stakeholders involved in the provision of BIM Education. Within academia, universities and TAFE institutions have already started to deliver a range of BIM course offerings. Within industry, professional associations have also started – albeit slowly – to offer BIM leaning opportunities to their members through their varied CPD programs. Driven by market imperatives, AEC organisations have continued to invest heavily in BIM training with a clear focus on developing staff's technical capabilities. In summary, although much progress has been made over the past few years, much effort is still needed to extend BIM education across professional boundaries and to encourage stakeholders to embrace a more collaborative approach to BIM learning and project delivery.

Summary

EP8. BIM adoption within industry and academia is a significant change process (technical, procedural, cultural) which requires a significant investment in systems and people.

EP9. Accreditation and professional associations should engage with universities to develop new collaborative BIM courses or to integrate the principles and technologies of multidisciplinary collaboration into their existing curricula.

EP10. Tradespeople and para-professionals stand to benefit and contribute to BIM and its wide-ranging effect on project lifecycle phases and construction supply chains. The VET sector should incorporate data-rich models and multi-party collaborative workflows into educational curricula and delivery strategies.

EP11. There is need to de-mystify the BIM process and develop integrated, coordinated and viable BIM training modules delivered via professional associations. These training modules should align with university/TAFE curricular and tightly complement their educational deliverables.

EP12. There is a need for BIM-ready graduates. Availability of adequately prepared graduates will minimise (or at least refocus) the training delivered by AEC organisations.

EP13. There is a need for regular BIM Learning opportunities and non-technical BIM learning materials, specifically tailored for senior and executive staff.

EP14. There is a need to consider how to assess and improve the BIM knowledge, skill and experience of current professionals, para-professionals and tradespeople.

BIM Education

E3 BIM Learning Spectrum

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E3 BIM Learning Spectrum [Version 1 – August 2012]

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INTRODUCTION

The BIM Learning Spectrum is composed of all BIM topics (technical, operational and managerial), across project lifecycle phases, and specialities. Depending on the perspective adopted, these topics can be identified as learning topics, teaching subjects or individual competencies. This paper adopts the perspective of the learner and will use the term individual **BIM Competencies**[1] to represent the granular elements within the broad BIM Learning Spectrum.

1 BIM Education focuses on individual attainment of BIM skill and knowledge. Every BIM subject matter – if used within the context of educating/training individuals – will be referred to as a BIM competency.

UNDERSTANDING INDIVIDUAL COMPETENCIES

The BIM Learning Spectrum includes all that should be learned about BIM technologies, workflows and protocols. It is the combined list of all learnable BIM subject matter within construction disciplines and roles; the ever-changing sum of individual BIM competencies which industry practitioners and students need to learn.

According to the US Department of Education, a competency is a 'combination of skills, abilities, and knowledge needed to perform a specific task'[2]. Using this definition as a base, a BIM Competency is the combination of conceptual knowledge, BIM skills (practical knowledge) and experience necessary to perform a BIM-related task.

2 Refer to Defining and Assessing Learning: Exploring Competency-Based Initiatives (2001), the US Department of Education; National Center for Education Statistics, page 1. Note that the Australian Qualification Framework (AQF) indirectly defines the term competency as follows 'Training Packages use competency standards to describe the skills and knowledge needed to perform effectively in the workplace' – refer to AQF Certificate I Guidelines.

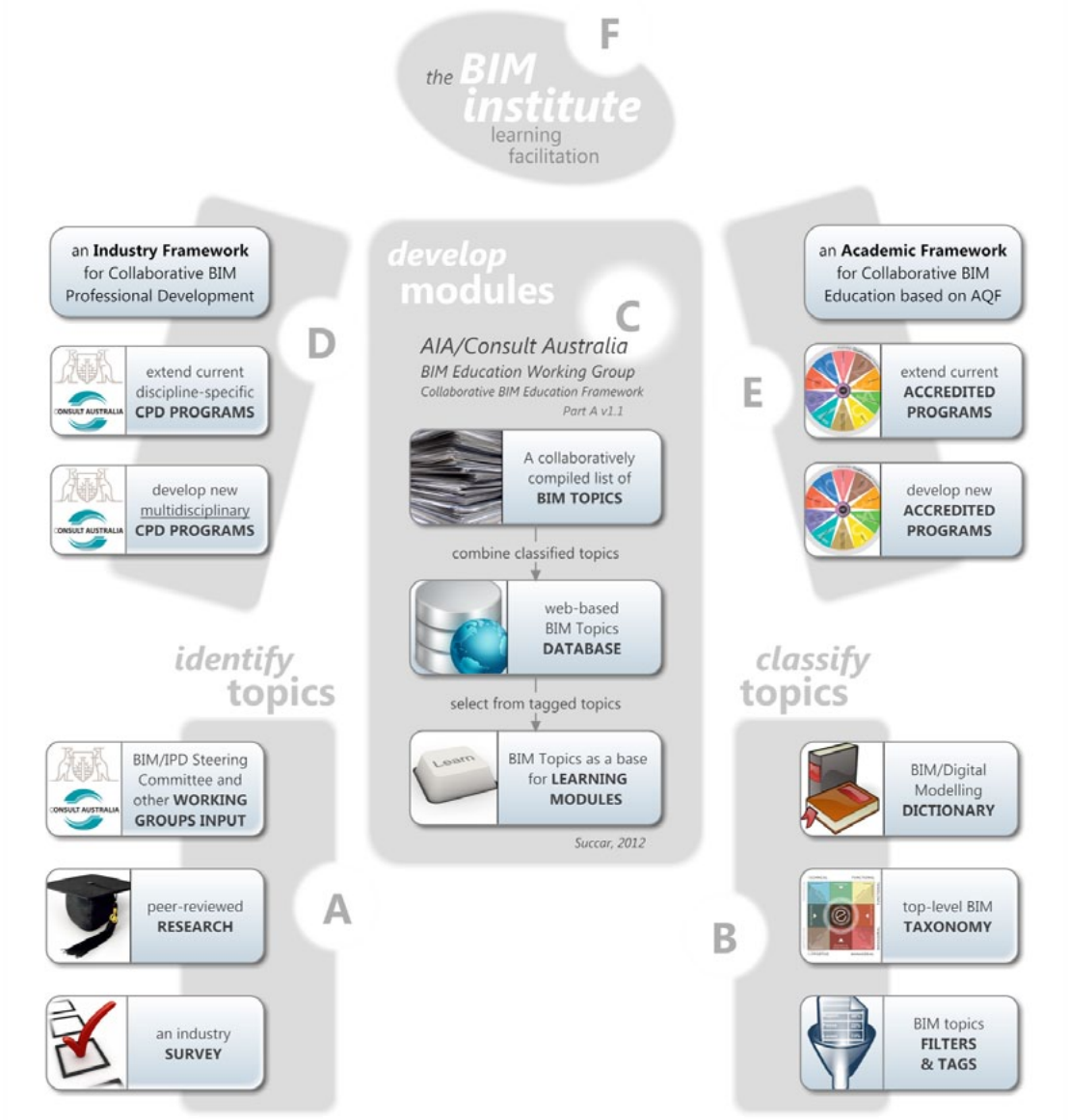

Figure 1. Collaborative BIM Education Framework Part A v1.1

There are hundreds or even thousands of BIM Competencies which can be learned by individuals involved in the design, construction and operation of the built environment. These individuals range in their position of responsibility and role within the construction supply chain. For example, an architect implementing a spatial program within a hospital model will require a different set of competencies from an engineer performing thermal analysis on those spaces. Also, the competencies needed by a junior modeller during their day-to-day activities are quite different from those required by a team manager responsible for coordinating the efforts of many individuals.

For BIM competencies to be defined in a useful manner, they need to be organised against overlapping criteria: disciplines, specialties, roles and levels of practical experience. Some classifications which can be used to organise BIM Competencies already exist (eg, OmniClass Table 33 – Disciplines) while others need to be specifically developed. In organising competencies, the EWG acknowledges that:

1. Some BIM Competencies will be applicable across several disciplines and roles while other competencies will be specific to a single discipline or role.
2. The same BIM Competency may be delivered and measured differently by each BIM Learning Provider. A university may, for example, use Bloom's taxonomy as a basis to deliver and measure student learning, while an AEC organisation may use a simpler three or five-scale model. To account for this variation between different BIM Learning Providers – and particularly between academia and industry – the process of identifying BIM topics or competencies should be kept separate from the process of measuring them.

DEFINING THE BIM LEARNING SPECTRUM

The Collaborative BIM Education Framework intends to generate discussion within and between industry and academia. As a first step towards generating a comprehensive approach, this paper introduces a partial framework (refer to Figure 1) subdivided into six main components:

Component A. Identifying BIM Competencies

The framework highlights three main ways to identify BIM Competencies:

- A seed set of BIM Competencies has already been identified by this Working Group[3].
- BIM Topics and Competencies will be identified through reviewing peer-reviewed literature, benefiting from relevant educational frameworks (refer back to Document E2 – 2.1 & 2.2), and surveying the educational requirements of participating institutions.
- BIM Topics are identified through a survey, a set of workshops and discussions with industry and by harvesting the knowledge of different groups through their representative associations.

Component B. Classifying BIM Competencies

For BIM Competencies as a basis for BIM Education, they should be clearly and consistently defined:

- A BIM dictionary to clarify BIM terms and acronyms across all topics. It will structure the syntax governing BIM Competencies (how a competency is named, defined, abbreviated, etc).
- A top-level taxonomy (a classification) to organise all BIM Competencies under a single hierarchy. This is important to collect all current and future learning topics in one structured list.
- A number of BIM labels (eg, role groups, disciplines, difficulty levels, delivery modes, etc) to organise BIM Competencies against several criteria (a faceted classification).

This may be better understood by referring to the sample table following:

3 A list of seed individual BIM Competencies may be published online at a later stage. Please visit the BIM Education page on the AIA/Consult Australia website - http://bim.architecture.com.au/.

BIM TOPICS (competency)	TAXONOMY (competency class)	TAGS or LABELS					
		Discipline	Sector	Speciality	Role Group	Difficulty	Delivery
Understanding Typical BIM Collaboration Workflows	F (Functional)	33 (all disciplines)			2 (Team Managers and Project Leaders)	3	Online Video
Legal Implications of Using Models as a Primary Source of Design Information	A (Administration)	33-21 (Design)	All		1 & 5 (Operational Management and External Service Providers – Legal)	4	Online Video, Workshop, Pamphlet
Developing and Managing Object Libraries	I (Implementation)	33-21	All		4 (BIM Managers)	2	Workshop

TAXONOMY: the sample used here includes nine mutually exclusive classes. Each BIM Topic can exist under one class only.

TAGS: each BIM Topic can be tagged indefinitely. Tags are flexible, non-exclusive labels which are used to organise and then filter competencies. **Discipline, Sector and Speciality** are tags based on OmniClass Table 33 (listed as Title Level 1, 2 and 3 respectively – Title Level 4 is not used here). OmniClass is an open standard developed by the Construction Specifications Institute (CSI). **Role Group** is a sample taxonomy to identify target audience based on their organisational roles. **Difficulty Level** is a sample scale applied to each BIM topic to indicate prerequisite levels of knowledge, skill, and experience (e.g. Difficulty Level 1 topics focus on 'BIM awareness' and have no prerequisites). **Delivery Mode** identifies the recommended format(s) for delivering a BIM topic to a target audience.

Tabel 1.

BIM Learning Modules (Target Audience)	**BIM Topics Included** (Competency Class)	**Delivery Level** (Delivery Method)	**Prerequisites**	**Optional Tags**
BIM Project Facilitation (Project Managers, Clients, Facility Managers)	**Developing a BIM Management Plan** (Implementation)	**Level 1** (workshop)	Understanding BIM Workflows	Workflow Management, Team Management, Conflict Resolution, etc...
	Understanding Data Exchange Protocols (Functional)	**Level 1** (presentation)		
	Understanding Model Progression Specifications (Technical)	**Level 2** (workshop)		
	...Other			
Model Management for Collaborative Projects (BIM Managers, Senior Technical Staff)	**Understanding Data Exchange Protocols** (Functional)	**Level 3** (online presentation)	BIM Managers, Technical	Data Management, Technical Roles, Auditing Protocols
	Model Auditing for Model Managers (Technical)	**Level 2** (lab)		
	...Other			

Tabel 2.

Component C. Collating Competencies & developing BIM Learning modules

The number of BIM Topics required by BIM Learners (refer back to Document E1) is quite large in number. To enable BIM Learning providers and other industry stakeholders to collate and classify BIM Competencies, a dedicated information system is needed. The EWG believes that an online **BIM Learning Hub** – a web-hosted database – is the most efficient way forward. With an adequate database structure and intuitive interface, the Learning Hub will be able to streamline the process of collecting and classifying BIM Competencies.

The online system will also be instrumental in developing **BIM Learning modules** – a collection of BIM Competencies, intended for delivery to a specific audience at a selected level of difficulty. The content and **delivery format** (course, lab, workshop, video) of each learning module depends on which group of BIM Learners are being targeted (an undergraduate student, a tradesperson, a construction manager).

BIM Learning modules can either be standardised (for the purpose of course accreditation) or customised by each BIM Learning Provider to match their constituent members. While all modules use the same BIM dictionary definitions and taxonomy classifications (as discussed in Component B), they can vary significantly in how modules are packaged and delivered to learners:

Component D. An industry framework for professional development

As discussed in Document E2, many organisations and their representative bodies already deliver **BIM Learning and accreditation opportunities** to their staff and constituent members. However, to deliver the needed **Collaborative BIM Training and Development** to current professionals across disciplines and specialities, there is a need to develop a **BIM Education Cooperation Framework** between industry associations. Such a cooperation framework – even if partially subscribed to – will allow the generation and joint delivery of much needed, collaborative BIM Learning modules (in the form of Continuing Professional Development courses or similar). A well-structured and accessible BIM Learning Hub will facilitate such cooperation and allow practitioners to contribute towards and make good use of discipline-specific and multi-disciplinary BIM Learning modules.

Component E. An academic framework for BIM Education

Tertiary institutions are facing specific challenges as they adopt ever-changing BIM technologies and multidisciplinary workflows (refer back to Document E2). Specialised academic frameworks for BIM Education will be needed to enable academic institutions to contribute to and benefit from the BIM Learning Hub. Such frameworks exist today (eg, the OLT project identified in Document E2) and can play an important role in aligning the deliverables of this collaborative framework with the specific requirements of tertiary education. Jointly identified and developed BIM Learning modules – customised for university lecturers or graduate/undergraduate students – can play an important role in facilitating the introduction of BIM topics into schools and faculties.

Component F. The BIM Institute

The Collaborative BIM Education Framework requires a substantial effort to implement. It also requires a well-coordinated, long-term commitment by industry stakeholders. In alignment with buildingSMART-Australasia's National BIM Initiative, the Education Working Group acknowledges the need for an organised effort – a National BIM Institute, BIM Academy or similar – to facilitate the development and delivery of BIM Education across industry[4]. The education-focused tasks assigned to such an institute should be collaboratively defined by all BIM Learning Providers – but may well include:

- Develop and maintain classification systems for organising BIM Education
- Develop and maintain the BIM Learning Hub
- Develop a coordination framework between professional associations for the purpose of multi-disciplinary BIM training and development
- Initiate BIM collaboration labs for sharing knowledge and testing new workflows
- Conduct BIM-usage surveys and publish relevant papers and reports
- Act as a central social space for all BIM Learners and BIM Learning Providers

To reiterate the importance of the Collaborative BIM Education Framework introduced above, the three BIM facets (the BIM Leaner, the BIM Learning Provider and BIM Learning Spectrum) are combined into a simplified yet typical scenario:

> Each BIM Learning Provider (a university, TAFE, professional association) has (a) a unique interest, ability and approach in delivering (b) a selected part of the whole BIM Learning Spectrum to (c) a targeted subset of BIM Learners.

> For example, a professional association (a Learning Provider) representing cost planners may be interested in delivering a CPD Program to their members (cost planners – a type of Learner) titled 'IPD from a Cost Planning Perspective' (a BIM Topic within the overall Learning Spectrum). However, the same professional association may not be well placed or interested in delivering other topics needed by the same learners. For example, 'Cost Estimation for Algorithmic Structures' and 'Cost-Estimation using [Software Name]' are better delivered through a tertiary course and a registered, online training video respectively.

Using the example above, it is in all stakeholders' interest to participate in a Collaborative BIM Education program which allows them to focus on developing their unique abilities and rely on other Learning Providers to deliver the complementary BIM topics needed by their constituents.

CONCLUSION

The BIM Learning Spectrum includes all topics that need to be learned by various BIM Learners – irrespective of their discipline, role or formal qualification. At the core of the BIM Learning Spectrum are thousands of individual BIM competencies – the granular learning topics underlying the many discipline, sectors and trades. Using a specialised taxonomy, these individual competencies can be collated into BIM Learning Modules, each customised to match the requirements of their target audience. The BIM Education Framework, introduced in this paper, proposes how to identify, organise and collate these competencies and modules. It also identifies two additional and complementary frameworks intended to encourage the proliferation of collaborative BIM education across professional associations and academic institutions. The framework finally proposes the formation of a BIM institute, an entity which can play an important role in promoting and facilitating BIM learning throughout industry and academia.

4 Such an institute will have many other objectives beyond BIM Education (eg, lobbying, communication, etc)

Summary

EP15. There are many BIM competencies which need to be learned by individuals involved in the design, construction and operation of facilities

EP16. A collaborative CPD program is an integral part of the Collaborative BIM Education Framework.

EP17. A web-hosted, socially connected BIM Learning Hub at the core of the Collaborative BIM Education Framework is needed.

EP18. A BIM Learning Module is a collection of BIM topics, customised for a target audience, and delivered at a defined level of difficulty.

EP19. An academic framework informed by research, discipline professionals and other industry stakeholders is a pre-requisite for delivering Collaborative BIM Education within tertiary institutions.

EP20. The establishment of a well-structured and well-funded BIM institution is essential to facilitate the development and delivery of Collaborative BIM Education across the construction industry