Soft skills requirements in a BIM project team

Kathryn Davies, kdav035@aucklanduni.ac.nz
The University of Auckland, New Zealand

Dermott McMeel, d.mcmeel@auckland.ac.nz
The University of Auckland, New Zealand

Suzanne Wilkinson, s.wilkinson@auckland.ac.nz
The University of Auckland, New Zealand

Abstract
Building Information Modelling (BIM) offers the possibility of prototyping building design and construction options in a simulated system, before construction begins, offering the potential for improvements in productivity, product quality and sustainability. In addition, the information resulting from the design and construction process can be transferred for use in the ongoing management and operation of the building. Underpinning these promised improvements is the understanding that BIM project teams need to embrace collaboration and work as more integrated units in order to achieve them. Through an analysis of interviews with BIM practitioners from New Zealand, Australia and the Netherlands, this paper explores the various BIM roles within projects, and the associated skills that are needed for successful BIM adoption, and development and delivery of BIM projects. Interviewees placed significant emphasis on skills such as communication, conflict management, negotiation, teamwork and leadership as important components of a BIM project. They also considered that these skills are generally overlooked in common definitions of the competences of a BIM practitioner, and in existing education and training opportunities.

Keywords: soft skills, personnel management, BIM, project teams

1 Introduction

The discussion around the importance of soft skills in the workforce, the difficulty of defining them and of identifying training approaches for their development is not new, nor is it limited to the construction industry. However, the recent emphasis on collaborative practice within Building Information Modelling (BIM) and integrated project delivery frameworks has brought it back into prominence in the construction industry (Eynon 2011). In the past few years, BIM has become an internationally established phenomenon. The benefits of virtually prototyping a building design and its construction process prior to development on site have been widely recognized (Bryde et al. 2013). The advantages of such a practice are presented as including enhanced coordination between project parties, better resolution of design, and more consistent documentation, all of which lead to better productivity on site and improved quality in the final building product. Following on from the design and construction stage, the improved documentation and knowledge generated for the building can contribute to more successful operation and occupation of the facility.

Much of the focus of BIM development has been on refining the software tools and technical structures required to deliver the enhanced outcomes promised by the technology (Miettinen and Paavola 2014). More recently, efforts to develop coherent education programs and BIM curricula have been evident, again with a considerable emphasis on software and technical elements (Sacks and Pikas 2013). Less attention has been given to the development of the non-technical capabilities of the people involved, although these are widely acknowledged to be an important part of the BIM process, and are sought after by employers (Zhao et al., 2015).

1.1 Defining soft skills

Although industry leaders and commentators often call for soft skills, both in the context of BIM and the wider construction industry, it is difficult to establish just what is meant by the term. Very few reports provide a definition or offer specific examples of the nature of the required skills or attributes. The Built Environment 2050 report (BIM2050 Group, 2014), for example, notes that "…it appears that the sector's inefficiency manifests from a lack of soft skills and poor cultural integration of education and skills, such as interdisciplinary teams and emotional intelligence" (p4). However, in defining the skills that the industry will require in the future, technical skills are defined in some detail but soft skills are not further elaborated. Sumner and Slattery's (2010) list of soft skills is more specific, and includes "effective time management practices, ability to provide effective solutions to conflicts, ability to maintain good relationships, and ease in helping to solve personal problems" (p182). This list aligns with the definition of Hurrell et al. (2012, p162), who describe soft skills as "non-technical and not reliant on abstract reasoning, involving interpersonal and intrapersonal abilities to facilitate mastered performance in particular contexts." As such, soft skills may be considered to include elements identified by other authors as personality traits (Succar et al., 2013), emotional intelligence (Love et al., 2011), interpersonal skills (Sacks and Pikas, 2013) and managerial skills (Edum-Fotwe and McCaffer 2000).

Other descriptions of soft skills use terms that are discipline-specific and arguably technical in nature. For example, Zerjav et al. (2013, p132) call for the embedding of "soft skills of frame identification, enforcement, and anticipation into the body of design management knowledge", where these skills are firmly grounded in design management practice. Similarly, the CIOB Skills report (CIOB, 2013) includes "soft skills (e.g. admin)" in a list of skills required by the industry. No definition is provided of which administration skills might fall within the soft skills category, nor of how these might differ from technical or IT skills, for example. "Communication and negotiation skills" and "Leadership skills", both often considered within the category of soft skills, are listed separately.

1.2 Competencies, culture and maturity levels

In the wider discussion around the development of BIM capability in the construction industry, there are a number of proposals for benchmarking and assessment of maturity levels and competencies of BIM practitioners, organizations and project teams. Most of these include a reference to some form of soft skills requirements in the project team, but again are less forthcoming in defining the required attributes or in providing detail on how they are to be measured or developed. For example, Sebastian and van Berlo (2010) detail mentality and culture, including individual and organizational motivation, as an element of maturity assessment. Succar et al. (2013) includes personal traits and characteristics as factors in measuring competencies.

2 Data collection and analysis

As part of a broader study on the impact of BIM on industry roles, relationship and skills, interviews have been carried out in New Zealand, Australia and the Netherlands with 45 BIM specialists from a variety of disciplines and company types. To be considered a BIM specialist, the participant either has a formal job description involving BIM or is identified by their peers as the BIM champion in their company. The sample comprises individuals who work for architects, project managers, engineers (structural and MEP), general contractors, documentation specialists, facilities managers, sub-contractors and fabricators. While most of the companies were involved to some extent in "social BIM", where collaboration and information exchange took place within wider project teams, many were also using "solo BIM" where modelling, simulation and analysis are used to inform the decision making within a single part of the design and construction process, usually because other project participants were unable or unwilling to share models and associated information.

The participant-led interviews explored the impact of BIM on professional roles and relationships in the wider construction industry across a range of topics, including industry background, skills development, practice and project-based responsibilities and roles, industry networks and relationships, career trajectory and expectations. The presented discussion is based on preliminary analysis of these interviews, and focuses on soft skills as one aspect of the data collected.

2.1 Key roles and characteristics of BIM specialists

Given the general description used in seeking participants for this study, the BIM specialists interviewed come from a wide variety of background disciplines, and represent company roles from technician level through to senior management. As a result, their work focuses on many different combinations of strategic, process and technical responsibilities. This provides a good representation of the spectrum of roles in which BIM specialists are employed, and the types of skill sets aligned with those roles.

The BIM specialists interviewed can be broadly categorized in five types. At the most senior level are the directors or senior managers who have responsibility for determining the direction of BIM practice within their company. These people are generally established practitioners, and thus well versed in their discipline, as a result of substantial practice experience. Management activities are also clearly a significant element of their role. Most have little or no skills with BIM software, but are very enthusiastic about the use of BIM within their companies and strongly support their staff in developing such skills. They see themselves in a BIM leadership role, both within their own organization and in the wider industry.

The second group are the BIM managers and coordinators who manage BIM processes at a project level. They tend to have a discipline-based background and hold a mid-level position within their company. Their responsibilities are across BIM process setup and execution for projects, coordination and quality assurance within project models and model exchanges, ensuring that models produced are fit for purpose and managing consistency of models from different parties. Their strength tends to lie in their knowledge of their discipline and the wider industry, though most have advanced BIM software and process skills to manage the task required, and good interpersonal skills for managing the people and processes involved in the project.

The third group of BIM specialists are the BIM managers who have a primarily practice-based role. They develop and implement BIM processes and standards within their company, often manage in-house training, and are the first point of call for trouble-shooting technical problems faced by others. In some cases they are directly involved with model creation and management at a project level, but all who had this as part of their role identified that this became a problem as the project-based work often takes priority and prevents them from giving proper attention to their process activities. Those in this role tend to be from a technical background, and their strongest skillset lies in BIM software and processes. However, they also require interpersonal skills, especially for the training aspect of the role, and usually have developed construction knowledge through their project experience.

The fourth group have a strong BIM-technical focus, and work primarily in model creation. In companies that are new to BIM adoption these people are often expected to move into the practice-based BIM manager role. They may lack discipline experience and have limited management and interpersonal skills, and are likely to have been employed on the basis of their knowledge of BIM software and standards. In some cases, these people have come from a construction background and have been diverted into a specific BIM role due to their proficiency with the software.

The fifth group exists alongside these BIM-specific roles in the more traditional industry roles, such as architects, engineers, contractors, etc., who are also required to operate within a BIM environment. Interviewees in this category do not usually consider themselves to be BIM specialists, but were identified by others as BIM leaders in their company because of their experience of working on BIM-mediated projects. Their strength is primarily in discipline-specific skills, and interpersonal skills for managing projects and project interactions are also required. Knowledge of BIM software is generally weak; as described by one participant in this category, "I know what it does, but it's not me that does it".

2.1.1 Job descriptions and role definitions

Very few of the BIM specialists interviewed said they had a formal role description that incorporated their BIM activities. Some form of BIM manager, BIM coordinator, or BIM specialist was the central aspect of the job title for just 12 of the 45, with a further 3 identified as BIM/CAD Manager, and 2 as Revit Manager. The rest of the participants were identified by a discipline-specific title (e.g., senior architect, project manager, quantity surveyor, architectural technician) which did not acknowledge their BIM specialist role. Many of the interviewees noted that their title did not accurately reflect their current activities in this regard, but a number also felt that it was important that they were not

characterized as a BIM specialist. They considered the wider industry to perceive BIM specialists to be "techies," usually at the technician level and limited to BIM software and standards.

3 Findings

3.1 Skill sets within BIM environments

Within the context of the interviews reported in this study, skills are grouped in three categories: soft skills, used here to mean personal and interpersonal management skills; BIM-technical skills, which relate to the use of modelling and associated software, BIM standards and frameworks, and technical aspects of information exchange and management; and discipline-specific skills, which relate to knowledge of construction, project and practice processes and techniques.

3.1.1 Soft skills

Personal and interpersonal management skills were rarely identified by BIM specialists as specific skills requirements within a BIM team, but more detailed exploration of the roles and relationships in a BIM environment brought out numerous characteristics that can all be categorized under this heading. Almost across the board, the response in the interviews to the question "What is the current roadblock to better BIM practice?" was "People". Following up on this revealed a variety of people-related issues that needed to be managed. In many cases the leading issue was change management and resistance to change. Successful project teams in a BIM environment require people who are flexible, open to new ideas, willing to discuss problems and negotiate solutions. As such, many of the skills required for successful project teams in a BIM environment are focused around soft skills.

Several interviewees stated that when making appointments they select candidates based primarily on communication skills, personal traits or personality; "I hire for personality, never hire for technology. That's skills to be learnt."

3.1.2 BIM-technical skills

Although BIM-technical skills would appear to be a primary consideration in BIM roles, almost all of the interviewees agreed that it was the least important skill set, and meant nothing unless it was supported by discipline-specific skills and soft skills. One respondent stated that in their company they "have no place for someone who just knows the software", and this sentiment was echoed by many others. Project teams were commonly selected on the basis of which people contributed the appropriate discipline expertise, and were the right "fit" for the team. BIM-technical skills were considered easily teachable to anyone who had the right attitude, and thus were just seen as an overlay to the other skill sets. In some organizations there was a role for those with purely BIM-technical skills, but this was viewed as a limited position that had little opportunity for development within the industry or for wider project involvement. "There is a role… as long as you know their strengths and weaknesses you can have them in the group and make sure that we do the process work around them and they can just carry on with what they like."

Companies which were focused on employing staff specifically for their BIM-technical skills were seen as immature BIM environments. This opinion was commonly expressed by those whose companies had previously adopted this practice but later moved on to more integrated BIM training where all staff were expected to work within a BIM environment, but in some instances by BIM specialists in companies where this approach was still currently in place. The focus on BIM-technical skills for their own sake gave rise to concerns about the flexibility of the resulting BIM environment, and staff responsiveness to project challenges. Adding BIM-technical skills on top of the other skills was considered a more robust approach. "There's no other way than that these traditional roles make the step to BIM. Because you need their in depth knowledge, of their part of the construction process. They have to use the BIM technology. And not have a certain person that is very handy with the tools and knows how to push the button, doing the work."

3.1.3 Discipline-specific skills

Considerable emphasis was placed on the need for good underlying industry knowledge. The idea that a person could become a BIM team member without a thorough understanding of construction was rejected by many interviewees. "If they want to be in BIM, first they have to be an engineer or a construction manager or an architect. After that they can be the BIM guy. But not without the background." Most of the BIM specialists interviewed were heavily involved in training and support

roles within their company, in which they assisted other employees in expanding their discipline-specific skills into a BIM environment.

3.2 Identified soft skills for BIM project teams

While the BIM specialist plays an important role in company and project implementation of BIM, other members of the project team are also operating within a BIM environment and need to have appropriate skills to function in that context. When asked what personal and interpersonal characteristics were most necessary in project teams, interviewees identified a variety of skills as particularly important within a BIM context, with some distinctions between what was necessary for a BIM specialist and for the wider project team. The most commonly described skills are explored here.

3.2.1 Communication

The ability to communicate well was foremost in the characteristics of a good BIM specialist, and also the most frequently cited skill required in BIM project teams. Communication, whether through oral, written or visual media is a fundamental skill in any construction project, but BIM projects were seen to have a particular need for skilled communicators. The use of BIM on projects increases transparency in project contributions, making each person involved explicitly responsible, at some level, for the project delivery. This requires team members at all levels to work with other participants in the wider project, to a much greater degree than in non-BIM projects. "There's a high level of interaction… Building those relationships in a project is just as important [as technical aspects]"

A distinction was drawn by some interviewees between communication and collaboration, with communication being used to mean simply passing on information rather than involving any deeper conversation about information requirements, resolution of issues or ongoing exchange processes. In this sense, communication skills in BIM projects can be considered a combination of soft skills together with the BIM-technical and discipline-specific skills required to make them effective.

3.2.2 Negotiation and conflict management

The collaborative nature of BIM projects gives rise to the potential for conflict over roles and responsibility, particularly at the outset of a project when these are being defined. The BIM specialist in particular is often called on to lead the development of BIM project protocols and execution plans, which requires negotiation skills to help the various project contributors to come to an agreement. However, all of the project team members have to work with this throughout the project as responsibilities are revisited and adjusted along the way.

Clash avoidance and clash detection processes can give rise to conflict between various parties to the project. In contrast to traditional project processes, such conflicts are more commonly resolved at an individual level within a BIM framework. As a result each member of the project team must be involved in managing conflict and negotiating solutions to problems, rather than relying on project leads in a more adversarial approach, as was previously the case.

3.2.3 Authority and leadership

Not every member of the project team needs to display leadership in the wider project context, but leadership more generally was a commonly identified soft-skill requirement in a BIM environment. In any construction project each person can be considered to have their own areas of responsibility, but interviewees felt that that this is accentuated in a BIM project team where project decision making is made in the context of a shared information model. In developing BIM environments, this is a particular issue. Each member of the team has to be able to lead the development of their own contribution and be authoritative in defending their information and process. Where team members are hesitant or insecure in their role and contribution, there is a risk that others may override their involvement and circumvent the process, or revert to previous methods of working instead of following agreed protocols.

3.2.4 Attitude

Although attitude cannot really be defined as a skill, many interviewees suggested that it was an important aspect of personal interactions, and the right attitude ranked alongside communication skills as a required skill of members of a BIM project team. When asked to explain what they meant by "good attitude", interviewees had similar descriptions. An openness to learning and developing

new skills was seen as core. Challenging the status quo and looking for improvements on current practice were also linked to this.

A related attitude, required particularly in the early stages of BIM adoption in an organization, is for team members to have a sense of self-confidence and security in their own ability. Several interviewees had stories of staff or co-workers who were apprehensive about their competence or anxious about the level of responsibility they had to assume in a BIM project context, and so were unwilling to take part.

3.3 Soft skills development

Respondents were not unified on what they considered to be the appropriate pathway for developing soft skills, for themselves or for prospective BIM specialists or other project team members that they might employ. Some had made conscious efforts to improve their own management and associated soft skills with training courses and education programs. Others were quick to acknowledge their shortcomings in the area but had not had the opportunity to develop or were unsure of how to do so. Different approaches were offered in how personal or team members' soft skills could be developed.

3.3.1 Personality

One school of thought is that soft skills are innate, part of the personality, and so can be developed if a person already possesses them but cannot be instilled if they are not already present. Participants discussed personality traits such as introversion and extroversion in this context. One respondent suggested that a shy or quiet person could be good at the technical side of BIM, but was likely to struggle with much of the management aspect of the role which required projecting an air of authority.

Many of the soft skills factors listed by participants as being based on attitude could arguably be considered personality traits rather than skills which are able to be isolated and learned. Characteristics such as willingness to accept change, openness to learning and developing new skills and relationships, self-confidence and a social and sharing outlook are all difficult to evaluate and may be comprehended differently in different contexts. As such, relying on personality assessments in order to develop team members with the desired soft skills is an uncertain approach, though mentioned by interviewees in terms of a person's "fit" in a team.

3.3.2 Experience

A number of participants argued that many of the soft skills identified stem from sound knowledge of the discipline, and that any BIM manager needs field experience in order to, variously "speak the language", "feel the pain" or "stand toe to toe" with other participants in the design and construction process. In order to achieve good communication, there needs to be common understanding of construction roles and processes. Authority and leadership will not be granted or respected without solid grounding in practical knowledge. "You get out on site and start arguing with the guys on their playing field, doesn't do any harm, doesn't do anything negative to show them you know what you are talking about, people actually start listening to you for a change." Similarly, experience is essential for project participants to negotiate effectively, as an underlying knowledge is required to ensure that clashes are resolved appropriately and that decisions are made that suit the wider project environment. Although negotiation may be necessary to resolve conflicts, there is no advantage to the project if it results in the wrong decision.

3.3.3 Internal - training and mentoring

Several of the interviewees from senior management roles made a strong case for company-specific training in BIM processes generally, and in soft skills specifically. Because BIM processes in most cases are still in the development stage, each company and every project is still evolving their own ways of working. Developing relationships, agreeing processes and establishing cross-project communication approaches were all identified as elements of soft skills that should be included in company-specific training and mentoring for BIM project teams.

A related aspect was the approach taken by some companies of trying to make a significant step forward in BIM by hiring in BIM specialists from outside organizations. In this case the point was made that while technical and discipline skills may be transferable across the industry, soft skills are more individual to each company in terms of its vision of BIM and approach to collaboration. As explained by one management level BIM specialist, "There's a lot of bigger firms that will go out and

purchase people… but I know that they are only going to be good for [BIM-technical skills] and not for the rest of it. So that's where I think that you are better off to develop people yourself than you are to purchase people." By bringing in external expertise, a company circumvents the stage of reflecting on their specific needs in the BIM process and what aspects are of most value to them, and thus risks implementing BIM in a way that does not deliver value to them. Developing internal people into the role who bring with them knowledge of the company and how it operates makes the soft skills aspect more prominent, as company expectations and values are carried through the process.

Mentoring was seen as an approach that delivered improvement in soft skills alongside development and sharing of BIM-technical and discipline-specific skills. The initial approach taken by many companies of employing people with BIM-technical skills brought with it risks of losing other skills that mentoring was used to address. Several interviewees identified that recent graduates and younger team members tended to have better BIM-technical and broader technology skills, whereas older, more experienced members are likely to be richer in discipline-specific skills. "We have to get more Revit knowledge in, and more BIM knowledge… but what we must be aware of, pulling in all young people, is demolishing your engineering knowledge. So we have to find a balance between engineering and BIM." As a side effect of establishing mentoring relationships aimed at drawing on the different BIM-technical and discipline-specific strengths existing in a company, soft skills are also enhanced. Communication skills are fostered through the need to exchange knowledge, negotiation and conflict management skills are developed through the process of supporting and working with team members from different backgrounds and priorities, and participants gain an appreciation of the different perspectives of others in the project team. Internal mentoring was also seen as a "low-stakes" approach both for the company and for the individuals involved, as any weaknesses or unsuccessful relationships were kept within the company, rather than exposed across project teams.

In one instance, as well as providing mentoring the company developed a "script" for project relationships. The team leader coached staff on the way their role interacted project participants. "I also give them direction, who your interaction is going to be with. So; you're supposed to interact with this person this way, you're supposed to interact with these ones this way, so that they understand exactly how their structure is." In this way relationships were modelled and structured so that even staff with limited interpersonal skills could develop their roles appropriately.

3.3.4 External - education and training

Currently, external training is most commonly offered by software companies, so it tends to be very generic and focused on simply using the software, rather than looking at the wider framework of processes and relationships. Some interviewees had worked with external providers to develop tailored training programs for their own staff, but most were critical of the courses and expertise such providers offered. Similarly, commercial skills accreditation processes were not seen to add any value. One of the key reasons for interviewees' dismissive attitude is the emphasis on BIM-technical aspects, with soft skills elements presented as secondary or not presented at all.

Most of the industry bodies are considered to be backward in supporting professionals' training needs. Interviewees from architecture, quantity surveying and engineering backgrounds all suggested that their respective industry bodies had only a very limited grasp of the changes that BIM is bringing to the industry, and none have a coordinated approach to BIM skills development. Some continuing professional development (CPD) events were mentioned, however, which generally consisted of companies and project teams sharing their experiences on BIM projects. These were considered useful as they offer insights into all facets of BIM within a project framework, including relationships and other soft skills issues as well as discipline-specific and BIM-technical aspects.

University and other higher education courses are seen as similarly behind the times. Most recent graduates come into the industry with only a very limited knowledge of BIM. Although current students are being introduced to BIM, this is often limited to BIM-technical skills, which interviewees considered the easiest aspect of BIM to pick up on the job. Project interactions and relationship skills were cited as the least likely to be developed in higher education. A number of interviewees expressed dismay that universities tended to isolate themselves in their delivery of industry knowledge and did not make more use of the potential for inter-disciplinary projects to develop collaboration and communication skills. Another concern regarding university and other higher education courses was that there was not enough engagement with industry. Interviewees suggested that lecturers have

little or no expertise in the way industry practice around project relationships and collaboration have changed with the advent of BIM, and so universities need to call on current practitioners to pass such information on to students. While discipline-specific knowledge has not changed greatly with the advent of BIM, and BIM-technical skills can be learned relatively easily and passed on to students, interviewees felt that the biggest area of change in the industry was within the soft skills and relationships area, thus requiring the involvement of active practitioners to help prepare students for the environment they will be working within.

3.4 Knowledge sharing

Discussion groups and social networks were considered an important source of information around BIM in general, and a way to develop relationships and social skills in an industry environment. The specialists interviewed appear to be a very interconnected group; they maintain social as well as professional relationships with their peers, and are very supportive of colleagues who are developing BIM expertise. Twitter and LinkedIn in particular are used to exchange ideas, share experience and ask for help, both within and across disciplines and regional boundaries. More locally, networks are evident in company-based or industry-based discussion groups, user groups or more formal workshops and conferences. Interviewees consider that all of these approaches to knowledge sharing help to develop soft skills and industry relationships, at the same time as exchanging BIM-technical or discipline-specific knowledge.

4 Discussion

4.1 Collaboration and BIM

As evidenced in many of the interviews, "solo BIM" can be used to deliver benefits without involving users in collaborative practice with other project participants. However, it is extremely unusual for a single person to take responsibility for design, modelling, simulation, analysis and decision making even within a single part of the process. As a result, internal collaboration is necessary at the least, even if the wider project team does not use BIM to any great extent. It may be argued that this situation is no different to the CAD and other simulation processes that took place before the advent of BIM, particularly with regard to the soft skills required. While there is truth in this view, the risk is that project participants or managers assume that the use of more advanced technology in a BIM project reduces or replaces the need for soft skills. Robles (2012) suggests that the contrary is true, that the increased use of technology in business is one reason behind the need for better personal and interpersonal skills.

The implementation of BIM technology is often assumed to be synonymous with collaboration, without examination of the human elements of the process. This view is evident in much of the academic presentation of BIM, in research and in curriculum development, where the relatively straightforward BIM-technical elements of practice tend to be at the forefront. This is also emphasized by the rhetoric of software producers and resellers, which suggest that collaboration is dependent on implementing the appropriate tools. One of the flaws of this assumption is examined by Dossick and Neff (2011), who identify that in fact a poorer quality of communication can eventuate when project participants simply transmit decisions and changes using a software tool to mediate the collaboration. Project participants may assume that because all the information is contained in a shared data environment, other members of the project team simply have to identify changes or requirements and work from that. This approach was characterized by some participants as "over-the-wall" communications, where information is passed along the chain without any direct discussion or interaction between members of the project team. Implementing BIM in a technical sense is not sufficient to develop a collaborative environment (Dossick and Neff 2010), and the influence of a strong project leader as well as the personal characteristics of team members are also important. Miettinen and Paavola (2014) similarly argue that the characterization of BIM as a transformative technology is simplistic and counterproductive, and that social and personal aspects must also be considered to achieve collaborative practice.

4.2 Role definition and skills recognition

Selection and development of staff soft skills is a challenge for all businesses, not just within the construction industry (Robles 2010). Often the requisite skills are not clearly articulated by employers,

and so are not listed in job advertisements or organizational promotion frameworks. As a result, employees may be unaware of what is expected of them. A more detailed definition of what activities and tasks are entailed in different roles within a BIM environment, and how they may differ from a traditional construction organization, may serve to assist practitioners in developing appropriate skills. The mentoring, training and staff support elements of BIM specialist roles currently appear to be under-represented in descriptions of such roles (Barison and Santos 2011). Better definition of these roles in particular would further help to ensure that the right skills are being transferred.

As described by Tennant et al. (2011), collaboration and team working occur more often despite the structure of the industry, rather than because of it. BIM offers a framework which can act to support team performance, but this will not be realized without commitment towards developing the necessary skills and rewarding the participants appropriately. Bishop et al. (2015) argue that institutionalized adversarial practices in the construction industry make truly collaborative practice unlikely, and undermine the opportunities for learning and skills development. However the openness of the interviewees to sharing knowledge, and their involvement in formal and informal networks does not support this view. Again, recognition and support of such knowledge transfer appears necessary.

5 Conclusions

Soft skills are essential in construction, as in most industries. They form a necessary part of the BIM specialist's role, and of roles in the wider project team in a BIM environment. Technology alone does not deliver collaboration, and communication, conflict management, negotiation, teamwork and leadership are all required within a BIM project team, whether for internal "solo BIM" or more extensively for "social BIM", to ensure that the potential for improved project information and increased productivity is realized.

Soft skills are not easy to acquire, and come from a combination of personality, experience and training or education. Mentoring is suggested as a particularly useful approach for skills development, as it can deliver valuable improvements across BIM-technical and discipline-specific skill sets, while at the same time contributing to soft skills development from the interactions and processes used. It has clear benefits in connecting recent graduates with good computer skills, with older and more experienced practitioners who can share their practical industry knowledge.

Industry involvement in education is an essential part of training students for current practice. This is especially true for soft skills around collaborative practice in BIM, as the changes resulting from collaborative project environments are difficult to articulate for anyone who has not been involved in such a project, and are evolving at a faster rate than changes to BIM technology or discipline-specific aspects of construction.

Better role definition of the expectations and activities of BIM specialists and BIM teams more generally may contribute to a greater understanding of the importance of soft skills in a BIM role. Such definition would also lead to better recognition of the contribution made by BIM specialists in sharing knowledge and developing industry networks.

5.1 Future work

Ongoing work on this project will extend the range of interviews, with additional participants in the United Kingdom and United States of America. Analysis of the five different industry contexts (Australia, New Zealand, the Netherlands, UK, and USA) will investigate how roles have developed at various stages of BIM market maturity and in different BIM environments. A definition of role requirements for BIM specialists and across BIM teams will be developed, based on the preliminary skills sets definition presented here.

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