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How are the Educational Institutes of Ireland Embracing the Paradigm Shift towards BIM?

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Abstract – The main objective of this paper is to evaluate how Building Information Modelling (BIM) is being implemented and embraced within Higher Education. The authors intend to examine the current delivery and aspirations of the sector.

As the Irish economy faces several more years of austerity, every opportunity must be seized to make design more efficient in Architecture, Engineering and Construction. Higher Educational Institutes must respond to ensure that graduates have the skill set to support this. This paper will examine how these institutions need to migrate away from the traditional iterative design approach/process to a more collaborative holistic approach using BIM.

This will involve a series of semi structured interviews of key members within educational organisations, such as Trinity College Dublin (TCD), University College Dublin (UCD) and National University of Ireland, Maynooth (NUIM). The researchers' organisation has to date set up a new multidisciplinary school which will be viewed as part of this paper. Should there be multidisciplinary schools in all organisations?

At an International level, BIM has become a critical tool for efficient and cost effective modern design. The UK is embracing this change and has mandated the use of BIM through the "Government Construction Strategy".

Ireland's educational Institutions need to embrace, what some might say is a paradigm shift towards BIM. This paper will identify what barriers currently exist which will prevent Ireland embracing this holistic shift head on.

Keywords –. BIM education, multidisciplinary design solutions, curriculum

I INTRODUCTION

At an international level, BIM has become a critical tool for efficient and cost effective modern design. The UK is currently embracing this change and has mandated the use of BIM through the "Government Construction Strategy".

"The pursuit of quality is a journey rather than a destination" [1]

In fact, the area of design, its methods and techniques has had quite a journey to reach the era of BIM. In reality, BIM technologies have been available in some form for the last two decades or so. Unfortunately, in previous years BIM had been perceived by some people within industry as a little too radical for the times [2]. However, with today's impressive digital age BIM has arrived at centre stage.

The potentially imminent shift from traditional design techniques to the concept of BIM creates both challenges and opportunities for higher educational institutions. This new collaborative and integrated design approach offers many new benefits to students, which numerous undergraduate and postgraduate programmes have begun to explore. This paper intends to examine some of the major challenges and opportunities that BIM presents within the educational environment.

The HEA contends that higher education landscape in Ireland must improve quality through centres of excellence [3]. This will offer opportunities for institutions to become experts in specific disciplines, for example BIM. This can be offered at both undergraduate and postgraduate level, which will allow students develop skills to enable them to play a strong part on the world

stage [2]. To ensure a high standard of delivery, this will require qualified staff, staff that are motivated and for staff to be allowed to pursue opportunities and conduct research in specific areas relating to BIM. Like all organisations, a clear career path should be established for staff to develop their talents through scholarly activities. Team leaders would be required to ensure relevant delivery of modules. Moreover, students must have access to teaching that is kept up to date and relevant through scholarship, research and professional development [2]

The National Strategy for Higher Education recommends the development of a Technological University for the Institutes of Technology in Dublin. This new age university will prepare students for real life complex professional roles in a changing worldwide labour market. This type of university has the unique opportunity to allow students advance their knowledge through the use of industry specific software, including BIM.

The National Strategy acknowledges that one of the key strengths of our higher education system has been, and should remain, institutional autonomy [3].

Ireland's past vision and innovation to invest in education as a whole, has played a major role in supplying the cohort of skilled graduates that helped the significant increase in indigenous engineering, manufacturing and export growth which was achieved towards the end of the twentieth century. However, even with the significant overall increases in investment in higher education, per capita expenditure remained modest by international standards throughout the period of growth, and has significantly decreased since 2009. This has unfortunately, and to the disadvantage of students, led to a widening of the staff to student ratio [3]. This situation makes the delivery of new software somewhat more challenging whilst trying to maintain high standards within the educational environment.

A comparison of the funding of higher education between England and Ireland reveals that funding per student in Ireland is between 19% and 29% lower than funding per student in England [4].

Hietanen and Drogemuller contend that, BIM can be first introduced into a module and then into other disciplines, either as a core part of a programme or as a separate standalone element [5]. It is, however, essential that students are still provided with an introduction to basic drawing fundamentals and drawing software. With this grounding they can then develop their BIM and cross disciplinary skills, thus, enabling the creation of holistic comprehensive design. The majority of BIM software requires the user/designer to interact with a multitude of

disciplines at a critical early design stage. This process must be fostered within the learning environment to encourage and promote collaboration and communication. With a changing labour market, in relation to a modern design process, this will be a key skill required from graduates. Students working alone within their discipline will be able to develop their BIM skills, but only to a certain point. There is a definite need for a multidisciplinary approach. The students must be allowed to engage in Problem Based Learning (PBL) which requires engineering resolution which could be as basic as co-ordination of services. In fact, some of the institutions surveyed highlighted that there was an educational shift back to PBL.

The 21st century engineer and architect must be able to deal with a rapid pace of technological change, a highly interconnected world, and complex problems that require multidisciplinary solutions [6]. Moreover, the higher educational student experience should equip graduates with essential generic foundation skills as adaptive, creative rounded thinkers – in addition to a comprehensive understanding of their relevant discipline [2].

Will the BIM approach become a completely separate discipline? The NBS Report (a trading name of Royal Institute of British Architects (RIBA) Enterprises LTD) contends that the historic rules of engagement between educational institutions and professional accreditation bodies tend to prefer separation and division between disciplines, thus, avoiding untested collaborative education [11]. This raises the question, can collaborative education be taught without actually being experienced in a real life industrial environment?

II BACKGROUND

The Government (UK) will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016 [12].

With the UK enforcing legislation relating to BIM, Ireland will inevitably follow suit. Moreover, with the European Union's directives and regulations pertaining to higher levels of energy performance in buildings, BIM will play a pivotal role in reaching these targets. In fact, a Client Mobilisation and Implementation Group have been developed to drive the adoption of BIM across the UK Government. Whilst in Ireland, the main driver behind BIM is the Construction IT Alliance, whose goal is to harness the potential of information and communication technologies for the Irish

construction sector.

When discussing BIM and the different levels within this concept, the following dimensions (D's) (or similar) are generally referred to:

- 1D - Client needs & requirements.
- 2D – Draughting, planning & specification.
- 3D – Modelling.
- 4D – Logistics & contracts.
- 5D - Quantifying.
- 6D - Project management, construction & commissioning.
- 7D - Buildings life cycle.
- 8D - Decommissioning.

Many different disciplines of engineering worldwide are working through the challenges presented by the adoption of BIM. There are enormous roadblocks and challenges both physical and in mind-set to be faced. Several organisations throughout industry are facing these challenges with enthusiasm. Thus, third level institutions also need to adapt and move away from traditional isolated and un-collaborative methods to more interdisciplinary methods.

III BIM STRATEGIES

To date there has there has been a BIM strategy set up in the authors' own institution, Dublin Institute of Technology, with some of the objectives of this strategy outlined below;

1. *To ensure our graduates have the required skills, competences, knowledge and understanding to meet the needs and expectations of industry;*
2. *To place College at forefront of BIM education in Ireland;*
3. *To unlock the potential within the College to provide real interdisciplinary education;*

4. *To provide education in BIM and related technologies at appropriate stages and at the appropriate NFQ level;*
5. *Meet the needs and expectations of industry.*
6. *BIM educational process, focusing on BIM as a whole business and interdisciplinary concept along with the adopted world standards.*

As part of this paper's research all institutions involved were asked the question: **Does your institution / school have a BIM strategy?** The summary response revealed that two of the institutions surveyed currently have a BIM strategy in place, whilst the other institutions do not have one in place.

This then lead to the next question which asked the survey participants; **What were the most significant barriers that existed to prevent the implementation of BIM within said institution?** The responses varied from each participant, quoting, "lack of expertise in the area", "lack of interest amongst staff members to up-skill in this new area", "problems associated with timetabling different disciplines to be in the same space together at the same time".

Time paints a clear picture, as outlined in the National BIM report [7]. Based on the figures below it would seem that educational institutions must urgently embrace the concept of BIM.

Table 1: BIM Statistics regarding usage and awareness of BIM 2013 [7]

| Neither aware nor using BIM: 1.1 | | |
|----------------------------------|------|------|
| 2010 | 2011 | 2012 |
| 43% | 21% | 6% |

| Just aware of BIM: 1.2 | | |
|------------------------|------|------|
| 2010 | 2011 | 2012 |
| 45% | 48% | 54% |

| Aware and currently using BIM: 1.3 | | |
|------------------------------------|------|------|
| 2010 | 2011 | 2012 |
| 13% | 31% | 39% |

IV RESOURCE ISSUES DELIVERING BIM

This section will detail the issues regarding the delivery of BIM courses. To successfully deliver a BIM related course, an institution must have a modern IT laboratory facility. This would require a dedicated server to accommodate the large storage capacity which is required for multiple BIM users. Technical Officers would also be required to provide support for lab PCs. There are also issues with software licenses that would need to be addressed.

V EVALUATION – FORMATIVE/SUMMATIVE

The evaluation of BIM skills and students progress should involve a combination of formative and summative assessment. This allows students to develop a BIM portfolio which would include academic technical papers, and a series of project – based digital models. Essentially, there are three skill levels involved in BIM introductory, intermediary and advanced [8].

There are potentially three barriers to the delivery of BIM in the educational environment [9]. Firstly, difficulties in learning BIM, this relates to existing professionals from industry which may be retraining or up-skilling. Presently, there are a large number of unemployed professionals competing for the same employment posts, therefore, graduates need to increase their knowledge and expand their skill set to prepare for re-entry into the labour market. Secondly, difficulties in using BIM software, again relates to existing professionals, as younger students tend to find it easier to adapt to modern technology / software.

Finally, a misunderstanding of the holistic BIM process, which may be the most problematic barrier of all. In fact, problems related to the misunderstanding BIM concepts are the most important hurdle to overcome.

VI RESEARCH

Barison and Santos contend that, institutions wishing to implement BIM are likely to face several problems, the greatest of them being the interaction between different disciplines [8].

There needs to be major changes in teaching methods to shape the future of industry. This will be a slow process but can be achieved by the implementation of educational stepping

stones which will allow young engineers steer society towards a sustainable future. Educational tools, alongside an overall awareness of BIM, needs to be embedded into young engineers. The reason being, it will form a significant part of their future roles.

As industry shifts towards adopting Integrated Project Delivery (IPD), our third level educational institutions must adopt a more collaborative approach to teaching. To future proof the higher education sector there must be an outward facing system which interacts, not only between disciplines, schools and other institutions but with the wider community. This will ensure an inward and outwards flow of knowledge, staff, students and ideas between institutions and its external community [2].

VII METHODOLOGY

The Authors felt the need to highlight that as part of this paper, less than half the institutions approached responded to the survey (6 out of 14). Thus, there is potential for future research relating to the educational sector and BIM. It would have been envisaged that this number would have been greater, but due to time constraints and the period of the academic calendar, it was tougher than expected to obtain responses. It should also be noted that this is only a small sample of the higher educational institutions of Ireland.

The survey consisted of twenty short questions. The majority of these questions were closed questions requiring ‘yes’ or ‘no’. A minority of questions allowed for comments and opinions. Some of the surveys were completed as face-to-face meetings while others were completed via an online survey.

The authors will try and provide a qualitative overview of the responses relating to the more important questions.

VIII METHODS OF THE SURVEY

As previously mentioned, the survey consisted of visits to the various institutions, whilst the remainders were carried out via online survey.

IX RESULTS FROM SURVEY

As outlined below in Fig1 it can be seen that 33% of the participants surveyed currently have a BIM strategy in place.

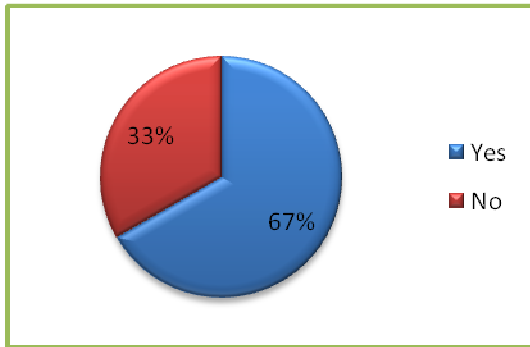


Figure 1: Does Your Institution Have a BIM Strategy?

All of institutions surveyed are still using traditional draughting tools such as AutoCAD and 83% of the surveys indicated that they still felt that traditional drawing packages such as AutoCAD have a place in the educational system and within industry (See Fig 2 below).

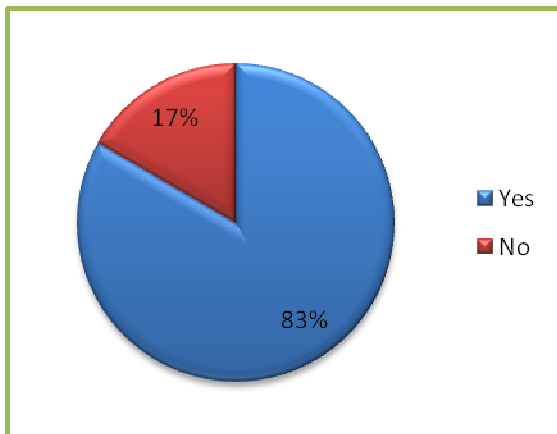


Figure 2: Do you still think traditional software (AutoCAD) still has a role to play in industry?

Throughout the various institutions there are several different software packages being used such as; Autodesk – Revit , Architecture, Structure and MEP, Energy plus, Navisworks, Cost X, Synchro, Ecotect Analysis, IES, Soildworks, CFD work, Google sketch-up, Optics and Matlab. In essence these different packages make up a lot of the different software types currently being used as part of the BIM process.

The concept of BIM was not something that was common knowledge throughout all institutions surveyed. In fact, only 33% of the participants surveyed stated that it was commonly known throughout their institution and this cohort also had a BIM strategy, as outlined in Fig1.

One of the questions encouraged the participants to comment on their personal views in relation to their understanding of the benefits of BIM. Table 2 below illustrates a summary of these answers.

Table 2: Summary of BIM Benefits

| Institution | Benefits of BIM |
|-------------|---|
| 1 | Better data storage |
| 2 | A lot more information available |
| 3 | Interaction/collaboration with a design team |
| 4 | Cost saving |
| 5 | Interaction/collaboration with a design team |
| 6 | Better design, Interaction/collaboration with a design team, Higher building energy performance, having regard for the whole BIM process – benefits too numerous to list. |

The same percentage figures applied to the amount of staff training that had been undertaken at the various institutions where 33% have had specific training in the area of BIM and 66% have not had any training.

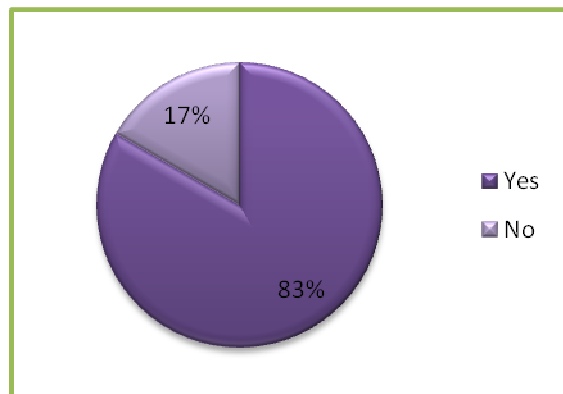


Figure 3: Do employers expect graduates to have BIM competencies?

Eighty - three percent (83 %) of participants felt that employers now expect graduates to have certain BIM competencies. Meanwhile, 17% felt that as long as the graduates have the fundamentals of their specific discipline, that the employers could train the individuals further as required.

All participants were in favour of a multidisciplinary approach to student learning, but had some underlying conditions. Some were of the opinion that a multidisciplinary approach would work better at postgraduate level rather than at undergraduate level; the reason being, that students were more mature and generally more motivated with in their discipline. Having a multidisciplinary approach would be a good experience for the students, provided it does not come at the expense of something else, particularly the fundamentals associated with each sub-discipline.

X DISCUSSION:

It is evident from this research paper that the new design process of BIM and the challenges faced whilst integrating in to the educational system will be somewhat more complex than just simply adding a new BIM module to existing programmes.

Unfortunately, some people from the educational sector and industry still believe that BIM is a specialised activity and that it is too major a leap to take forward at this early stage [11].

This mind set can present problems with the implementation of new design methods / tools. Ireland is already behind the UK in terms of integration of BIM and if this change is not embraced the gap will widen further leaving our economy exposed.

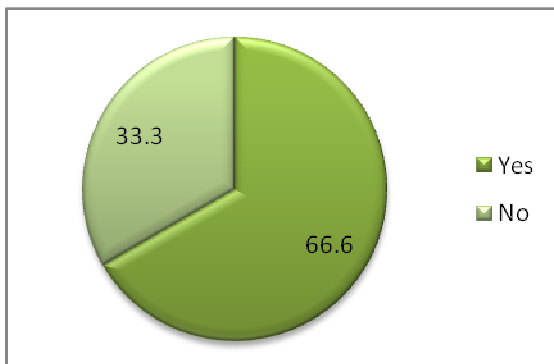


Figure 4: Awareness of the CITA BIM Group?

Of all the participants surveyed, 67% were aware of the CITA BIM group and the main drivers of BIM in Ireland at present.

Barison and Santos argue that, BIM has the potential to be an intrinsic part of the whole engineering sector. Moreover, they go on to detail a teaching strategy / structure; wherein fundamental principles of BIM should be taught first followed by BIM concepts, such as teamwork and complexity [10].

This could be implemented over a number of years as the students develop and advance their skills.

XII CONCLUSION AND FUTURE RESEARCH

This paper set out to examine the potential educational barriers which may delay this paradigm shift towards BIM. With no policy or legislative structure in place for BIM, this presents future research opportunities for collaboration between academia, industry and relevant government bodies.

In the next few years, as the use of BIM increases throughout industry, the demand for highly skilled graduates will follow suit. It was also the opinion of the surveyed participants that the use of BIM in the construction sector would most definitely increase manifold. Thus, it is the responsibility of third level institutions to take action and correctly adapt programmes to meet the future needs of the labour market, both nationally and internationally.

This paper highlights several significant challenges with the implementation of BIM. It also presents an opportunity to further examine the implementation of BIM throughout industry. A larger cohort could be surveyed which would allow a paper to be developed concentrating specifically on industry and a range of businesses.

What will the role of an engineer look like by 2050? Surely it would be unrecognisable from today? The BIM revolution is undoubtedly here to stay and is completely changing the way design and maintenance takes place in the built environment.

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