DT-168 MSC IN CONSTRUCTION INFORMATICS

Module 2 – Computer Mediated Communications
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Using BIM and Web-based conferencing tools to improve interdisciplinary communication and thereby enhance the design decision making process within an Architectural Practice.

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Abstract:

It is people's ability to work together that promotes improved efficiencies through harnessing of the collective group intelligence. By improving the means by which people communicate we encourage a collaborative approach to working which ultimately results in better practices.

"Design is a complex process that continues to grow in complexity because of the dramatic increase in specialist knowledge. There are now many contributors to a design process from a wide variety of organizations across increasing geographical locations. This gives rise to a design process that consists of a continual exchange and refinement of information and knowledge. Even the most experienced design teams can fail to manage this complex process and supply information at the wrong time and the wrong quality to members of the production team." (Gray 2001, as cited in Moum 2009)

The growing complexity of legislation, adversarial contract arrangements and the emergence of numerous fields of specialist knowledge have all contributed to an increasingly fragmented construction industry. Against a backdrop of difficult economic conditions the challenge faced by those seeking to implement improved information and communication technologies in modern construction is one of integration and vastly improved quality of information.

Historical overview of Information & Communication Technology in Construction

In ancient times, when a building was to be procured the client would meet with the 'Master Builder' to define a project brief. This Master Builder would be the individual with whom the complete knowledge about the design and construction methods for every project would reside. These individuals would be solely responsible for overseeing every aspect of the construction project from its inception to completion. The lack of availability of suitable media for the purpose of communication meant the Master Builder needed to be on hand at every stage of the project to communicate and oversee each detail as the work progressed. Obviously this method of construction was heavily flawed as the success or failure of every project relied entirely on the ability of one individual to communicate his design with the vast numbers of craftsmen involved throughout each stage of the project.

The gradual evolution of writing and drawing on parchment meant that the Master Builder was now able to produce diagrammatic representations of proposed designs. This was a slow and time consuming process which ultimately led to the Master Builder spending more time producing drawings and less time instructing works on site. Effectively the fragmentation of the industry had begun. The master builder assumed the role of Architect and spent less and less time co-ordinating construction works and more time producing detailed drawings. Other individuals would now need to assume responsibility for overseeing the construction of these designs and the teams of workers on site.

Prior to the end of the Middle ages parchment was the only available transferable type of media on which information would be scripted, it was expensive and typically available only to a few. It would have been used mainly for generating copies of the most important documents of the times. It was not until the end of the middle ages that paper, derived from cellulose, became available in Europe. This discovery heralded the beginning of a communication revolution that would change the face of construction in a profound way. Paper was now available to the masses. Painters, inventors, engineers and scholars now had a means of communicating with each other not previously possible. The teachings of the master builders and scholars could now be easily recorded. The invention the Gutenberg Printing Press in 1440 suddenly made replication of written transcripts available to the masses. The ability to draw on this knowledge ultimately improved the collective group intelligence with the result that mankind was able to greatly develop the technology and processes by which he constructed buildings. (Z. Turk, lecture, November 2012)

Improved means of communication have increasingly promoted new fields of study, each producing its own type of specialist area within the core of the construction sector. With the creation of each new discipline within the construction industry the role of the Architect (Master Builder) became even more fragmented. Building design in the modern era now draws upon the services of teams of specialist design professionals covering a broad range of areas including Energy Performance/Structure/Services/Costing and Facilities Management.

As technologies and materials evolved so too did the craftsmen required to implement or install them at the various stages of each project. The Site manager role of old has now evolved to Construction Contracts Managers and each of the construction trades falling in under the umbrella of sub-contractors. Instead of the information residing within the head of a single individual, 'The Master Builder', the construction and building industry now consists of multiples of fragmented specialist organisations who must co-ordinate and share increasing amounts of information across vast amounts of software platforms and all within the constraints of the contractual environment in which they operate.

The challenge facing the construction industry now more than ever is one of integration of these specialist teams and an ability to successfully manage and improve the quality of the information, which is being shared between each discipline.

So while it would appear that the age of the Master Builder is well and truly confined to the pages of our history books, the principle on which the Master Builder was based may very well hold the key to solving the problem faced by the modern day construction industry.

Building Information Modelling is a technology, which provides the AEC industry with a means of integrating and communicating the complex array of information through every stage of a buildings lifecycle from inception to demolition in a single, virtual, data rich environment.

Through utilisation of BIM servers we allow for the creation of a single location within which all the specialists and stakeholders can interact and play out the virtual construction of every aspect of a building long before a sod is ever turned. The role of a fully functioning BIM could be likened to that of the brain of an ancient Master Builder, the exception being that unlike in Ancient times, all specialist knowledge would be integrated into a single BIM to which all stakeholders would have immediate access to up to date, fully co-ordinated and accurate information at every stage of the BIM's development.

Project Background:

I am presently working to promote the adoption and implementation of BIM at a medium sized Architectural Practice in Ireland. Over the past 12 months I have trained with and achieved my professional certification for Revit Architecture and I am the sole practitioner of Building Information Modelling Processes within the practice.

While there is a general acceptance that time and money will need to be invested in the development of BIM, financial and resourcing constraints mean that this is proving difficult to realise.

My typical day working as an Architectural Technologist remains pre-dominantly within the 2D AutoCAD platform, however more opportunities are arising for the use of BIM on some of the new projects.

Having investigated some of the capabilities of BIM through a simulated collaboration project on my previous 'Interoperability & BIM' Module, I have experienced first hand how collaborating within a BIM environment, through model sharing and linking, can greatly improve the methods by which cross disciplinary designs can be co-ordinated.

My aim in undertaking this project is to establish an improved means of communication of design information and queries with our Design Team Partners at any given stage of project development. Having experienced the capabilities of screen and application sharing which are available through the web-based conferencing classrooms I was keen to investigate how this technology could be directly applied to my own daily working practice.

Project Overview:

Through a combination of Building Information Modelling and Web-Based Conferencing technology the project seeks to find an improved method of managing, sharing and communicating design information between an Architectural Practice and its Design Team partners during the design development stages of a project.

Building Information Modelling allows the creation of a data rich, detailed and accurate 3D representation of a project at every stage of its development and throughout its entire lifecycle. The ability to see the implications of every design change as it happens, in a virtual environment, provides designers with the opportunity to improve their designs through allowing a more informed decision making process.

While web based conferencing has been in existence and is being utilised globally by business professionals for over a decade, it is not widely used as a tool to promote improved collaboration within Architectural Design Practices in Ireland, if at all.

It is hoped that the findings of the project will demonstrate the process to be viable and worthy of adoption within the practice on future projects.

Together with providing a more improved means of collaboration, through improved communication, the ability to host web based design meetings, where appropriate, will reduce the amount of time spent travelling thus promoting a more efficient use of time and a more environmentally friendly means of conducting our daily work practices.

Section 1

Introduction

This section will give a brief overview of the existing practices typically undertaken within an Architectural firm in work sharing and collaborating during the Design Development Stages of a construction project.

It will identify areas where inefficiencies presently exist together with demonstrating where improvements can be realised through the adoption of Building Information Modelling and Web-Based Conferencing technology.

Overview of existing collaboration process.

Data creation, co-ordination and communication problems in traditional work sharing practice.

The design development and information sharing process presently being utilised by the practice centres on the production of 2D drawings and text documents, which are typically shared via e-mail.

The very creation of 2D drawings requires careful co-ordination of countless items across multiples of views. None of the information is dynamically linked with the result that time consuming reviews need to be carried out regularly to ensure consistency of the information.

Co-ordination of designs with our partnering consultants is carried out through x-referencing dwg files which again require careful, time consuming examination to determine potential areas where conflicts may arise or where changes have occurred. As a project progresses to site and as more sub-contractors become involved, the amount of information requiring careful co-ordination increases exponentially.

The process of communicating design queries at all stages is usually through excerpts from various plans/sections or elevation views accompanied by e-mails, which attempt to describe a given scenario. Following the issuing of this information, typically a phone conversation will ensue between the relevant parties to determine a satisfactory outcome.

One of the main problems with this method of communication is its reliance on users ability to translate the available 2D information into the, often complex, 3D environment which it is intended to describe. This can often lead to incorrect responses based on misinterpretation. In many cases additional information will require to be issued or stakeholders who will require more time to familiarise themselves with the particular area before offering an informed response. (Eastman, 2011;Crotty, 2012)
Ultimately the process can end up taking far more time than would be necessary if better means of communication were utilised.

Improved data creation, co-ordination and communication opportunities provided through BIM and Web-Based Conferencing software.

The dynamic linking and bi-directional association of the components created within a BIM ensures that all views taken within the model are consistent and that they remain consistent and accurate at all times, regardless of the view in which any modifications are made. This allows for greater confidence in the standard of the information being produced and results in far less time checking for inconsistencies. (Eastman, 2011; Kymmell, 2008 ;Crotty, 2012)

The ability to create intelligent links between selected critical items across models from multiple disciplines, which will highlight changes or modifications in real time further enhances the accuracy of the models and ensures that accurate co-ordination across multiple disciplines is maintained at all times.

Creation of an immediate and accurate 3D representation of the model means that for all parties there are no ambiguous areas of the design. It ensures that everyone has a full appreciation of the constraints within which they have to work and any failure to adhere to these constraints is immediately identified.

A change anywhere in the model means a change everywhere. Providing that a central model server is being used, or that regular updates are being synchronised, then all users of the model can be assured that they are always working with the most current set of data available.

Web-based conferencing platforms afford users an opportunity to share applications from their own PC's with selected users within a virtual meeting room. If we utilise the sharing of Building Information Models across these conferencing platforms, we can promote a much-improved means of communicating design issues as they arise. What further enhances this means of communication is that multiple users can engage in the discussions at any given time. Models can be interrogated, navigated and updated in real time. Engaging with the model in this virtual environment also affords users a much better understanding of areas, which may have been difficult to describe with 2D representations. Ultimately the use of these platforms can vastly improve the means by which we carry out the process of design interactions between multiple disciplines while reducing the time and energy, which may otherwise be expended through traditional practices.

Section 2

Project Outline:

The project will investigate if the perceived efficiencies to the traditional sharing practices can be realised by sharing Building Information Models across Web-Based Conferencing Platforms. It is hoped that through collaborating within this virtual environment users will be able to engage in more informed discussions relating to project issues and that through the real time navigation of complex building geometries a clearer appreciation of potential problems can be realised. Ultimately the project aims to demonstrate how this practice of work sharing with a live BIM can contribute too much improved design outcomes.

The project will centre on the sharing of a BIM model across a number of Web Based conferencing platforms.

While the 'test-scenario', which will be invoked during the project, is of a simple nature it is intended only to demonstrate the potential areas, which may be explored within more complex levels of model co-ordination and development.

Project Aims:

The following are the intended areas around which the project will focus:

- To determine through simulated meeting environments, the most appropriate web based collaboration software for hosting design meetings.

- To determine the suitability of Solibri Viewer as a means of conducting navigation of an IFC model by parties who may not be familiar with 3d modelling software platforms

E.M Rogers in his 'Diffusions of Innovations' 2003 (as cited in Crotty 2012) highlighted some of the key attributes of innovative hardware or software solutions as follows:

- *"Relative advantage: the degree to which innovation improves on the idea it supersedes;*
- *Compatibility with existing values, technologies and needs;*
- *Complexity: its ease of comprehension and implementation;*
- *Trialability: the extent to which it can be experimented with, before implementation;*
- *Observability: the ease with which the results of an innovation can be observed by others;"*

(Crotty 2012)

It is intended upon completion of the project investigations to measure the findings against each of these items as a means of further validation.

Project Procedure:

The initial steps taken were to establish the most suitable 'free' Web-Based Conferencing tools for the test projects. Following further research a shortlist of 4 platforms was drawn up.

The next step was to assemble a focus group of individuals, from within the industry, who would become actors for design team members during the tests. In assembling the group it was important that individuals understood the typical workings of the AEC however, more critically, it was vital that the selected members were unfamiliar with the proposed technologies in order to discern feedback, which would be representative of 1st time users.

As previously referred to in the attributes of innovation, one of the key components in the successful implementation of any new process or technology within the Construction Industry is the simplicity with which said processes/technologies can be adopted.

The assembled group consisted of a Senior Contracts Manager, Director of an M&E Consultancy, Chartered Structural Engineer and Practicing Associate Architect.

Of the group assembled all were aware of BIM and Web Based Conferencing tools, however only the M&E Consultant was familiar with the workings of BIM and none had partaken in Web Based Conferencing prior to the test.

The group demographic ranged from 33 to 64 years of age and while all were computer literate the range of IT abilities were varied.

Prior to the meetings an e-mail was circulated identifying the proposed agenda for the night. It outlined the platforms, which would be investigated, and the procedure, which would be followed in each virtual meeting room. The potential difficulties which can be encountered within the web based conferencing were highlighted and as a failsafe I encouraged each user to establish a skype profile through which we could communicate if difficulties arose in linking to any of the meeting rooms.

Skype itself was not used due to its multi-user interface being subscription based.

Each of the users was issued with a score sheet, which identified a number of key areas to be rated during the tests. The test sheet would be used to determine the user experience under the following headings:

1. Ease with which Virtual Meeting Rooms could be accessed following invitation

2. Ease with which user interface could be navigated

3. Ease with which the audio could be heard without interruption

4. Ease with which the screen sharing demonstration could be followed

5. Ease with which users could communicate with the host and each other

6. Likelihood that the users would consider using the platform in their particular field of work

Each of the items identified was to be scored on a scale of 1 to 5 with the platform receiving the highest mark being selected for further investigation.

The following are the platforms on which the tests were conducted along with the average marks awarded to each:

1. Anymeeting 16/30

2. Vyew 12/30

3. Mikago 5/30

4. Buddy Meeting 14/30

5. Cisco WebEx* 26/30

*The results of the tests carried out on the initial 4 ‘free’ platforms only served to determine all four as being unsuitable for proposed intent. CiscoWebEx is a subscription-based product, which was trialled on a 14-day licence.

Within the initial platforms there were numerous difficulties encountered with the audio feeds. The screen sharing application was ‘clunky and jarred’ when navigating the IFC model. In all cases conducting a synchronous conversation proved impossible.

The initial findings were very disappointing and all participants left the meeting with little confidence in the potential for the technology to be implemented or adopted.

Having ruled out the best of the ‘free’ software platforms the next step was to identify a suitable subscription based tool. Cisco WebEX and Adobe Connect were identified and due to its more competitive pricing and initial set-up costs WebEX was selected for evaluation. Once the trial licence was obtained for WebEX another 2 meetings were organised with the same participants. Thankfully more positive outcomes were realised within both meetings.

All users found the application to be extremely easy to gain access to following receipt of the initial invitation.

The interface once inside the meeting rooms was extremely easy to understand.

The screen sharing allowed a seamless presentation of the IFC Model, which was conducted in Solibri Viewer. In turn each of the participants were given control of the screen using the screen sharing functionality. This allowed all parties to navigate and interrogate the model themselves.

Again all participants agreed that the Solibri Viewer platform was extremely useful as a means of sharing the BIM with users who would not necessarily be familiar with modelling software.

The whiteboard function allowed live mark-ups of screen grabs to be made. These items could be stored and mailed immediately after the meeting to all relevant parties.

All reported being able to participate in synchronous conversation at all times during the meetings.

The only negative comments made related the requirement to register an e-mail address when entering the meeting room. Otherwise the product scored full marks in the other categories.

The general consensus within the group was that the WebEx platform was definitely one, which they would all consider using in their own practices in the future. The ability to navigate the BIM model in the IFC viewer was seen as a particularly useful means of conducting design review meetings.

When reviewed against the previously mentioned adoption criteria from Rogers Diffusion of Innovations the following are the findings:

1. *Relative advantage: the degree to which innovation improves on the idea it supersedes;*
   The process of sharing the 3D object model to enable a better and shared understanding of complex building geometries clearly improves the means of communication between design team participants (Moum 2009) when compared with the existing e-mailing of 2d drawing excerpts which rely to a large degree on user interpretation at the point of receipt. A 3D model is unambiguous in its physical representation.
2. *Compatibility with existing values, technologies and needs;*
   While the BIM software will require training of staff that will be using it on a daily basis, the web-conferencing and IFC software's are extremely user friendly and can be quickly picked up once interfacing begins.
3. *Complexity: its ease of comprehension and implementation;*
   As outlined above training will be required in the use of BIM modelling software for designers and technical staff, however the web-conferencing and IFC viewing platforms

provide users with an almost immediately recognisable set of tools and functions. The biggest perceived obstacle to their implementation is the initial unfamiliarity with the use of a headset and mic.

4. *Trialability: the extent to which it can be experimented with, before implementation;*

Even within the 14-day free trial period the full extents of the web conferencing are easily tested and trialled. BIM as a process represents a shift in the way in which the AEC industry conducts in business. The adoption and implementation of BIM will require investments in training; software and ultimately time in order to define establish a clearly defined set of office protocols for BIM. It cannot simply be bought out of a box and its successful implementation will require careful and considered planning to ensure its true potentials are realised.

5. *Observability: the ease with which the results of an innovation can be observed by others;"*

As can clearly be seen from the results of the user score sheet the benefits of adoption of the practices can be seen immediately be all parties who engaged with the software during the trial procedures.

Project Findings & Conclusion:

The findings of this project have clearly demonstrated the potential for utilising BIM and Web based conferencing technology, within an Architectural Practice, to improve the means by which we communicate and collaborate with our design team partners.

The technology, should it be adopted, will result in numerous savings on the costs associated with getting to and from meetings.

Less time spent travelling will result in more time in the office, which ensures a more productive use of time and generates additional savings.

Utilising the available technologies also provides for a more environmentally friendly means of conducting some of our daily business through reduction of our carbon emissions.

Further more, the simplicity with which the BIM can be shared, and the ease with which the models can be navigated and interrogated, through IFC Viewers, mean that even the least technologically advanced users will be able to interact within the virtual BIM environment.

By providing a simple means of access to a collaborative BIM environment for all stakeholders, regardless of technological maturity, we not only promote a more inclusive process but we generate an increased awareness and understanding of the new processes which are being adopted around the use of BIM and hopefully in doing so we can cultivate a more positive attitude its adoption at all levels within the AEC sector.

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