Combining Augmented Reality and Building Information Modelling

An industry perspective on applications and future directions.

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This paper presents a study which has evaluated current research on the topic of Augmented Reality (AR) and Building Information Modelling (BIM), conducted semi structured interviews with a panel of industry experts and surveyed a sample group of 43 within the wider UK construction industry . Industry experts were interviewed using semi-structured interviews and results were thematically analysed with the data gathered from the literature review. 5 core themes used to structure a nine item industry and practitioner questionnaire. Results suggest that use of AR and BIM within the construction industry will continue to grow with the advent of emerging technologies. Use of AR and BIM combined with 3D Scanning, Wireless Sensory Network will also increase and the synergies between BIM and these emerging technologies will improve overall efficiencies in design, delivery, maintenance and demolition of projects. The findings of this study contribute further knowledge to understanding the implications and possibilities that utilising AR and BIM will have in the construction industry.

Keywords: *Augmented Reality, Emerging Technologies, Building Information Modelling, AEC Industry*

The aim of this paper is to investigate the applications both current and potential, of combining Augmented Reality (AR) and Building Information Modelling (BIM), whilst also providing an insight into attitudes towards utilising these technologies within the construction industry. Coates (2010) reported that there are current limitations of BIM, including a lack of integrating with contextual information, real world capture and feedback. This could be minimised through adopting an immersive technology such as AR. It has also been recognised by Chi et al (2012) that there will be further development in AR and construction, whilst Wang et al (2012) identifies that a merging of both AR and BIM technologies will address shortcomings of current onsite BIM construction which separate physical information from virtual information.

This paper presents a study which has evaluated

current research on the topic of AR and BIM, conducted semi structured interviews with a panel of industry experts and surveyed a sample group of 43 within the wider UK construction industry . Experts from within the construction industry formed the expert panel, each member was then interviewed using semi-structured interviews. The expert panel included architects, government advisors on BIM implementation, BIM and facilities management experts and researchers in the field. The results of the interviews were then thematically analysed with the data gathered from the literature review. 5 core themes were established from the thematic analysis and used to structure a nine item industry and practitioner questionnaire which addresses the use, advantages and implications of AR and BIM within the UK construction industry.

Results suggest that use of AR and BIM within the construction industry will continue to grow with the advent of emerging technologies. Use of AR and BIM combined with 3D Scanning, Wireless Sensory Network will also increase and the synergies between BIM and these emerging technologies will improve overall efficiencies in design, delivery, maintenance and demolition of projects. Whist the applications currently considered the most valuable to industry and practitioners is the improvement of communication between architect, contractor and sub contractor and the ability to view composite visualisations of BIM on site located within the actual context allowing greater testing and refining of design prototypes.

It is the author's intentions that the findings of this study will contribute further knowledge to understanding the implications and possibilities that utilising AR and BIM may have in the construction industry.

BACKGROUND

The founder of Intel, Gordon Moore published Moore's Law in 1965, stating the power of computing technology doubles every two years, whilst the cost of technology decreases proportionally. This pattern has consistently occurred over the past fifty years irrespective of financial, cultural or social market stressors. It is therefore reasonable to apply Moore's Law to mobile computing and advances in AR technologies, and to assume continuing development, refinement and reduced cost.

Currently one of the advantages of utilising BIM is its capacity to enable the different disciplines involved with a project to communicate using the same model, thereby reducing fragmentation and identifying and addressing any problems which may arise prior to construction; advantages that ultimately improve the cost, time and quality of the finished product. These advantages are characteristically synergistic with those offered when adopting AR technologies.

AR can currently be used with smartphones, tablets and other wearable mobile devices, creating a cross platform multi-user environment which allows users to view and edit digital information overlaid onto the real world environment. It offers the user an enhanced experience with greater exposure and access to supplementary or additional information. Proctor and Van Zandt (2008) argued that AR has cognitively been able to increase and streamline access to stored information, reducing retrieval time in some short term memory chores by displaying information within the working environment; thereby potentially increasing task efficiency and productivity; a valuable process to emulate in the construction industry.

With the advent of new technologies and wearable devices in the form of Google Glass and Occulus Rift, there has been a resurgence of interest in AR; and with an increasing number of hardware and software developments in the field of AR and the complementary fields of cloud computing and wireless sensors, AR is poised to be more accessible to both casual users and industry in the near future.

Shin et al (2008) produced a useful study using work tasks identified by the Architectural, Engineering and Construction (AEC) industries to identify application areas of AR, however new technologies have emerged since this study which adds to the po-

tential number and variety of applications of AR and the nature of those applications within AEC industries. Wang et al (2013) have also investigated the potential of AR and BIM. Their study investigates BIM, AR tracking and AR visualisation using past literature to make logical assumptions of the types of tasks within the construction industry that could benefit from AR. Their study focused heavily on the process of information searching, and potential time saved through the adoption of AR.

Adding to the body of knowledge the study reported in this paper captures the current attitudes, trends, applications and perceived future applications of AR and BIM in the UK construction industry at this time, from the perspective of the professional community. It draws on expert knowledge from industry and the latest research and technological advances, to offer a valuable and timely insight.

Chein (2014) reported that BIM is an emerging technology in which digital information models are employed in a virtual space to achieve high-quality and efficient construction and management throughout the life cycle of a facility.

BIM is most frequently perceived as a tool for visualizing and coordinating AEC (architecture, engineering and construction) work, avoiding errors and omissions, improving productivity, and supporting scheduling, safety, cost and quality management on construction projects. It incorporates all the building components, including geometry, spatial relationships, properties and quantities (Zuppa Dino et al, 2009). BIM can also generate and maintain information produced during the whole life cycle of a building project-from design to maintenance-and can be applied to various fields (Yoon et al, 2009).

AN INDUSTRY NEED FOR COMBINING AR AND BIM

According to Rankohi (2013) AEC and FM have a high demand for information needed to enable evaluation, communication, collaboration which is utilised through information technology. The adoption of AR has clear efficiency benefits with regards to accessing information in a more timely and useful way. This is supported by Dong and Kamat (2013) who state that AR will improve visualisation, information retrieval and interaction for AEC and FM within construction.

INCREASED INTEREST IN AR AND BIM

Using Google trends, it is possible to track the popularity of search terms used from 2004 to present. Since 2005 until 2014, internet searches for AR and BIM have increased, this can be seen as an indication of increased interest in these areas. The figures on the graph reflect the number of searches performed for a particular term relative to the total number of searches conducted on Google over time. These figures are calculated on Google's search trend algorithm and are quantified as a percentage of searches (figures 1, 2).

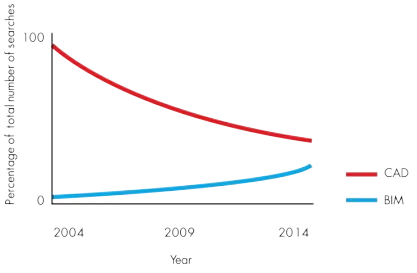


Figure 1
Google (2014) Google Trends of search terms "BIM" vs "CAD" from 2004 - 2014

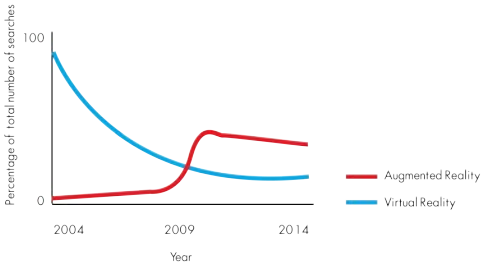


Figure 2
Google (2014) Google Trends search terms "Virtual Reality" vs "Augmented Reality" from 2004 - 2014

According to Google trends, from 2004 to 2014 the search term "BIM" has steadily increased from 3% to 21% of Google trends algorithmic rating. The term CAD (Computer Aided Design) which is synonymous with traditional computer aided two dimensional drafting in industry has decreased from 93%

to 45%. This could be seen to reflect the trend of the construction industry moving away from traditional Computer Aided Design towards Building Information Modelling.

Comparing Augmented Reality with Virtual Reality from 2004 - 2014 has shown that the term Augmented Reality is searched more than Virtual Reality since 2009.

What makes this change of interest to this study is that it corresponds with the release and increased utilisation of enabling technology in the form of smart mobile devices such as phones and tablets, both of which now have AR capable features.
Furthermore with the release of Google Glass in 2014 interest is set to grow. Google Glass is a wearable device which allows digital information to be visually superimposed over the users real world view, publicity of AR has increased in the media. Uptake of this new enabling and potentially disruptive technology is set to further increase interest in AR applications.

THE STUDY

Following a literature review a number of experts within the industry were selected to form an expert panel that underwent a semi-structured interview, to establish core themes on the use, advantages and implications of AR and BIM, in the construction industry. These core themes then provided the appropriate language and structure for an industry and practitioner questionnaire which was completed by 43 respondents. The expert panel comprised of 3D visualisation and BIM software user experts, facility managers, BIM coordination managers, government advisors on BIM implementation and BIM professional training and education managers.

Cohen et al (2009) categorised structured and unstructured interviews noting their differences. The unstructured interview allows for more observation whilst structured interviews more closely reflect questionnaires. As interviews or questionnaires rely on the value of personal language as data, the literature review and semi-structured interviews have been used to produce five core themes, in turn providing a reasoned and appropriate language for the nine item industry and practitioner questionnaire.

Data collected during interview is often difficult to compare as wording and sequencing will most likely be different in each interview (Patton 2002), however comparability can be increased by structuring the interviews and standardising the structure for each participant.

Data from both the literature review and transcriptions of the semi-structured interviews with an expert panel were thematically analysed. Thematic analysis is widely used when analysing qualitative data (Boyatzis, 1998).During analysis, themes are identified in relation to the research question, which in the context of this paper was to identify current and potential applications of BIM and AR in the construction industry whilst providing an insight into current attitudes regarding the combination of these technologies.

There are six stages to effective thematic analysis:

1. Immersion reading - during interviews, notes are taken to highlight key themes, the interviews are transcribed and analysed for key themes, allowing the researcher time to familiarise themselves with the data (Riessman, 1993).

2. Generate initial codes - after information relevant to the research question has been highlighted initial codes are organised into emerging themes. This stage of coding organises data into meaningful groups (Tuckett, 2005).

3. Search for themes - coded groups are then combined to create larger themes, during this process coded themes, sub themes and extracts of data will be collated, miscellaneous themes will be identified and significant themes will emerge.

4. Review themes - the relevance of themes to the research question is reviewed, if non-congruent themes are identified, data from

the theme may be re-appropriated to another relevant theme or discarded from the analysis.

5. Defining and naming themes - drawing on paraphrased relevant extracts from the original data, ensures themes are representative and justified to the research question.

6. Report - the thematic analysis has produced themes that provide a concise, reasoned, logical, non-repetitive and interesting account of the narrative across the original data set.

Based on the thematic analysis of current literature and the expert panel interviews five core themes were identified. The five core themes below were used to structure the nine item industry and practitioner questionnaire.

1. Application of BIM and AR.

2. Societal and Cultural Ideals of BIM and AR.

3. Adoption and Advancement of BIM and AR.

4. Emerging technologies combined with BIM and AR.

5. Emotional response and attitudes towards AR technology

A BRIEF OVERVIEW OF THE FIVE KEY THEMES FOLLOWS.

Theme 1: Application of Augmented Reality with BIM

During the interviews themes of general applications of AR and BIM, and their potential advantages for a wide range of disciplines in the industry arose frequently. The expert panel also reported that the manner in which BIM is currently used in industry creates a disconnection between the virtual model and real context. The use of AR combined with BIM would allow virtual data to be superimposed onto the current context on site.

Advances in onsite construction mean that contextualising virtual data in this manner would have many benefits toward a project with advances in onsite construction. As identified by Wang et al (2012) the current disconnection between BIM and its context must be improved.

Participants recognise the disconnect between the virtual data and the context, as well as the potential for visualising data from the construction sequence, and potential improvements in collaboration between different disciplines on a project.

Expert panel member no.4:

"..with new built there's a real potential to have a fully accurate house build MEP model that sits behind the architectural structural model and in that sense it would be very easy to utilise augmented reality and to view where services are and where they sit behind walls"

Nine key areas of application were identified:

1. Clash detections.

2. Visualisation of services on site.

3. Health and Safety On site - CDM co-ordinator. Safe routes can be projected to each team member to improve safety.

4. Visualisation of construction sequence on site. - Improved efficiency of onsite logistics - small building footprints in urban sites - Project Manager, Site manager.

5. Refurbishment visualisation load bearing structure, services etc- improved communication with the client. Architect, Interior Designer, Client, Contractors.

6. 6. Improved communication between Architect and Contractor and Subcontractors. Illustrate and communicate details to exact specification to ensure delivery of high quality, minimise misunderstandings, save time and money on project for client.

7. Facilities management - locating component information for maintenance and component replacement.

8. Visualisation of Building Big Data (Wireless Sensory Network Integration) - Producing feedback for Architect for improved future designs, better understanding and visualisation of project with digital information overlaid onto real objects.

9. Visualisation of BIM on site with context insitu- improved design connecting BIM to real life. New method to test and prototype designs.

Theme 2: Societal and Cultural Ideals of BIM and AR

The expert panel proposed that the adoption of AR and BIM would be affected by the level to which emerging AR technologies are adopted by society as a whole; wider adoption by society and subsequent commercial success was recognised as a key driver to refining and developing AR technologies.

Cultural and sub-cultural differences between disciplines in the construction industry were also reported as creating further implications towards adopting BIM and AR, with the panel recognising the difference in aptitude and attitude amongst different disciplines within the construction industry. A broad range of BIM competency was identified with large areas of the construction industry being considered at a lower level of competency when compared to large architecture and construction companies, for whom the value of adopting BIM has been increased efficiency and monetary savings. Arayici (2011) also recognises the implications of the current socio-cultural environment for the successful implementation of BIM within the construction industry, noting the need for cultural acceptance of BIM as necessary to fully achieve the potential gains and benefits offered by BIM.

Interestingly two members of the expert panel, one a digital immigrant (those born before the advent of digital technology) and the other a digital native (those born during or after the introduction of digital technologies) both identified an increasingly problematic generation gap within the industry between digital immigrants and digital natives. This generation gap and differing attitude is problematic as the expert panel members recount numerous issues of the younger digital native being restricted from implementing new technologies and new technology centric working practices despite the potential benefits because those in charge are somewhat technology averse digital immigrants. It is accepted that an industrial culture shift will occur naturally as the younger digital natives move into management roles in the construction industry.

Theme 3: Adoption and advancement of BIM and AR

All members of the expert panel viewed BIM adoption and advancement as continuously increasingly in the construction industry, all holding the view that this is unlikely to change. BIM was recognised by the panel as moving away from a computer aided mass production solution to towards a high quality bespoke design solution, offering new freedoms for designers to create bespoke solutions with prefabricated components.

Increased adoption of BIM and AR was recognised by all panel members to be dependent upon the efficiencies it offers, with the efficiency of any new technology in the industry being measured by its cost effectiveness. Although it is expected that as accessibility to AR technology increases the cost benefit of using the technology will follow resulting in increased adoption.

Theme 4: Emerging Technology Combined with BIM and AR

The panel recognised that the use of Augmented Reality within Building Information Modelling will not be the limit to how BIM develops but a potential strand in its development over coming years. It is likely that BIM will incorporate a number of current emerging technologies such as wireless sensor net-

works, big data, 3D printing and 3D scanning, although these new technologies are relatively new and can be further researched. the potential applications and benefits of using these technologies further blurs the line between virtual and real realities and further connects the physical context to the digital data.

Big Data was highlighted frequently by the panel as an area of further development. However concerns were raised on the management and manipulation of such large data sets.

Expert panel member no.2:

"There's quite a lot of big data. There's quite a lot of data now being acquired about buildings but there isn't a lot of analysis and understanding. And the big thing there is in this feedback, I don't think the findings are being fed back and impacting, and informing the next project. That will come, yeah, I look forward to the day when we actually have the feedback circle "

Theme 5: Emotional Link with Technology

Interestingly the emotional implications as to how AR could potentially change and affect people and communities was also highlighted, this unexpected yet related theme indicates a potential area for further study. It also identifies the need for further research into how humans experience, use and understand space through AR. AR could be the medium by which individual data sets of human experience can be collated and overlaid creating an even richer BIM model.

RESULTS FROM INDUSTRY AND PRACTITIONER QUESTIONNAIRE

The five themes derived from the expert panel interviews directly informed the industry and practitioner questionnaire. The nine items of the questionnaire and the results from industry participants (n=43) are presented in Fig.3 and Table 1.

Figure 3
Pie chart showing the sample age groups from the industry and practitioner questionnaire.

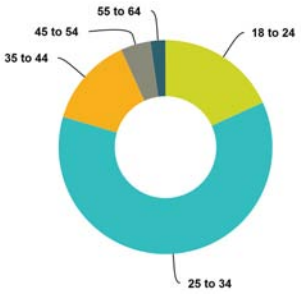
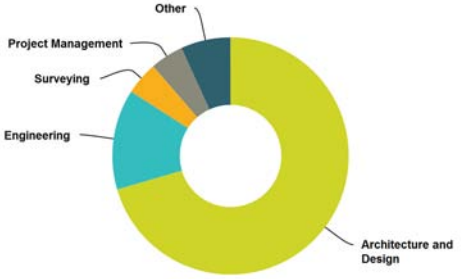


Table 1
Table showing the sample age groups from the industry and practitioner questionnaire.

Age group	Percentage
18-24	18.60%
25-34	60.47%
35-44	13.95%
45-54	4.65%
55-64	2.33%

Figure 4
Pie chart showing the sample occupation groups from the industry and practitioner questionnaire.



Occupation	Percentage
Architecture and Design	69.77%
Engineering	13.95%
Other	6.98%
Project Management	4.65%
Surveying	4.65%

Table 2
Sample occupation groups from the industry and practitioner questionnaire.

Years using BIM technologies	Percentage
None	2%
Less than 1 year	12%
1-3 years	30%
4-7 years	44%
8+ years	12%

Table 3
Table showing the sample occupation of BIM experience groups from the industry and practitioner questionnaire.

Proportion of projects utilising BIM technologies	Percentage
None	2.33%
10%+	4.65%
20%+	-
30%+	2.33%
40%+	2.33%
50%+	6.98%
60%+	2.33%
70%+	-
80%+	9.30%
90%+	13.95%
100%	55.81%

Table 4
Table showing the proportion of projects utilising BIM technologies from the industry and practitioner questionnaire.

Item 1: Age groups of survey respondents

Over 60% of the industry and practitioner respondents (refer to Fig.4) were in the 25-34 age group followed by the 18-24 group (18.6%) group and the 35-44 group (13.95%). The results (also see Table 2; remark: 'Other' include Manufacturing Technical and Process BIM Management and BIM Consultancy) are indicative of the concerns raised in theme two, regarding digital immigrants and digital natives and they clearly show that the majority of responses came from digital natives.

Item 2: Occupation of respondents

The industry and practitioner questionnaire was made available to a wide range of respondents from numerous disciplines as it was disseminated through a number of BIM user and BIM expert online groups. With nearly 70% of the respondents being BIM users from the Architecture and Design profession, this also reflects issues recognised by the expert panel in theme 2 regarding the uptake and wide range in competency amongst the different disciplines in the construction industry. Occupations listed in the others category included, manufacturing, technical and process BIM management and BIM consultancy. Whilst architecture and design show a higher response rate, the response rate for other disciplines could be seen as indicative of increasing utilisation in BIM use amongst other construction disciplines.

Item 3: How long have respondents been using BIM technologies?

Results are given in Table 3.

Item 4: Proportion of projects on which BIM technologies are currently utilised

Results are given in Table 4.

Item 5: Has utilising BIM technologies hindered or improved your work performance?

67.44% of respondents indicated that utilising BIM technologies had made a significant improvement to their work performance, 30.23% noted a slight improvement and 2.33% noted no effect to their work

performance. There were no responses reporting utilising BIM technologies as a 'slight hindrance' or 'hindrance'.

Item 6: Use of smart phone or tablet to view or edit.

Only 58% of respondents reported using a smart phone or tablet to view or edit digital construction information.

Of those respondents 76% indicated they used smart devices to edit or view 2D CAD drawings. 60% indicated they had used smart device to edit or view standard 3D models and 48% of those using a smart device indicated they have used it to view or edit a Building Information Model. So whilst established 2D drawings are most frequently viewed and edited using smart mobile devices, only 25% of the overall number of respondents currently use the smart devices to view and edit Building Information Models.

Item 7: Will BIM and AR become more common place in industry with emerging smart mobile devices like Google Glass?

The majority (79%) of respondents believed that emerging smart mobile devices like Google Glass will make the use of BIM and AR more commonplace in the construction industry. Google Glass is a wearable smart mobile device allowing the overlay of digital information onto the real environment.

Item 8: Combining BIM and AR: A fad or genuine area for expansion of working practices?

93% of respondents felt that the combination of BIM and AR offered a genuine area for expansion in working practices within the construction industry. Despite the relatively low (25%) utilisation of smart mobile devices for viewing and editing BIM reported amongst participants, this may be attributed to the appropriateness of current smart mobile devices for viewing and editing digital data as 79% of respondents felt that emerging smart mobile devices like Google Glass will make the combination of BIM and AR more commonplace within the industry, potentially because the technology is deemed more appropriate and will increase access.

Item 9: Prioritise nine applications of BIM and AR

Respondents were asked to prioritise the nine applications of BIM and AR as identified in the thematic analysis of the expert panel interviews. Rating each area of application from one (high priority or high value application) to nine (low priority or lower value application). Interpreting the results in Figure 5 it is evident that the respondents felt that applying BIM and AR to improve communication between architect, contractor and sub contractor was the highest priority and considered the highest value application to the group of respondents with utilising BIM and AR to view a composite visualisation of BIM overlaid onto the real context to allow greater testing and refining of design prototypes as the second highest value application. Where as it is evident from above that respondents considered the lowest priority application to be using BIM and AR to visualise Big Data from wireless sensor networks which could provide information on occupancy, thermal performance and lux levels. The nine applications are listed below ordered from highest value to lowest value application of BIM and AR in the construction industry.

1. To improve communication between architect, contractor and sub contractor.
2. To view composite visualisation of BIM on site located within actual contexts allowing greater testing and refining of design prototypes.
3. To visualise construction sequence on site improving onside logistics.
4. To improve health and safety on site.
5. To conduct clash detection on site during construction via smart devices.
6. For facilities management post build, locating component information for maintenance.

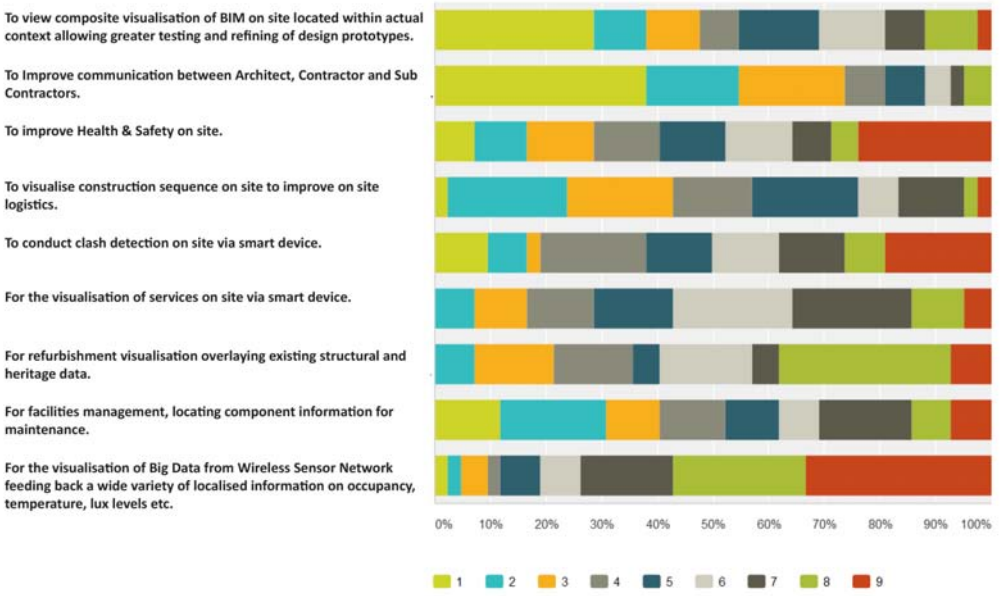


Figure 5
Graph showing the priorities of perceived usefulness of Augmented Reality and Building Information Modelling scenarios from the industry and practitioner questionnaire. Note: Light green from the left indicates high perceived usefulness. From the right red indicates low perceived usefulness.

7. The visualisation of services on site via smart device.

8. For refurbishment visualisation overlaying existing structural and heritage data.

9. For the visualisation of Big Data from wireless sensor networks feeding back a wide variety of localised information on occupancy, thermal performance and lux levels.

These results are intended to identify specific areas where future BIM and AR research should focus in order to be relevant to industry application. Thematic analysis of expert panel interviews yielded nine areas of application, the industry and practitioner questionnaire has organised these areas of application, identifying the most valuable applications of BIM and AR to industry.

ATTITUDES TOWARDS NEW TECHNOLOGIES

A recurring implication to the adoption and integration of new technologies in the construction industry is the generational divide in attitudes towards those new technologies. With the digital immigrants often acting as a barrier to adoption and integration. This will over the coming years become less of an issue as digital natives move into key management and decision making roles in industry.

Prensky (2009) identified and labelled two distinctly different groups of technology users. Digital natives, who are defined as those born "into" technology and those that are growing up with technology as a part of their everyday reality. Digital immigrants, those that are seeing the emergence of new technology and interacting with it later in their lives, having to adjust and adapt to the use and capabilities of that technology.

DIGITAL NATIVES DIGITAL IMMIGRANTS

Prefer to receive information quickly from multiple, varied sources. Often prefer the controlled release of information from limited sources.

Utilise information in the forms of images, sounds, and video often preferable over text. Often prefer to gather information from text based sources.

Are open to trust that information in these forms is reliable. Often distrust / question the validity of information that is not text based.

Are most effective in connected, collaborative communities with high levels of interaction and engagement. Are most effective when not disturbed, often preferring private and personal space for introspection to be most productive.

Has a strong ability for divergent thinking and creative problem solving often multi-tasking and parallel processing information. Has a strong ability to focus and concentrate, with a linear thinking style preferring limited information presented in a linear, logical and sequential fashion.

Further understanding the typical characteristics of the digital native and the digital immigrant could make effective adoption and integration more achievable in industry, by structuring the introduction of new technologies in a manner which both digital immigrant and digital natives find acceptable.

MOVING FORWARD

Improvements and accessibility of AR technology will increase during the next decade as indicated by Moore's Law. In the initial stages of this study during the semi-structured interviews with industry experts, participants reported that technology and culture (specifically mass cultural adoption of new technologies) are interlinked with one another, as technology improves over time, becoming faster, miniaturised and seeing a greater reduction in manufacturing cost, so too will the uptake of AR technologies increase. Industries will benefit from AR however it will take time for the general population to accept and adopt AR in their day to day lives, however as long as there is significant consumer interest the technology will continue to be refined and evolved .

One common view of from the expert panel interviews was that the future of the construction industry will involve a synergy of technologies including 3D scanning, mixed reality models, wireless sensory networks which will all be based around and be interoperable with BIM. There was also the common view that Mixed Reality (MR) which includes both Augmented Reality and Virtual Reality will be used in the future in conjunction with 3D scanning, big data, smart cities and smart homes. Combining and networking technologies will create richer and more efficient working practices with regards to design, construction and maintenance within the industry.

The expert panel viewed these technologies as being accessible through cloud based systems, which both store and process and synthesise all building data from concept, design, development, construction, maintenance, refurbishment and demolition. AR and BIM will heavily impact and benefit building projects from cradle to cradle through other technological advances involving wireless sensor technology and big data, collecting and using information throughout the buildings life span.

The construction industry will however need to adapt to gain the full benefits of combining AR and BIM technologies. As mentioned the culture within construction is managed by an older generation of digital immigrants, as time advances, the digital native generation will move into positions of leadership within the industry, 3D immersive collaborative environments will become the norm within construction.

Further research can be conducted to include a larger number of experts opinions within construction. There potentially may be differences in opinions with architects on their thoughts to how AR and BIM will be used in the future of construction.

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