

# HEALTHY BUILDINGS: INNOVATION, DESIGN & TECHNOLOGY

## ICAT 2016

ANTONIO GALIANO GARRIGÓS  
TAHAR KOUIDER



**CONFERENCE PROCEEDINGS OF THE 6<sup>TH</sup> INTERNATIONAL  
CONGRESS OF ARCHITECTURAL TECHNOLOGY  
UNIVERSITY OF ALICANTE 12-14 MAY 2016**

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# COMPARING COMMON DATA ENVIRONMENT PLATFORMS FOR STUDENT COLLABORATIVE WORKING

*A Case Study from Ulster University*

DAVID COMISKEY, MARK MCKANE, ANDREW JAFFREY

*Ulster University, Northern Ireland*

*da.comiskey@ulster.ac.uk*

*m.mckane@ulster.ac.uk*

*ac.jaffrey@ulster.ac.uk*

AND

PAUL WILSON

*Technical Director, Digital Project Delivery, AECOM*

*paul.g.wilson@aecom.com*

**Abstract.** PAS1192-2 (2013) outlines the “*fundamental principles of Level 2 information modeling*”, one of these principles is the use of what is commonly referred to as a Common Data Environment (CDE). A CDE could be described as an internet-enabled cloud-hosting platform, accessible to all construction team members to access shared project information. For the construction sector to achieve increased productivity goals, the next generation of industry professionals will need to be educated in a way that provides them with an appreciation of Building Information Modelling (BIM) working methods, at all levels, including an understanding of how data in a CDE should be structured, managed, shared and published. This presents a challenge for educational institutions in terms of providing a CDE that addresses the requirements set out in PAS1192-2, and mirrors organisational and professional working practices without causing confusion due to over complexity. This paper presents the findings of a two-year study undertaken at Ulster University comparing the use of a leading industry CDE platform

with one derived from the in-house Virtual Learning Environment (VLE), for the delivery of a student BIM project. The research methodology employed was a qualitative case study analysis, focusing on observations from the academics involved and feedback from students. The results of the study show advantages for both CDE platforms depending on the learning outcomes required.

## 1. Introduction

The 2011 Government Construction Strategy stated, “*Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016*”. The construction sector was considered to be underperforming, and there was an acceptance that standards needed to be raised to attain increased productivity levels. Traditional methods of managing design information on large projects normally involves each project stakeholder managing the production of Computer Aided Design models, drawings, and documents within their own distributed environment. This usually occurs on a range of disconnected file servers. Hard copy drawings and paper documents are created and presented at review and design development meetings, or emailed to other project design teams so that progress can be seen and issues highlighted for revision and update. There are many problems with this traditional approach to information management and sharing, and it was recognised that change was required.

Technology is a key driver to support this transformation, with the requirement for hosted collaborative environments and three-dimensional virtual models as part of an overarching process known as Building Information Modelling. In essence, the BIM process shifts design to a three-dimensional environment, with all project stakeholders working in a collaborative manner to deliver built assets. A result of the increased emphasis on collaborative working means that project information needs to be stored and shared in a more structured and standardised way, and in a way that can be accessed at all times from any location. The method for this

sharing of information is via a Common Data Environment (CDE). As the industry as a whole becomes more comfortable working and sharing information in this way, it is important that the CDE becomes an industry norm for the delivery of all construction projects. For this to take place, and for BIM working methods to become commonplace, the current barriers restricting widespread adoption need to be tackled.

Lockley (2011, p.20) outlines that “*Educational establishments...should and will seed the next generation of professionals who understand BIM as a technology that supports collaborative working*”. However, a recent BIM Academic Forum survey by Underwood et al. (2015, p.26), highlighted “*a majority 66% of respondents agree that HEIs are failing to keep pace with BIM skill requirement and industry knowledge demands*”. There is therefore a necessity for the education sector to make a conscious effort to provide students with the required knowledge to secure future employment in this area.

This paper builds upon previous work by Comiskey et al. (2015a), published in the Conference Proceedings of the 2015 CITA BIM Gathering, and presents the findings of a two-year study undertaken at Ulster University, comparing the use of a leading industry CDE platform with one derived from an in-house VLE, for the delivery of a student BIM project. The aforementioned publication outlined how collaborative student working was being implemented within Ulster University and included an overview of the two CDE platforms used in the delivery of these projects. This initial work has been developed for this paper by introducing a review of CDE literature, comparing the two CDE platforms in a greater level of detail and providing analysis and feedback on the lessons learnt. This has been complemented by input from an award winning industry expert and from the Head of the Office for Digital Learning at Ulster University.

## 2. Common Data Environments

In 2013 the PAS1192-2 document was published. Amongst other requirements and recommendations, it identified the “*provision of a single environment to store shared asset data and information, accessible to all individuals who are required to produce, use and maintain it*”. The document also provided guidance on the possible structure of a CDE. Essentially, this structure is based around the provision of four main areas; Work In Progress (WIP), Shared, Published and Archive. In these areas information can be stored, approved and passed from one area to the next at a relevant point in the project delivery process. The benefits of using a CDE are most apparent as designers create, manage and share their models, drawings and documents. However, the best practice processes, workflows, document coding standards and metadata that a CDE employs, ultimately allows a vastly improved level of consistency and quality to be implemented. The CDE also has project delivery team roles, responsibilities and authority rights for effective information management and exchange (so that team members can only access information and areas to which they are assigned). File and layer naming conventions are also a requirement as part of this process, extended from those defined in BS1192: 2007.

CDE usage was highlighted as good practice back in 2007 with its inclusion in the aforementioned BS1192 publication, but its benefits were realised prior to this with the Avanti programme advocating its use. Indeed the early origins of what is now known as CDE usage can be traced back further to the Heathrow Express scheme (see Bew & Underwood, 2010, p.54-55). However, CDE usage for project delivery has been almost universally non-existent until relatively recently, and something alien to most within the construction industry. The 2016 mandate and the required use of a CDE has meant that the skillset required of a current built environment graduate is changing, with the core skills of collaborative working and technical literacy becoming increasingly important. As such, it is likely that it will be the current generation of graduates who will

implement such working methods in practice within their various disciplines.

## 2.1. CDE USE IN EDUCATION

The built environment sector is going through a process change from an individualistic, silo-based approach within individual disciplines and organisations, to a more joined up and collaborative approach to project planning, design, delivery, construction, and operation. For such change to gain momentum and become deep-rooted in the ethos of those within the sector, it is important that education mirrors industry and produces graduates that are innovative, knowledgeable and equipped with abilities of working and problem solving for the long term success of the industry.

One way of implementing this change is by encouraging more team tasks and groupwork. Damsa (2014, pp.247-248) outlines:

*“Learning in small groups that focuses on solving open-ended problems and on managing the collaborative process has been proposed as a way to expose and enculture students to complex learning situations that stimulate engagement in collaborative knowledge production”.*

Such change is already taking place within those institutions introducing collaborative (BIM) learning within their programmes of study. There are good examples of such practice on a number of Architectural Technology related undergraduate programmes. These include Dublin Institute of Technology, where a group of students used a BIM software platform to assist with a collaborative learning approach, involving a practitioner, on a studio project (see Matthews, 2013) and Waterford Institute of Technology, where students from a number of programmes, including Architectural Technology, worked collaboratively in producing a scheme to fulfil a brief that was adapted from a real life project (see Stubbs et al, 2014). At Copenhagen School of Design and Technology, the design of the

Architectural Technology and Construction Management programme ensures that collaboration is to the fore (see Comiskey et al, 2015b, pp.239-241), and at the authors' own institution, Ulster University, collaboration between students within the same institution and internationally has been documented (see Comiskey et al, 2015a).

Whilst Matthews (2015) makes reference the use of Google Drive as a basic CDE for postgraduate students undertaking a multidisciplinary collaborative project, there generally appears to be a lack of published literature focusing on CDE use in the delivery of collaborative BIM projects in built environment related programmes at undergraduate level. There is also a lack of studies comparing the most suitable CDE platform for the delivery of such projects.

The drivers and motivation for developing CDEs for collaboration within the built environment education sector are similar to other subject areas. The world is becoming more technologically driven, and students, regardless of discipline, are expected to enter the world of work with an understanding of developing technology and innovation, including how to successfully interact, work, share information, and collaborate in an online or cloud based environment. This is especially true in the built environment sector at present, with BIM helping to drive this change, along with the requirement for collaborative problem solving as projects increase in complexity (Comiskey et al. 2015b, p.240). This presents a challenge for existing digital learning infrastructures within institutions, which are arguably not designed to support a connectivist approach to teaching and learning.

CDE use can also present a challenge for academics, especially in relation to the teaching of ICT. As outlined by Smit et al. (2005):

*“Some educational leaders take the view that precious time in lectures and tutorials should not be used for teaching ICT but should be used to pass on learning content – they say students must learn ICT tools independently. Others blend ICT training into lectures and tutorials.”*

It is important that the latter approach is adopted by academics to allow students to fully understand the workings of a CDE and apply it in practice. Even those academics that are embracing technology-enabled collaboration still face the challenge of constantly up-skilling to ensure they are comfortable facilitating learning via this medium. However, it should be remembered that many of our students are already comfortable using cloud-based environments due to the availability of platforms such as Dropbox, OneDrive, Box and Google Drive. In addition to this they are also used to collaborating with others through engaging with various gaming platforms. Therefore, the concept of working collaboratively and sharing information via a CDE is something that should be easily understood, once the general principles are presented.

### **3. Research Methodology**

The research methodology employed for this paper was a qualitative case study analysis, focusing on direct observations from the academics involved and feedback from student cohorts over both academic years. There was also an aspect of participant observation (see Wellington, 2004, p.45), as the authors were actively involved in the design and structure of both CDE platforms and assisted any students having difficulty using them for their projects. A case study approach was considered particularly applicable for this project. As outlined by Cohen et al. (2011), “*case studies investigate and report the real-life, complex dynamic and unfolding interactions of events, human relationships and other factors in a unique instance.*” Although there can be disadvantages of using a case study approach, such as potential bias (Nisbet & Watt, 1984 cited in Cohen et al. 2011), it was felt that such an approach would enable the thoughts and observations to be captured in real time, and provide those wanting to implement a similar approach with an opportunity to evaluate the effectiveness of both CDE platforms within a traditional academic setting.

#### **4. Case Study**

Realising the impending changes as a result of the government mandate, and acting on their own research findings suggesting that BIM modules should be taught in a collaborative manner (Eadie et al. 2014), the authors aimed to ensure their students were adequately prepared and equipped with the necessary skills for moving into the workplace. Therefore, beginning in the 2013/14 academic year, consideration was given on how teaching could be adapted to include collaborative working via a CDE. The following case study builds upon the work presented by Comiskey et al. (2015a), outlining how the collaborative student project developed was delivered via two separate CDE platforms.

##### **4.1. 2013/14 ACADEMIC YEAR**

The student cohorts involved in the collaborative BIM project were studying on separate programmes, Architectural Technology and Management (ATM) and Quantity Surveying and Commercial Management (QSCM). With the structure and content of the modules for the 2013/14 academic year already in place when the project was conceived, the proposals needed to be structured around the delivery method already in place. Stage one of the process entailed numerous meetings between the project leads to evaluate the curriculum of both programmes and identify where collaborative working, delivered via a CDE, could be scheduled. It was decided that delivery in a Level 5 (Year 2) module would be best, as attainment at this level did not contribute towards the student exit award at Ulster University. A module within each programme was then chosen for which the coursework scenario and requirements could be amended without affecting the learning outcomes. A joint coursework brief, contextualised around the development of a Design & Build tender submission, was produced which allowed students to work collaboratively, to produce architectural designs with associated costing, tender programme and commercial management information, and present their proposals to an assessment panel.

The coursework task ensured collaboration between students, but communication and sharing work via the use of a CDE was also required. The challenge to be overcome was that project CDE usage in an educational context was something new, with the University not having access to any of the main CDE platforms. After consideration, it was realised that the in-house VLE was in essence a CDE for educational resources within modularised subjects, which combined represent a programme of study. It was considered that if modules were considered as 'projects', then perhaps the VLE could be harnessed as a CDE for the simulated BIM project. Therefore, it was decided to implement a speculative proposal to create a bespoke CDE using the in house VLE. Meetings were scheduled with the VLE technical support team, to explore the capability of the system based upon outline sketches provided of folder structures and the file exchange protocols and access permissions envisaged. This allowed the VLE technical support team to set-up a suitable 'Programme Support Area' within the VLE, permitting access to the cohorts involved. Folder structures and permissions associated with the various student groupings were then set up. A number of meetings took place between the project leads and the technical support team to pilot test the system and ensure thorough understanding.

There were a number of infrastructural challenges to overcome in order to successfully fulfil the learning outcomes of the BIM collaboration, these issues were largely related to the organisational structure of the University and how this structure was reflected in the institutional VLE. Typical to most implementations of VLEs, courses are organised in a hierarchical structure based on Schools and Faculties. Each student belongs to his or her node in the structure and is enrolled based on their relationship to the institution. Collaborating outside of these structures necessitates the creation of new, more agile digital learning environments to support collaborative multi-disciplinary learning. The VLE support team created a new BIM collaboration area and enrolled students from each of the two modules to create a virtual space to facilitate sharing information, communicating and collaborating. A custom enrolment script was created

to ensure that any changes to the source module enrolments in the student records system were reflected in the BIM area.

The students were enrolled in the area as a single cohort and it was necessary to sub divide the cohort into multi-disciplinary groups. Once the area was created and populated, and following discussions with the academic team, the technical team identified a number of digital competencies that students would require in order to successfully engage with BIM collaboration in the workplace. Concepts such as document version control, document permissions and collaborative authoring are new skills to undergraduate students and the team felt that these concepts should form part of the learning experience. Blackboard Learn contained a document management system providing a large degree of the functionality required to support the workflows outlined in PAS1192-2. The system is commonly known as the 'Content Collection' within Blackboard Learn. Each group had a folder within the Content Collection, with permissions that only allowed collaboration within their own group, in which they could share and collaborate on documents. Blackboard Learn had the potential to allow each group member to granularly assign permissions, allowing controlled access to any document depending on the nature of the collaboration. However, this facility was not used due to the inexperience of the academic staff involved. Instead, folders were set-up with pre-defined access permissions for the students, who then shared documents by moving a copy of the file or document into a shared folder and assigning an appropriately updated file name, as suggested in BS1192.

The BIM workflow necessitates effective communication in addition to document sharing, and this was enabled using the communication tools within the Blackboard Group Area. Each group had access to a private discussion board, although email seemed to be favoured, and private controlled communication tools allowing students to share information and communicate to only those students enrolled in their multi-disciplinary group. Using this structure, the students were able to work in a way that mirrored industry practice. This included using the WIP area to host their individual models as the project progressed and making these available via the Shared area for mark-up and comment at the appropriate juncture. The

CDE was also used for the creation and hosting of a joint group project presentation at the end of the semester. Feedback was positive, with comments including:

*“...I found it to be a thoroughly educational as well as enjoyable experience in the sense that it was a great opportunity to be involved within an authentic multidisciplinary team highlighting how one must appreciate the value of communication...”*

*“Overall it was a very good experience and helped me get a better understanding of how different professions within the construction industry can be more efficient and communicate better using BIM...It was interesting to work with other professions collaborating on a project and was an enjoyable beneficial experience”*

*“This project, and the exposure to sharing information and communicating via the common data environment which was created as part of it, has set me up perfect[ly] for my placement...”*

#### 4.1. 2014/15 ACADEMIC YEAR

The project was extended in the following academic year with one additional programme within Ulster University (Civil Engineering) and one external programme at Pennsylvania State University (Landscape Architecture) becoming involved. Discussions took place regarding how best to facilitate the international aspect and it was decided to approach a leading industry CDE provider to inquire about the possibility of using their platform. The reasoning behind this was that it would not only facilitate the international collaborative aspect, but also allow comparison to be made with the in-house CDE. Asite agreed to allow the use of their platform for the duration of the project. An immediate advantage of using the industry CDE provider was that they were familiar with the workflow and the setup required. The project leads were required to forward

information in terms of the group structures and student details and this was populated into the CDE. Using the BS1192 and PAS1192-2 folder structures, the group folders were created.

The academics involved in the project spent time demonstrating the features of the Asite platform to the student groups involved. This included ensuring they were confident uploading content and sharing this at the relevant point in the project. Each of the students had their own WIP area, along with access to the following folders; Shared, Published Documentation, Client Shared and Archive. This was slightly more advanced than the previous year, but it was useful from the academics perspective to reaffirm that the content they had created previously had been presented in a way that was comparable with a leading CDE provider. During the semester it became noticeable that a number of the ATM students didn't always use the WIP area whilst working on their designs. They seemed to revert to using cloud based storage environments they were more familiar with or USB drives. Although they had been told that the content within the WIP folder could only be viewed and accessed by them, there seemed to be a reluctance by some to use this area, possibly in case other members of their group could access the information and inadvertently use an incorrect version of their model.

The CDE had other functionality, including the ability to create project forms, generate reports and manage project procurement, but most fundamentally, the ability to view the 3D models loaded into the folders without the requirement for local software. This function also facilitated saved viewpoints and red-line mark-ups, which students could elect to use instead of Navisworks, which had been used for this type of collaboration in the previous year. However, the only additional feature that was used by some was the discussions section, to clarify any issues arising between the students. Some of the functionality didn't appear to work as expected, but because the project leads were unable to adjust the system settings (due to their limited experience of the platform), they were unable to assist in an efficient manner and had to employ work-around solutions. Asite did facilitate comprehensive training sessions and provide a detailed overview

of the system, but the time required to fully master the system should not be underestimated. This was an important lesson that was taken from the project. Although it took some time for students to become confident using the Asite platform, in class observations towards the end of the semester suggested that they were becoming more familiar and comfortable with its workings. Feedback from students involved in the 2014/15 academic year included:

*“Collaboration with the QS Students was interesting because it enables you to communicate with people from different sectors of the construction industry...I found it difficult using the common data environment at the start, but once I got the hang of it, it was useful for sharing projects and I realised the benefits.”*

*“I found the project was a very good experience...it gave me a very good idea of what it would be like working in industry as we were working as a team to achieve the same objective. It gave me a really good insight as to what it is like working and communicating to other members of the team from different disciplines...”*

## **5. Discussion**

The academics involved had not worked in this way previously and were unsure about the student reaction and how effective the CDE and collaborative workflow would be. However, the results for both of the CDE platforms were broadly positive. Throughout both projects there were many similar challenges to overcome, not least the many structural barriers to collaborating which exist within Higher Education Institutions (HEIs). This is exacerbated when the number of students on each programme varies significantly, as was the case in both projects. Although the work was shared on a CDE, face-to-face meetings (between students at Ulster) were scheduled as a means of introducing the students, with a minimum of two

meetings, one at the outset of the project by means of an introduction, and the second at the joint presentation. These were viewed as important in the overall process, especially within the vocational context of the brief. The face-to-face meetings required a certain degree of flexibility between the project leads and students due to the timetabled challenges and the fact that the programmes were delivered within different schools.

Focusing on the CDE derived from Blackboard, the most significant challenge was in reflecting the requirements of PAS 1192-2 and providing a realistic 'real world' environment. This was especially challenging, as the University VLE had never previously been used in this way. Although the VLE support team were technically competent, they had no background in construction and were unaware of the structure and content required. The fact that the students were new to not only the BIM process, but also the technology, made the challenge all the greater. Finally, as neither of the lecturers involved had worked with the technology on a live project, there were confidence challenges to be overcome in terms of moving forward with the experimental digital application project. Fortunately, the project leads had similar aspirations for the project and were enthusiastic BIM advocates, so exploring the potential for the project was enjoyable and the risk to the students was minimised, because their learning outcomes could be achieved even without engaging in the process.

Regarding the industry standard CDE, the main issue from the academics' perspective was in becoming sufficiently competent in the use of the platform to advise the students how to use it for their projects. The system was a fully functioning CDE and had a lot more features than the in-house CDE, including an area for project forms, reports, federated models and procurement related documentation. Although the students did not use these areas, they still were useful in terms of demonstrating how a CDE should be used in practice. For future projects, the ability to use the platform to keep a record of Meeting Minutes would be a feature that would be recommended. This would not only provide the students with an additional feature of the CDE platform, it would allow a record of progress and actions to be recorded and also allow them to experience a task they will be required to perform in professional life.

The potential for some students to be daunted by the perceived complexity of the system should also be highlighted and became apparent in some of the responses in the end of module surveys. Due to workload and other commitments the academic team were unable to devote the time required to fully familiarise themselves with the entire suite of features, and as such used it in a limited manner. For example, the ability to assign actions to other members of the collaborative team against documents posted within the shared folders didn't work with the default project settings, but the project leads hadn't the time or experience to remedy this. As outlined in Comiskey et al. (2015a), this was an important learning outcome from the project and highlights the significance of the Information Manager role. There were many positives, which were apparent both in this study and outlined in the previous paper, these included the opportunity to provide students with the experience of using a leading industry CDE platform, and from the academic perspective, the ability to filter and search for files that were uploaded by the various students within project areas was very useful, especially at assessment time. It also facilitated the international collaboration in a much easier manner than would have been the case if the in-house CDE had been used.

As a pilot project, this study was beneficial in comparing the main features of both platforms to facilitate a collaborative educational assignment task. However, additional work on a much larger scale will be required before any conclusion could be drawn on the benefits of using an in house CDE compared to one used in professional practice. As new features are added to CDEs and VLEs they may become interchangeable and further experimentation may be required with different systems.

## **6. Conclusion**

The time commitment consumed outside normal working hours cannot be underestimated when embarking on such a journey. Before the CDE platform can be used, the time involved in developing the infrastructure,

designing the contextual brief, administering and supporting the students through their workshops and resolving their technical queries can be taxing. However, the satisfaction of observing the learning outcomes evolving throughout the project and the enhanced employability skills being presented at the end of the project provided a rewarding return on investment.

The use of the industry standard CDE was very beneficial and provided the students with an insight into the workings of a professional information management workflow using BIM. Similarly, the in-house CDE provided the students with an understanding of the basic makeup of a CDE and allowed them to become familiar with its workings. Others wanting to implement similar projects should weigh up the required learning outcomes. If the aim were to provide students with a basic grasp of the workings of a CDE at a low level, with collaboration limited to other programmes within the same institution, then an in-house CDE would be sufficient. This could take the form of a basic folder structure for sharing documentation, whereby model viewing and red line markup is accommodated using desktop applications. Such a process would be most suitable for Year 1 students. However, if the aim were to replicate the full suite of CDE features such as; federation (where multiple discipline models are being developed, possibly within different institutions), the allocation of action distribution/deadlines, and red line markups/saved viewports all hosted within the CDE as a service, then it would be much more difficult. In this case a professional CDE platform would be the best way of delivering these services. This would be most suitable for Year 2 and 4 students, as long as they have an understanding of the information delivery cycle and how a CDE operates. However, this opens up a new discussion on the level of BIM related content delivered within institutions that would allow a thorough grasp of such workflows. Another factor to be considered for future implementation would be the willingness of CDE providers to allow free of charge educational use of their platforms. If this were not the case, considering the challenging economic environment in which many HEIs operate, would there be a willingness within institutions to pay the subscription fees?

In terms of future CDE usage at Ulster, changes to the digital learning environment, in line with development of learning technologies in the marketplace, will result in easier communication and collaboration opportunities via existing platforms. The latest version of Blackboard Collaborate (Ultra) is mobile responsive, works on multiple devices and is designed to allow multiple cohorts to connect in a flexible way between themselves and external contacts that may not have an institutional identity. Integrations between more agile document management and version control systems and the institutional VLE will allow more informal sharing and collaboration reflective of industry practice. Tools such as Github and Dropbox provide rapid iterative development opportunities between individuals during the prototyping phase with final documents being refined and published in controlled firewalled systems when appropriate. This mix of policy and control with flexibility and agility will introduce students to technologies that are being used in practice to enable effective collaboration.

Although many of the VLE weaknesses appear to be overcome by new features, CDE platforms are likely to develop further. This poses a challenge for technical teams within institutions who are trying to mirror these features, and equally for academics that may be expected to use them.

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