CitA IRISH BIM INNOVATION AWARDS 2016

Design Category

GARLAND - Mercer Institute for Successful Ageing (MISA), St James’s Hospital, Dublin

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INTRODUCTION

GARLAND is an international consulting engineering firm, based in three locations throughout Ireland and with offices internationally. The company's history spans more than 75 years and over 30 countries worldwide. Our highly experienced teams are renowned for prestigious work within the healthcare, educational, industrial, infrastructure, commercial and residential sectors. It was as a result of this reputation for excellence that GARLAND were selected by BAM Building to provide Civil and Structural Engineering services, as part of a Design and Build Team, for a 7 storey centre of excellence at St. James's Hospital, Dublin.

BAM Building Ireland were successful in being awarded the contract to design and build the Mercers Institute for Successful Aging (MISA) on the campus of St. James's Hospital. The project commenced in 2013 and was completed in May 2016 and is now the largest centre of its type in Europe.

The 15,000 square meter building includes research facilities, consultation spaces, meeting spaces, day area, roof terrace spaces, a courtyard and naturally lit foyer, conference rooms and 76 en-suite bedrooms with further ward spaces to accommodate a total of 100 beds.

The confined site allocated for the building, within St. James's Hospital complex in Dublin City Centre, necessitated an irregular floor plan. This complicated the structural layout which also needed to accommodate the architectural spatial requirements. As a result, the building's floor plan increased from third floor up, introducing the requirement for a considerable transfer structure at this level. This added complexity in terms of the interface between the structural elements and the
routes for mechanical, electrical and plumbing services, required detailed coordination between all Design Team members.

The use of Building Information Modelling (BIM), as a means to coordinate, collaborate and scrutinise proposed designs as well as improving on-site design visualisation during the construction phase, was in its infancy in the Irish industry when this project commenced. Its successful implementation was fundamental in the delivery of this world class facility.

The detailed design and construction of the project was delivered using BIM processes, led by the design and build contractor in accordance with PAS 1192

**INNOVATIVE USE OF BIM**

The decision to adopt Building Information Modelling for collaborative purposes on this project was reached at an early stage owing to the significant coordination that would be required within the multi-disciplinary design team. However, the innovative applications of BIM throughout the project went much further. The project commenced as a Level 2 BIM project in 2014, some 2 years before the UK BIM mandate took effect in 2016. It is one of the first BIM delivered projects in Ireland to a recognised standard, as its central delivery process.

The heavily congested nature of the site of the MISA Project on the campus of the State's largest acute hospital added an additional layer of complexity to the project. In addition, part of the structure was located over an existing underground car park facility which needed to be strengthened to accommodate the new building. This all had to be accurately mapped to provide the detailed information required to produce a design which accurately reflected the on-site reality which would confront the contractor. Given the fact-track nature of the project, redesign was not going to be an option. Point cloud scanning of the structures adjacent to the proposed building, along with existing building to which MISA would be linked to as well as the basement structure, was undertaken as the first action prior to the commencement of the design. This was the first time such scanning was utilised for the purposes of producing a structural BIM model in this country. Its accurate 3D reflection of the site proved invaluable. The interaction between the proposed MISA Building and an existing adjoining building was only fully realised as a result of the point cloud scan and the BIM Model. A potential clash with an existing overhanging section of the existing building which heretofore had been misrepresented on record drawings received at the outset was avoided due to the use of this approach. Such an occurrence, had it only been realised during the construction phase, had the potential to affect not just programme but the internal layout and operations of the room within building. Identifying this at an early stage in the design allowed for engagement with the end-users to achieve a solution which was to the benefit of all parties.

As the structural engineers on the project, the generation of digital representations of both the physical and functional characteristics of the building afforded a more detailed platform from which to scrutinise proposed designs. Early coordination of key structural elements with the architectural requirements was achievable using
BIM processes as it enabled both parties to appreciate the challenges each faced and provided a better understanding of where small modifications could have a real impact on other team members. Integration of the model with bi-directional finite element structural design packages ensured a structural design that took account of all other elements of the design. The ingenuity of the final design solution was greatly aided as a result of this efficient visualisation and its integration between software.

As a direct result of this project, and having experienced the benefits it provides, a full roll out of BIM technology throughout our organisation has been undertaken. BIM is now the predominant process by which we deliver our services.

**COLLABORATION AND COMMUNICATION**

The decision to adopt BIM for collaborative and communication purposes was reached early on in the project owing to the significant coordination required within the multi-disciplinary design team. It involved real and further investment in software, and training and up skilling of existing staff members by all stakeholders.

Through the use of BIM on this project, a fuller appreciation of the power of the technology was developed. The difficulty often faced on projects of this nature, is coordinating the locations of service openings within the building and agreeing same with the services engineer, the Architect and us, the structural engineer. Through the use of BIM, the services and their required opes could be fully visualized, clashes identified and any locations likely to cause problems for either the Architect or the structural engineer resolved. This reduced the uncertainly of the design at an early stage of the process. By being able to sit as a team and navigate the model, such issues were resolved quickly where often they would only be realized during the construction process only after expending a lot more resources, time and effort. The resolution of such issues at an early stage resulted in less tensions within the design and construction team, which can often develop on projects. The impact of this was a more harmonious, productive design environment which benefited the project as a whole.

Initially, the Architect developed a schematic model in a BIM environment from a 2D representation of the end-user's requirements, inherited from the Project Client. This then allowed us, GARLAND, to export the model to a finite element analysis package.
to determine structural requirements and feed back into the structural model. This in turn allowed the structural layout to be coordinated with the architectural requirements and once completed; the Services Engineers imputed their requirements.

Once we had put our resources into the initial model generation, we were able to make changes efficiently to the model and from there generate construction drawings where required. Again, once the initial model was delivered, BIM also provided for a more efficient, time effective process, which had a beneficial impact on drafting resources required during the life of the project. We used the 3D Model to improve some of our existing workflows including reinforcement detailing.

Owing to the impracticalities of a central server system for three independent design firms, an online collaboration system, Business Collaborator, the common data environment, was used in accordance with PAS 1192.

Using the individual discipline models uploaded on a regular and weekly basis from the common data environment, BIM Glue, was utilised to create a federated model of the various discipline models was uploaded to the cloud. A BIM Manager for the project was appointed and had responsibility for the integration.

Weekly coordination meetings were held, alternating between webex on-line virtual meetings and meetings which occurred as part of the fortnightly Design Team Meetings. Clash detection analysis, undertaken by the BIM Manager prior to each meeting, identified potential issues which were then discussed by all stakeholders. Viewpoints were also tagged to BIM 360 Glue and notifications issued to the party concerned on an ongoing basis as the means of communicating issues outside of formal meeting. These viewpoints were logged in a database as a tracking
mechanism. One of the challenge faced during the project was the potential for confusion caused by team members uploading information to the model which may not have been compete at the time of upload and non-communication of this fact to other team members. As a result, others designs and model development were then in danger of progressing using this less developed information. It was through the use of tagging viewpoints and regular communication that this challenge was overcome and resolved.

INTEROPERABILITY

Revit Software, as well as NavisWorks and BIM 360 Glue were agreed as being the tool to be adopted on the project. The implementation of a BIM Execution Plan, to which each stakeholder input and agreed to, was essential to ensure that the approach taken would be both efficient and effective. This set out the processes, based on the PAS 1192 series of standards, that all parties agreed to adopt for the project.

We also uploaded IFC versions of our model for use by specialist contractors who were using alternative tools to Revit such as Tekla.

In addition to the use of BIM processes within the design and coordination of the building layouts, BIM Field 360 was utilised by BAM Building’s Site Engineers. This provided the site team with a better understanding of the structural design and interface challenges. This on-site design visualisation capability, through the use of hand-held tablets, provided for greater collaboration between designer and contractor.

USE OF INTERNATIONAL STANDARDS

This project commenced as a Level 2 BIM project in 2014, some 2 years before the UK BIM mandate took effect in 2016. Although we have undertaken a number of BIM projects to varying degrees from lonely and solo BIM to the sharing of some model information for coordination purposes, this was our first fully collaborative project with BIM to an agreed standard, PAS 1192, as the central delivery process. This includes our reviews and inputs into the Employer’s Information Requirement (EIR), BIM Execution Plan (BEP), our development of a Task Team Information Delivery Plan (TIDP) and the Master Information Delivery Plan (MIDP). We utilised the Common Data Environment (CDE) in accordance with PAS 1192 including file
naming requirements. As a result of this project and the application of the standard we reviewed and revised a number of our internal ISO 9001 procedures to ensure alignment with PAS 1192.

EDUCATION AND TRAINING

As with any new concept, the most difficult challenge was the lack of experience in the process, use of the tools and the full and proper application of standards to its full potential from the start of the project. This was true across the constituent member firms of the Design Team. However, through training and both self and shared learning, this challenge was overcome successfully during the project.

Managing expectations also proved to be a challenge. While fortunate in that our Client, the Contractor in this case, was knowledgeable as to the potential benefits of BIM, the reality of the time required to generate a fully integrated and coordinated model, and from it construction drawings, was not fully appreciated. By engaging our Client in the process and involving them in the weekly review meetings, they became a stakeholder in the process. As the model developed, the benefits to the Contractor’s team on-site became evident thought the use of software such as BIM 360 Field.

Other challenges arose throughout the process which had not been foreseen. One of these was the workplace cultural reform that the use of BIM imposed. This manifested for us in the increased responsibilities and external project positioning placed on our BIM Technicians. This resulted in loss of control of some elements
the Project Engineers would normally have dealt with. In order to overcome this, a closer working relationship was required and developed between the BIM Technician and the Engineer which benefited our successful delivery of the project.

**RISK MANAGEMENT**

Using our 3D structural model, the contractor was able to develop a 4D construction scheduling model linked to their project programme. Our 3D model was also used within a federated model to carry out cash detection and resolution. Our 3D model and the 4D model were used to ensure the safe construction of the building within a live acute healthcare campus.

The visualisations from our model was used to engage with project stakeholders including end users, staff and hospital management as a tool for visualising and managing project and campus risks.

**KEY PROJECT OUTCOMES**

The benefits our Client, the Contractor for the project, obtained from the use of BIM technology were many.

Through the use of visualization tools and an accurate representation of the structural elements on a 3D BIM Model, a reduced number of change orders were required. This helped in increasing efficiency and eliminating administrative expenses on redesigns. This was particularly effective in providing the end user with 3D virtual demonstrations of the proposed building, enabling them to request changes at an early stage prior to the commencement of construction. This also allowed our Client to execute ‘what-if’ scenarios to test alternative design solutions and present them to the end users.

The technology also facilitated enhanced communication between our Client and the Design Team, allowing issues to be resolved collectively and quickly. In particular, the Clients on-site team's use of BIM 360 Field enabled them to visualize the structure in 3D format during the construction process. Issues could be easily identified and tagged to the appropriate member of the Design Team using viewpoints.
BIM allowed clashes to be detected at an advanced stage in the design which was advantageous in reducing on-site delays. The requirement for coring through structural elements was also reduced as a result which was economically beneficial. This also had obvious structural advantages, allowing GARLAND to design around such required openings.

KEY LEARNINGS

As a result of our continual involvement in professional bodies and belief in the value of sharing knowledge for the benefit of the industry, we have presented, to our industry peers, this project as a structural engineering case study at a number of events. These included the Revit Users Ireland Group meeting on 30th September 2015, to London Digital Show 2015 on 22nd October 2015 and this year at CITA Smarter Series event held on 4th May 2016.

Our key findings of what worked well for us on the project were:

- We were able to show our structural intent and requirements in 3D to other members of the design team, technical advisors, client and contractors. This improved communication and understanding of the structural design accords the project stakeholders.

- The correct use of a Common Data Environment allowed us to search, find and access information we needed when we needed it. We were confident that we were using the correct and current revision of items. We spent time with other companies discussing problem solving and adding to the project instead of on administration.

- We found that once we had put the additional and frontloaded time into the generation of the initial building model, that we were able to react and respond to change requests in a much quicker manner, something which is
demanded for the construction of the structure on a design and build project given it commences upon appointment of the contractor, our client.

- Once all of our team members were comfortable and familiar with the file naming requirements of BS1192 and PAS 1192, we were able find, track and access the drawings and documents we needed within the CDE when we required them. As all team members were using the same file naming system to a standard and to that outlined in the BIM Execution Plan resulted in a consistent and collective approach to file naming.

- The use of clash detection on the federated model resulted in us altering structural designs and arrangements virtually, prior to construction, instead of altering or strengthening already constructed elements to accommodate service opes.

What we improved and learned during the project:

- Initially, the production of our 2D drawings was not to the same standard of our AutoCAD produced drawings at first. However, we quickly learned how to apply view templates and as the project progressed we were able to produce better looking drawings

- We learned that our technicians became more externally facing during the project. Instead of being behind the external face of the engineers, our technicians were now communicating with external parties much more frequently on problem solving, clash resolution and coordination and on the application of the BIM Execution Plan to the project
Given the project was being undertaken across the design and construction teams to Level 2 standard of PAS 1192, it allows us to apply the standard in practice rather than in theory.

We learned that we spent a greater amount of time, earlier in the project to achieve our first data dump and issue of construction documentation to the contractor. Given the design and build nature of the project this was a challenge given the contractor wanted to start on site with the structural foundations as early as possible.

We realised the quantity of data and the value of managing this data. The CDE assisted in this manner, but we also had to manage our own internal data. Given the number of people we had working on the project we developed splash screens within the Revit Model to confirm where others linked models and other design inputs within the model were stored and could be updated.

What we have been working on since our learnings on this project:

- We have been educating ourselves on the timely development of our 3D models. We learned on this project that we modelled the service openings too early and before the involvement of the specialist contractor, the mechanical contractor. We have been refining our model development and levels of detailing within the models to match the project stages and deliverables required.

- We have been improving our use of 3D models across our design process. We have been improving the bi-directional flow between our authoring tool and our analysis tool. We have carried out a number of bi-directional workflows on our work on 140 Pembroke Road which is currently under construction in Dublin.
• We have been developing and improving our internal BIM Procedures to comply with PAS 1192-2 with the aim of getting externally accredited

• We have been developing and improving templates being used on our BIM tools to ensure immediate and continued compliance with standards including BS 1192 and PAS 1192

CONCLUSION

GARLAND have been at the forefront of championing the benefits of BIM within our industry in Ireland. A Director of the firm, chairs the BIM Committee of the Association of Consulting Engineers of Ireland, as well as being involved in the multi-disciplinary CITA BIM Group, which promotes the use of BIM within the industry, across Ireland.

The economic costs associated with investing in BIM, in terms of not only software but also the training and up skilling of staff, are not insignificant and are well known. It is therefore all the more significant that GARLAND had the foresight to invest in BIM at a time when Ireland was going through the worst economic crisis in our history and the construction industry was in turmoil. However, the investment paid off! We have been one of the first Consulting Civil and Structural Engineers in Ireland to offer BIM services to clients. Not only this, but we have been the driving force on design teams that have used BIM technologies, introducing and often guiding colleges through the process. BIM is now the predominant means by which GARLAND deliver our services.

GARLAND is one of Ireland's longest established Engineering Consultant Firms. We pride ourselves in not only keeping up with the industry in which we operate, but to be to the forefront of it. Embracing new ideas and technologies is what has enabled
the company to operate for over 78 years and allowed us compete more effectively in the international market. BIM is obviously such a development and we have embraced this change as the future of the company and the construction industry.

The decision to incorporate BIM technologies within both the design and build process was truly an innovative concept within the Irish Construction Industry in 2013. We believe that its successful implementation on this project exemplifies the benefits of using this technology and vindicates the decision to incorporate it on the MISA Project.
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