Heritage Building Surveying & Information Modelling – a HBIM approach

Company Background

Murphy Surveys was established in 1983 by Peter Murphy; a visionary of his time in the field of surveying. Peter believed that the future of the industry lay in technological progression and to deliver a more efficient and quality-focused service.

Now 33 years later, Murphy Surveys has offices in Kildare, Dublin, Cork, Belfast, London, Northwich and Scotland. Employing more than 200 staff and offering world-class solutions globally to public and private sector clients, including government bodies and blue chip companies. MSL have grown year on year, because of its commitment to innovation and striving to exceed our clients’ needs. The continuing adoption of these core principles are a cornerstone of the development of BIM and HBIM methodologies within the company.

Current BIM standards:

There are many BIM standards and guidelines internationally. While the UK has a mandated BIM requirement on government projects we do not have such a mandate in Ireland currently. However, many businesses here work in the UK also and with close proximity we have tended to adopt the UK standards and the same can be said with BIM. The BIM standard currently is a PAS (Publically Accessible Standard), namely, PAS 1192 Parts 2 & 3 with Parts 4 and 5 very recent additions to this. PAS 1192 : 2 is the Specification for information management for the capital phase of construction projects using building information modelling (BIM). Part 3 concerns information management for the operational phase of assets using BIM.

While these standards apply quite easily to design projects and subsequently to operational projects, Surveyors have the task of compiling data on old and existing projects with little pre-existing information, and turning these into ‘hit the ground running’ BIM projects. The standards cover the
requirements for the main design teams on these projects but does not clarify the roles and requirements of sub-contractors, or how groups of sub-contractors can work together.

The fact is, as a surveyor, we do not simply take measurements with total stations anymore. Using laser scanning techniques and UAV (unmanned aerial vehicles) we can gather massive amounts of data on whole urban sites very quickly and on difficult areas such as inaccessible rooftops, while displaying this information can be done in a variety of ways that many clients aren’t aware of. It has resulted in MSL developing in house workflows for delivering BIM that encompasses many software types, and uses many delivery options from local to cloud storage and web viewing options where we can give data to clients without the need for them to store it themselves. A survey is no longer a set of drawings but also a model environment and an online portal allowing 360 degree navigation and dimensioning of realistic laser scans similar to a Google Street View scene only with added functions. Using these techniques MSL deliver high quality Survey BIMs that not only comply with current PAS standards but seeks to set its own standard when it comes to BIM offerings and value for a client.

**Project Brief:**

MSL were appointed by our Client to undertake a measured building survey of a historical site within Dublin City Centre. The project involved high quality surveys of areas of most concern with surrounding buildings and topography surveyed as context to different degrees. Our BIM survey would be used as a starting point and background for a design BIM process. Overall the project area
covered c. 20,000 square meters consisting of dense urban heritage buildings approx. 4 storeys high for much of it. The environment was extremely complex and intricate with basements featuring a maze of different barrel vaulted ceilings, as well as floors and walls that were sagging and warping to a high degree in many different planes and sections. Varying constructions also made it hard to understand the spaces easily on a project this size.

Staff Involvement:

**Alan Halpin B.Eng Civil Eng., BIM manager (Ireland)**, has a wide range of experience in the construction industry from Civil engineering to architectural and sustainable design. He also has qualifications in Quality Engineering and lean practices and brings this added value and experience to Survey BIM projects. He has been involved in BIM, covering small to large scale design and surveying projects intensively for over 6 years, spanning various countries and disciplines in Australia, UK and Ireland. He is passionate about BIM and the value it brings to any project. He is also an advocate for BIM standards and procedures and the overall adoption of these in the mainstream Irish market.

**Stuart McCann, BIM Technician.** Stuart graduated from Institute of Technology Carlow in 2011 as an architectural technician having completed his final year thesis using Autodesk Revit. Since then he has worked with Murphy Surveys BIM/Scanning department on a wide variety of projects from residential to large scale land and pharmaceutical surveys and brings much experience in both office and site based surveying. This combination of architecture and site surveying & scanning provides valuable skills for BIM Surveys as the information needs and data capture of a BIM project can be different to a traditional survey. Knowing the best way to get this data is massively important to all BIM projects.

**Alex Macovei, BIM Technician | R&D.** Alex graduated from University of Brasov, Romania in 2013 and has a bachelor degree in Geodesic Engineering. He has worked with Murphy Surveys since February 2014 working on complex Data centre facilities and data management and has developed customised workflows that allow better data integration to BIM and 3D modelling environments. He has also carved out a position within a Research and Development role where he tests and implements new and emerging technologies and softwares in BIM data capture areas as well as the UAV and VR/Augmented Reality space.

Objectives:

The aim was to provide laser scan surveys and an accurate BIM model of the site and surroundings that could be used as part of a BIM design and retrofit project of the heritage site in question. This
model would need to be set up in accordance with PAS 1192 and would require information such as material changes and detail items such as cornicing, radiators, sills, and site surrounding hardscape, and set up as linked separated files which could be used in a variety of ways for the BIM design project.

**Challenges:**
The whole site proved challenging to get access at appropriate times. Many areas were off limits or were extremely difficult to get access to, while other areas were hard to physically survey such as rooftops due to poor access, dangerous conditions on the rooftops and poor stability for laser scanner tripod set up. Unprotected edge and parapets made it difficult to survey certain roof faces while moving between properties on rooftops became hazardous. So many of the adjacent buildings had different access requirements, and this resulted in many trips back to site, and delays in gathering relevant survey data for such areas.

**Innovative Use of BIM:**
The nature of BIM tends to be consistency of standardised objects and cost efficiency, so a heritage site whereby every second floor is sagging far beyond the desired model tolerances, in excess of 120mm over 5m spans in multiple directions in many cases, demands a customised approach. This approach meant that rather than simply modelling best fit scenarios, we were aware that many other subcontractors would use our data based on CAD exported sections only, so such floors were modelled efficiently and accounted for the main sagging and deviations using sub-points for simplicity, while other minor deviations were noted in custom deviation parameter fields and survey comments fields for scheduling and tracking. It allowed us to maintain the connections and visibility of native BIM objects along with provision of important notes and comments available for data
extraction, scheduling and filtered views. CAD based sub contractors would still able to use our data in an improved manner rather than if we followed standard BIM modelling practices meant for design purposes ie. using standard regular components in a best fit manner.

Other challenges involved the staggering natures of the project site. Varying levels and adjacent constructions were to be modelled and set up in plans and sections in one building file originally, this was however revised once the nature of the site was better understood and captured in the laser scans, so individual building pairs were created that were logically connected together and could be turned on or off then in a master site file. Care was taken to not divide the site into too many components as to become confusing when linked into other projects or for documentation purposes. Opportunities for heritage recording are possible in this BIM environment while inventory and schedules can be extracted quickly.

To improve the use of a hBIM for conservation needs and usability we inserted small spherical objects into each room in the model at the survey scanner positions used originally to survey the site and structures. These small floating objects contain a link url to a cloud stored 360 panorama image recorded by the scanners which allows viewing of high quality detailed photographs that can be panned 360 degrees with zoom functions to inspect the room spaces and site situation at time of survey, enabling more detailed recording of architectural and heritage features of significance while improving the integration of survey data into one point of access.
Placing these small spheres into relevant spaces allows any user to move between the model environment and the associated 360 HQ panorama images quickly and efficiently from the correct location and overcomes problems with navigating a separate folder of images with confusing naming conventions and lack of ease in assessing where images relate to model points of views and positions. Further to this, high quality images of individual architectural features can be linked to model components easily through input of relevant url links to the appropriate parameter field in the properties of the components for further recording opportunities within the same model.

Security of the images is protected by passwords which can be changed by the owner of the information but allows permitted users of the model to view surveyed imagery tied to model objects. Using the 360 imagery taken by personnel while carrying out laser scanning also allowed consistency in tracking a complete set of images with scanner locations and data and also reducing time spent collecting information such as separate photography and survey data collating trips.
Laser scan information is also linked into the models for viewing but the availability of high quality imagery is a more convenient and lightweight solution in many cases for clients alongside a model file.

This method allows the client to gain a complete construction documentation set and visual record all from one source in the model file and speeding up project understanding and communication of survey information to stakeholders.

To model structure and spaces this was carried out by modelling direct to laser scan information linked into the model environment. Laser scans are processed immediately after site collecting and once registered are a complete point in time record of the 3D space and surrounding of the site. They can be used instantly to measure and view the survey site before waiting for a model and other CAD deliverables to be produced from the laser scan survey.

Below are Ortho Images with CAD overlay, produced from the laser scan data.
Laser scans are excellent health and safety tools that reduce the need to manually survey objects at dangerous heights and locations and conditions. As a risk management tool this was ideal on a complex site such as Parnell Square. Access and dereliction bring about their own risks and structural safety concerns but using laser scans helped to mitigate this in most situations. The laser scan survey and the final model itself provides an excellent 3D spatial understanding of the spaces concerned so that trips to the site by related personnel can be reduced. Further 4D and 5D opportunities as well as clash detection between survey information and design information can be carried out downstream by the client or design team thereby supporting the overall BIM process.
Collaboration and Communication:

Project progress meetings were held at key intervals prior to final delivery of survey models to assess suitability, integrity, and method of model building techniques as well as general progression of works. Murphys met with key stakeholders involved on the project to ensure that all involved were kept up to date and to agree best methods of modelling to suit the client and the employers information requirements on the project.

Models also included custom 3D views where items containing comments specific to the survey were filtered and highlighted for easier viewing and comment by the client when interrogating the model at anytime allowing for further collaboration opportunities.

Interoperability:

In order to alleviate file formats differences Murphy Surveys produced a revit file deliverable aswell as an IFC 2x3 Coordination view 2.0 format export of the files which were tested using Solibri before submitting to the client for use in other software. Issues with any elements or materials in the conversion process were communicated so as to allow a speedy resolution to any problems encountered before final submissions.

Laser scan information was delivered in raw and processed formats where relevant for archiving purposes while Colour ortho photography overlayed with CAD information was produced for external and internal elevational sections of each room and space from the laser scan information. This was
delivered to client in a variety of formats including PDF for sharing and security as well as traditional CAD formats that the client had specified.

Finally, Model information has been uploaded to Autodesk a360 for sharing online to the client and stakeholders at [http://a360.co/2dbKkoE](http://a360.co/2dbKkoE). Security has been controlled through sharing permissions and downloading restrictions where needed but the aim is to share the model to users that do not have required software for collaboration opportunities and interoperability purposes. The model can be shared now online, inspected, cut and sectioned easily, as well as measured and marked up and shared to others for comment. The spherical objects hosting the 360 panorama images can be viewed from inside the A360 environment through the associated URL links also, all through a web browser only.
Use of International Standards:

The Project was modelled using Revit 2015 as the authoring tool. Before modelling however all relevant BIM personnel on the project were familiar with and had experience working to standards and specifications such as AEC (UK) BIM Protocols for Revit, PAS 1192-2:2013, LOD Specification 2015 as minimum as well as best practice on complying with EIR, AIR, BEP and Supply chain model responsibility matrix documents and so forth. All relevant documents relating to best practice International BIM are stored on company servers in logical folder systems so that new BIM personnel can access these while training or refreshing their knowledge of requirements and guidelines before working on live projects. Building on these standards modelling approaches were defined to best suit the client’s requirements while keeping to the spirit of model integrity, efficiency and information usability within. Combining these approaches with surveyed real world information from a laser scan was difficult in many cases on this heritage project as non-standard approaches had to be adopted to enable adequate information provision in cases.

The purpose of the BIM survey was critical here as decisions were made regarding usability of standard components such as walls and floors and other architectural and structural elements in terms of dimensioning accuracy versus parametric function and flexing within the model. Standard elements were used where possible and customised modelling reduced where possible however in a heritage project such as this where warping, bowing, sagging, deformation and damage are common place and dimensioning is the key factor, modelling approaches were changed in order to describe such information visually in a better way with regard still to efficient and compact model sizes and behaviour and logical object and file naming according to BS 1192-2.

Outcomes and Results:

The outcome of this HBIM project was a survey BIM that met the client brief but also a HBIM methodology that has provided us with a new understanding of how to approach large heritage surveys in BIM formats. From quoting stage right through to deliverable options and model structures / techniques MSL have developed new procedures and methods for delivering High Quality HBIM’s at this scale while demonstrating less than 5% tolerance from original modelling estimated time which is excellent considering the challenges we faced on site. Survey observations and structural condition notes were inputted to the models and further heritage recording is possible for asset and conservation recording using 360 panorama images inserted by url links into floating model objects at
scanner locations. Other high quality images can be linked to individual model elements in the same way further improving heritage opportunities and asset management or conservation workflows. BIM Deliverables included IFC and Revit models, and high quality Laser scan files while other deliverables included photographs and condition reports internally.

From this data animations and renderings were also possible (Watch Animation Here) as well as many other downstream uses for ongoing BIM projects over the lifecycle of this complex site, using both the scan and model information.

UAV information was not specified for this project but advances in the previous year mean that MurphyUAV can now provide such services on projects this size and area much more easily as a specialist service. Rooftop access outlined in this document would be much less of an issue and data gathering significantly speeded up by using such data methods which can then be incorporated directly into laser scan projects and BIM projects aswell. Surrounding context can be gathered very quickly and easily and linked into Models once processed.
The desire to excel is what pushes Murphy Surveys to innovate and develop high quality BIM and HBIM surveys. Below are some of our accreditations and is the result of our hard work in this sector to provide better surveys, better data.

Murphy Surveys through their unprecedented understanding of spatial data have adapted to ensure that they remain at the fore of surveying in Ireland. Unlike many other companies operating in the BIM sphere, all data acquisition is captured in house and processed thereafter. It is important to note that Murphy Surveys are strategically placed to deliver survey information across Ireland and Britain, supplying all of the data requirements for the emerging UAV sectors, and also for Asset Management, Building Surveys, Hydrographical, Utility, Civil and Land Surveys all within a single BIM sphere. This data can be used for traditional means and also for spatial coordination, orthographic elevations, reporting, data extraction and many other uses.