AUTODESK UNIVERSITY 2014

Case Studies: Managing 19th-Century Architecture with 21st-Century Technology

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RC5992

This class will demonstrate the benefits we have achieved from using reality capture technology in our day-to-day workflows. We have welcomed the adoption of reality capture technology in our experienced architectural office and in doing so we have seen the rewards. We have a vast depth of work in 19th-century London architecture, and the ability to capture the existing conditions of Victorian architecture and then use this for construction has enabled us to confidently achieve the design outcomes we strive for.

Learning Objectives

At the end of this class, you will be able to:

- Know where to start when considering the technology
- Learn how to feel comfortable in your next reality capture project
- Discover tools in the suite products from Autodesk that will assist in point cloud conversions
- Learn how to use third-party Autodesk plug-ins to manage the project

About the Speaker

Cheyne Bird is an Australian architect. A graduate of Adelaide University, he has 8 years of professional experience in design, construction, and professional consulting services. He currently resides in London and works for Flanagan Lawrence as the company's Building Information Modeling (BIM) coordinator. Cheyne is responsible for pushing the company's adoption of new technologies and workflows. He has brought to London his comprehensive knowledge of point clouds, and is assisting Flanagan Lawrence's adoption of reality capture on 19th-century architecture.

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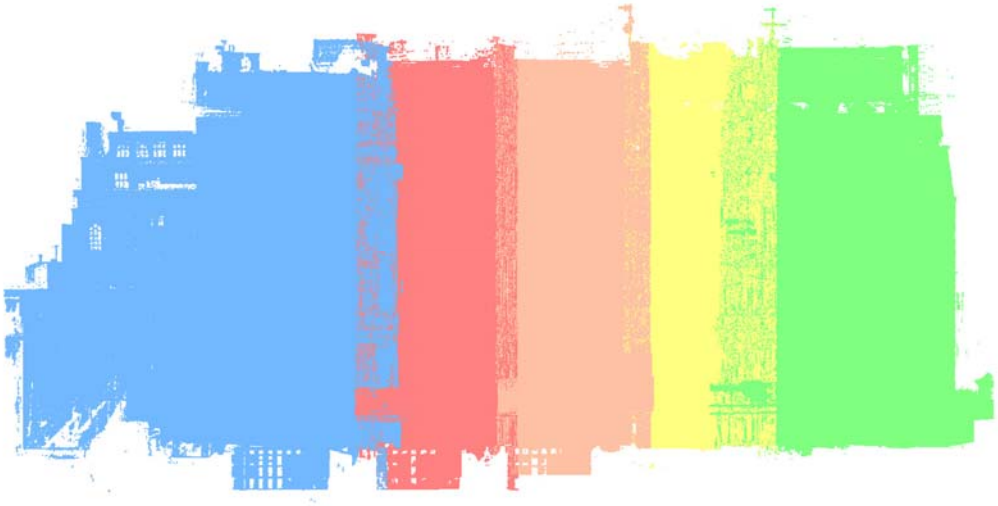
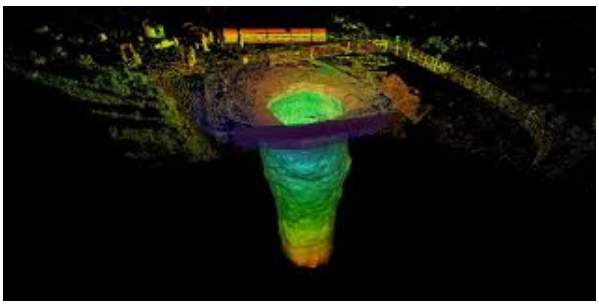
Contents



Introduction

Reality capture was a hot topic in the Architectural, Engineering and Construction industry in 2012. The ability to link a surveyed 3d model into your Autodesk Revit project, a new era in how we captured existing data was seemingly born. However, point cloud technology was not new technology, it had been used in a broad spectrum of other industries for a number of years, nonetheless the ability to capture existing data was one that brought excitement while also caution and hesitation.

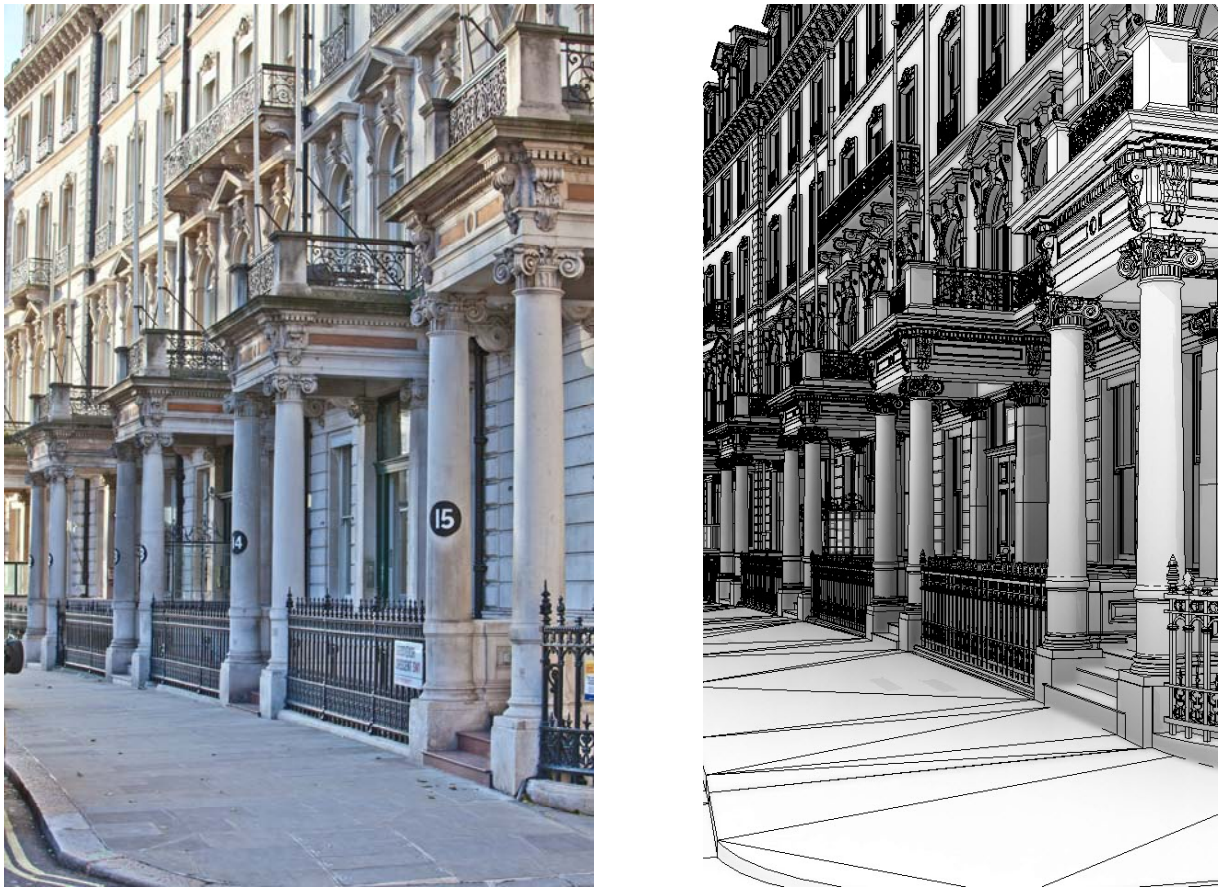


Lazer scanning had been used in other industries since the 1960's (body scanning and point cloud capture on the mining site.)

Reality capture in its simplest terms is, photographic and/or laser-generated data used to create a 3D pixel map. This map is known as a 'point cloud'. A 3D model can be built around the point cloud. Normally this would be a model of the existing fabric to help the design process. You could have confidence in the point cloud, as *everything* that was captured in the acquisition of the point cloud would be visible.

The addition of Autodesk Recap to the Autodesk suites and 3rd party products to help with the conversion, we saw the integration of the point cloud tools and workflow increase. However with new tools and the benefits we see in the technology, it is not to be seen as the solution. Informative and expert judgement is still required during the acquisition of the point cloud and the conversion of the point cloud into useful design documents and models. As the hardware and software continues to improve, the use of point clouds can only increase and be put to use in our design, construction and analysis workflows

Along with the capture of existing buildings, we are now seeing this technology used throughout a buildings life-cycle. We will discuss our companies' processes we have established when using point clouds, while also discussing advantages and disadvantages we have seen along the way while also best practices we are trying to use.



Remodelling exisitng buildings with Autodesk Revit to capture heritage listed facades.

Flanagan Lawrence

Flanagan Lawrence is an award-winning, design-led architectural practice based in London, UK.

The practice has an impressive collective expertise across a broad range of sectors and building typology, including large-scale commercial projects and high-end residential schemes, as well as cultural, hotel and leisure, education, infrastructure, logistics, business parks and major master planning projects both in the UK and internationally.

Flanagan Lawrence has worked with a diverse body of clients in both the private and public sectors.

Public sector work has included performance space as well as office space and regeneration schemes. clients have included the Royal Welsh College of Music & Drama, Sadler's Wells Theatre Trust, Soundforms plc ,The Sage Gateshead, as well as tertiary education client bodies such as Magdalen College, Oxford, Imperial College, London, and Brunel University, Institute of Physics (Czech Republic), Manchester City Council, Mid-Bedfordshire District Council, Reading Borough Council,

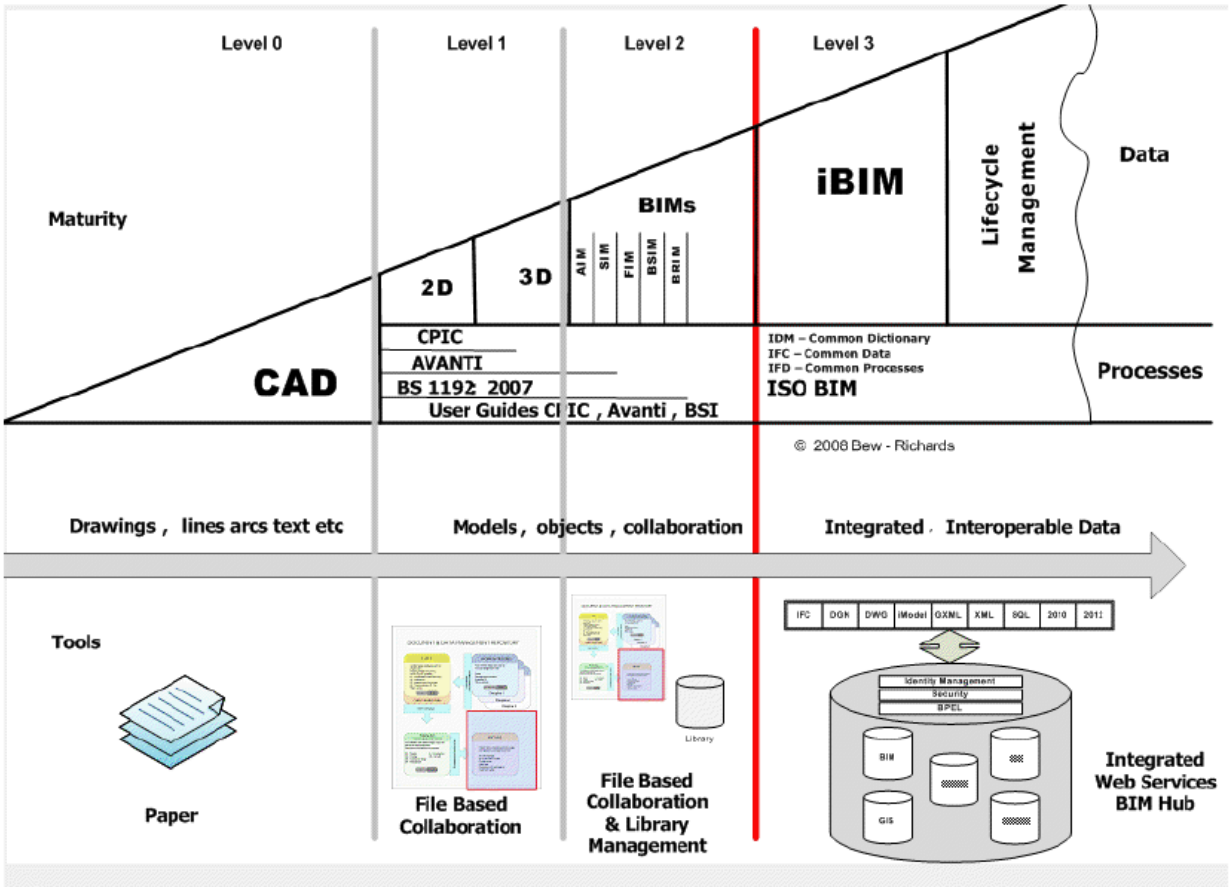
Private Clients have included Ask Property, Athos, BAA Lynton, British Land, Brookfield Europe, Candy & Candy, Chelsfield, Development Securities, Espalier, Finchatton, Grainger, Great Portland Estates, Grosvenor, Herby Holdings, Land Securities, Londonewcastle, Muse Developments, Quintain Estates and Developments, Segro, and Sellar Property Group.

Working in a dynamic studio environment, our work process is driven by analysis, creativity and rigorous commercial understanding. We are dedicated to the creation of fresh and progressive architecture.

Flanagan Lawrence

BIM in the UK

Building Information Modeling is fast becoming the standard for the construction industry. This is evident in the English Government's Construction Strategy, which requires collaborative BIM on all projects by 2016. They have identified BIM as a growth area and have put milestones in place so they can be seen as world leaders, with goals such as all central government departments will adopt a standardised procurement methodology using BIM or 'Level 2 BIM Maturity' by January 2016.

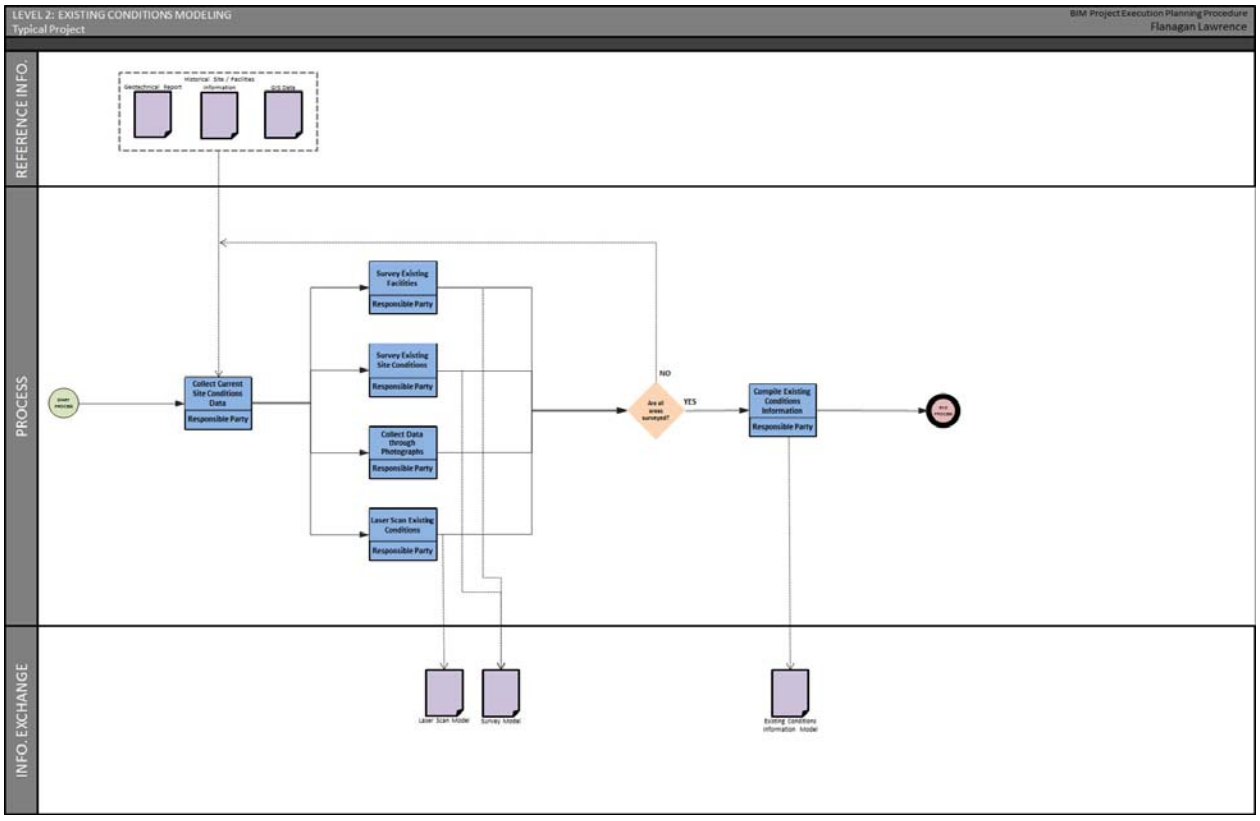


BIM maturity levels diagram copyright Bev-Richards

Staging process

Existing Conditions Modeling

At the commencement of a project the acquisition of site data is vital. Despite recent technological advancements, the process of obtaining existing site condition drawings and models has changed little over time. It typically involves commissioning the responsible parties for the data and feeding this information into our documents. The addition of 'Laser Scan Existing Conditions' and the creation of a 'Laser Scan Model' have fed into this workflow to provide us with more accurate and up to date information.

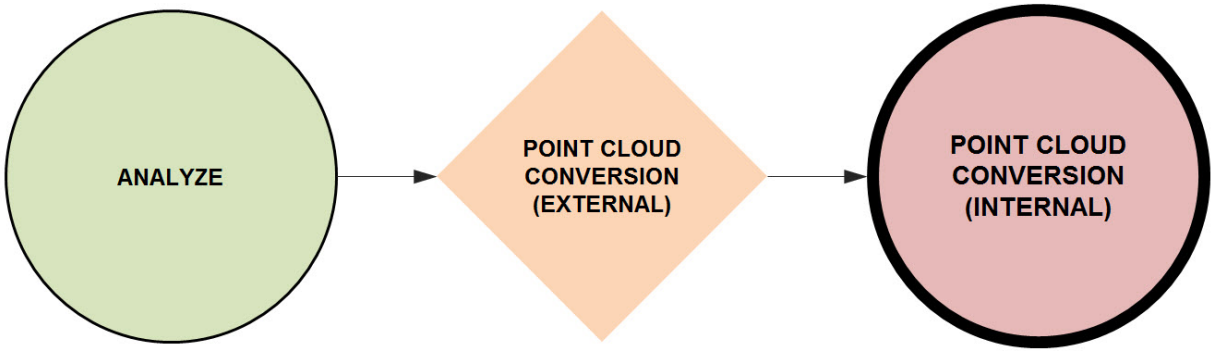


Existing Conditions Modeling – Typical Project Flowchart based on Penn State Template

Systematic approach to using Point Clouds

The addition of this technology to our industry has brought a level of caution to our office and to the documentation of projects. A level of hesitation and unease from interested internal parties, primarily from an insurance, liability and reliability standpoint needed to be addressed before we could proceed in using the technique on a more regular basis.

We felt it would be best to set our requirements and expectations of the technique. Testing the process out on a couple of key projects allowed us to ascertain the advantages and disadvantages that may arise. This would assist when rolling out a point cloud solution across our office on a project. The testing would be similar to the way we would review and analyze new software to our office.



1. For the first project we would outsource the acquisition of the point cloud and use it within the Autodesk Revit project to analyze the site position and to attain some key information.

2. For our second project we would again outsource the acquisition of the point cloud data, and this time the same party would build a Autodesk Revit model to our specifications, to which we would link into our current project.

3. The final phase would look at bringing these techniques in house. We would still look to outsource the point cloud acquisition (however we are looking at different techniques we could test) and do the conversions from point cloud to Autodesk Revit model internally.

1st Project

18-20 Grosvenor Street

Client: Grosvenor

Area: 6,000 sq. m

Status: On Site (due for sign off early 2015)

Location: Mayfair, London

Project Description

The project involves the unification of two neighbouring buildings to create a single, high quality unit comprising Grade A offices on lower ground, ground and 4 upper floors and retail units fronting Grosvenor Street and Brooks Mews in London.

Project Location in Yellow (0.5miles to Hyde Park and Piccadilly Circus)

18 Grosvenor Street is part retained - with the façade and an interesting interior at first floor level providing distinctive character - whilst the remainder is new build, extending the full depth of the site, with side light wells bringing daylight into the centre of the building. A contemporary stone frontage to Grosvenor Street responds to the elegance of the existing street, whilst a brick clad elevation to Brooks Mews takes its reference from the warehouse aesthetic of the context.

An active chilled beam approach to the cooling of the building, combined with opening windows, makes a significant contribution to the building's sustainable credentials, resulting in a "Excellent" BREEAM rating.

Flanagan Lawrence worked closely with Westminster City Council to arrive at a scheme which seamlessly blends the site's historic interest with new build elements.

Flanagan Lawrence were appointed to undertake the initial feasibility studies in 1999 and have worked on a number of detailed planning applications since then, changing the design to respond to updated regulations and market conditions. They have also been appointed to design the interiors of the building and are developing a design which reflects the Mayfair location.

Project Challenges

18-20 Grosvenor Street is an exciting project for Flanagan Lawrence. This prime real estate office project in the West End of London is a development we are proud to be associated. The complex construction of the building was an excellent learning experience for the team. Situated either side of our plot was heritage listed facades dating back to the 1700's.

18-20 Grosvenor Street; Early 1900's

A few key challenges that arose were:

- Full site access for an intrusive survey was very limited, due to an existing sitting tenancy which would expire, late 2012. This restricted the information that the team could acquire on site, and with a difficult old building, the 2006 2D survey information quality was limited in some areas.

- The project site is surrounded by 3 heritage listed buildings (2 on Grosvenor St, one to Brook's Mews). This meant we had to assure we did not damage them during demolition and construction, while all key areas had to be preserved. The buildings either side of

the site were constructed around the same time as 18 Grosvenor Street, so there were some areas of which boundaries were shared (i.e. Chimneys). The inability to have an intrusive survey limited our understanding.

- Damage had occurred to 19-20 Grosvenor due to a combination of less than sensitive refurbishments and possible WW2 bomb damage. Understanding of this came about on site when demolition had commenced.

- 18-20 Grosvenor Street is accessible on two streets, Grosvenor Street as well as Brook's Mews.

Street Views; Brooks Mews

Step 1 - Analyse (1st Point Cloud)

During the design process and after the demolition, questions were raised in relation to accuracy of the original 2D survey data of the site and its proportions. We approached the client about obtaining point cloud data for the following reasons.

- The value of extra square foot is vital to achieve a return on the investment of the project
- Accurate interfacing with listed building either side

Party Walls and Chimneys from buildings either side to be retained

- Accurately line up existing façade wall sweeps to be retained with parts of the new construction
- Project Team were piloting the use of BIM as a coordination tool.
- Lack of comprehensive street level data from Grosvenor Street and Brook Mews.

Subsequently we decided the best approach would be to have the site scanned before demolition began, and then again afterwards. Because the building was let when the first scan was commissioned we were unable to have an internal scan, so relied on two individual point clouds from both streets.

Having the site scanned pre demolition it allowed us to:

- Have a historical record of the building before demolition
- Obtain spot heights of principle facades

Scanning the façade allowed us to obtain levels of façade sweeps accurately which we were picking up with our new façade

- Ascertain heights of adjoining buildings

By having the site scanned post demolition it allowed us to:

- Validate the plot boundary
- To know the falls across the site

18-20 Grosvenor Street – Lessons Learnt

Grosvenor Street Elevation (Point Cloud overlaid Autodesk Revit Model)

We acquired the point cloud data late 2012 and with the ability to bring a point cloud directly into Autodesk Revit we were excited to test this. The files received were very large and this meant we had to put some processes in place with our IT department to handle the volume.

- Point clouds to be transferred by external hard drives or over an intranet
- All processed point cloud data should be stored on external hard drives

The reason why we chose not to store the data on the server was that we found the huge data crippled the server.

Once we had linked the point clouds into Autodesk Revit we encountered another challenge, correctly locating the scans. Unfortunately the laser scans for the pre demolition were individual scans and not registed as one and there was no coordinate system within the point cloud to place them. This meant, essentially we were forced to manually align them with survey information we had received previously.

The post demolition scan helped to validate our positioning; however it also brought about challenges when scanning the site.

- During demolition, shared walls of the buildings were covered and propped up to prevent any movement. When the site was scanned the buildings faces were covered so scan accuracy was lower than desired.

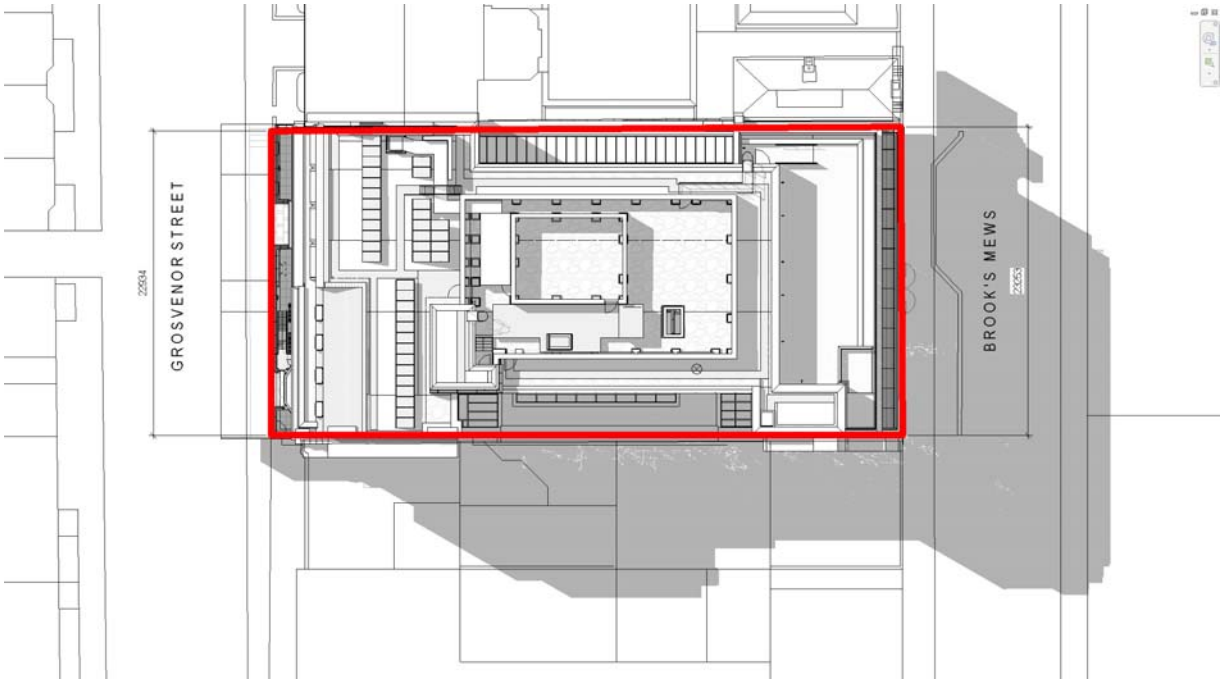
Aerial Image Covers and Props visible for scan

In early 2013 post demolition, the contractor required information from the Design Team to set out the building grid on site. If the Design Team had used the original 2d Survey information, the building would have been located incorrectly; clashing with neighbouring listed buildings. We

were able to pre-emptively realign the building precisely on site; preventing a costly late design change to rectify this.

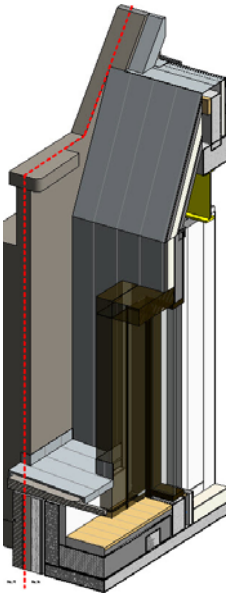
Through the challenges we saw a number of benefits from using point cloud data. Key points that came out of the process:

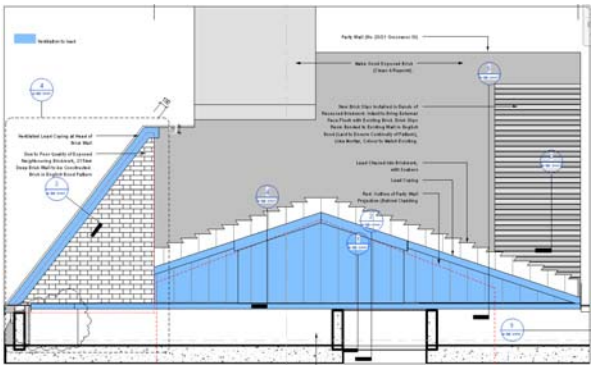
- The post demolition scan allowed us to validate the shape of the site boundaries



Site Plan; site boundary along Brook's Mews was 300 wider

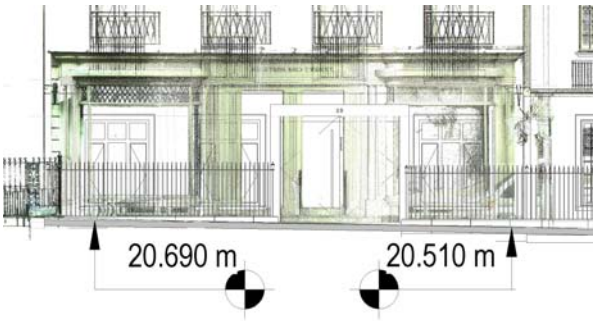
- Validate the location of the new building within the site.
- Have a closer tolerance with neighbouring buildings and party walls.
- Consider the risk of modeling existing conditions if they were to be relied upon at a later state (consider approcirate insurace cover).
- Understand in greater detail the neighbouring Party Wall interfaces and elevation elements.





Accurately model adjoining party walls with confidence from the point cloud

- Review accurate site levels



Site Levels along street frontages

2nd Project

11-15 Grosvenor Crescent

Client: Wainbridge

Area: 10,500 sq. m

Status: On Site

Location: Belgravia, London

Project Description

The refurbishment and re-modeling of 11-15 Grosvenor Crescent represents a unique opportunity to breathe new life into a building which has suffered from years of unsophisticated intervention and to combine it with a dynamic new addition which will complement the historic fabric.

With its Grade 2 Listing the buildings gain their stature by presenting a strong and confident face to the street frontage, sitting as a mediating element between the more historic stucco terrace to the west and the 1980's commercial architecture towards Hyde Park Corner.

The reversion of the land use from office to residential presents an opportunity to design a coherent series of architectural elements which will use a more contemporary typology to combine comfortably with the grand scale of the Listed building and deliver a residential environment totally appropriate to the requirements of living today. The building mediates between differing townscape scales and this mediation will be continued, using materiality as well as scale and proportion in a carefully composed composition.

The zone separating old and new will take its reference from other notable interventions in historic buildings such as the Asprey Store in Bond Street, the Royal Academy and the Victoria & Albert Museum – and the use of winter gardens and courtyards will allow light and air to permeate the heart of the scheme.

The existing building will be restored and where existing features have been lost, the grandeur of the original concept will be replaced. The approach to the introduction of contemporary elements such as bathrooms will be to separate them from the existing fabric – a light touch approach which will see the best of the old sitting comfortably in contrast with the new.

The terrace of five buildings will remain as separate entities at ground and first floors - entrances to the substantial apartments and the main entrance to the building will reinvigorate the existing porticoed frontage.

Lateral apartments on upper floors will deliver high quality residential layouts, spreading across a number of buildings and acknowledging the original plan forms by retaining original party wall lines whilst maintaining a comfortable and logical flow of space through the units.

The opportunity exists here to create a significant residential development in the heart of Belgravia delivering highly sustainable and beautifully crafted accommodation which uses location and orientation to deliver ideal residential units in an architecturally coherent composition.

Project Challenges

The redevelopment of a Grade II listed grand terraced house built in c.1860 is a project which Flanagan Lawrence was keen to apply the lessons learned from 18-20 Grosvenor Street. The redevelopment brought similar interesting challenges which, without the adoption of early point cloud data would have been incredibly difficult to resolve.

With a lack of existing drawings from the developments to 11-15 Grosvenor Crescent (primarily at the rear) over many years and little access to the site, the choice to use 11-15 Grosvenor as our second project for testing a point cloud solution was crucial to the success of the project.

Key risks that were noted:

- Lack of existing drawings to cross reference
- Walls not straight, ceilings sagging, floors warped
- The retention of heritage listed items
- Little access to the rear of the building
- Building was not rectilinear

Step 2 - Point Cloud Conversion (External)

We decided early that commissioning the acquisition of a point cloud was necessary, due to the little amount of documentation of the existing structure and the heritage listing of 11-15 Grosvenor Crescent. We also decided that we would require an as built Autodesk Revit model from the scan as well. The motivation to outsource the modeling process was:

- Legal reasons
- Clients request for a clear break of responsibilities/ liabilities
- Time required to create a very complex model
- The time spent learning how to manage the point cloud and tools associated.

The process of scanning an existing building, externally and internally of this scale brought about the challenge of how much needed to be scanned and how much needs to be modeled.

At the time of the acquisition our design focused on the retention of the Grosvenor Crescent façade and the heritage listed reception rooms. While at the rear (Grosvenor Crescent Mews), we intended to demolish the existing extension to build a modern building that responded to the adjacent buildings materiality and lines.

Project Location; 0.5 miles to Buckingham Palace and 0.2 miles to Hyde Park

We were concerned that the complexity of the task would delay the survey so we decided we would only have the Grosvenor Crescent façade and the heritage listed front rooms and stairs scanned and modeled.

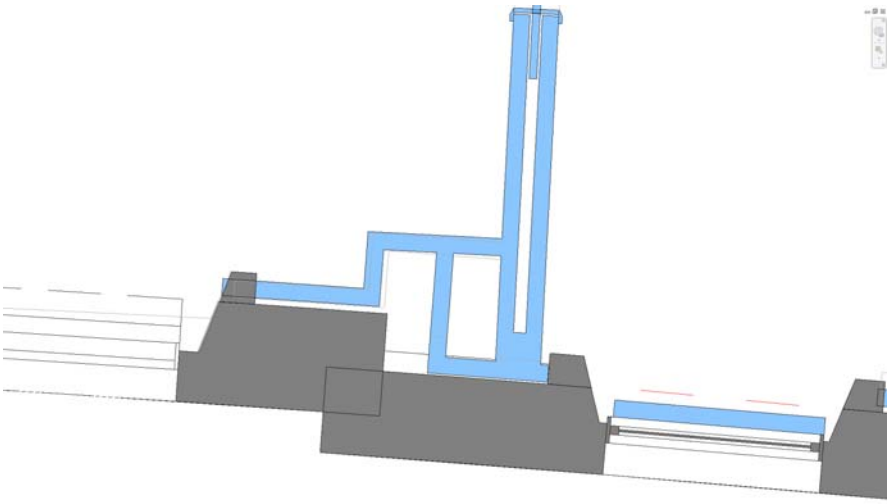
We required a model with sufficient detail for General Arrangement (GA) documents and it needed to be accurate to a tolerance of 5mm. We used the AIA e202 modeling standard for guidelines.

The existing Autodesk Revit model we received was then copied and linked into our design file to produce our drawings, while retaining an accurate as built model. Some challenges that arose from this workflow were:

- Location of scanned model
- The level of detail

The project and contracted modeling team needs to understand what each other is delivering, i.e. Level of Detail,

- Phasing (We needed to show the demolished proposals)
- Modeling gaps between adjoining walls



Linked point cloud converted model and design intent model. Issues with lining up walls, joining wall sweeps,

Curved wall façade with tolerances are stepped. What is necessary for design intent, an accurate model with minimal tolerances or a façade which communicates the design?

During negotiations with the planning department, it transpired that we would require a scanned model of the rear façade to be able to create more accurate demolition plans. This meant we could revisit some challenges we were having with the initial scanned model where the level of detail and the location of the objects were not very accurate/ appropriate. After considerable delays in the delivery of the initial model, we advised the client to appoint a different scan/ modeling surveyor.

11-15 Grosvenor Crescent – Lessons Learnt

Outsourcing both, the scanning and modeling process enabled us to focus on the design development of the project. It also enabled us to locate key areas of the project such as party walls and facades which were heritage listed. We found the process of working with an external party was a relatively smooth and the turn-around for the second model was relatively quick.

Areas which we would address in future in relation to the process would be:

- Time allocation
- Communication

We should be treating the consultant who is creating the as built model like all other consultant we require for the design process. If we are to obtain an as-built model that will perform all tasks we require, the consultant and the design and management team will need time allocated to brief them on the project. This discussion should also be on going as the model is developed.

Regular model reviews and meetings allow for the model to be tested and reviewed to assess whether all building components required are:

Modeling an existing heritage listed room; Regular model reviews will communicate what level of detail is required

- Modeled to sufficient level of detail
- Modeled correctly and accurately
- Named correctly to project standards (BEP-BS1192)
- Imbedded with important information – COBie (BS 1192-4)

It assists the consultant in understanding the project brief while reducing time spent modeling irrelevant data. Communicating and allocating time with the consultant before and during the modeling the process will save time further down having to remodel, review, and reassess what has been provided.

Using the as-built model as a link provided us the benefits of:

- Having a model outside of the central file which the design team was aware was accurate.
- Restricting the movement of as-built objects

However it also brought its own issues such as:

- Time spent moving between two files
- Phasing (Demolishing elements)

It is important to involve the point cloud contractor at the earliest convenience, this will allow for a dialogue to begin. It is best to err on the side of caution when briefing your scanning provider on what elements of the structure need to be captured. Having more data scanned allows for a deeper understanding of the surrounds while removing the risk. The addition of Autodesk Recap to the Autodesk suites has allowed us to have a deeper discussion with the contractor over a program which we can review and make notes on what needs to be developed.

A surveying consultant should be appointed early so that an as-built model can be used throughout the design process. In the future we hope that as-built (completed) buildings will be derived from point cloud data, giving he project a consistent start point.

Step 3 – Point Cloud Conversion Internal

After testing Point Cloud Technology, Management and Modeling on these key projects we are finding that the technology is progressing quickly and a lot of clients and contractors are either requesting or providing us with point cloud data at a variety of stages during the project. Therefore we have researched ways in which we can incorporate this technology into our workflows. A couple of items which we considered when planning resources to deliver survey (design intent) models in house were:

- Time
  - Modeling time/ Level of Detail/ Skills in modeling
  - Download time and data storage
  - Managing the point cloud/ cleaning it up
  - Training

- Costs associated
  - Staff hours required to manage the point cloud
  - Acquiring the point cloud/ lack of accessible area/ repeat visits

Registering multiple point clouds can take an extensive amount of time. 32gigs of point clouds took approximately 8hours.

- Legal consequences
  - Liability taken for modeling ‘as built’ buildings

We felt the potential benefits out-weighed the additional risk

Autodesk Software and Point Clouds

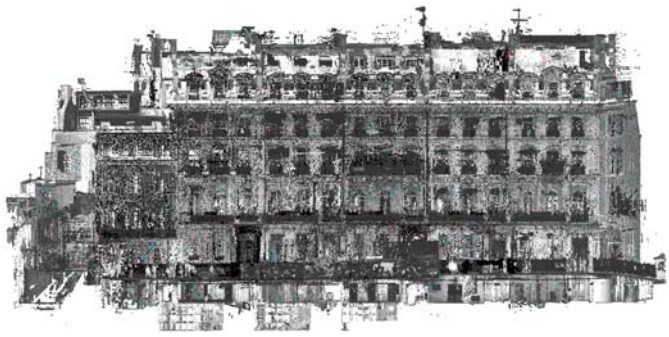
With the addition of Autodesk Recap to the Autodesk suite, it gave us a program, and a way into the manipulation of the point cloud. We are using Autodesk Recap as a point cloud management tool. Primarily it is used to create a point cloud that can easily be managed in Autodesk Revit. Prior to using Autodesk Recap, we found that if we brought the point cloud directly into Autodesk Revit that it is was often too large to manage have irrelevant objects.

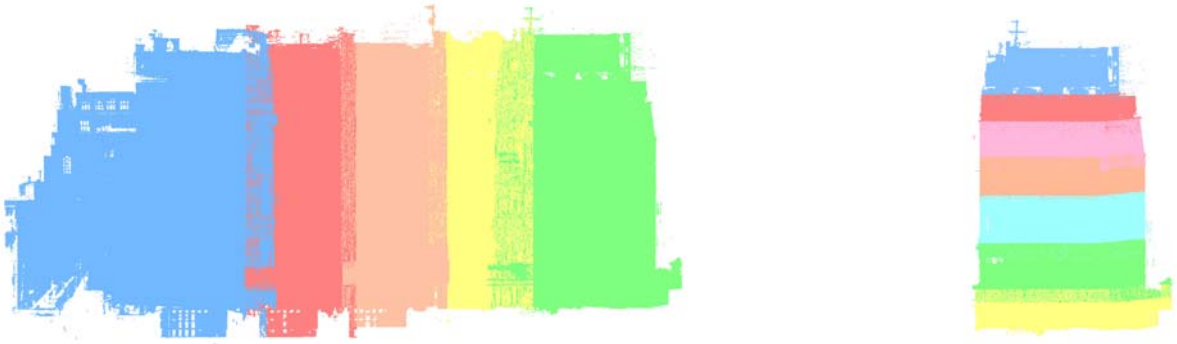
The current workflow we are using is:

- Import the raw scan files into Autodesk Recap
- Use the decimation tool to reduce the number of points
- Delete points surrounding the building which are irrelevant
- Save the initial model

We also find that on a complex project this file will still be too large, so additional management is often needed. This will typically be discussed by the project lead and the BIM team. Breaking the point cloud into separate .rcp files so these can be switched on or off according to the area being reviewed. This is typically done by splitting the model:

- By floor level
- By key sections
- Into key areas





Point cloud split into sections (1. Original elevation 2. Split into apartments (elevation) 3. Split into floors (elevation))

We try to keep the file size of each .rcs to a minimum so that we can best manage the process. Restricting the size of the point cloud file enables:

- Smooth interaction with the point cloud in Autodesk Revit
- Only relevant points are visible
- The ability to turn on or off key areas

Once the point cloud is linked into Autodesk Revit the process of converting the point cloud to Autodesk Revit geometry can begin. This is usually done by orientating to a view of the point cloud and tracing around visible points of objects. Some general tips when modeling and using point cloud data in Autodesk Revit

- You will be working in 3D a lot when modeling, setting keyboard shortcuts to various tools (Tools such as KiwiCode's Quick Menu tool could assist)
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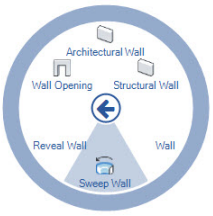


KiwiCodes Quick Menu tool which will allow you to have all the tools you need on hard at all times

- Restricting Autodesk Revit from highlighting the point cloud
- Create generic model element to use
- Point clouds in Autodesk Revit will use a vast amount of memory
- Pin the point cloud in place and disallow 'select pinned elements'
- Link original point cloud in typically auto- Origin to Origin and then any subsequent point clouds should be loaded in Auto – Origin to Last Placed

Point Cloud Add-ins

Creating Autodesk Revit components with this workflow gave us a model that we were relatively confident of its accuracy. However we wanted to investigate other technologies to the market to see if we could create a model which we felt reflected the accuracy of the point cloud and also made the process a little more streamline.

Creating Families from Point Clouds

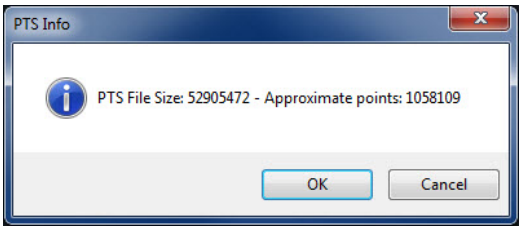
Autodesk Revit does not allow you to bring the point cloud directly into the Family Creator to create a component. If you want to create Autodesk Revit components in the Family Editor and you will need an add-in for AutoCAD which will allow you to convert a point cloud to a .dwg file which you can then import

The tool we tested was an add-in from LandTech Consultants. It gave us the ability to bring the point cloud file into AutoCAD and convert the individual points from the point cloud into AutoCAD points.

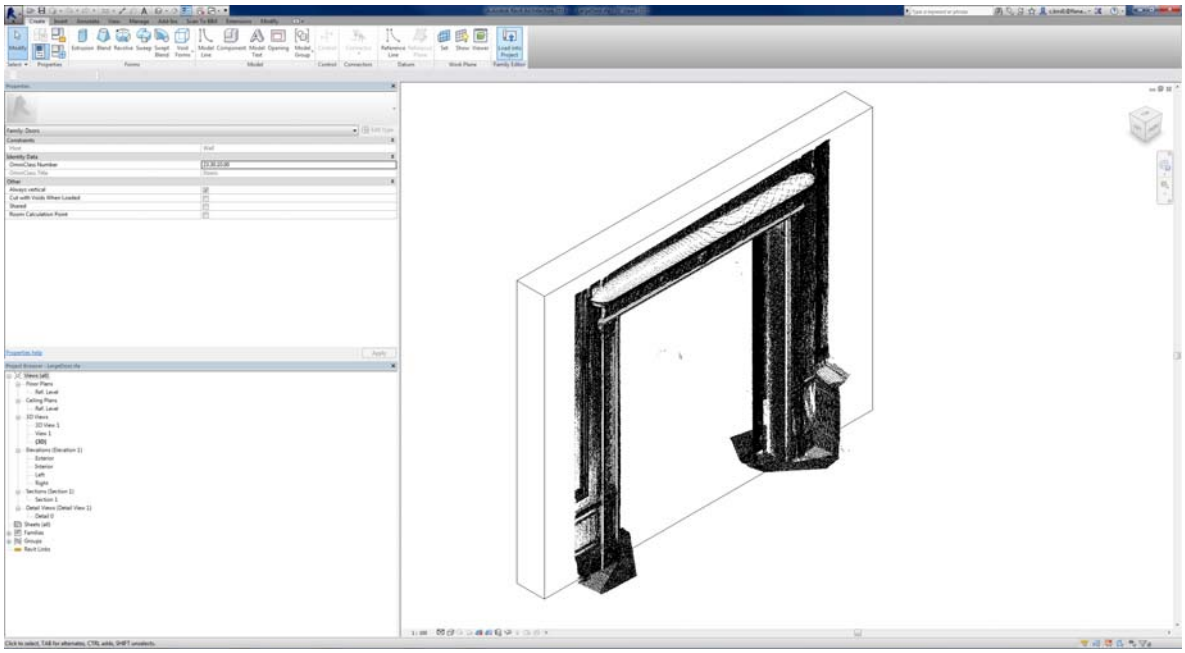
The workflow for creating an existing retained door after we had installed the lisp tool went like this:

- Open Autodesk Recap
- Convert the native point cloud into an .rcp/.rcs
- Decimate the point cloud to an appropriate level
- Select irrelevant points and delete them
- Export as .pts
- Open AutoCAD

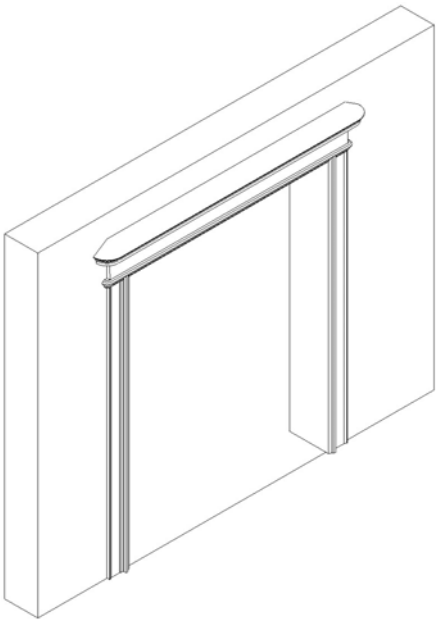
- Create new file
- Type ‘PTSIMPORT’
- Select exported pts file and wait for the conversion



- Save as .dwg file
- Open Revit and create new door family
- Load in exported .dwg file
- Orientate the .dwg file to wall and begin modeling
-



- Once saved and loaded and it all looks correct, delete the DWG file and purge the family



Final Revit Family produced form a point cloud with the amount of detail we required for the internal elevations.

The final result was an accurate component that we could add all information needed and reuse at a later point. We found the process of converting it accurate, easy and with skills in creating an Autodesk Revit family already, the process of tracing over the object in the family editor no different than previous Autodesk Revit families

Additional Point Cloud Functionality

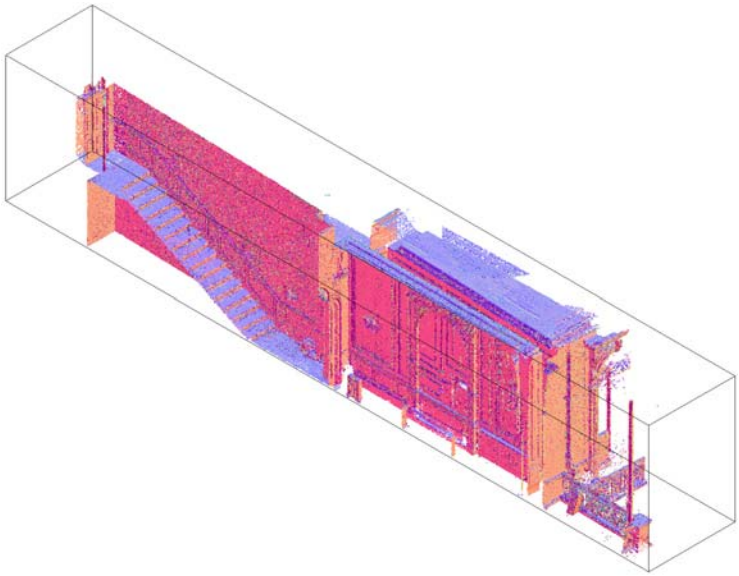
Following on from our tests of using the Autodesk Revit functionality, we wanted to test some additional tools which would allow us to

- Automating the point cloud conversion
- Validating the point cloud conversion
- Managing and viewing the point cloud

The tool we tested was Imaginit's add-in for Autodesk Revit, Scan To BIM. The add-in came with a lot of additional tools, and the learning process was easy to pick up and teach. After using the add-in on various projects, key tools that we felt assisted the conversion process were:

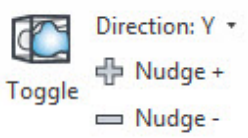
Managing and viewing the point cloud

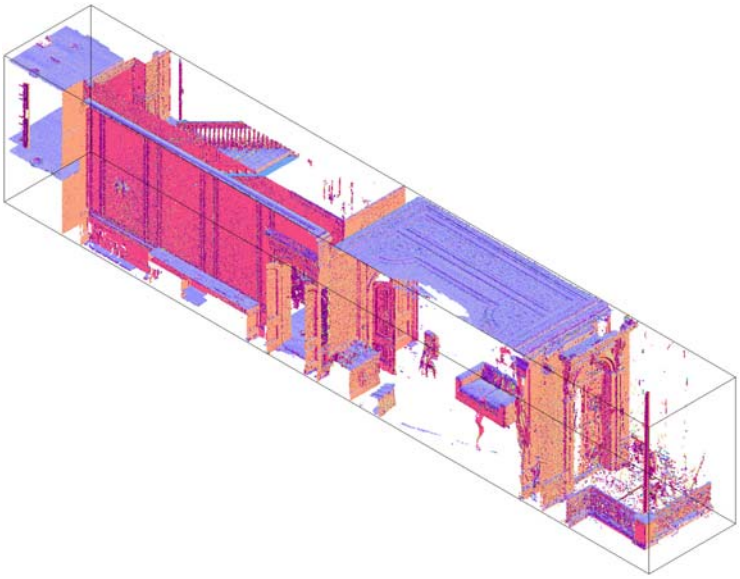
- Create a Work View/ 3D section box by simply drawing a rectangle in a plan view and naming the view.



Create a quick 3D section box by simply drawing a rectangle around the point cloud area you require

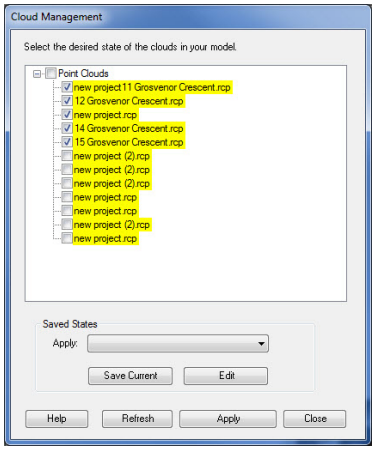
- Nudge Tools allowing you to smoothly move the section box along an x,y or z axis





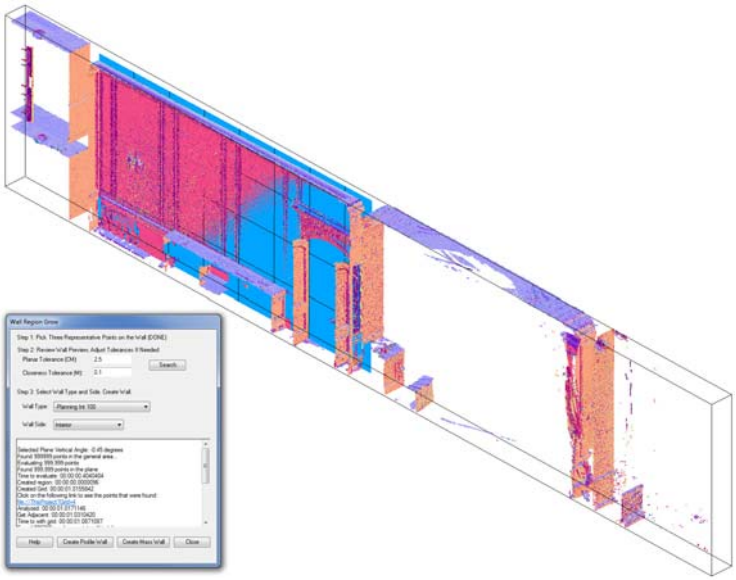
Instead of creating new section boxes or manually dragging the box across use the nudge tools to move onto the next wall

- If you have many point clouds loaded into your project, Cloud Management allows you to turn on or off individual scans, while also setting up saved states i.e. turning off all point clouds loaded except for the Ground Floor.



Automating the point cloud conversion

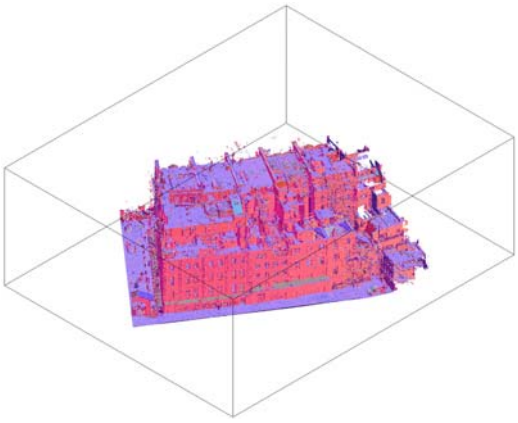
- Create a wall by clicking on the points that represent the face of the wall.

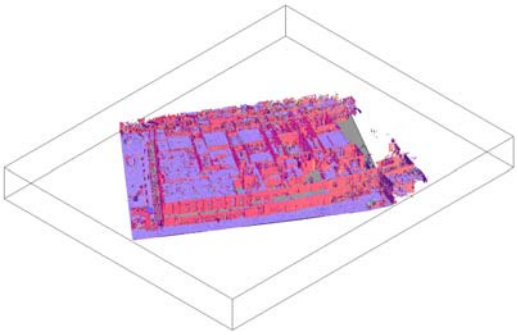


Click on three points that represents the face of the wall for the tool to analyse and create a wall along the face of the points

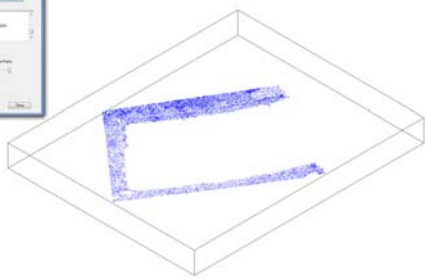
- Create a Toposurface directly from the point cloud

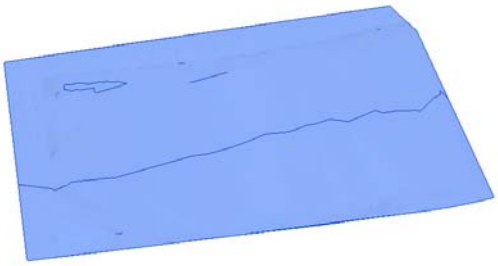
Create a topography from your point cloud that you can host site elements



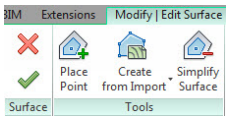


Use the section box tool to adjust the limits of the point clouds that is visible

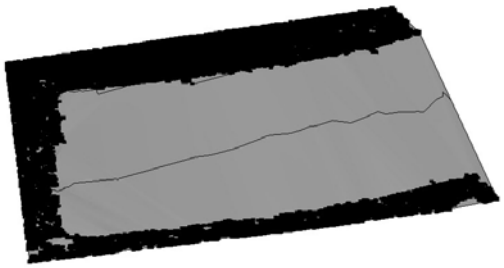


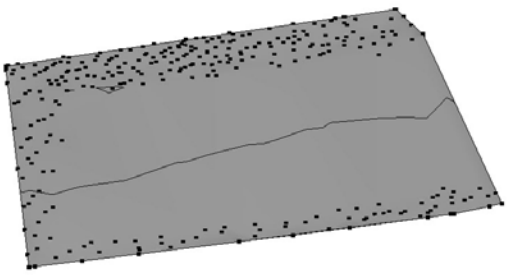


Select the create toposurface tool and draw a window around all the points, Adjust the grid size and slope allowance do the entirety of the toposurface is selected



Use the simplify surface tool to remove an excess of points which have been used to create the toposurface

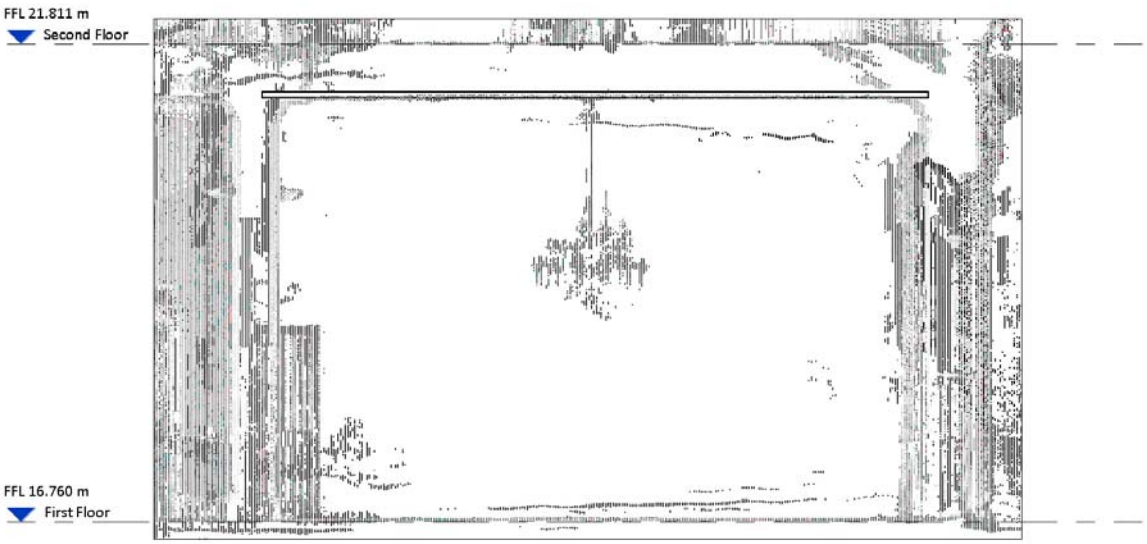




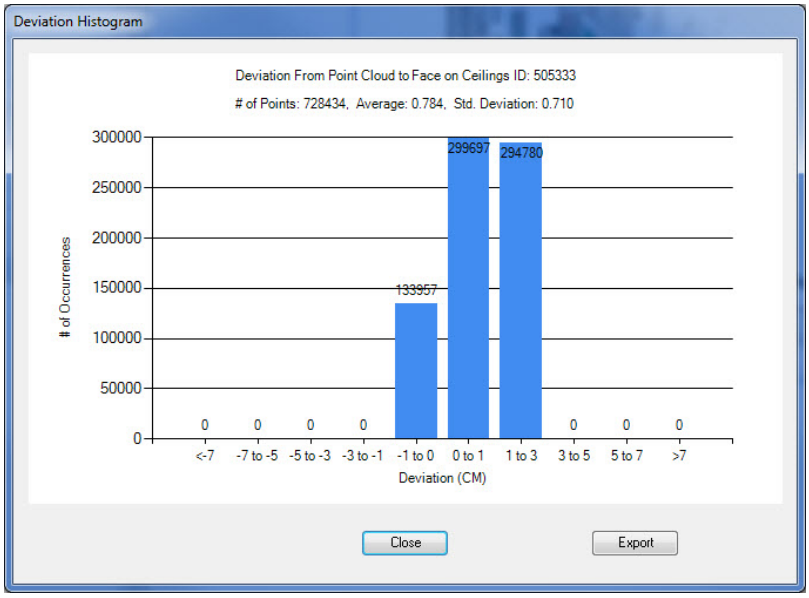
Your final topo made directly from the point cloud

Validating the point cloud conversion

Want to understand the sagging of an existing to be retained ceiling. Model a ceiling in Autodesk Revit along the surveyed height and run the deviation histogram

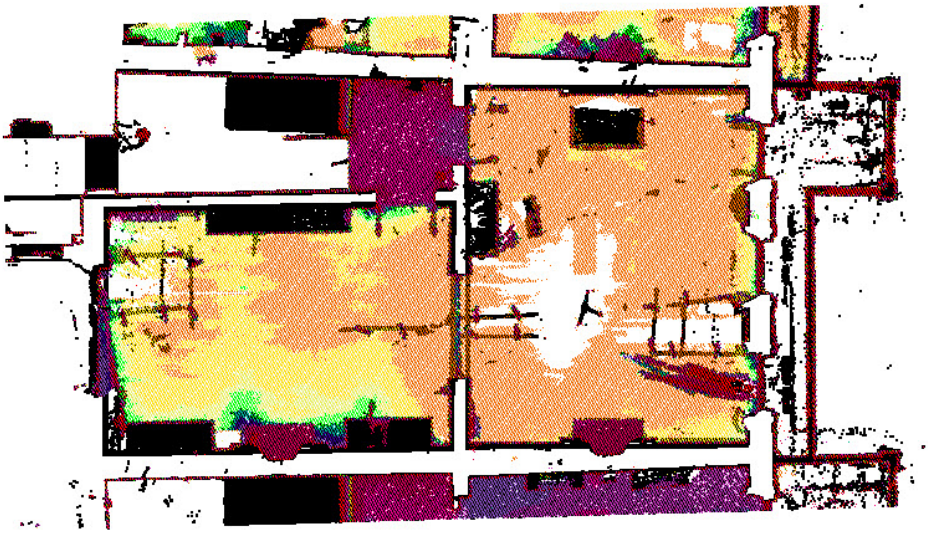


Use the deviation histogram to understand how close the point cloud is to the modelled ceiling



From running the analysis on the modeled ceiling I can explain to the client the ceiling is sagging over the surface, approximately 4cm

- Create an image to explain the deviation of the floor over the level



This image tells me the floor in the retained reception area is fairly level. I can also see there is a step down to the stair well to the top left. The apartment to the bottom of the images floor is not at the exact same level as this apartment also.

Conclusion

The addition of point cloud data to the acquisition of site and property surveys has given us greater confidence when working on BIM projects with existing buildings and sites of significant complexity; however it should not be seen as the answer to all our questions. A point cloud can prove a source of information that can assist in understanding and providing:

- Existing site conditions
- Existing plans of the building
- Information on access to site
- Issues to do with materials of scanned objects
- Details on key areas that need to be scanned
- Details on key locations that will enable an accurate project grid
- Accuracy of the buildings of as built data
- A source of information that can assist with heritage consultation
- Validation of quantities on site
- And more…

This information can be key to the success of a project, however if we are not communicating with the point cloud provider/ or point cloud converter this process can cause difficulties. Involving the contractor at the earliest point and providing them with the information required on items such as:

- Existing site plan
- What needs to be scanned
- Point cloud density
- Providing them with existing drawings and data
- Project grid
- Accessing hard to reach spaces
- Materials of objects scanned
- TruView
- Who is to the owner of the Raw Survey Data, Point Cloud Data, TruView, final model
- When they will have access to the site
- Days needed to be on site to scan in regards to construction/ demolition

With this information, the commissioned scanning provider can be efficient on site, producing a point cloud which will suit the need of you and your client.

During the process of converting the point cloud, either internally or externally, it is important to handle it the same as any other BIM data project. The model must follow the same guidelines set out in the BIM execution plan or project standards on items such as:

- Datum levels required for project (possibly defined by the survey model)
- Naming standards of elements
- Views required to be created
- Project grid (Northing's - Easting's)
- Phasing (or at the very least a management policy)
- Level Of detail
- Scope (Scoping drawings)
- Generic model items from other resources/ the team
- Level of deviation
- Linking files

The earlier that we can receive an existing model, the sooner that an accurate design process can commence with the confidence that we can produce a design that can be delivered

Point cloud data has, and can, assist us in understanding the existing fabric of site and building conditions. It should not be viewed as the panacea to our questions. Set a good line of communication with your point cloud consultant about what is required from the scan, and create an environment where the project team is on board. With processes in place, point cloud data will provide results and significantly de-risk the entire project.

Acknowledgements

I would like to thank the companies listed below and for all their time and the assistance from a few key individuals.

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LandTech Consultants

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