Gain a practical understanding of reality capture and scan-to-BIM technologies

Case in point (cloud)

Conor Shaw + Kelly Cone

Class Description

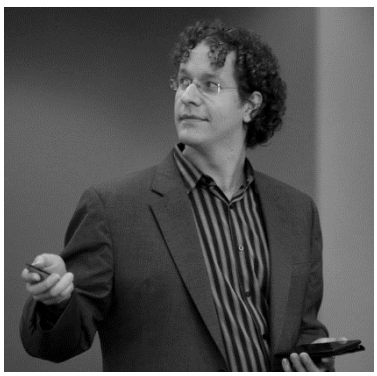
This class will delve into the world of point cloud data processing. A number of recent scan to BIM projects, both manual and automated, will be presented and discussed. We'll play with some scan data (surveyed from the BiLT conference venue here in Edinburgh) and attendees will gain an insight into practical modelling procedures for as-built modelling projects and experience semi-automated scan-to-BIM software up close.

The Edinburgh International Conference Centre will be our modelling subject for the class

About the Mentors:

Conor is a veteran RTC/BILT Europe speaker, Edinburgh to be his fourth appearance. As part of the panel discussion on standards in Delft 2013, he spoke about BIM implementation for small companies. In Aarhus he presented work on scan-to-BIM applied to historic buildings and was rated a top 10 speaker. This was followed up in Ljubljana with some further work into the world of reality capture and BIM. This year he'll be taking a different track and running a roundtable discussion, digesting the UNFCCC global climate talks and their effect on our industry. Trained as a construction engineer, in 2016 he received his M.Sc in Construction and Real Estate Management from the HTW Berlin. He established Shaw Architectural Solutions in 2014 which offers BIM consultancy services worldwide with clients include Engineers in Berlin, Surveyors in Belfast, Contractors in New York and Architects and private clients in Helsinki. Recently Conor has been involved in establishing a network of professionals with a shared vision of promoting ecological building practices and is currently in the middle of building a 185m^2 guesthouse in Finland from wood, straw and clay!

Contact: ***conorbshaw@hotmail.com***



I am passionate about process and technology innovation and how they can change industries and people's lives. My education is in architectural design and documentation, but my experience within the AEC space is far more varied.

I have implemented various practice technologies into design, estimating, and construction teams and workflows; worked on amazing projects such as the SaRang Global Ministry center in Seoul as a designer, and Renzo Piano's addition to the Louis Kahn Kimbell Art Museum as a contractor; and have had the privilege of growing and leading one of the most talented VDC & Process Innovation teams in the industry.

Those experiences have taught me there is a better way to create our built environment, and I want to make that way become a reality. As a first step in that journey, I have joined ClearEdge3D to help them develop the tools necessary for design and construction firms to get the most out of reality capture within the AEC industry, with the goal of closing the gap between the virtual and real world.

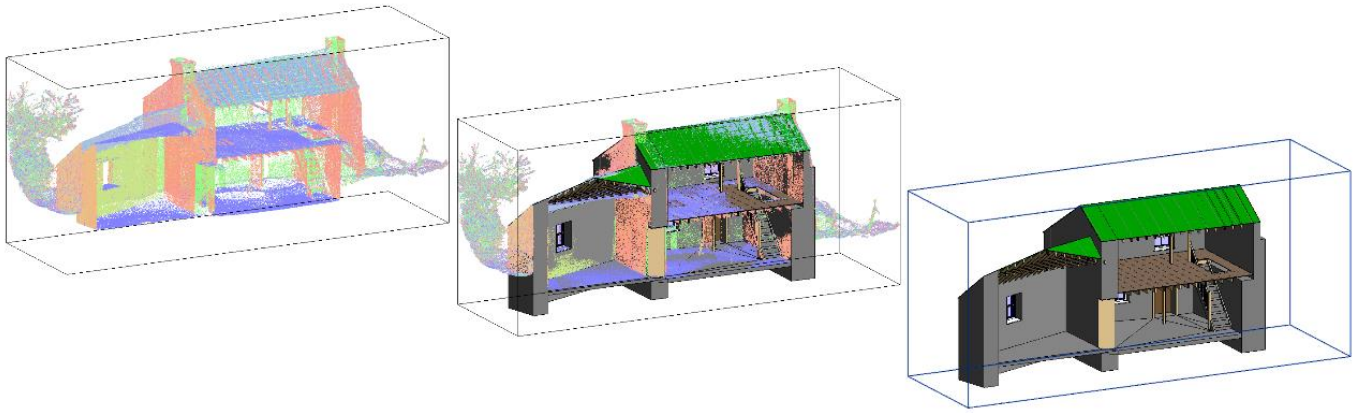
Contact: ***kelly.cone@clearedge3d.com***

Scan data to BIM geometry

Renovation projects necessitate the gathering of existing situation data about a building. Traditional surveying methods have been error prone, subjective and require significant manual effort.

Recently, highly advanced data capture through the use of laser scanning, can provide millimetre accuracy in the form of 3D Point Cloud datasets.

For use in the contemporary design process it is then usually necessary to convert this data into 3D BIM geometry. Automating this step is a major gap in the industry, and has so far been coined Scan-to-BIM (although Scan-to-BIM '*geometry*' may be more accurate).



3D Point Cloud to building geometry in Revit

Terrestrial Laser Scanning

Also referred to as LiDAR, LADAR or 3D Laser Scanning.

A rapidly pulsing laser beam which sweeps an area to capture accurate "as built" information through the calculation of geometric (XYZ) co-ordinates and mapping of (RGB) photos.

Becoming widely utilised for data capture in industry.

Leica C10 laser scanner

Point Cloud

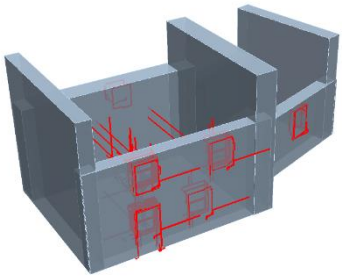
The result of a Terrestrial Laser Scan survey is a Point Cloud containing millions of digital XYZ and RGB points in space.

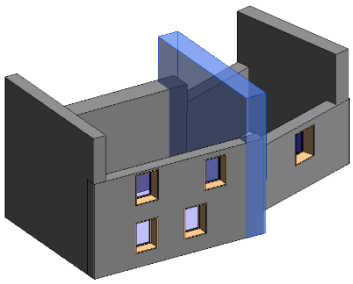
The Point Cloud can be viewed in 3D or sliced up into plans and sections to produce drawings or models

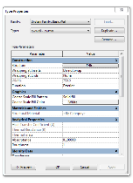
Scan-to-BIM

Manually tracing over a point cloud in BIM authoring software requires great manual effort, and despite the scan data being of millimetre precision, the resulting BIM quality depends highly on the skills and experience of the operator and their interpretation.

Scan-to-BIM is a semi-automated BIM geometry creation process whereby Scan-to-BIM software recognises surfaces from the point cloud dataset and places BIM geometry.







Semi-automated Revit geometry creation with Scan-to-BIM software

Edgewise 3D

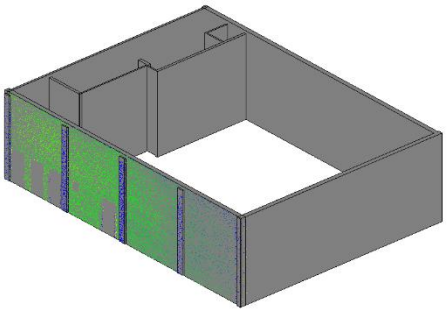
Edgewise 3D from *Clearedge* will be used in the workshop as recommended by [1]Son et al. Other vendors include*: IMAGINiT Scan-to-BIM, Leica Cyclone and Trimble Realworks*

Edgewise 3D works as a suite of 3 packages; Building, Structure and Plant.

- Building

  Walls, windows, levels and topography

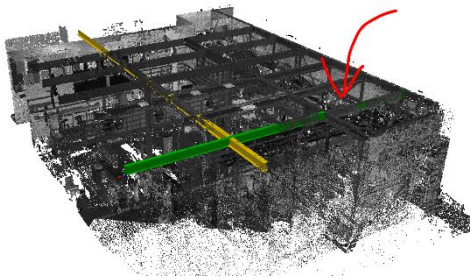
  - Process scan data to find surface
  - manually select suggested levels
  - automatically mass create walls
  - manually clean up walls
  - manually extract windows
  - import to Revit as native systems and families
  - use the plugin to check and correct geometry within Revit



- Structure

  Columns, beams, channels, angles

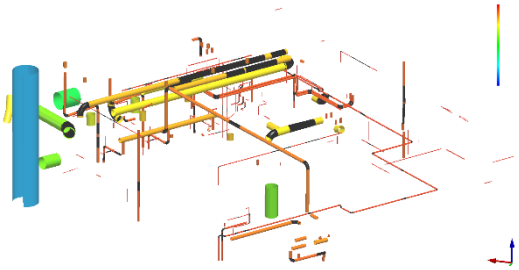
  - Manually extract structural elements individually
  - mass create repeating geometry with pattern recognition function
  - import to Revit as native systems and families



- Plant

  Pipes, ducts, mechanical components

  - Process scan data to mass create pipes
  - clean up and extract missed pipes
  - optimise and apply standards
  - create bends and components
  - import to Revit as native systems and families



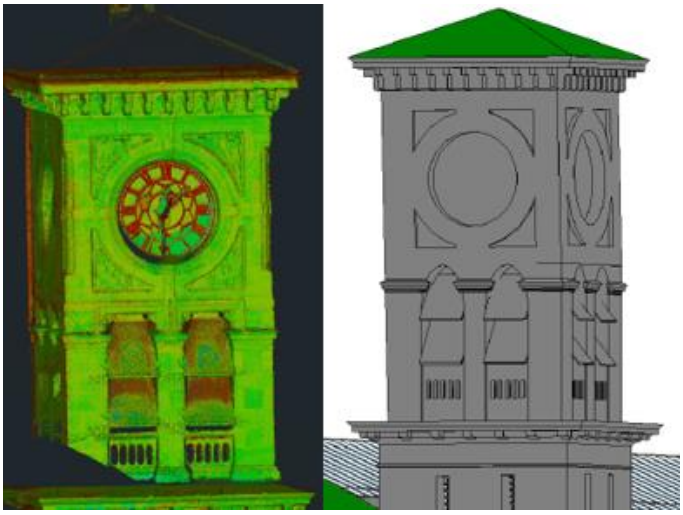
[1] Son, H., Kim, C. & Turkan, Y., 2015. Scan-to-BIM – An Overview of the Current State of the Art and a Look Ahead.

Example as built (manual) modelling projects

Below are the project specifications for the 3 cases which we'll look at in the workshop. Elements highlighted in **bold** could have benefitted from application of semi-automated scan-to-BIM software. For each of the projects some learning outcomes are listed.

Waterside station, Derry

- Teams' first live project delivering as built BIM from scan data
- 100 budgeted hours (all inclusive; communication, training, reporting, follow up)
- Basic training for team (2 afternoons delivering modelling basics)+ day with client
- 3 week deadline
- Model intended for planning permission (stone by stone CAD provided separately for heritage permissions)
- LOD: +-30mm tolerance, deflection of structures to be captured
- ELEMENTS**: Levels, walls**, roof, floors, **openings, trusses**, stairs, curtain walls, stone window surrounds, **piers**, arches, gargoyles, clock tower, bell tower, glass warehouse atrium, gutters, **downpipes**



Learning outcomes

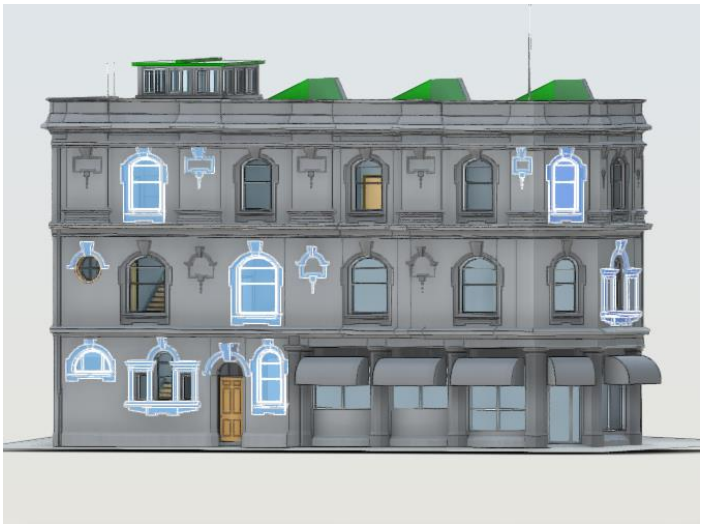
Possible (better) to learn BIM on live project

Would have been a very good case for use of automated geometry extraction (walls, levels and trusses)

Useful to sub-divide large cloud into logical areas (wings in this case)

Butcher's building, Belfast

- 80 budgeted hours
- 2 week deadline
- Model intended for planning permission (client = project architect)
- LOD: +-30mm tolerance (report provided on deviation from tolerance)
- ELEMENTS: **Levels, topography, walls**, roof, floors, **openings**, stairs, curtain walls, **columns**, stone window / door surrounds (highly varied), gutters, **downpipes**



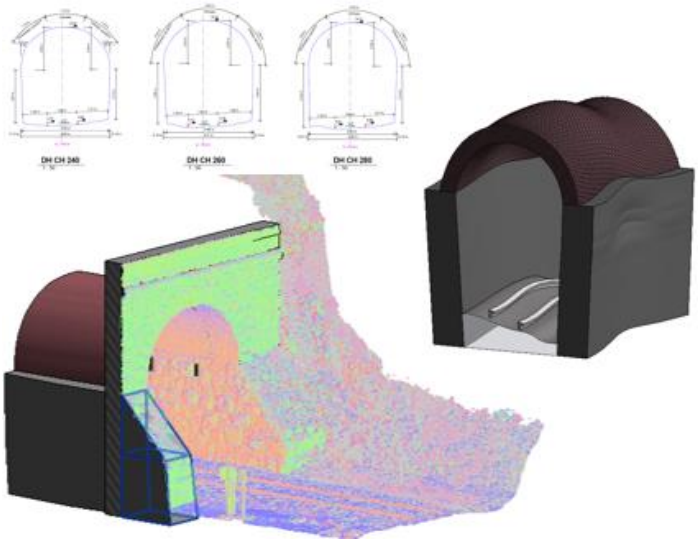
Learning outcomes

If it wasn't surveyed, don't fake it. Just inform of the missing information.

Providing a metadata / modelling assumptions and deviations report helps to reassure and inform clients

Castlerock & Downhill Tunnel repair, Northern Ireland Coast

- 140 budgeted hours (160 used)
- 4 week deadline
- Model intended for export of 2D CAD for planning and to identify 3D location of missing bricks in the vaulted tunnels (restoration planning)
- LOD: +-30mm tolerance, deflection of structures to be captured
- ELEMENTS: **Levels**, **walls (maybe)**, vaulted tunnel roof, ballast, tracks, refuges, portals, electrical equipment, missing bricks / blocks



Learning outcomes

Early mock-ups are great for assisting with expectations management and clarifying the true needs of clients ordering BIMs

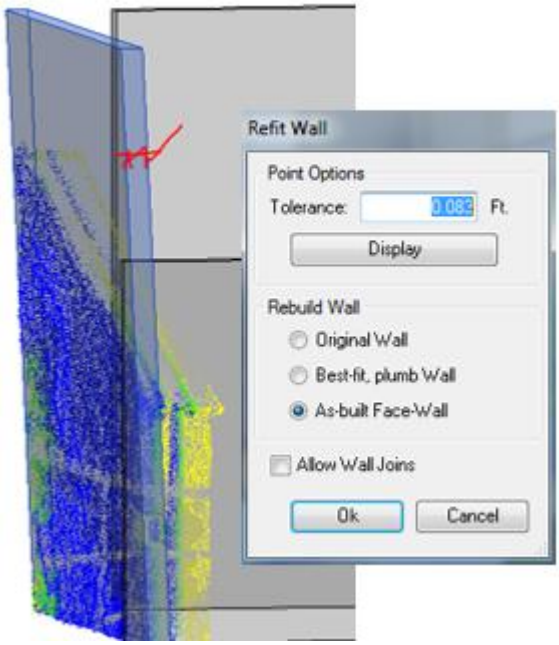
Clients don't always know what it is they need from their BIM, sometimes it is necessary to write EIR for them…

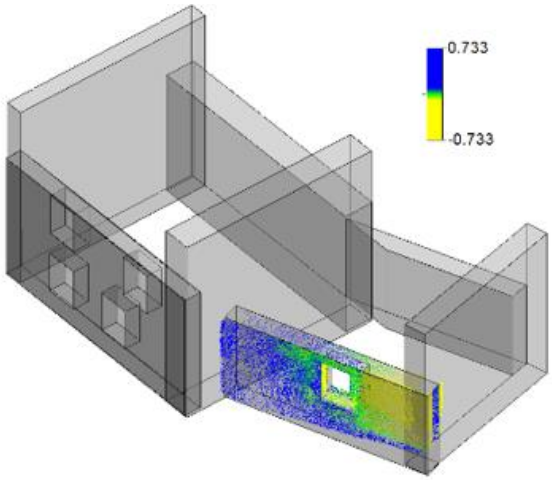
A360 a good tool for delivering product prior to allowing download (before bills are settled)

Application to heritage buildings

"the **virtual reconstruction** procedure of historical-**cultural heritage** is **not an easy task**, because the **objects to model consist** of components whose heterogeneous, complex, and **irregular characteristics** and morphologies are **not represented in the BIM software libraries**" [2]

Some features of semi-automated Scan-to-BIM Edgewise3D software are particularly well suited to heritage (non uniform) structures.





Refit wall tool allows the user to toggle between plumb, best fit… etc. achieving a more or less close to reality (fit to points) as required by the project.

Extraction tool in the structural suite are excellent at picking up non-straight structural components such as columns and beams.

Elements duplicated using the *smart* **array** tool in the structural suite will not only find matches in a linear direction, but the created elements will refit each instance to the new points.

The Revit plugin has some useful features for QA. Check the fit of the modelled elements to points using the **heat mapping** tool.

Another useful aspect, for anyone that has worked with large point cloud data sets in Revit, is that **the software creates a database** of the point cloud. It will then **only bring in points associated with the object being queried**, saving on performance by not requiring that point clouds be loaded into the project.

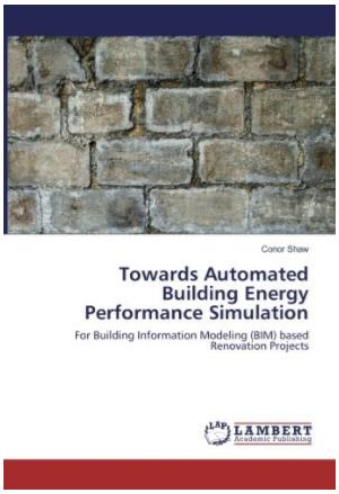
[2] López, F.J.; Lerones, P.M.; Llamas, J.; Gómez-García-Bermejo, J.; Zalama, E. A Review of Heritage Building Information Modeling (H-BIM). Multimodal Technologies and Interact Journal, 2018..

Case in point (cloud)

Conor Shaw, Shaw Architectural Solutions
Kelly Cone, Clearedge 3D

Research project (presented at previous BiLT Academy in Ljubljana, + available for free download)

Title:
Towards automated building energy performance simulation for BIM based renovation projects



Collaborators:
HTW Berlin, Metropolia University Helsinki, Buro Happold Engineering, Farrimond MacManus, Clearedge 3D

Awards/Publication:
CIBSE Building Simulation Award 2017
SEEDS 'most pragmatic approach to sustainability' 2018
(Full text) LAP Academic Publishing
(Paper) Nordic Passive House Conference 2017, Helsinki
(Paper) SEEDS 2018, Dublin

ISBN: 978-3-330-04338-1
Full paper online at: **https://proleek.wordpress.com/**

Aim

"Develop a workflow which reduces the manual effort required to simulate building energy performance in renovation projects by improving data exchange."

Method

- Terrestrial laser scanning for data collection
- Scan-to-BIM for converting Point Cloud to BIM geometry
- Single Analysis Model as centralised energy model
- gbXML export/import to simulation tools

Developed workflow concept

Findings

- Manual effort was significantly reduced through the use of available technology
- Custom plug-in required to move data (TASmanianDevil)
- Beware of over-automation, modelling can be an important step for familiarisation

Looking for inspiration for an upcoming school project? Interested in interdisciplinary collaboration, interoperability and cutting-edge design technology? Read the full report.

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