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CI322699

Developing an Execution plan for Scan to BIM (sBEP)

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Learning Objectives

- Discover requirements for a Scan-to-BIM job
- Learn how to define and set standards for level of accuracy and level of development
- Learn about QC workflows using Revit templates, Navisworks, and Virtual Reality
- Learn how to save time in handling and modeling from large-size point clouds

Description

The quality of a Scan to BIM (Building Information Modeling) model can vary, depending on the surveyor, instrument used, field conditions, especially on the requirements specified. There are, however, no industry standards templates available to follow. This class will focus on the essentials for developing a Scan to BIM execution plan. Starting form providing & clarifying scope of work to define LOD requirements shall be discussed. There are a lot of potential risks that need to be identified and highlighted when picking up a Scan to BIM job. We will discuss some of these cases with project examples. Basic tools like Revit, ReCap, Navisworks available can help us through this process of visualizing model mistakes and getting a quality product. We will learn several tips that can assist us while facing the quality control of a model replicated from a point cloud. Those tips will also help us locate where the focus should go in each case. The goal of this class is, therefore, not only to learn the available tools, but also to analyze the current gaps in setting up Scan to BIM project execution plan.
The agenda we will focus on will be:

- Taking down requirements - Essentials
- Setting expectations – With the client and team
- Stating LOD requirements
- Identifying risks
- Identifying tools
- QC Workflow
    - In Revit - Filters/schedules/plans and sections
    - Using Navisworks (saved viewpoints)
    - Integrating XR with Point Cloud
- Script to enable copy of relevant scan data to users local
- Involving the design team to use ReCap & commenting tools

About the Speaker:

Raghavendra Bhat is a BIM Leader at Stantec Pune office, providing integrated project delivery expertise utilizing Autodesk software. Bhat has over 14 years of professional experience working in the architecture, engineering, and construction (AEC) industry using BIM technology on a wide variety of international and local projects (for example, federal government, public works, wet infrastructure, and skyscrapers). Besides that, he has worked on planning execution for several point cloud Jobs. Bhat has also mentored, trained, developed standard guidelines and project standard templates. Coordinate with a global team to support mainly the Water Delivery Group including developing communications, comparing methods, and collaborating towards common growth and integration of BIM globally.

Joseph C. Huang, PhD, AIA, is a Principal Architect & BIM Practice Leader at Stantec. He has more than 20 years of professional experience in the AEC industry and has served as the BIM Manager for numerous large-scale projects including the Panama Canal Third Set of Locks. His project experience ranges from vertical construction to large-scale infrastructure, where he has successfully integrated BIM into project design and construction phases. Besides that, he presents BIM-related topics regularly to universities and global AEC industry groups at international conferences. Joseph is a licensed architect registered in Illinois, USA, a member of the American Institute of Architects (AIA), a LEED Green Associate, and an Adjunct Professor teaching VR/AR/MR integrating with design and construction at Master of Project Management Program in Northwestern University.

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Contents

INTRODUCTION

[Enter the body text here]

PROJECT INFORMATION

PROJECT DESCRIPTION

[Write a short project description defining the Scope of work]

PROJECT SCHEDULE

[Provide a reference of a timeline for the scheduled start and finish]

KEY PROJECT CONTACTS / ROLES AND RESPONSIBILITIES

[Fill in the below table with project team contact details]

Role	Name	Email ID	Contact number

CLIENT OBJECTIVES

FAQ'S

{Refer Appendix A – Frequently Asked Questions [template].}

REQUIREMENT SHEET TO SURVEYOR

{Refer Appendix B- Scan Requirement Sheet [template]}

It's essential to clearly specify the scan requirements to meet the need of post processing workflow.

This included agreeing on the Scanner type being used, Density of scans required to be captured, Details on if RGB values need to be captured, Confirmation on the scan being geolocated, specify what clean-up are necessary, requirement of 360 Real Views and obtaining few Setout points (SOP) defined to cross verify.

FIGURE 1: EXAMPLE OF SETOUT POINT (SOP) RECORDED BY A SURVEYOR

	A	B	C	D	E
1	SOP1	359710.422	677960.702	14.358	
2	SOP2	359701.790	677929.706	11.477	
3	SOP3	359668.450	677913.524	11.032	
4					
5					

FIGURE 2: RECORDED COORDINATES AT SITE FOR REFERENCE

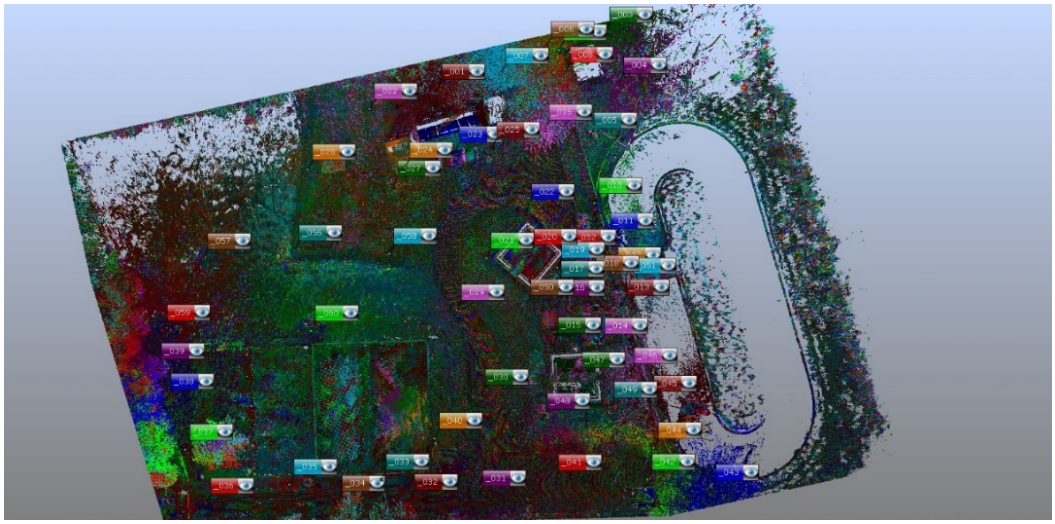


FIGURE 3: SURVEYOR ISSUES A LIST OF SCAN POSITIONS.

SCOPE AND PLANNING

TAKING DOWN REQUIREMENTS

{Refer Appendix C – Client Requirements [template]}
Use table in Appendix C to document the Client requirements, Special considerations / Requirements etc. to be documented.

- *Attach additional documentation like photos / markup's / ReCap notes*

SETTING EXPECTATIONS - WITH CLIENT AND TEAM

Arrange Kick-off meeting with the Client to

- Define and document the scope of work
- Agree the Level of Detail
- Agree on the deliverable formats
- Agree on the QC process

Arrange Kick-off meeting with the Team

- Discuss the above listed points Plus
- Workflow that will be adopted
- Agreed project schedule

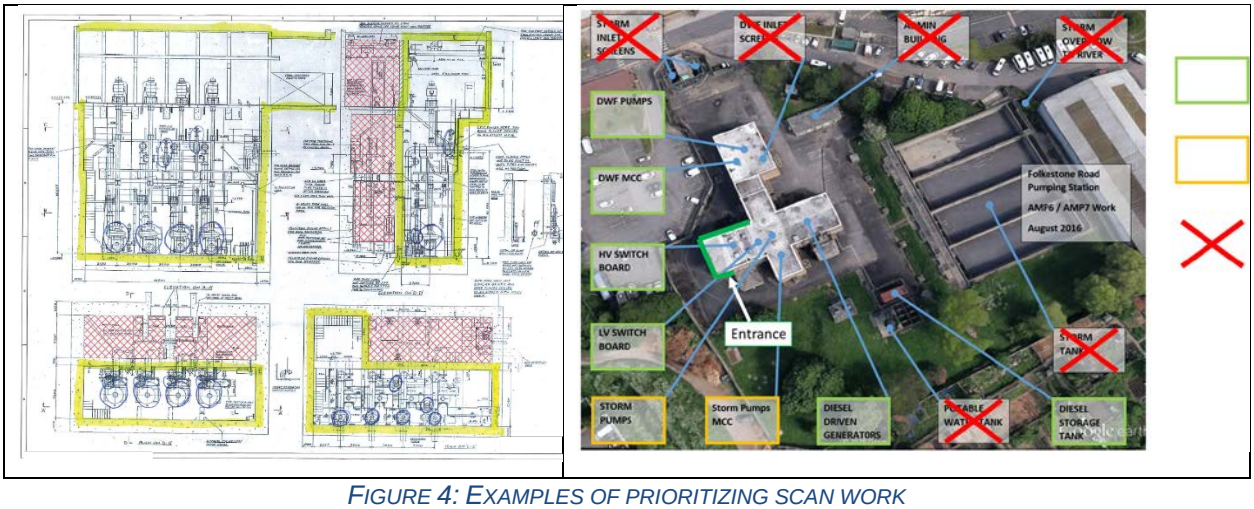
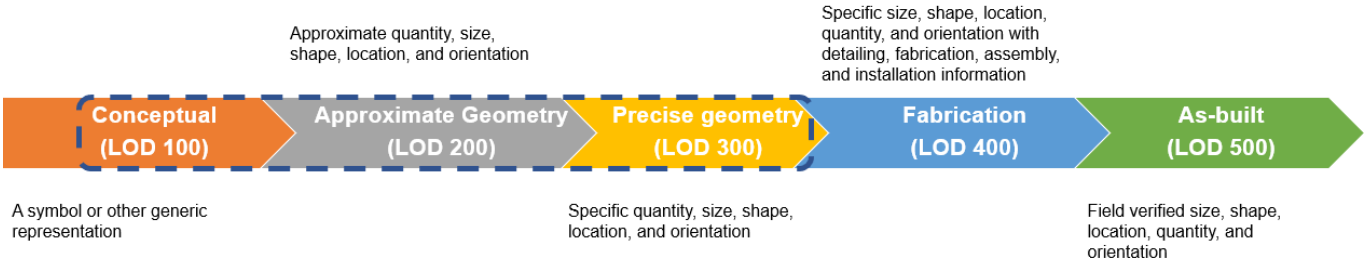


FIGURE 4: EXAMPLES OF PRIORITIZING SCAN WORK

LOD REQUIREMENTS



For each building element that needs to be modelled, the required modelling LOD of the element should be defined. LOD refers to “Level of Detail” in this case.

Level of Development is the progressive development of the BIM model from conceptual design stage onwards until the completion of construction.

Level of Detail describes the degree to which the element model is detailed and specific. The distinction between approximate geometry and precise geometry is rather vague and subjective.

Therefore, in the proposed scan-to-BIM framework, the model LOD consists of three levels, namely “conceptual”, “approximate geometry”, and “precise geometry”. Wherever applicable, the required modelling accuracy of the element quantity, size, shape, location, and orientation should be defined as supplementary to the required LOD. For example, the required LOD for a wall can be “precise geometry” with 10 mm modelling accuracy regarding its size, shape, and location.

Non-Geometric Attributes

While the model LOD is focused on the required geometric attributes of an element, the required non-geometric attributes should also be defined for each element to fulfil the needs of the intended BIM application.

For BIM-based building energy simulation, the materials of building elements and thermal properties of building materials are necessary. Some other non-geometric attributes include surface properties (e.g. colors and reflectivity) of building elements, mechanical properties of structural elements, acoustic properties of walls, technical specification and warranty information of equipment, etc. It is worth noting that the scan-to-BIM process can collect only some of the above-mentioned non-geometric attributes such as the spatial relationships between building elements, materials of building elements, and surface properties of building elements. However, it is still useful to identify all the required non-geometric attributes in this step so that the requirements are well documented and other data sources may be deployed in a later stage to provide the required attributes.

TABLE 1: SAMPLE TABLE LISTING THE NON-GEOMETRIC ATTRIBUTES

	Required LOD (Accuracy)	Non-geometric Attributes
Floors	Approximate geometry (>2", Shape Size and Location)	Material
Roof	Approximate geometry (>2", Shape Size and Location)	Material
Structural Framing	Approximate geometry (Shape Size and Location)	Material
Mechanical Equipment's	Approximate geometry (Shape Size and Location)	Manufacture / Capacity
Electrical Equipment's	Approximate geometry (Shape Size and Location)	Manufacture / Capacity
Pipes	Approximate geometry (Shape Size and Location)	Material
Pipe Accessories	Approximate geometry (Shape Size and Location)	Material
Pipe Fittings	Approximate geometry (Shape Size and Location)	Material
Walls (Masonry/Concrete)	Approximate geometry (Shape Size and Location)	Fire rating / Material
Doors & Windows	Approximate geometry (Shape Size and Location)	Type / Material / Swing Directions
Openings	Approximate geometry (Shape Size and Location)	Type

{Refer Appendix D – Non-geometric Attributes required [template]}

IDENTIFYING RISKS

TABLE 2: SAMPLE LIST DOWN RISKS/REASONING/IMPACT/QUANTIFY (HRS./TIME) / MITIGATE (SOLUTIONS) IF ANY.

Risks Identified	Reasoning	Impact	Hrs. /time	Solution
Scan Coordinates not correct				
No RGB values registered				
No 360 Real views embedded				
Scale/Units of the scan inappropriate				
Point cloud density is low				
Scan captured with low Interior Lighting				
Ghosting				

Unstructured Format				
Scan Data Size				
If estimating LOE based on As-built scan PDF				

IDENTIFYING TOOLS

There are various tools available to assist with the Scan to BIM conversion. Below are some widely used applications from which you can choose based on the workflow you adopt.

TABLE 3: NAME OF SCAN TO BIM TOOLS AND ITS COMPATIBILITY WITH OTHER CAD/BIM SOFTWARE.

Name	Compatibility	Notes
Edgewise (ClearEdge)	Revit, AutoCAD MEP, Plant 3D	
PointSense (Faro)	Revit, AutoCAD	
Leica CloudWorks (Leica Geosystems)	Revit	
Scan to BIM (Imaginit Technologies)	Revit	

DEFINING WORKFLOW

For quick implementation have a couple of workflows predefined. Based on the type of Job the team can choose from the standard workflow.

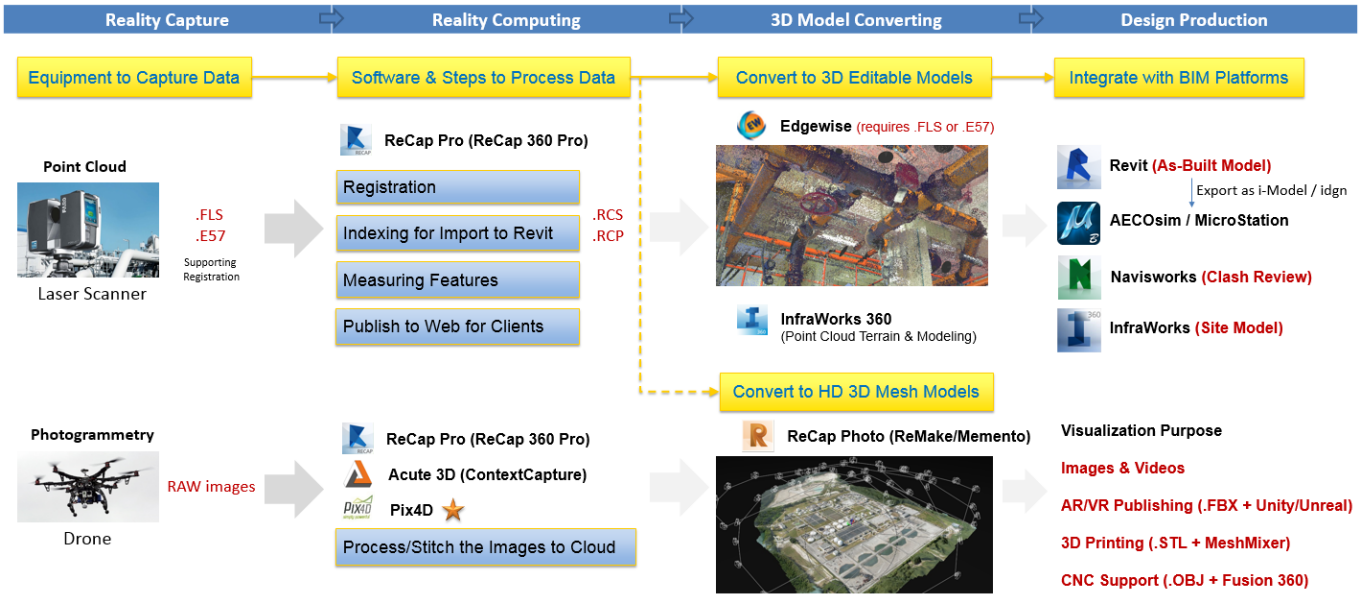


FIGURE 5: SHOWS THE TOOLS AND PROCESS DURING EACH PHASE OF SCAN TO BIM JOB

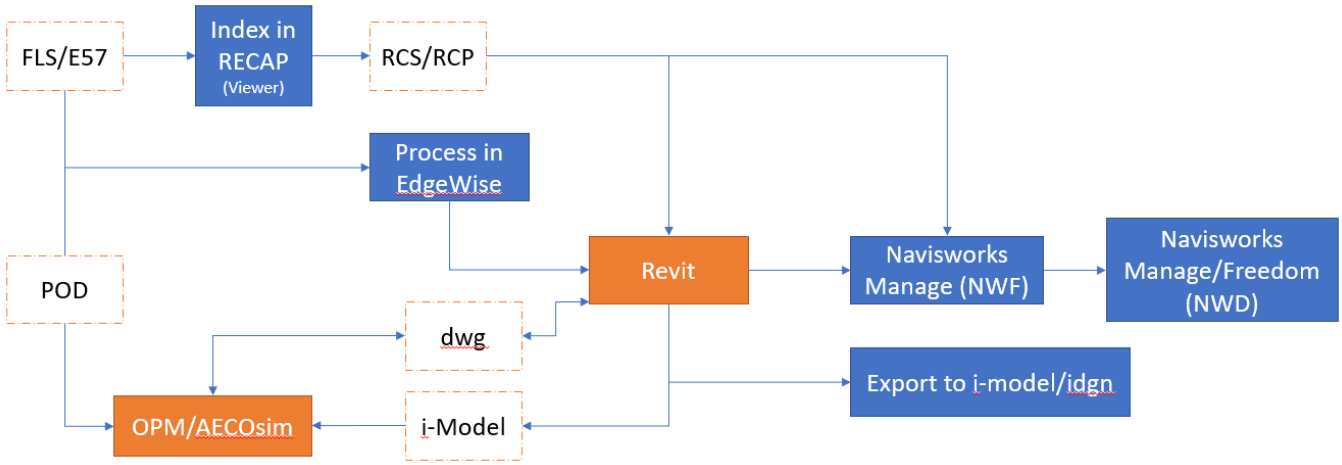


FIGURE 6: GENERIC WORKFLOW FOR AUTODESK AND BENTLEY PRODUCTS

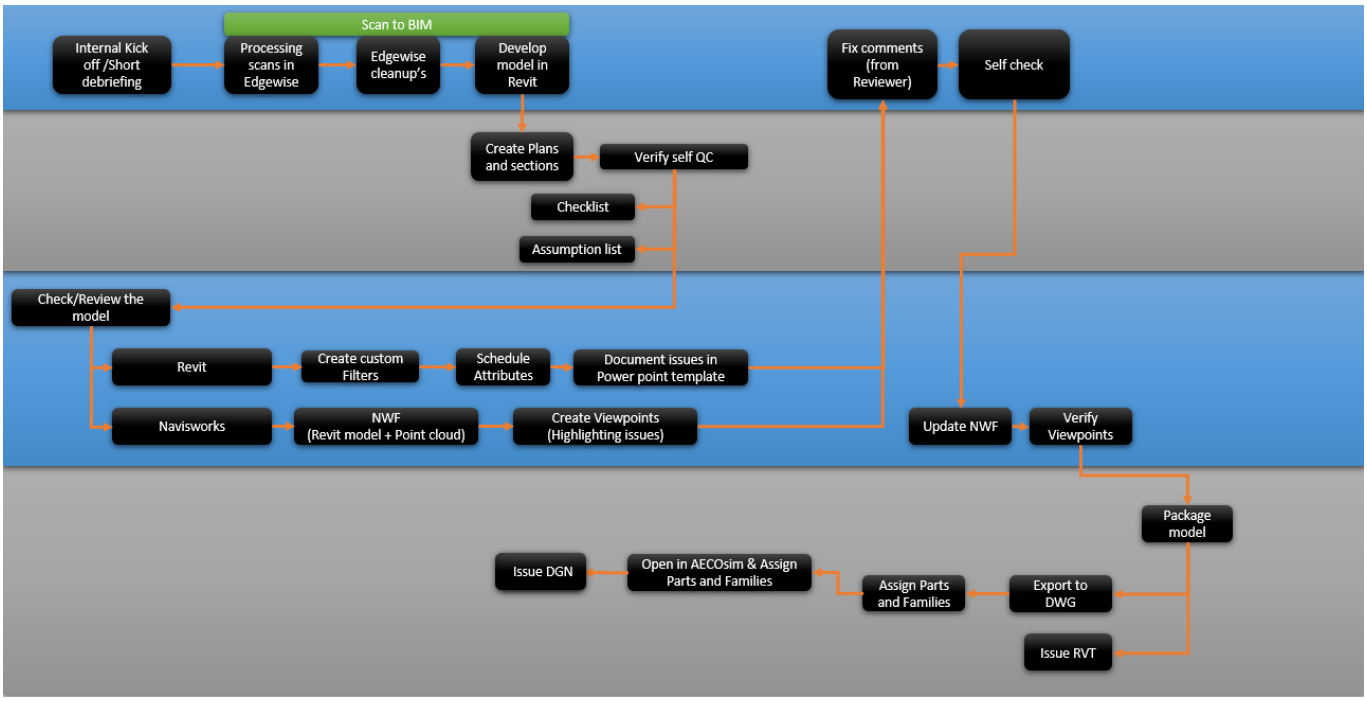


FIGURE 7: CUSTOMIZED WORKFLOW BASED ON PROJECT REQUIREMENTS

ESTIMATION (LEVEL OF EFFORT)

When estimating the level of effort always break down the entire SOW into multiple areas. Even breaking down the areas based on the LOD will help. Then also consider sub dividing them based on Disciplines. This will help drill down and provide an accurate LOE estimate.

- ❖ Area wise break down
- ❖ Discipline wise Breakdown
  - o Categorized Included (refer Table 1: Sample table listing the Non-geometric Attributes)
    - ▪ Floors 4” thickness and above (Solid if composition not known)
    - ▪ Railings
    - ▪ Doors
    - ▪ Windows
    - ▪ Walls (Solid if composition not known)
    - ▪ Pipes 2” diameter and above (assume Pipe type if not provided)
    - ▪ Pipe Accessories (use from Standards library if cutsheet not provided)
    - ▪ Pipe fittings (use from Standards library if cutsheet not provided)
    - ▪ Structural Members (main frames only no Connections)
    - ▪ …
  - o Categories Excluded
    - ▪ Pipe openings in Concrete 4” and below
    - ▪ Temporary site elements
    - ▪ Electrical conduits

- Electrical Switches
- Electrical Lighting Fixtures
- Sign boards
- Plantation
- …

{Refer Appendix E – Level of Effort (LOE) estimate [Template]}

COMPETENCE AND TRAINING

If the team or client requires any special training needs to operate a specific software, please do list them down.

{Refer Appendix F – Training Plan [Template]}

STANDARDS AND CONVENTIONS

Project Units:
Project Base point:

Revit Version / Build:
Navisworks Version:
ReCap Version:

DATA TRANSFER / INFORMATION MANAGEMENT

DATA TRANSFER OPTIONS

- Project FTP
- Portable Drive
- Autodesk A360 Drive

MAKING DATA AVAILABLE TO THE MODELLING TEAM

Script to enable copy of relevant scan data to users local

Using simple DOS robocopy script, you can automate the copy of scan data to users local. Copy the below code into a text file and save it with .bat extension.
You would need to replace the source and destination path. Where source is the location from where the data needs to be transferred and destination is the path on users local where the data needs to be populated.

```
@echo off
SET Source="\\inpun1d15006\Point Cloud Data\Project name\ReCap"
SET Destination="C:\Point Cloud Data\Project name\ReCap"
IF NOT EXIST %Destination% md %Destination%
robocopy  %Source% %Destination% /E
PAUSE
```

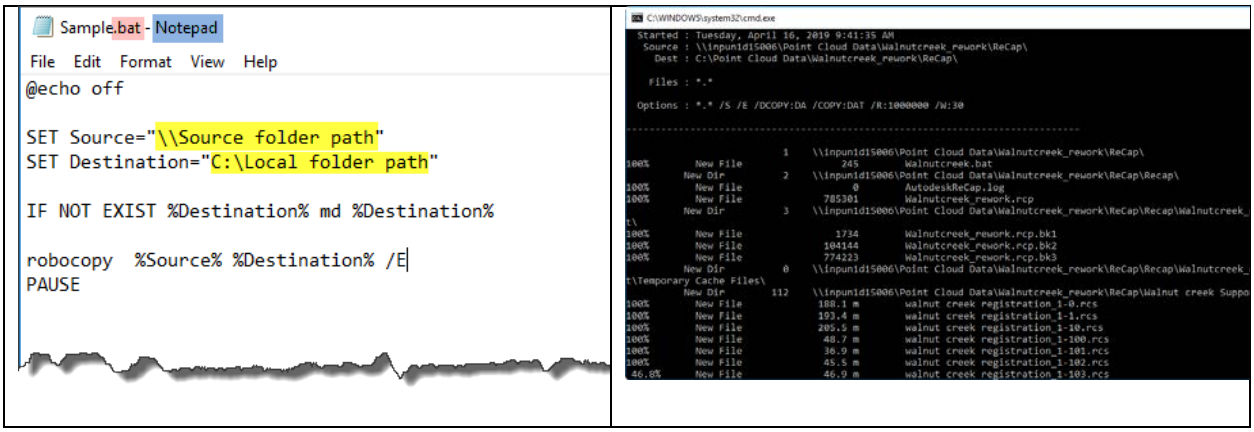
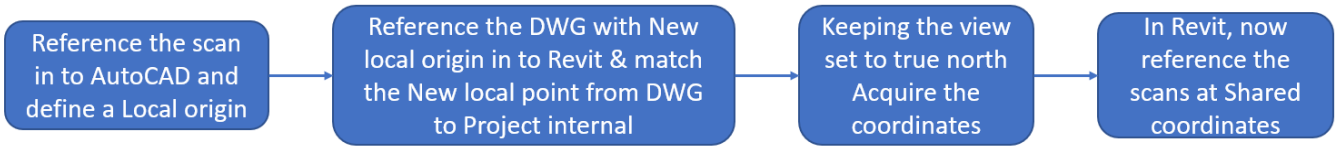


FIGURE 8: ROBOCOPY SCRIPT TO ENABLE COPY OF RELEVANT SCAN DATA TO USERS LOCAL

MODEL SETUP AND MODELLING PRACTICE

There could be several ways how the Models setup can be done. It will be up to the team to agree on a standardized workflow for a certain project.
You can have 2-3 different approaches defined of which the team can choose the workflow for the project.

Outlined below is a simple workflow that helps define a local origin (closer to the scan location) in AutoCAD and then use that to position appropriately in Revit (within 2-mile radius) & acquire the coordinates from the DWG file.



MODEL QC PROCESS/WORKFLOWS

USING REVIT

Model Owner creates generic plans and sections and lays them on to the sheets.

- Need to have basic interior/exterior dimensions added
- Need to have few SOP coordinates indicated
- Need to verify the walls are perpendicular and not off by an odd angle.
- Have Low point / High Point on slabs shown if slopes modelled.
- On Sections Elevations show clear height between floors
- Show Top of Concrete/Steel/walls where possible.
- All dimensions can be rounded off based on the accuracy required to be shown.

- On some of the views where it makes sense to have the point clouds referenced leave them on. (Source for visual check)

USING NAVISWORKS

Create an NWF file by appending the Revit models and Scan Data. Publish a NWD for the reviewers.

- Review the model by inspecting each area and create saved viewpoints (Create folders date wise).
- Publish an XML of the Saved viewpoints to the modelers.
- Model owner loads up the XML into their session of Navisworks, reviews and updates the model
- Revit link in the NWF is refreshed and existing comments on saved viewpoints can be reviewed by the reviewer.
- Continue the check and Review process until all comments are addressed and documented.

ADVANCED VISUALIZATION USING EXTENDED REALITY (XR)

Besides using Autodesk ReCap, Revit, and Navisworks to QA/QC the Scan to BIM modeling process, we also can use some advanced technologies like Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) to review the point cloud scanned data in a more immersive environment. Extended Reality (XR) is an umbrella term which covers a broad spectrum of experiences that blur the line between the real world and the virtual environments.

We would like to share with you four different workflows we have tested and identified. There are some new technologies out there for us to do more exploration.

1. FLS > Fuzor > VR/MR Headsets

a. FLS (Faro) is a common point cloud binary format. Fuzor lets you directly drop in your FLS and PTS point cloud files as well as combine them with your project model for design, analysis, and validation purposes.

b. Fuzor is a next generation VDC solution software for the construction industry which provides VR, Coordination, Collaboration, 4D construction simulation, 5D cost tracking and much more.

c. There is a VR mode easy button inside of Fuzor. Once we connected the VR headset like Oculus Rift, HTC Vive, or Windows Mixed Reality Head Mounted Display (HMD), we can easily see the imported point cloud inside of Fuzor via the VR headset.

d. As long as the point cloud got imported into Fuzor, we can upload that to Dropbox via Fuzor's Mobile Cloud interface and view it from Microsoft HoloLens (MR headset) via Fuzor App (theoretically). However, it depends on the file size (recommend

under 600MB, and that's why the option 2 via RCP/RCS inside of Revit is better) and speed of internet.

FIGURE 9: VIEWING THE FLS POINT CLOUD IN FUZOR SOFTWARE

FIGURE 10: VIEWING THE FLS POINT CLOUD IN FUZOR SOFTWARE WITH AVATAR MODE

2. RCP/RCS > Revit > Fuzor > VR Headsets

a. This is the highly recommended workflow because Autodesk ReCap can compress the raw scanned point cloud data like FLS to a light-weight format called RCS. RCP is the project file that groups together multiple RCS scan files. We usually rely on this process to trace

over the point clouds and model the 3D geometry in Revit. We can see the modeling progress with RCP/RCS superimposed on top of Revit model, or just the pure point cloud in Fuzor by exporting the Revit model via Fuzor plugin.

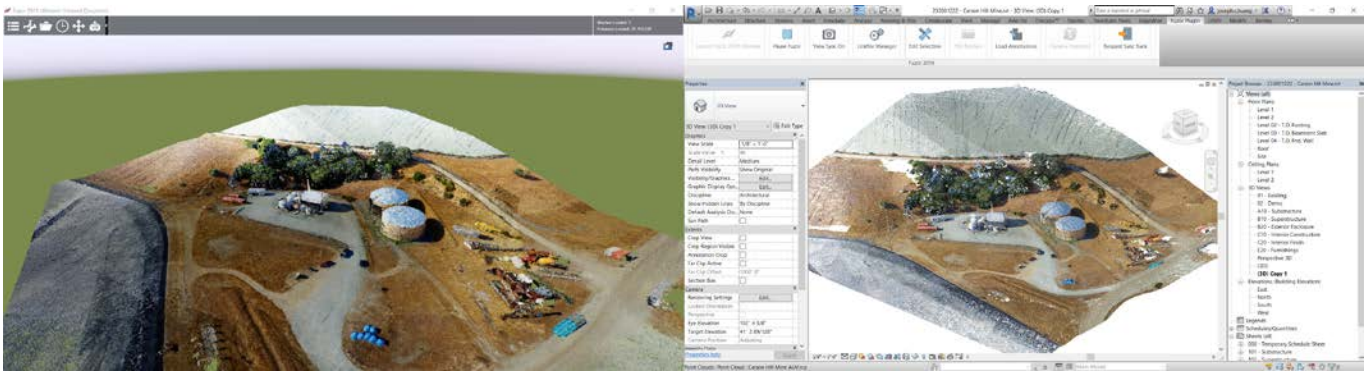


FIGURE 11: VISUALIZATION OF RCP/RCS POINT CLOUD AND REVIT MODEL IN FUZOR (LEFT IMAGE)

b. If we plan to only view the point cloud in Fuzor with a VR headset, we can quickly build a floor element in Revit. In this case, the first-person avatar has a gravity detected floor to walk and teleport.

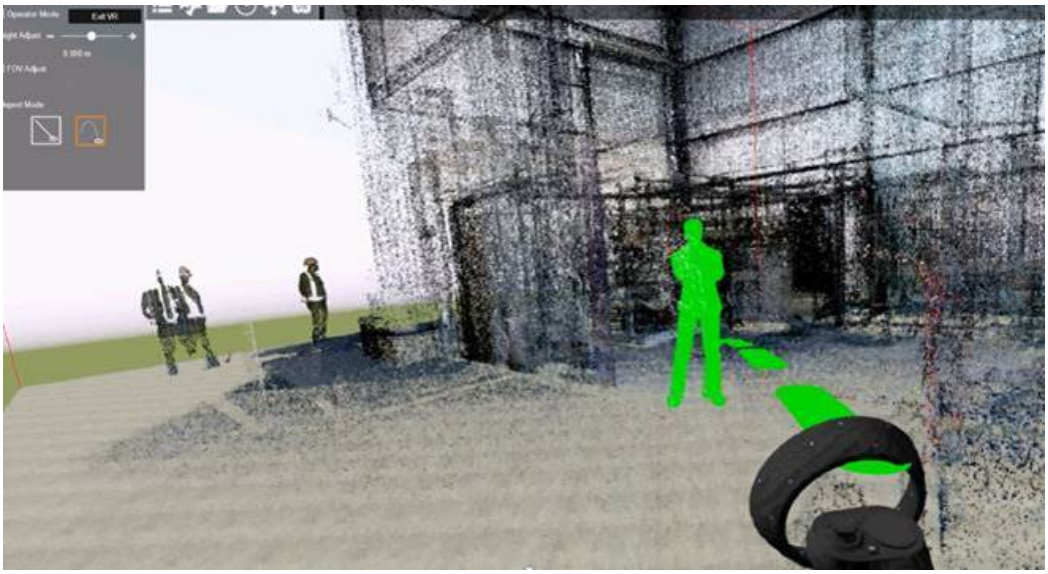


FIGURE 12: TELEPORTATION INSIDE OF FUZOR TO SEE THE POINT CLOUD VIA A VR HEADSET

3. LAS/LAZ > SketchUp > Symmetry > VR Headsets

a. Many architects start their preliminary design by SketchUp software. This workflow relies on Symmetry plugin in SketchUp with the LAS/LAZ point could imported.

b. We can view the imported LAS/LAZ point cloud data via SKP (SketchUp file format) from HTC Vive VR headset after I installed Symmetry Alpha on Steam.

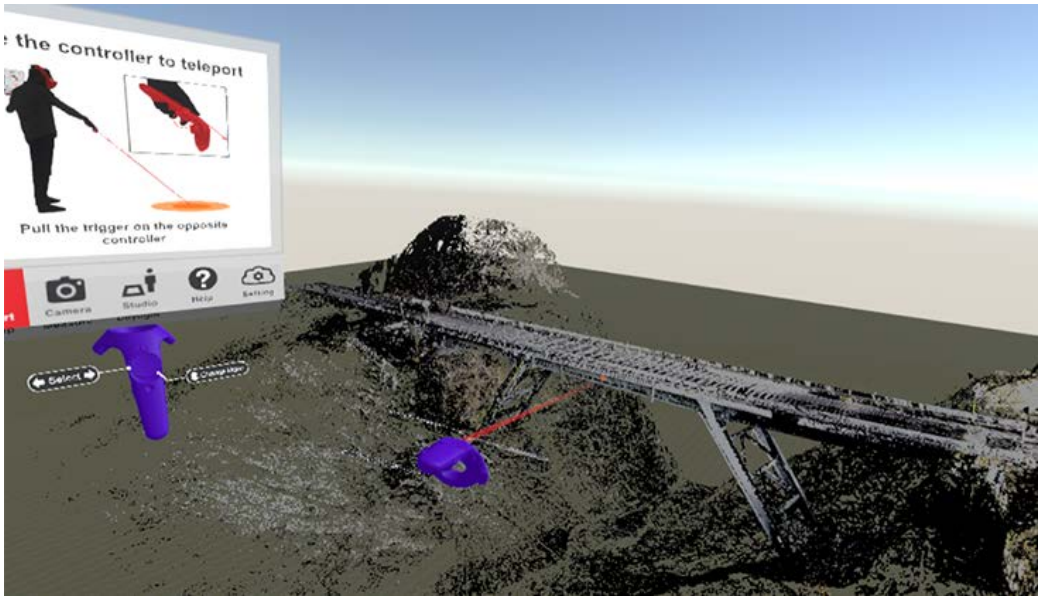


FIGURE 13: VIEWING THE LAS/LAZ POINT CLOUD FROM SYMMETRY & VR HEADSET

4. LAS > Sketchfab > AR & VR from Mobile Devices

a. This workflow ends up with a mobile device like a smartphone or tablet.
b. Sketchfab is a web-based platform to publish, share, and discover 3D models with VR and AR viewing capabilities. Their mobile app (iOS and Android) can quickly convert the 3D content into VR mode for Cardboard VR and AR mode just like playing Pokémon Go.
c. This is the app you can view the point cloud data so smoothly from your smartphone or tablet.

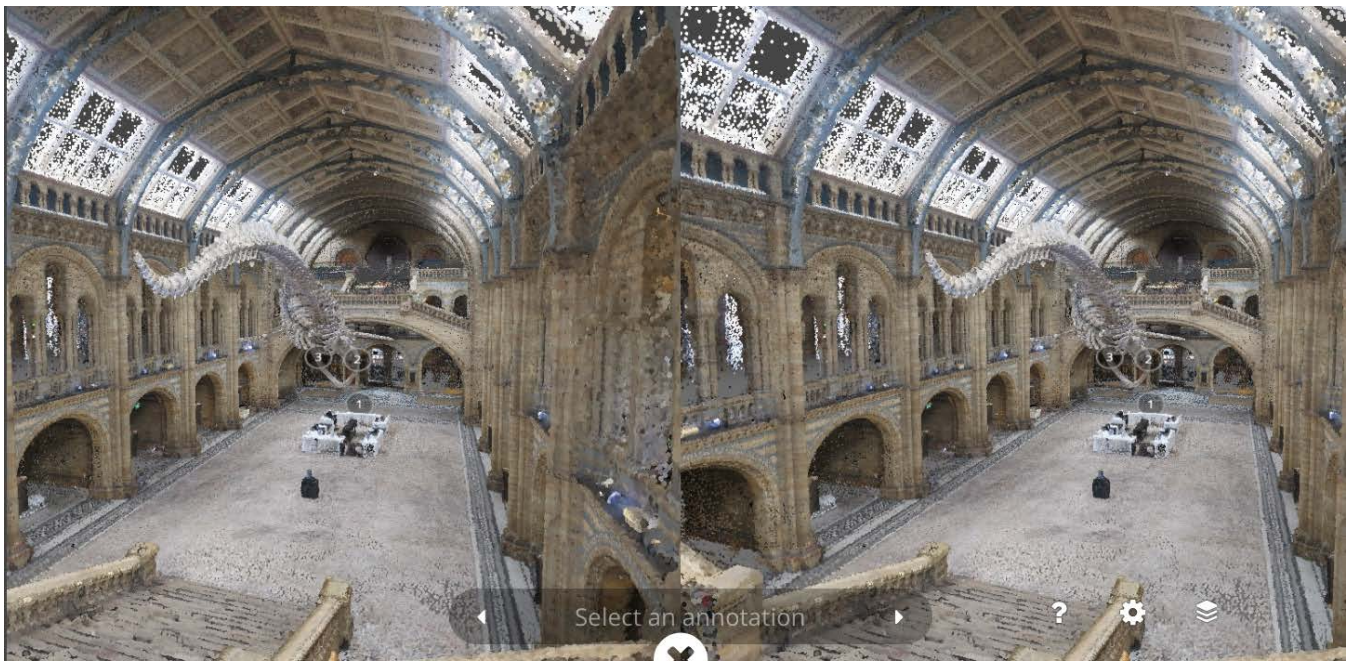


FIGURE 14: VIEWING THE LAS POINT CLOUD FROM A SMARTPHONE WITH A CARDBOARD VR

5. RCP/RCS > Revit > Revizto > VR Headsets and Mobile Devices

a. Revizto is a visual collaboration and real-time issue tracking software for AEC industry. Project team members can identify and manage model-based issues in the 3D space and on 2D sheets, including addressing clash groups from Navisworks.
b. It supports point cloud like RCP/RCS embedded Revit and Navisworks models.
c. We can view the point cloud by running the corresponded Revizto Viewer with Oculus Rift or HTC Vive VR headset connected to a computer and turned on.
d. It also has a viewer for iPad and Android tablets to navigate the model, create markers, walk-throughs and screenshots and collaborate in real-time.

FIGURE 15: VIEWING THE RCP/RCS POINT CLOUD AND REVIT MODEL IN REVIZTO

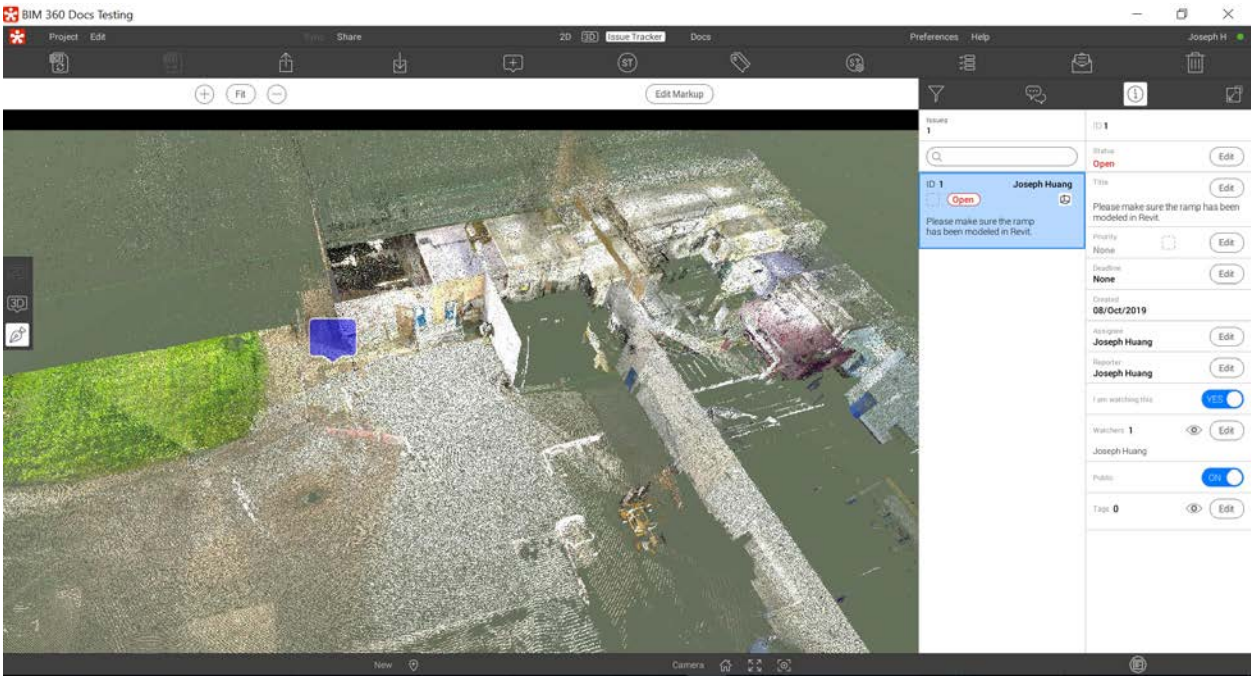


FIGURE 16: VIEWING THE RCP/RCS POINT CLOUD AND REVIT MODEL FROM BIM360 IN REVIZTO

Appendix A – Frequently Asked Questions [template]

Frequently Asked Questions	Response
Do we have As-Built Scan PDF or DWG's available? Historical data.	
What is the LOD to be applied for the models?	
Any additional Attributes to be assigned?	Refer Appendix D
Are the Models Workshare enabled?	
On what CDE will the models be hosted?	
Which version and build of Revit is to be used?	
Which version of ReCap is to be used?	
Which version of Navisworks is to be used?	
Will the team need any additional add-on's or Software's to be installed?	
In what format will the final deliverables be?	
Which template is to be used?	
Has shared coordinates been setup?	
Should I reference the point cloud into Revit at Shared coordinates?	
Location of scan data on local server?	
Would all elements modelled go on to "Existing Phase"?	
Is there a Model QC checklist available?	
Should we use out of the box families or is there a specific standard required by the client?	
Is there a specific naming convention to be followed?	
Is there a model breakdown structure defined? And what disciplines shall be involved.	

Appendix B- Scan Requirement Sheet [template]

Scan Requirement	Notes
Scanner	
Scan density	
RGB values registered	*Yes, Required.*
Scan's Geo located to Coordinate system	*Having all the independent scans geo located is very essential.*
Scan Formats Required	*E57, RCS/RCP (2 formats required)*
Scan Cleanups	*Any points captured far off from the Area of Interest need to be deleted.* *If there are scans of trees and plantation in the background captured (not in Area of Interest), would need to have them cleaned up and not included in the final format being submitted.*
Embed 360 Real views	*It is essential to have the 360 Real Views embedded with the scans.*
SOP (Setout points)	*Request to obtain few setout points with X,Y, Z information. Will be very valuable Just in case need to orient/verify/position the model.*

Appendix C – Client Requirements [template]

Client Requirements	Notes/ Details Agreed to

Appendix D – Non-geometric Attributes required [template]

Category	Required LOD (Accuracy)	Non-geometric Attributes

Appendix E – Level of Effort (LOE) estimate [Template]

Areas	Budget		
	Civil	Structural / Architectural	Process Mechanical
Scope of work – Study (5%)			
Team Meetings & coordination (5%)			
Model setup & Model management (5%)			
Check Review (15%)			
Total			

Appendix F – Training Plan [Template]

Training Plan				
Resource Name	Revit	Navisworks	Edgewise	ReCap