3D Modelling from Point Clouds

URL: https://autode.sk/3IVS3r2

1. Introduction

1.1 Level of Detail

The Level of detail for this project is Level 4 as it will contain the following:

- Detailed architectural and structural elements
- Modelled of services
- Higher level of detail in families and fixed furnishings
- Base sweeps, architraves and heater is modelled

To conclude, the point cloud density, accuracy and features coverage modelled are fit for purpose and are suffice for Level 4 as level of detail.

1.2 Workflow

Since in this project the point clouds had been provided, the workflow between field surveying and initial look in Autodesk Recap are interchange compared to in actual works surveying. Below are the diagram of the work flow. Diagram below shows the workflow.

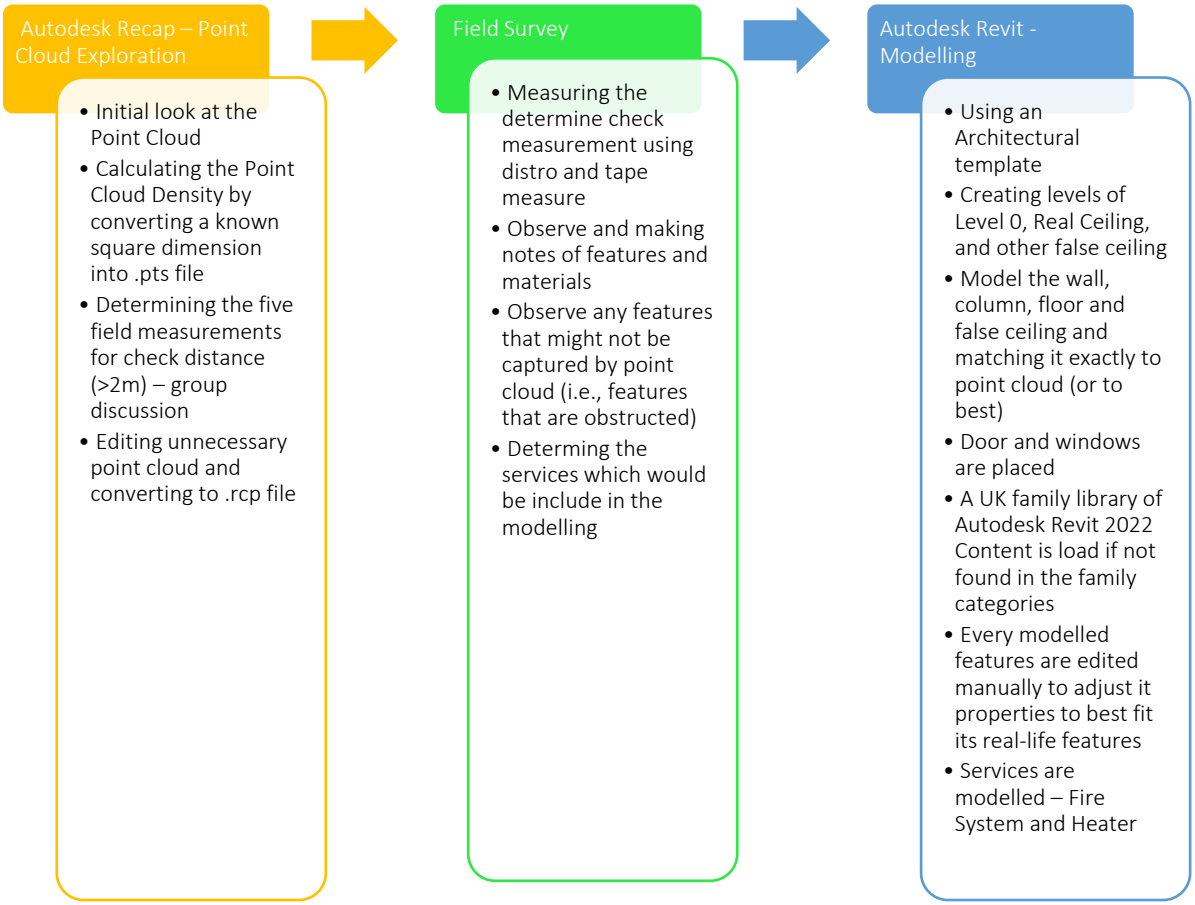


Figure 1: Workflow of this modelling

2. Modelling and Assumption Made

2.1 **Floors**

The thickness of the floor is assume to be 34.4cm. During the field survey, the floor slab has been measured and calculated from the exposed slab of the staircases.

2.2 **Walls**

The wall are modelled based on the internal finish face wall boundaries captured by the point cloud. All **internal** and **external** wall have the high of 4.382m (actual ceiling).

2.2.1 **External:** The thickness assume to be 43cm as a rough measuring of external wall from other parts of the same building while was done in field survey. The material is concrete.

Figure 2: External walls are highlighted. This is deduce because the external wall have windows on it side and are facing outdoor.

2.2.2 **Internal:** The internal wall model has two type which are 17 cm and 13cm. The material is concrete.

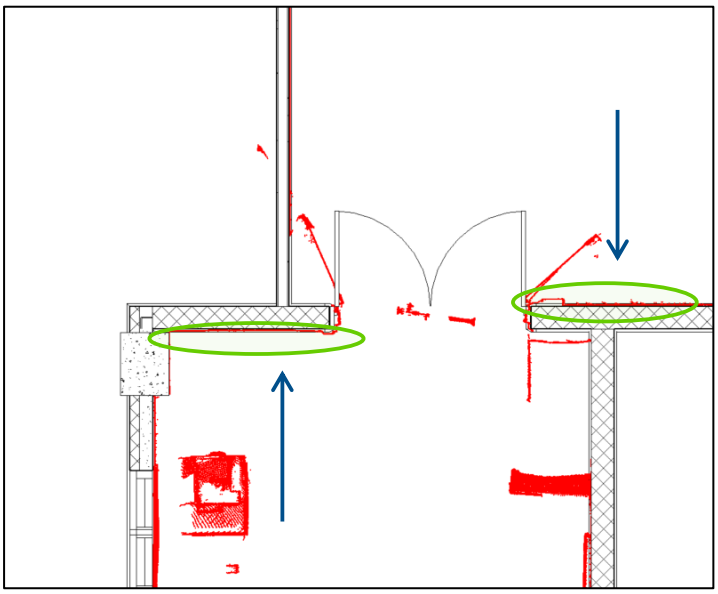


Figure 3: The 17cm internal wall is measured and derived from the gap between the point cloud boundaries on the Room 102 B side and Print Room side.

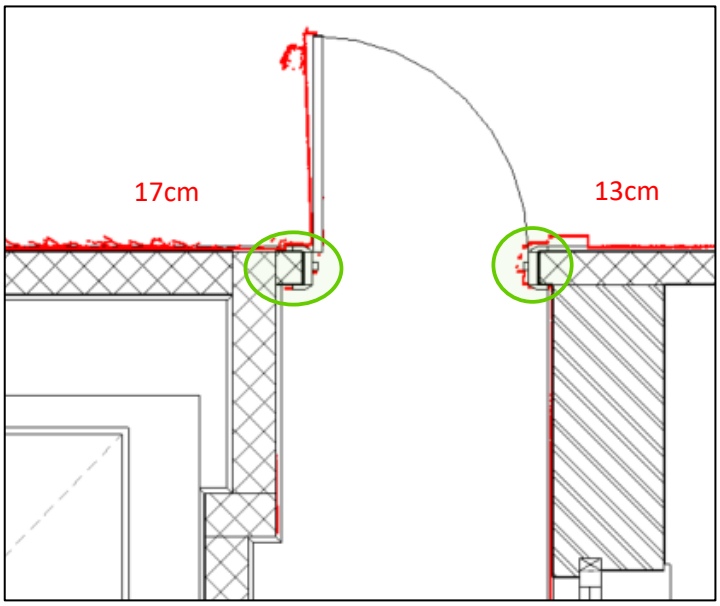


Figure 4: The 13 cm internal wall determined because of its best fit to the door frame of Room 102 A door.

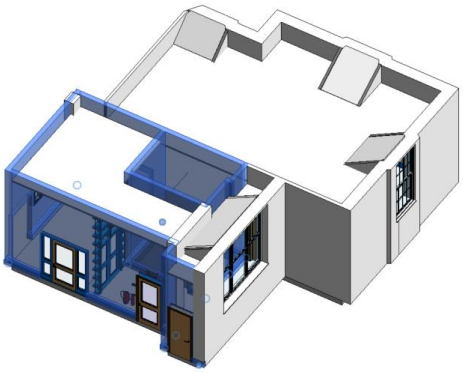


Figure 5: 17cm Internal walls are highlighted

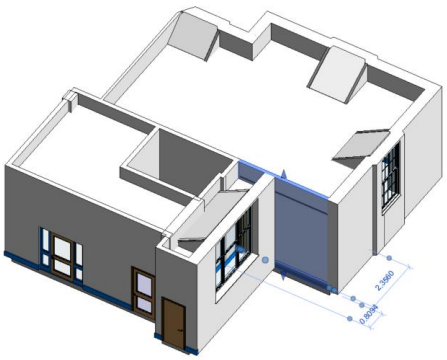


Figure 6: 13cm Internal walls are highlighted

2.2.3 **Partition Wall:** The partition wall is use for the slanted ceiling extrusion from the flat ceiling. It is also use for the wall of Room 102 B. This is assume so because the wall is part of the slanted ceiling. The material is concrete.

Figure 7: Partition walls are highlighted: use for slanted ceiling extrusion from the flat ceiling.

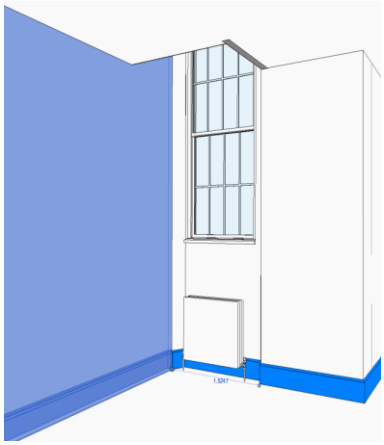


Figure 8: Partition wall are also used for the internal wall of Room 102 B as it .is part of the slanted ceiling for window side Room 102 B

2.2.4 **Curtain Wall:** host the double fire door that need UCL ID.

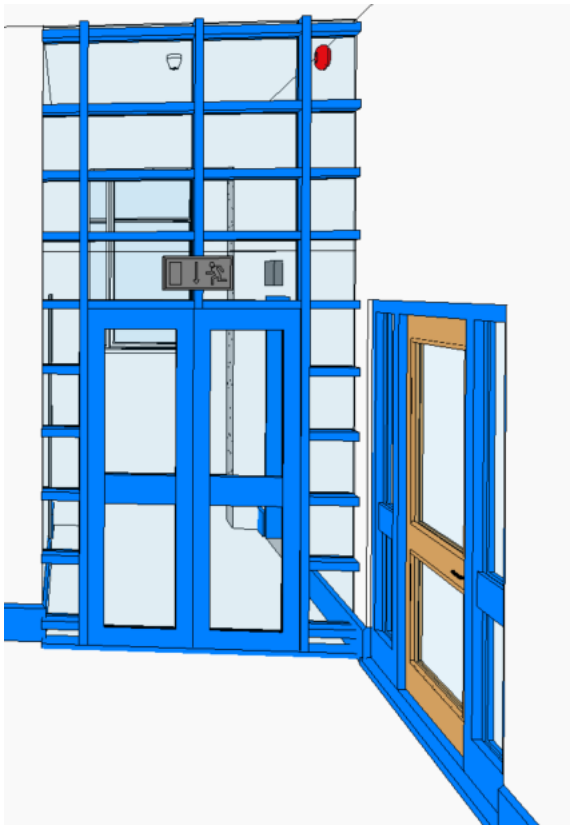


Figure 9: Curtain Wall are model from curtain wall storefront with glass panel and mullions. The curtain wall have height a of 3.782m which are the false ceiling of Print Room and Lift Corridor.

2.3 **Ceiling**

The ceiling is modelled in a per room basis format as per the measured height rather than in a zone format. This is because the false ceiling have variation of height depending on its location. Table 1 are the measurement from the floor to the ceiling in relation to point cloud.

Location	**Measurement (m)**
Actual Ceiling	4.382
Chadwick 102 Room A and Room B	3.507
Print Room and Lift Corridor	3.782
Corridor Room 101 and 102 (without slanted ceiling)	3.501

Table 1: Actual and false ceiling height

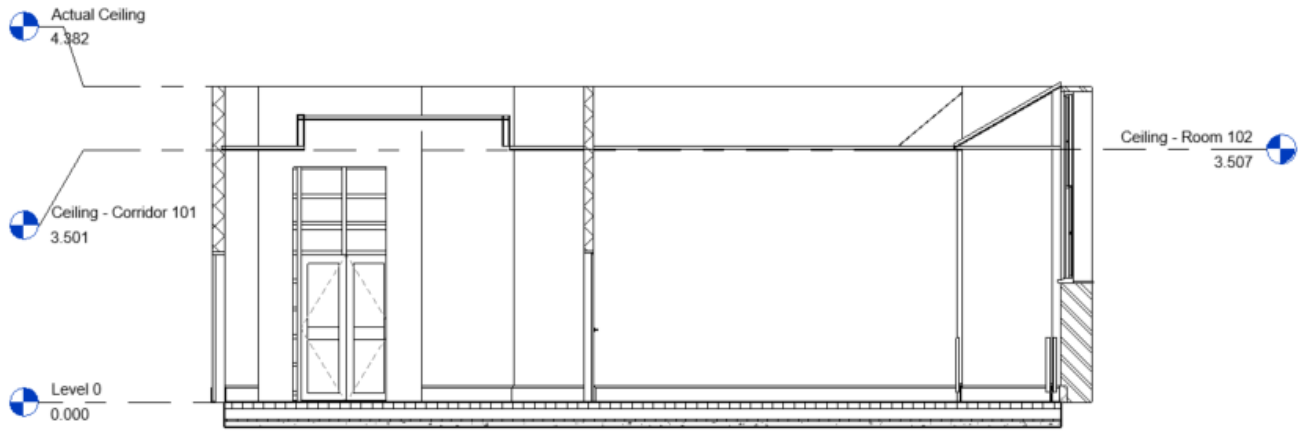


Figure 10: Cross section of ceilings from Corridor 101 to Lift corridor to Room 102

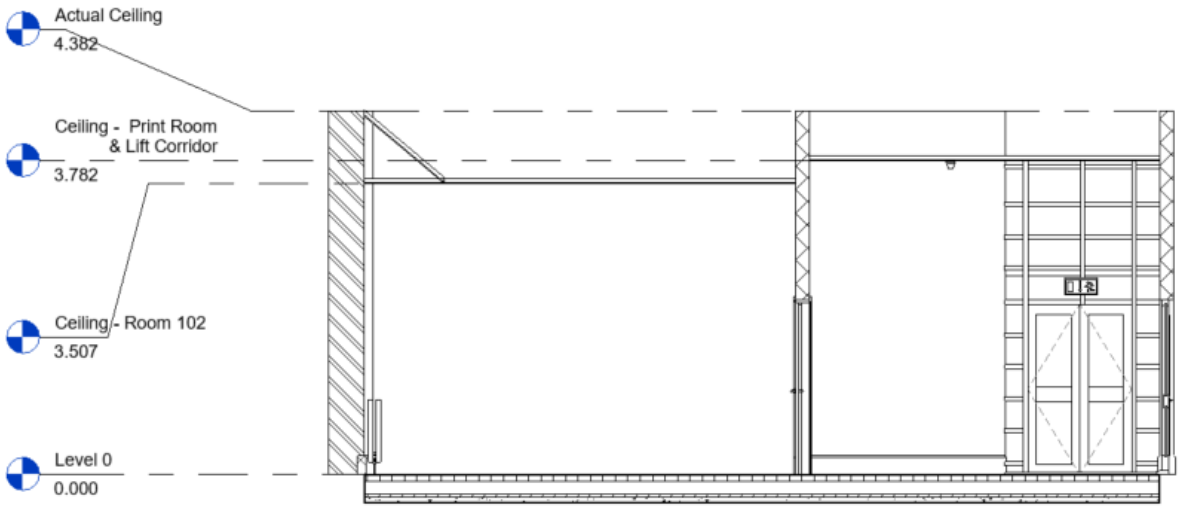


Figure 11: Cross section of ceilings from the Room 102 B to Print Room

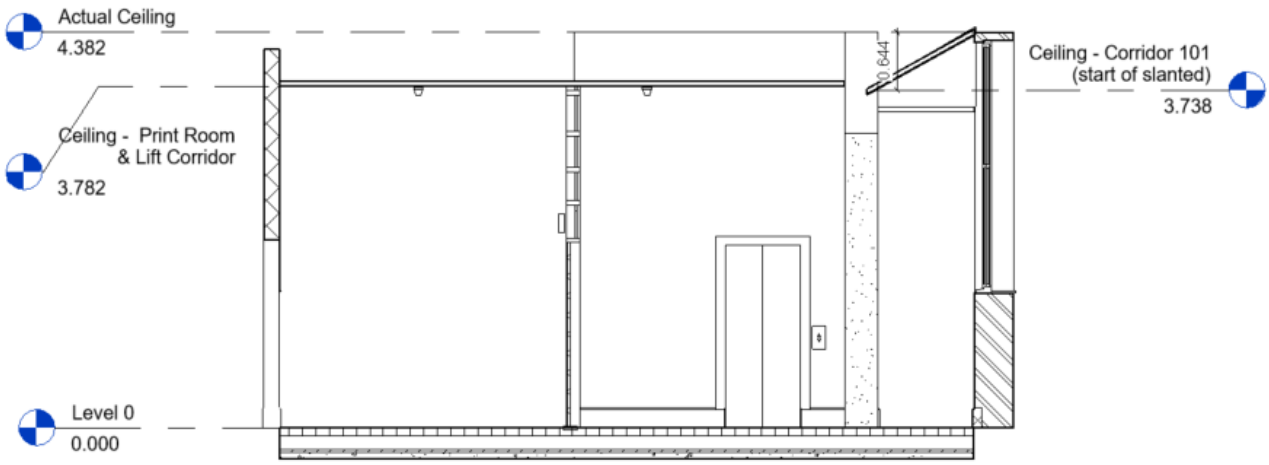


Figure 12: Cross section of ceilings from Print Room to Lift Corridor to Corridor 101

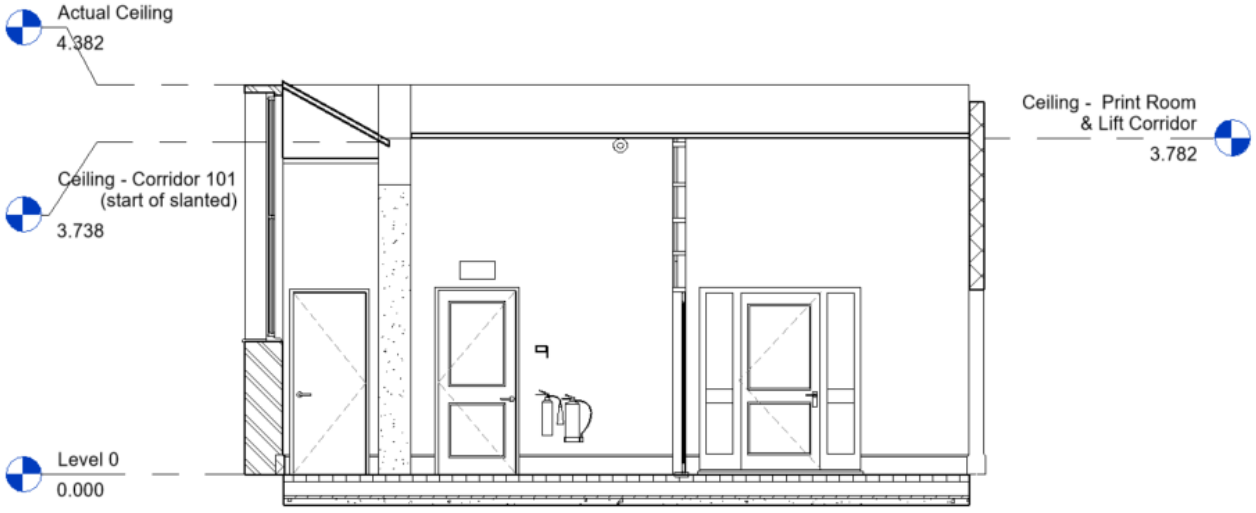


Figure 13: Cross section of ceilings from Corridor 101 to Stair Door to Head Department (facing it)

2.4 **Column and Beam**

Column and beam are made out of concrete. The height of these column are assume to be up till the actual ceiling.

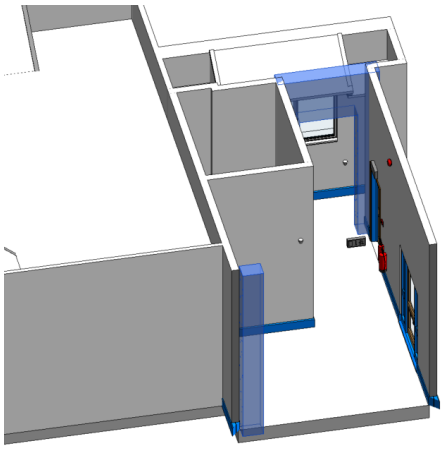


Figure 14: Column and beam are highlighted

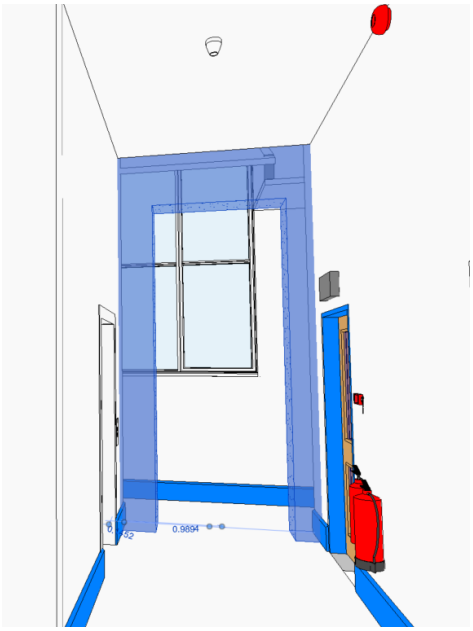


Figure 15: A rectangular column and beam in the lift corridor which are cut open to its surfaces

2.5 **Lift**

The lift car is not measured internally, hence the dimension is assume to have the generic dimension of 10 person lift. The door trim is shown to the correct size.

2.6 **Doors**

The determining factor if either a door family or a wall opening will be used is if it has a door frame. A **wall opening** can be seen in the print room corridor which leads to Geometrics Laboratory. Doors are **dimensioned** to the largest opening width and height measured which are the inner face of the architrave. Below are the Door Schedule.

<Door Schedule>			
A	B	C	D
Mark	Family	Rough Height	Rough Width
Door - Leading to Stairs	Doors_IntSgl_w-Transome	2.110	0.950
Door - Head Department	Doors_Assembly_Sgl	2.110	1.810
Door - Room 101	Doors_IntSgl	2.090	0.900
Door - Room 102 B	Doors_IntDbl_1	2.110	1.510
Door - Room 102 A	Doors_IntSgl	2.110	0.920
Door - Curtain Wall	Doors_Dbl_Glass_5	2.053	1.257

Table 2: Door Schedule

2.7 **Windows**

Windows are dimensioned to the largest opening width and height measured which are the inner face of the architrave. Below are the window schedule.

<Window Schedule>			
A	B	C	D
Mark	Family	Rough Height	Rough Width
Window - Slanted Corridor 101	Windows_SCO_Horz_Bar_Tpl	2.800	2.800
Window - Print Room	Windows_Sgl_Plain	0.640	0.480
Window - Print Room	Windows_Sgl_Plain	0.640	0.480
Window - Print Room	Windows_Sgl_Plain	0.640	0.480
Window - Print Room	Windows_Sgl_Plain	0.640	0.480
Window - Front Room 102 A	Windows_Sash_w-Bars_2	2.650	1.200
Window - Side Room 102 A	Windows_Sash_w-Bars_2	2.650	1.100
Window - Side Room102 B	Windows_Sash_w-Bars_2	2.700	1.250

Table 3: Window Schedule

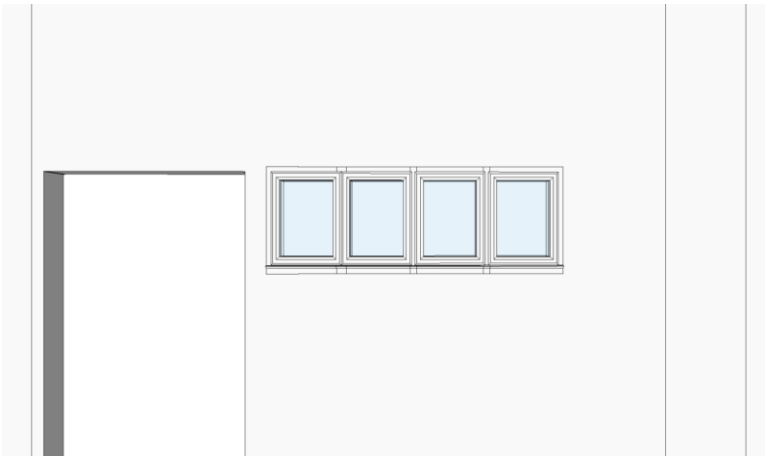


Figure 16: Internal wall Print Room windows

2.8 **Services**

Two services choose are Fire System and Heater.

Location	Fire System Component
Print Room Corridor	• White Smoke Alarm • Exit Sign above Curtain Wall door • Fire Door Curtain Wall – (see section 3.6)
Lift Corridor	• White Smoke Alarm • Red Fire Alarm – (see section 3.6) • Fire Extinguisher • Fire Extinguisher CO2 • Fire Break Alarm – (see section 3.6) • Exit Sign above Door Stairs

Table 4: Fire System listed components respective to its location

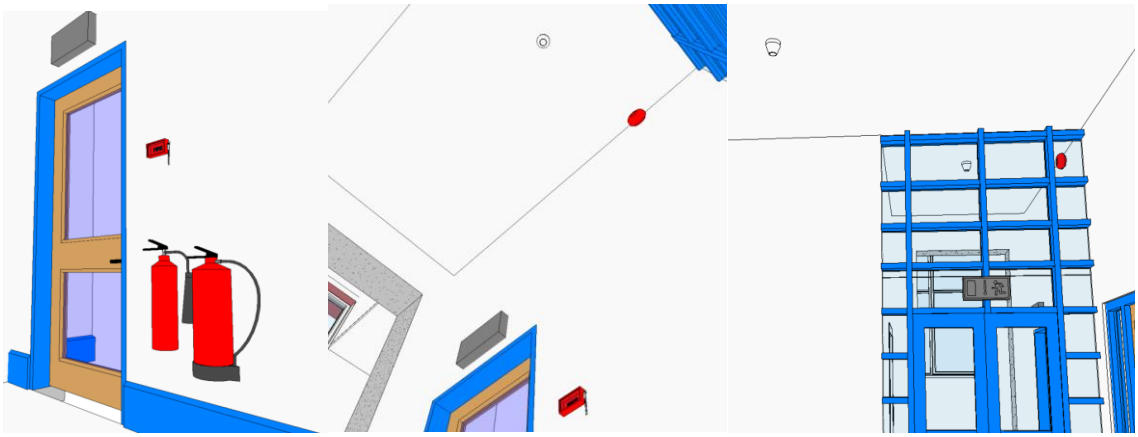


Figure 17: Fire System that are listed in the table above

There are 3 heater that are directly below the three windows in Room 102 A and B.

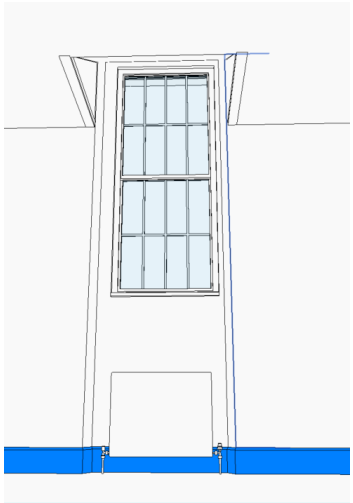


Figure 18: An example of heater which are all in Room 102 under the windows

3. Geometric Simplification
   3.1 Nature of the Building: The wall between the room, corridor and the lift shaft are not straight and have a lateral deviation. The ceiling also have a miniscule lateral deviation. The material is concrete.

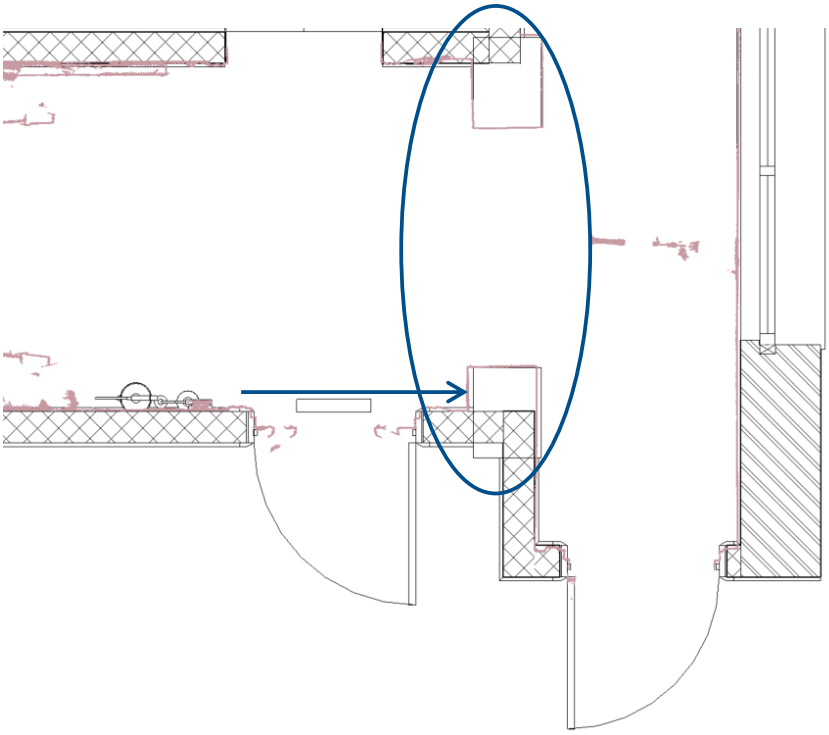


Figure 19: Orthogonal constraints of Revit and the deviation with the point cloud

   3.2 Frame of Doors and Windows: are not modelled perfectly to the point cloud as some of the families are restricted. However, the average design and thickness of the frame is taken to account when choosing the best family to model the doors and window.
   3.3 Front Window in Room 102 A: This window is modelled as a full size. This assumption and simplification is deduce because of the existent of the panel and its extrusion which are there to be able to instal the whiteboard.

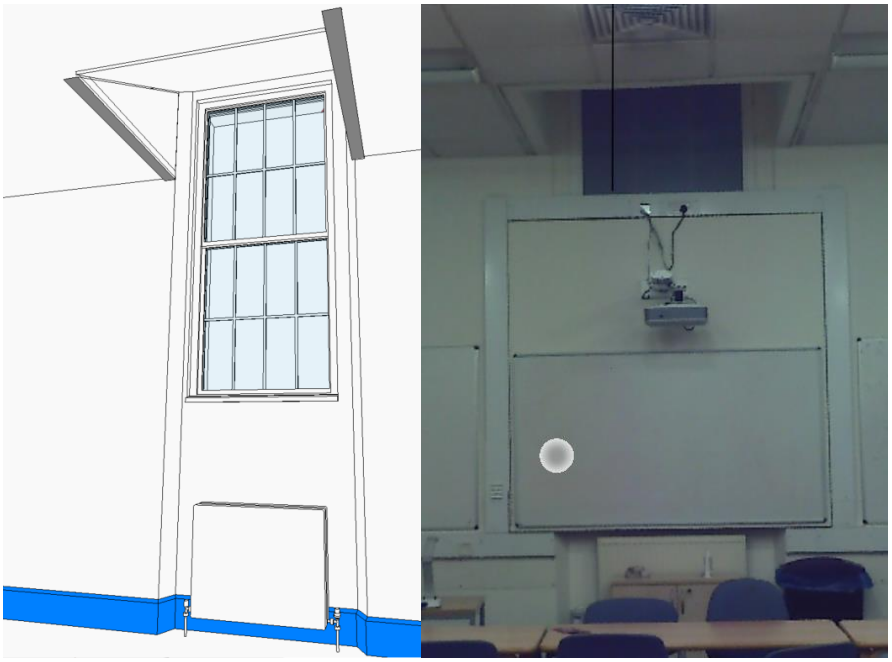


Figure 20: Front windows of Room 102 A that are now been covered by panel

3.4 Width of Curtain Wall : Because of the restrictions in Revit, the Width of the curtain wall is set to default Curtain Wall Storefront.

3.5 Base Sweeps: Although, all internal surface of walls have a base sweep, the modelled have a little extrusion which are not the case as in real life as it is flush to the wall. This is because of Revit restriction.

Figure 21: Extrusion of base sweeps in Revit model

3.6 Fire System: The fire alarm in red are model on the wall rather on the ceiling due to Revit family limitation and the break glass box are connected to any duct. Additionally, the fire door of the curtain wall are also not being model as only door family under curtain wall panels is allowed to insert into the glass panel of the curtain wall.

Figure 22: Fire Door that are on the curtain wall which cannot be model because of Revit family limitation under Curtain Wall Panels

4. Accuracy and Modelling Tolerances

The repeated check measurement are taken by using distro and averaging it.

4.1 Check Distance

Check Distance (m)	1	2	3	Average (m)
Chadwick Room 101 Width	6.350	6.351	6.350	6.350
Chadwick Room 101 Length	9.271	9.269	9.268	9.269
Print Room Width	3.265	3.265	3.265	3.265
Print Room Length	4.223	4.227	4.224	4.225
Small Corridor Vertical Height (Without the Slope Ceiling)	3.502	3.502	3.502	3.502

Table 5: three measurement of check measurement using Distro and its average

4.2 Deviations

Location	Check Distance (m)	Model Measurement (m)	Deviation (m)	Deviation (mm)
Chadwick Room 101 Width	6.350	6.353	0.003	**3**
Chadwick Room 101 Length	9.269	9.277	0.008	**8**
Print Room Width	3.265	3.278	0.013	**13**
Print Room Length	4.225	4.230	0.005	**5**
Small Corridor Vertical Height (Without the Slope Ceiling)	3.502	3.501	0.001	**1**

Table 6: Calculation of deviation between Check Distances and Model Measurement of point cloud

The modelling tolerance are categorised as a High-level Tolerance which the model data constructed to a tolerance of 15mm of the point cloud.

5. Sheet

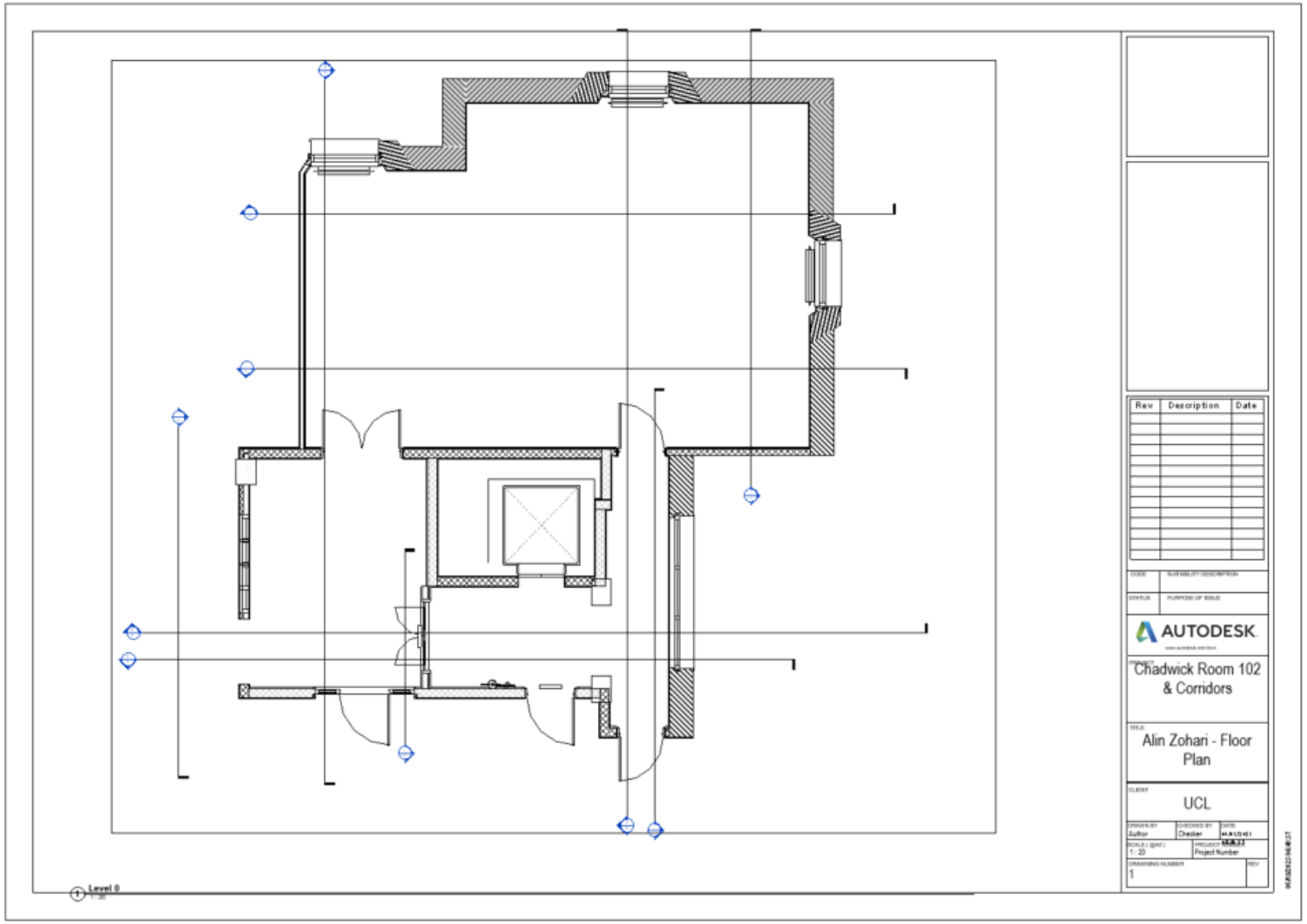


Figure 23: Floor plan sheet

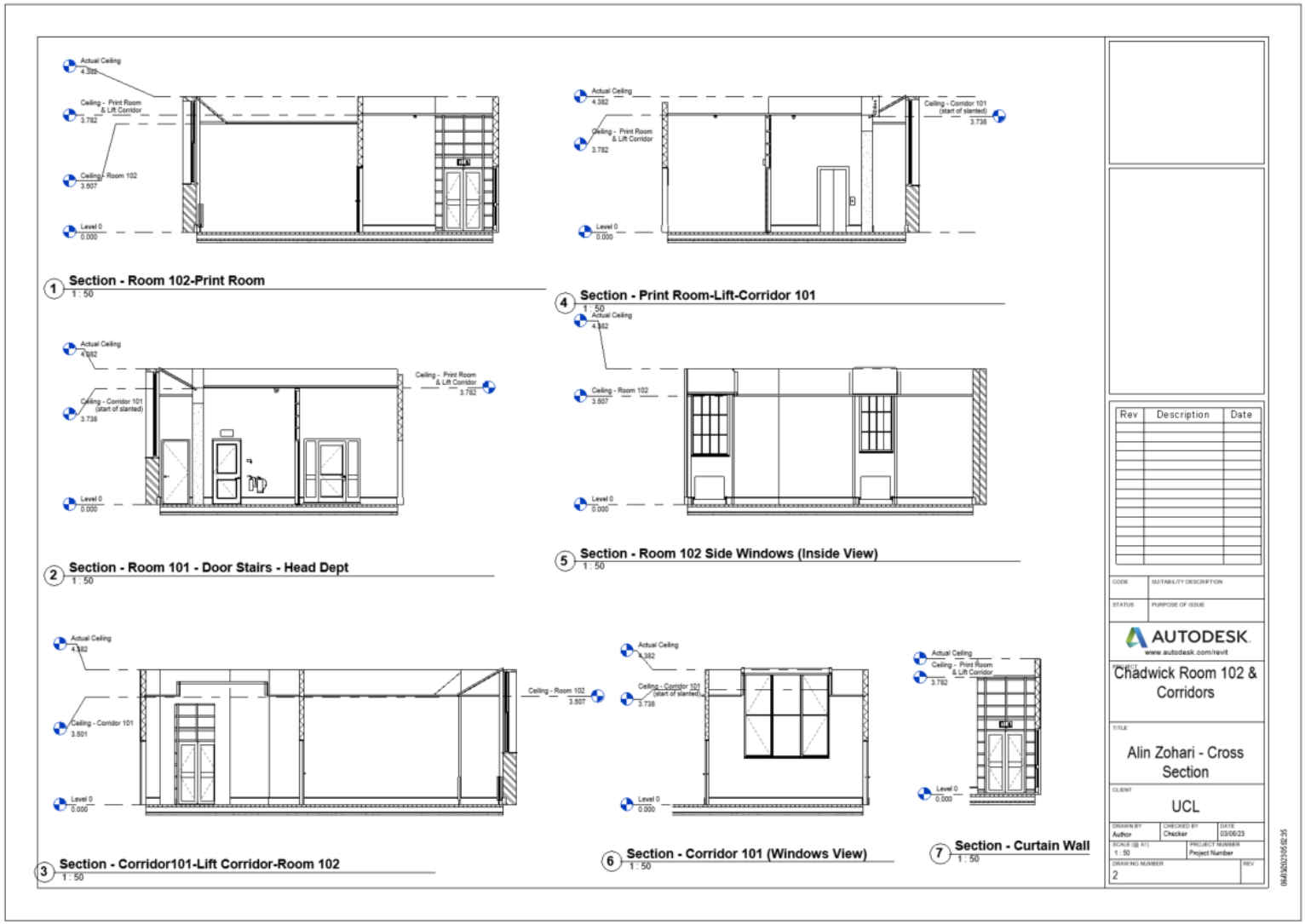
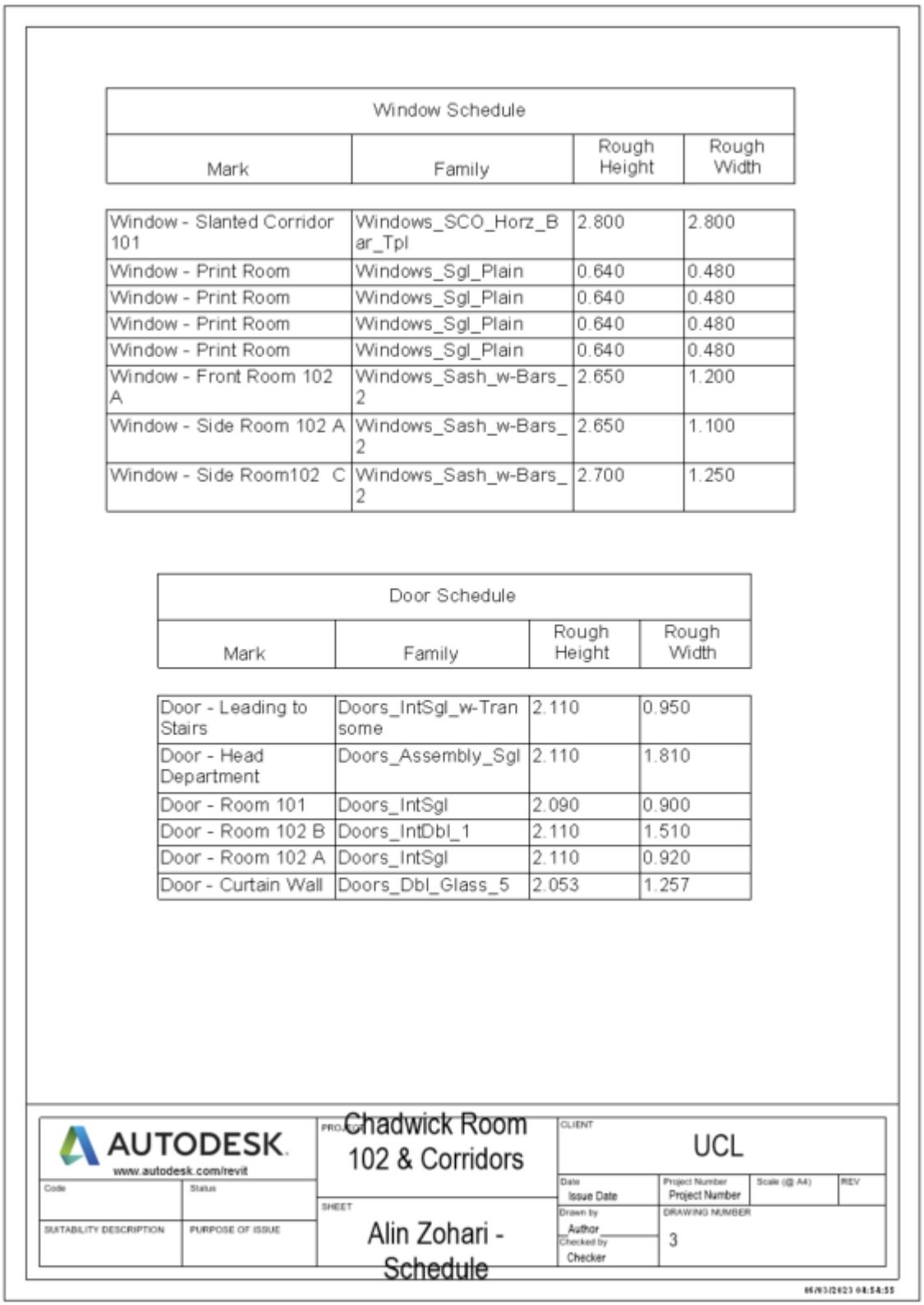


Figure 24: Cross- section sheet



Window Schedule

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Door Schedule

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Door - Room 102 A	Doors_IntSgl	2.110	0.920
Door - Curtain Wall	Doors_Dbl_Glass_5	2.053	1.257

Figure 25: Window and Door Schedule Sheet

6. Conclusion and Problem Encountered

All through this project one problem encountered in every steps of modelling is the orthogonal constraints. This is caused primarily by the use of Revit and the limitations on orthogonal design that this fosters. This is where a definite fitness of purpose play an important role in modelling.

7. Reference

Craven P. (2014), "BIM Survey Specification"
https://www.plowmancraven.co.uk/bim-survey-specification/

Thomson, C. and Boehm, J. (2015). Automatic Geometry Generation from Point Clouds for BIM. Remote Sensing, 7(9), pp.11753–11775. doi:https://doi.org/10.3390/rs70911753.