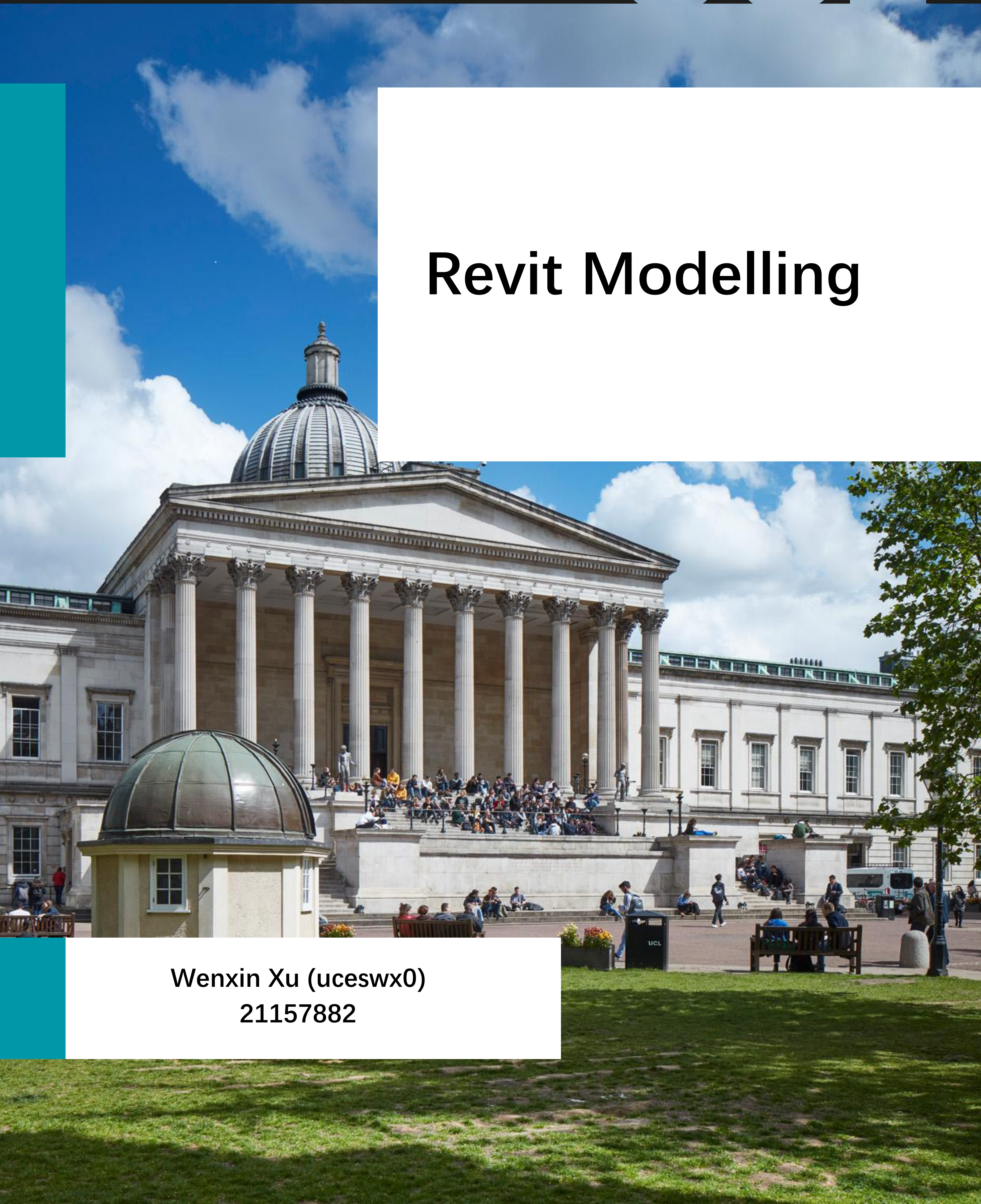
Department of Civil, Environmental & Geomatic engineering



Revit Modelling

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1 Project Description

Due to the requirements of total asset life cycle management, the construction industry, which accounts for 7% of the UK's GDP, is deficient in information technology, and the UK government intends to promote a change in information technology in it, which led by BIM technology [1][2].

This project is based on the above background and uses the laser scanned point cloud data for 3D Revit modelling and analysis of level4 and individual services of lighting and fire alarm systems for the understanding of target area, Chadwick 102 & surrounding corridors (Figure 1-1) at University College London (UCL).

Project modelling are stored at: https://bit.ly/3txuahS.

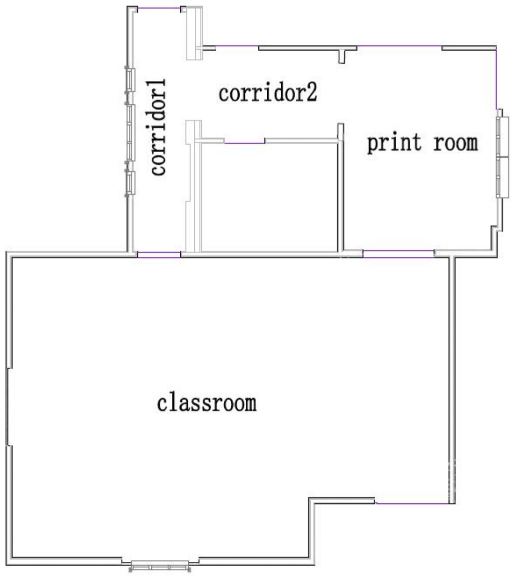


Figure 1-1 target area

2 Modelling process

The model is built to level 4 standards which includes detailed structures, fixed furniture and prominent surface elements as required by the UK Government[1].

The project is modelled by existing UK package and no new elements are built. The modelling is carried out through a process as shown in Figure 2-1, with the specific process being: (1) point cloud data pre-processing. Importing the point cloud data and adjusting the display area and floor elevation. Creating the wall as the baseline to rotate the point cloud data and align it to wall axis; (2) building structure modelling. Drawing structural elements in room order and modifying details by creating different sections to view the point cloud; (3) Initial verification of basic structural modelling. Checking the topological geometry of the structural elements, checking the distance error between the point cloud and the modelled structure; (4) Detail modelling; Fixtures, Furnishings and Equipment (FFE) elements' selection and commissioning, individual services addition; (5) Modelling integrity checking. (6) Modeling summary.

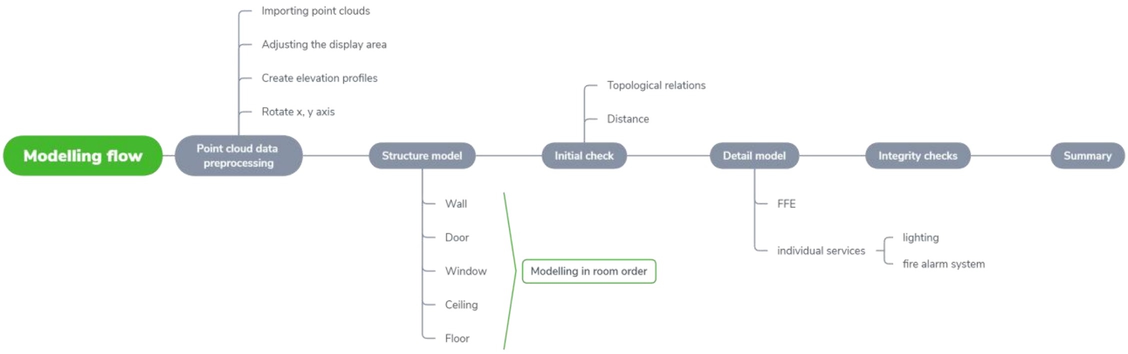


Figure 2-1 Modelling flow chart

3 Model structure results and analysis

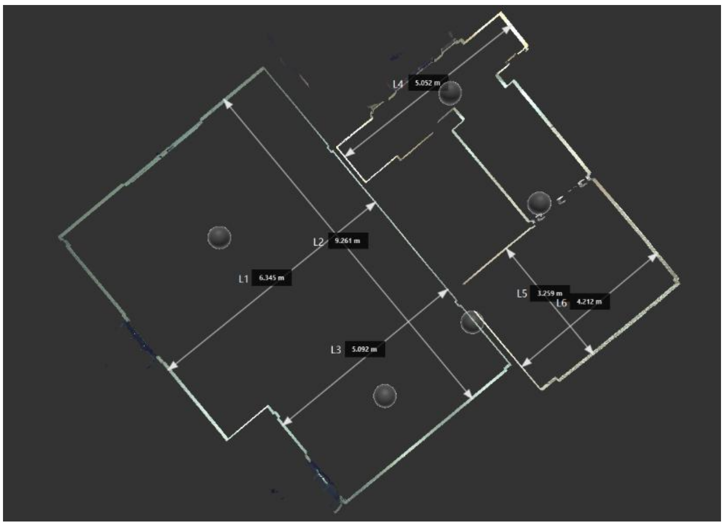
3.1 Model assessment

In order to ensure the accuracy and precision of the modelling[3][4], the distance check is needed. Six distances (>2m) in different directions of the three rooms in the plan and the elevation values of the classroom are selected for verification.

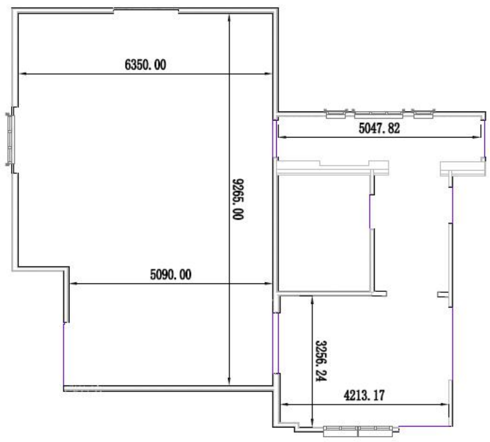
The ReCap plane distances are measured using the freehand distance tool, and the z-value deviations are reduced by lowering the view frame elevations and observing deviation values to reduce the error caused by z-value deviations, and the minimum value is selected as the distance, as show in Figure 3-1(a). The ReCap vertical elevation is measured by fixed z-axis and the result is shown in Figure 3-2(b). Revit distance are measured by exporting CAD drawings for distance measurements, the results are shown in Figure 3-1(b) and Figure 3-4(b).

The results of the comparison are shown in Table 3-1, where the mean error is averaged using the absolute value of error and the weighted error is distance weighted to the absolute value of error.

The mean deviation is 2.92mm and the distance-weighted deviation is 2.93mm, which is far less than the heigh-level modelling tolerance 15mm. The modelling results meet the accuracy requirements[4].

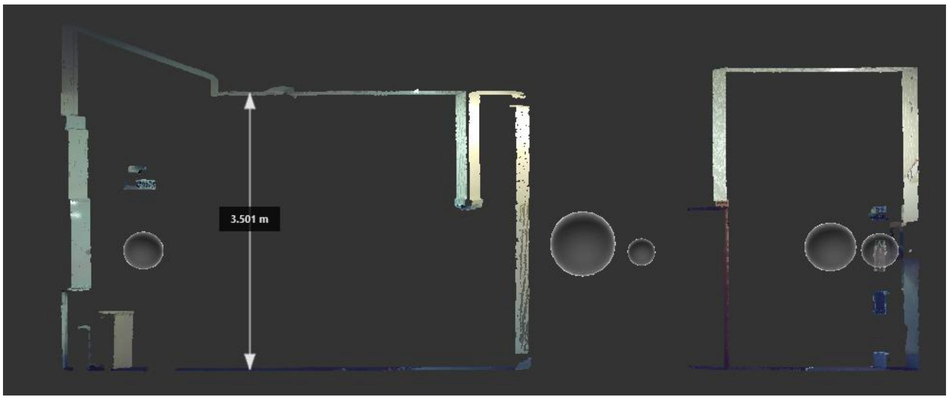


ReCap plane distance measurement

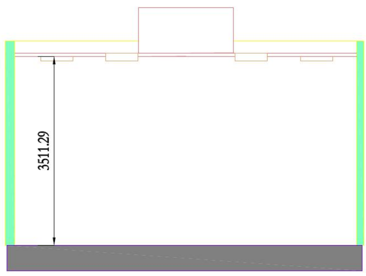


Revit plane distance measurement

Figure 3-1 Plane distance measurement



ReCap Elevation Survey



(b) Revit elevation survey

Figure 3-2 Vertical elevation measurement

Table 3-1 Distance check

	Classroom			Corridor		Print Room	
	L1	L2	L3	H1	L4	L5	L6
ReCap	6345	9261	5092	3510	5052	3259	4212
Revit	6350	9265	5090	3511.3	5047.82	3256.24	4213.17
Error	-5	-4	2	-1.3	4.18	2.76	-1.17
mean error	2.916						
Weighted error	2.927						

3.2 Presentation of modelling results

The planar results in Figure 3-3 are shown in Figure 3-4, the 3D modelling results and the different profiles in Figures 3-5 to 3-8.

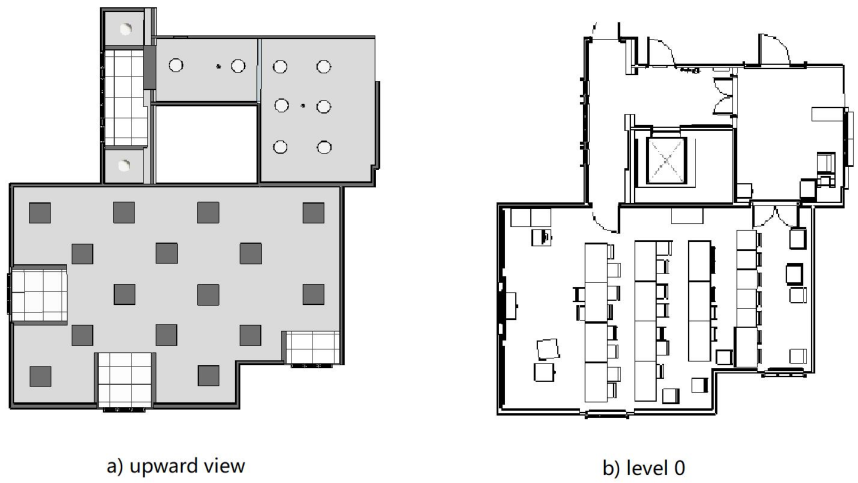


Figure 3-3 Floor plan

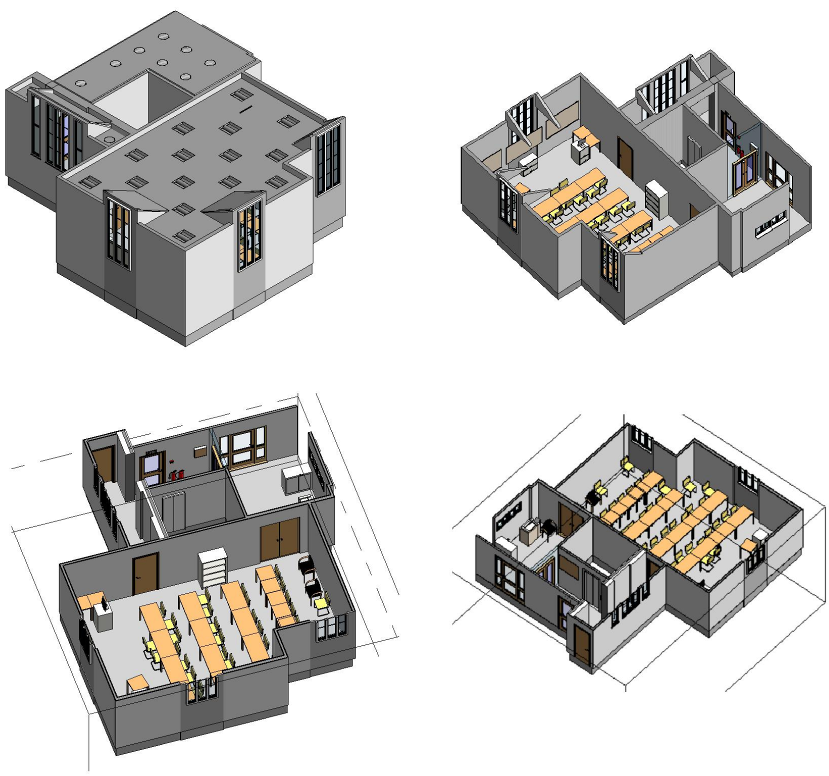


Figure 3-4 Three-dimensional display

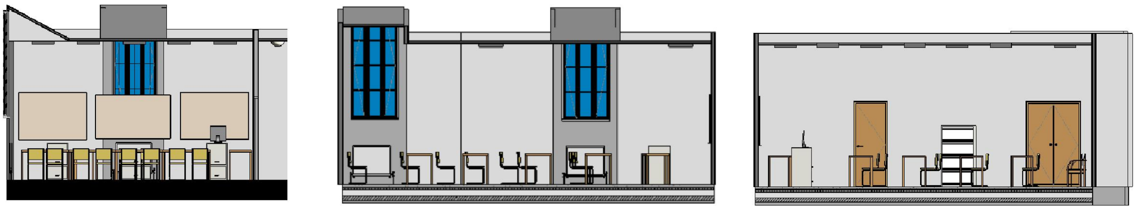


Figure 3-5 classroom

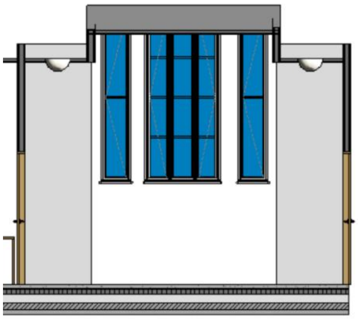


Figure 3-6 corridor1

Figure 3-7 corridor2

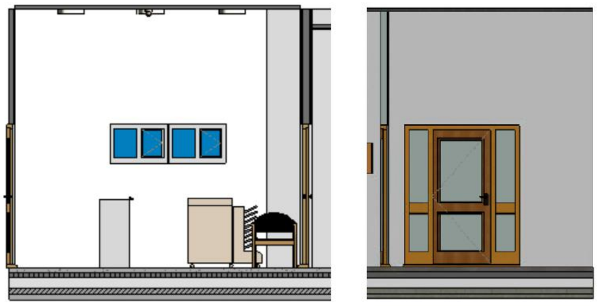


Figure 3-8 print room

3.3 Modelling process

3.3.1 Modelling of structural elements

This section explains the basis for the selection and construction of elements in the modelling process.

The wall element is first created by using the point cloud as the inner edge of the wall, and aligning the wall elevation to a specific level. The wall thickness is determined by intercepting the section with two sides of the wall (e.g. the door section in Figure 3-9) and measuring the distance of point clouds several times, selecting the corresponding thickness of the wall from the existing elements, or creating a wall by changing the thickness of the material slightly less than the required thickness of the element. The walls in the same room are made of the same material as the established walls.

Figure 3-9　Determining wall thickness with point clouds

In particular, in classroom the wall in same plane have different thicknesses at the two doors, and is aligned to the wall of the print room by using the trim and extend tool, Figure 3-10 show the result. By looking at the window section and ReCap's photography we see that the wall thickness is narrower at the window, and by intercepting the window section to ensure that the outer edges of the wall are aligned and then determining the wall thickness from the point cloud data at the inner edge (Figure 3-11).

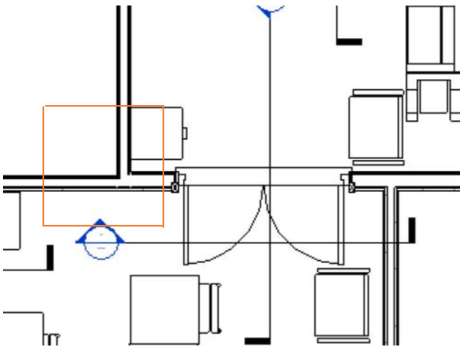


Figure 3-10　Wall connections

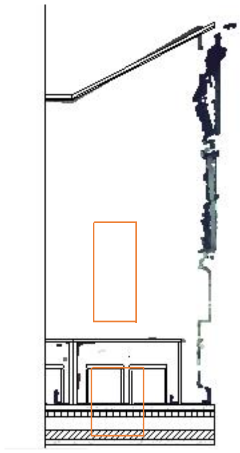


Figure 3-11　window wall thickness

The thickness of the wall connected to corridor1 and corridor2 is obtained by measuring the distance of the point cloud data, which includes the operation of wall hollowing and interruption for thickness change. The point cloud data for this wall is rotated slightly clockwise, and as the other walls overlap well with the point cloud, it is tentatively assumed that the point cloud data is misspliced here and therefore the distance error for corridor1 is larger than for the rest of the room (e.g. Table 3-1).

The wall element results are shown in Figure 3-12.

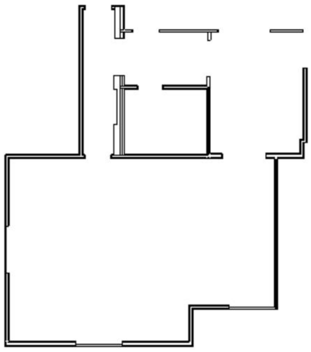


Figure 3-12 wall modelling

Once the window and door elements are identified by looking at the ReCap image, sections are created in Revit to initially measure the required length, width and height, modifying the details of the elements and add them to the wall sections, and then modifying the details of elements again by checking the location of the different section point clouds.

For the ceiling and floor, the default elements are selecte. Because of different ceiling height the ceiling is divided into three areas (1) classroom, (2) corridor1, (3) corridor2 and print room, as shown in Figure 3-13. In particular, the ceiling curves upwards at the windows, requiring the creation of separate ceilings and walls.

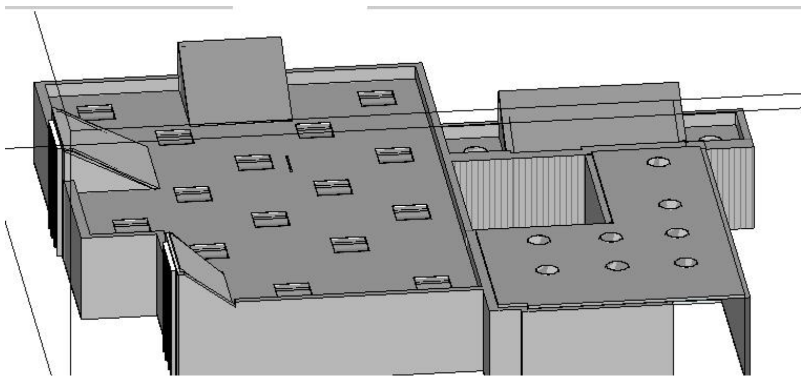


Figure 3-13 Three ceiling heights

3.3.2 FFE and services modelling

This section gives an overview of detail modelling, the specific modelling method is to view the ReCap photos to select the correct elements to be imported into the library, and viewing the point cloud and switching between different views to check that the modelling position is correct.

The FFE modelling includes desks, chairs, storage cabinets, blackboards, printers, heaters, display boards. Services include fire alarms, fire alarm buttons, fire hydrants, escape signs and three different types of lights.

4 Problem

The right-hand wall of corridor1 is not offset parallel to the y-axis.

Select two control sections to create three walls based on the point cloud data, adjusting the positions and topological relationships between them

The thickness of the wall at the classroom window is different from the other walls on the same position and the heater cannot be placed at its original thickness.

Observing the trend of the wall in ReCap, it is found that the wall in the window plane is slightly thinner than the rest of the area, and the point cloud data is intercepted from the longitudinal section of the wall at the window, interrupting the original wall to create an outer edge alignment of the new wall based on the point cloud.

The sloping plane of the ceiling could not be realistically modelled by cutting the original ceiling and using the slope arrow tool.

Modify the borders of the original ceiling and cut away the deflection area. Create a new ceiling in the same plane by sketching the ceiling and deflecting it upwards using the slope arrow tool.

Reference

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