Design of an upgraded HVAC system for an existing building. Robert Hynes

Aim of the Project

The Aim of the project is to Design an upgraded HVAC system to meet current demands and improve efficiency, comfort and sustainability.

Background

HVAC (Heating, Ventilation and Air Conditioning) refers to the systems within a building which control the temperature, humidity and air quality of a space.

This study was done on a section of the newly built classrooms in the Aula maxima building of the TUS Moylish campus.

As buildings age or evolve in their use, their existing HVAC systems may become outdated, inefficient, or incapable of meeting modern standards.

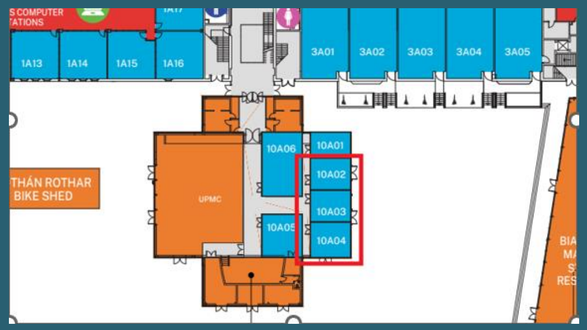

Figure 1: location of study on TUS Moylish room map

Revit modeling, site surveys, AutoCAD drawings and calculations were used to see if and where improvements can be made to the design of the HVAC system to improve comfortability, air quality and efficiency. This dissertation explores how targeted, practical retrofits can bring a well-functioning but inefficient system up to modern sustainability standards, reduce energy waste, and create a healthier, more responsive learning environment

Evaluating existing system

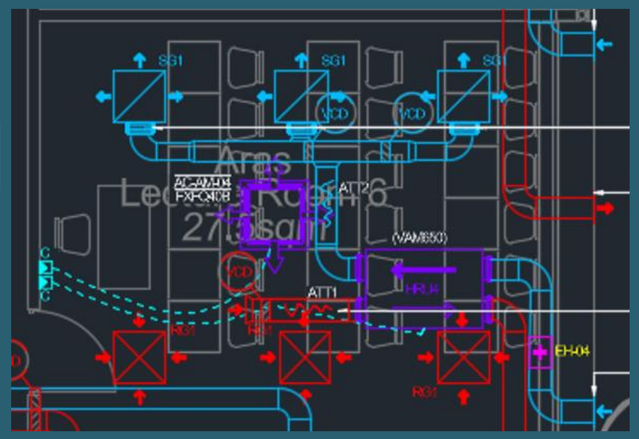

Figure 2: AutoCAD drawing of HVAC system

The existing HVAC system serves several classrooms in the Aula Maxima building at TUS Moylish. The system uses HRUs and ceiling cassette units to provide ventilation, heating, and cooling. Each room has multiple supply grilles connected by branch ducts to a main supply line.

The HRU supplies fresh air from an external intake grille and removes return air from the ceiling space. Return airflow is directed back to the HRU through ducting with bell-mouth intakes and attenuators. Volume control dampers are used to balance airflow, and the ceiling cassette units are connected to outdoor condensing units for temperature control.

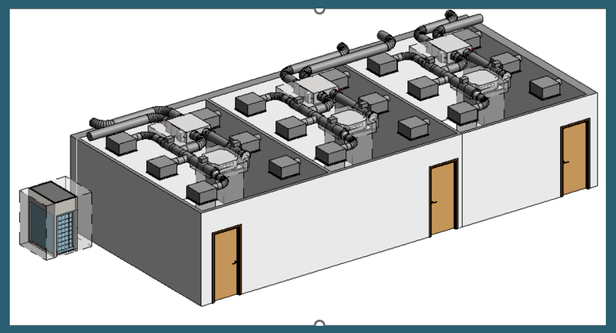

Figure 3: Revit model of existing system

Calculations

$$\dot{V} = N \; x \; Required \; air \; flow \; per \; person$$

$$QHeating = U \; x \; A \; x \; \Delta T$$

$$Qsensible = 1.2 \; x \; \dot{V} \; x \; \Delta T$$

$$Q \; latent = 2500 \; x \; \dot{V} \; x \Delta w$$

$$Qcooling = Qsensible \; x \; Qlatent$$

$$Cop = \frac{cooling \; capacity}{input \; power}$$

Figure 4: calculation formulas used

A series of manual calculations were carried out to evaluate the performance of the existing HVAC system and determine the actual requirements for each classroom. These included:

- **Airflow Requirements** – Based on occupancy and standards, each room was calculated to require **136 L/s** of supply airflow.
- **Heating Loads** – Calculated using wall, floor, ceiling, and window U-values and temperature differences. Required heating load ranged from **1.625 to 1.654 kW** depending on room layout.
- **Cooling Loads** – Sensible and latent cooling loads were calculated separately and then combined. Total cooling requirement per room was **3.094 kW**.
- **Ceiling Cassette Performance** – Each unit had a **cooling capacity of 3.4 kW** and a **heating capacity of 4.7 kW**, exceeding the calculated demand.
- **Airflow Supplied by System** – Combined airflow from the HRU and cassette was **over 430 L/s**, which is more than three times the calculated requirement.

Q heating lecture room 6				
compoents	area (m^2)	dealta T °C	U (W/m^2.k)	Q hetaing (W)
walls external	29.22	11.28	0.2094	69.01857504
walls internal	na (heated room)			
Door	na (heated room)			
floor	25.74	11.28	4.9573	1439.338175
ceeling	25.74	11.28	0.5	145.1736
Total Q kw	1.65353035			

Q heating lecture room 4-5				
compoents	area (m^2)	dealta T °C	U (W/m^2.k)	Q hetaing (W)
walls external	16.67	11.28	0.2094	39.37507344
walls internal	na (heated room)			
Door	na (heated room)			
floor	25.74	11.28	4.9573	1439.338175
ceeling	25.74	11.28	0.5	145.1736
Total Q kw	1.623886848			
Average	1.638708599			

Figure 5: sample calculation result

Conclusion

The analysis of the existing HVAC system in the Aula Maxima classrooms showed that it comfortably meets and exceeds the required heating, cooling, and airflow demands. This ensures good thermal comfort and air quality for occupants, particularly in a classroom setting.

System Requirements per room		
Volume flow rate	Cooling load (kw)	Heating Load (kw)
136	3.094	1.63
Existing system		
total volume flow rate l/s	cooling capacity (kw)	heating capacity (kw)
411.67	3.4	4.7

Figure 6: result comparison table

While no redesign was carried out, the calculations and system modelling provided a clear understanding of how the current system operates and how its performance aligns with real-world requirements. The project highlights the importance of assessing HVAC systems against actual building needs and lays the groundwork for potential future improvements

References

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