

Executive Summary

This HVAC project is a senior design project that will participate in the ASHRAE HVAC Design Calculation Competition. The building that is used for this competition is a theoretical university building in Denver, Colorado that is 93,000 sq. ft. This building has classrooms, workshops, labs, server rooms, offices and more. Owner's requirements, floor plans, required standards, and weather data are provided by ASHRAE. Our senior design team's goal is to design an HVAC system for this building. To do this, we work with the following programs: Bluebeam Revu, Hourly Analysis Program (HAP), and Revit. These programs are used to mark up the floor plans given, calculate the loads in the building, and placement of system(s) in the building, respectively. The task list for this project includes floor plan mark ups, rendering a 3D model of the building, importing given information and room specifications to calculate the loads, HVAC system(s) selection, making mechanical floor plans, and finalizing HVAC design.

Background

HVAC systems are essential for maintaining the well-being of people in buildings. They are also among the largest consumer of energy in a building, therefore, designing an efficient HVAC system is a major engineering challenge. Since buildings account for 37% of U.S. energy consumption, improving HVAC efficiency is also important for sustainability. The ASHRAE HVAC Design Calculations Competition represents the initial steps of an efficient HVAC system which involves accurate load calculations, appropriate system selection, and compliance with ASHRAE standards. The competition is also a good step into the MEP industry as it provides students experience with realistic building projects.



U.S. Energy Consumption By Sector in 2025 (2)

Load Calculations

- Bluebeam – PDF markup software
- Hourly Analysis Program (HAP) - Load Calculation Program



The loads for the university building were calculated in HAP. This load information combined with our zoning plan has been given to Texas AirSystems for system quotes and system sizing guidance.

Zone Name / Space Name	Cooling Sensible (MBH)	Time of Peak Sensible Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (sqft)	Space CFM/sqft
Zone 01						
Metal Work Shop 1210	153.5	June 19:00	10501	11.7	1455.4	7.22
Metal Work Shop 1220	77.7	June 19:00	5318	5.1	796.5	6.68
Zone 02						
Lab Support 1230	2.6	June 21:00	2589	0.1	203.5	12.73
Research Lab 1240	13.0	July 21:00	8196	0.1	640.9	12.73
Research Lab 1240A	8.4	July 21:00	572	3.2	368.9	1.55
Research Lab 1250	17.3	August 21:00	1182	0.1	868.3	1.36
Research Lab 1250A	10.7	July 21:00	731	4.2	496.3	1.47
Zone 03						
Classroom 1100	22.2	November 13:00	10471	7.0	827.8	12.65
Classroom 1110	15.0	October 14:00	17496	6.1	1383.1	12.65
Classroom 1120	19.3	November 13:00	8924	5.3	705.4	12.65
Classroom 1130	22.5	November 13:00	10832	6.7	856.3	12.65
Classroom 1140	27.5	November 13:00	11985	10.1	947.4	12.65
Classroom Support 1120A	6.8	November 12:00	466	2.3	114.0	4.09
L1 West Corridor 1000C	4.0	September 16:00	275	1.5	2010.7	0.14
...	...	...	...	...	...	...

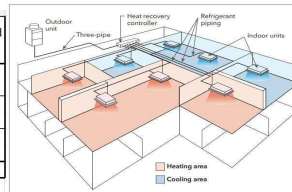
HAP Loads and Airflows Output Table (Excerpt)

System Selection

The selection of the systems is dependent on the goals that need to be met for this competition. Service Life and Reliability are weighted heavily based on their importance. There are more criteria than these 3, but this is just an excerpt.

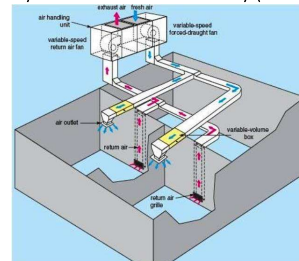
Factor	Weight	VRF	VAV	GSHP	Weighted VRF	Weighted VAV	Weighted GSHP
Environmental Impact (GHG)	8	2	1	3	16	8	24
Service Life	9	1	2	3	9	18	27
Reliability	9	2	1	3	18	9	27
					43	35	78

Note: Higher Score is Better



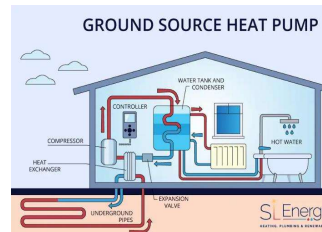
Variable refrigerant flow systems can deliver cooling to some zones and heating to others, with no reheat needed (an air-source system is shown here).

System Selection Trade Study (Excerpt)



Variable Air Volume System (4)

Variable Refrigerant Flow System (3)



Ground Source Heat Pump System (5)

Deliverables

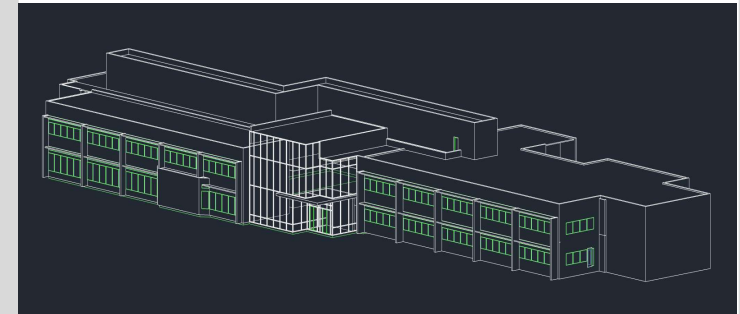
- Revit – 3D Architecture Engineering and Construction (AEC) software used for mechanical plans.



After compiling the load calculations and guidance and quotes from our advisors, we will select a system that best fits the needs of the client and meet all their requirements.

The selected system that will be placed into the building to for proper installation and scheduling of components, e.g., ductwork. The model of the building was done first by using the drawing files given by ASHRAE for a 2D drawing and then build the 3D model on the drawing.

Our final deliverable is a 35-page technical report for our load calculations and system election as well as a 15-minute visual aid (PowerPoint or YouTube) describing our reasoning for the system selection.



Building Exterior in Revit

Acknowledgements

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References

1. ASHRAE Standards 62.1, 90.1, 189.1, and 154
2. <https://www.eia.gov/totalenergy/data/annual/>
3. Variable Refrigerant Flow (VRF) | Slipstream
4. Electrical-knowhow
5. Ground Source Heat Pump Installation Guide | SL Energy