ASHRAE HVAC System Selection

Team 4
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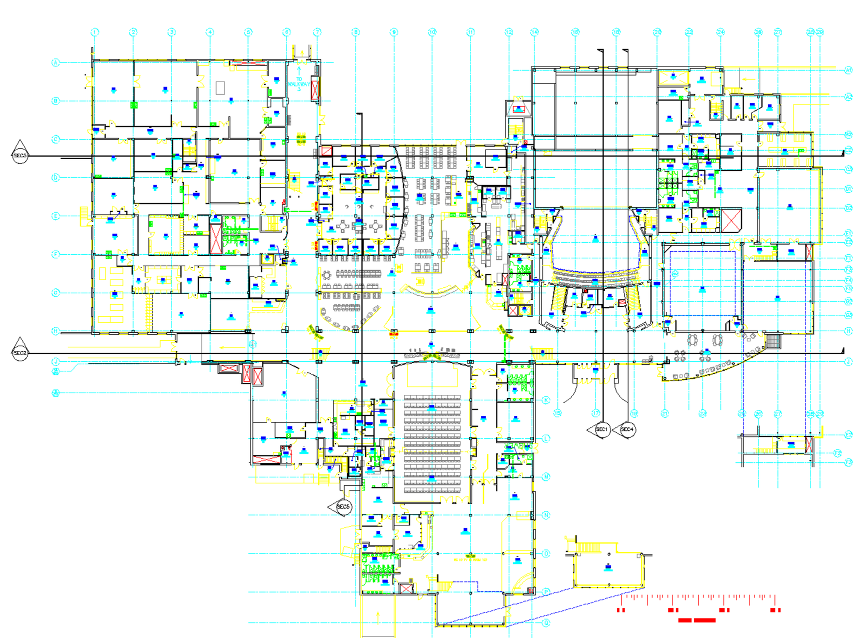
Background and Requirements

ASHRAE Design Competition

The ASHRAE design competition exists to inspire students to become involved in the design of energy-efficient HVAC systems.



Building Details

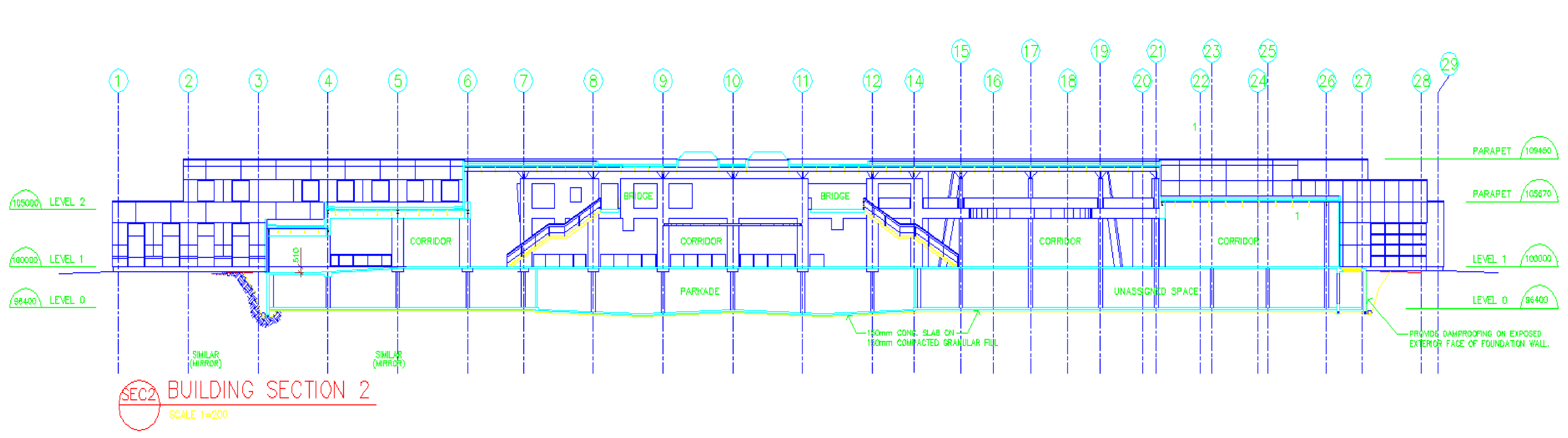
University Performing Arts Centre in Sydney, Australia

- 3 Floors
- 23 000 m^2
- 488 Spaces

Spaces Include: Classrooms, Dance Studios, Visual Arts Studios, Theatre with Full Auditorium, Performance Spaces, Food Services, Workshops and Offices.

Competition Requirements

- Comparison of 3 HVAC Systems
- Compliance with ASHRAE Standards
- Minimize Noise
- High Internal Air Quality (IAQ)
- Maintain Positive Building Pressure
- Load Calculations for Building
- Equipment and Material Schedules
- Budget of 15M$

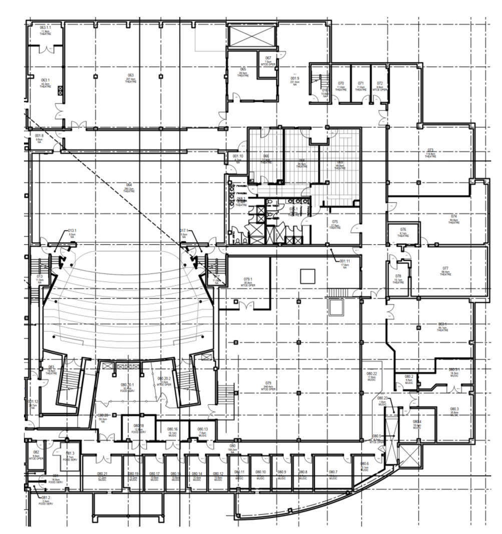


Design Process

Load Calculations

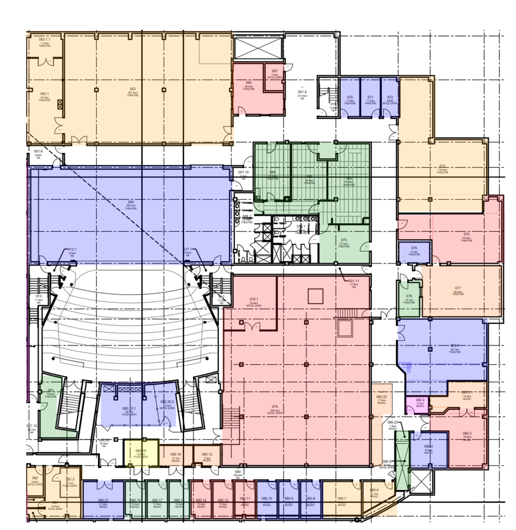
Each space was analyzed for sheathing parameters, occupancy density, occupant MET, lighting and equipment loads and outdoor air requirements.

These space were subsequently modelled in Carrier's Hourly Analysis Program (HAP) Software and simulated for a standard year based on ASHRAE Weather Data to determine peak heating and cooling loads for each space.



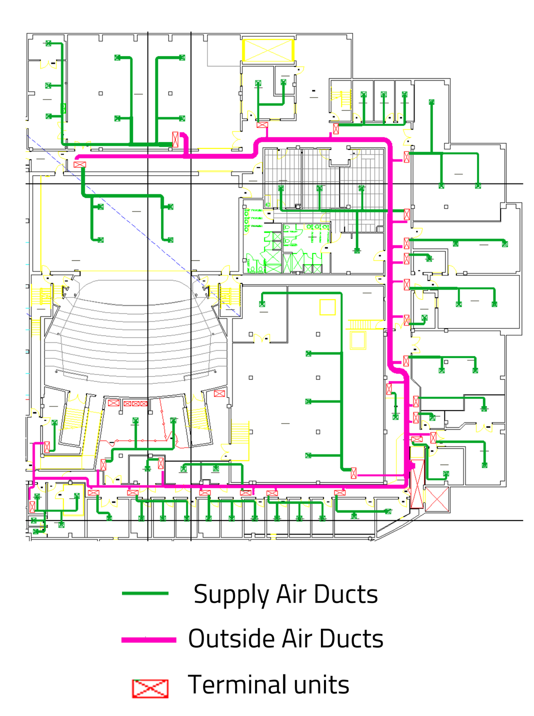
Zoning

The building was divided into 198 separate zones, each of which would be serviced by an individual terminal unit. Spaces were grouped into zones after considering peak cooling loads generated in the space, time of the peak, space schedule and the thermal comfort of its occupants.



Duct layouts

Each zone is served by a terminal unit which provides heating and cooling to the zone. Ducts were sized based on airflow and diffusers sized for each space. Outside air requirements are met by Dedicated Outside Air Handling units which supply outside air to each terminal unit which brings it into each space.



System Selection

Dedicated Outdoor Air System (DOAS) with Terminal Cooling/Heating

- Constant Outdoor Air Supplied Ensures High IAQ
- DOAS Maintains Positive Building Pressure
- Easy Maintenance and Replacement
- Allows Comparison of 3 Systems Without Complete Ductwork Redesign.

Three Systems

Three HVAC systems were chosen to compare: water source heat pump (WSHP), ground source heat pump (GSHP), and fan coil (FC).

The three parameters were chosen to compare each system:

1. Energy Consumption
2. CO_2 Emissions
3. Life Cycle Cost Analysis

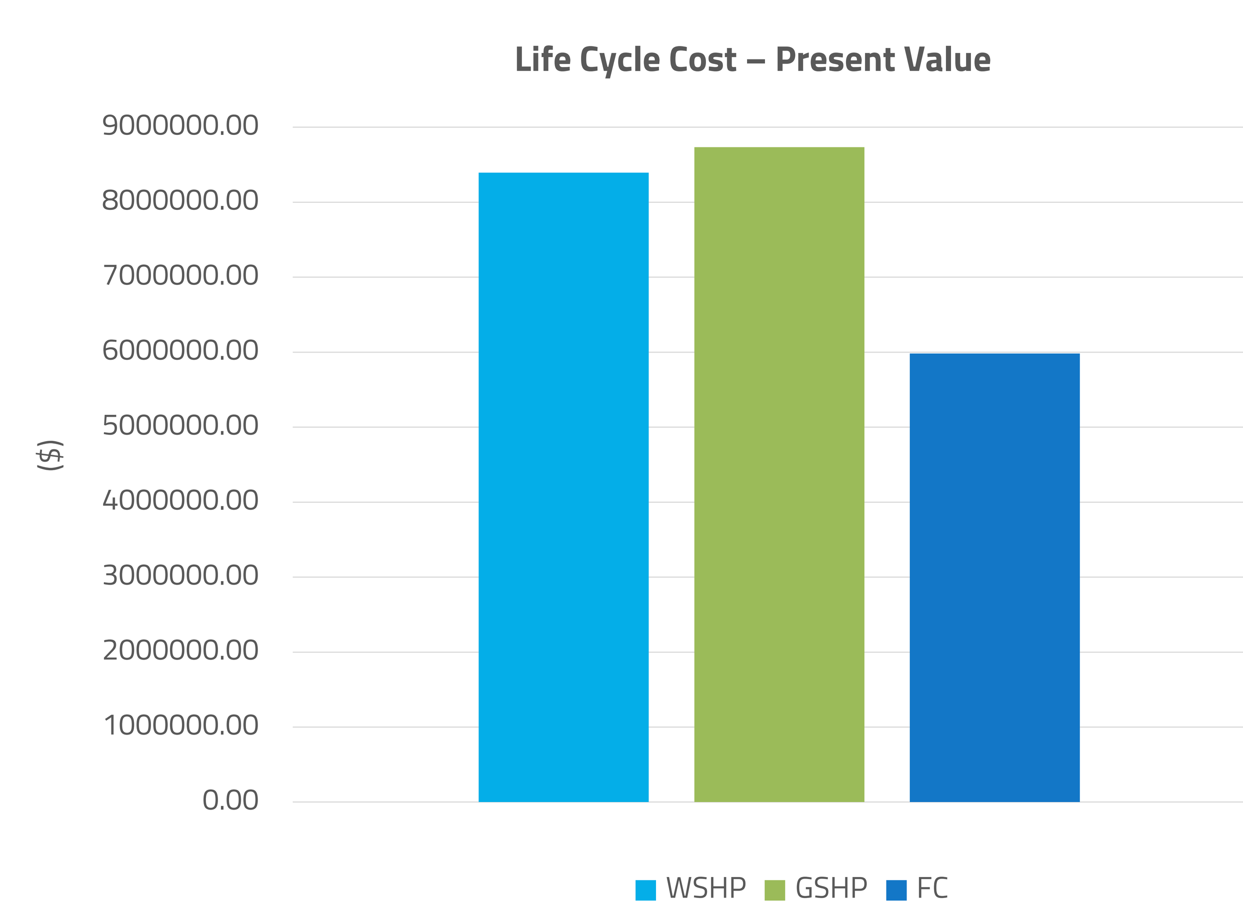
Annual costs and emissions

	Annual energy cost ($)	Electricity consumption (kWh)	Natural gas consumption (THM)	CO2 (kg)
WSHP	148 389	2 221 705	94	1 587 763
GSHP	121 315	1 818 822	0	1 299 404
FC	124 081	1 277 152	18 184	1 013 033

Life Cycle Cost Analysis

A 30-year Life Cycle Cost Analysis was done to compare the cost of each system. This analysis includes the following costs:

- Capital for Terminal Units
- Terminal Unit Replacements
- Operations and Maintenance
- Annual Energy Consumption
- Installation Costs



Recommendations

Of the 3 systems evaluated, the team selected Fan Coil Terminal Units with DOAS as the best option.

Over a 30-year life span fan coils are the cheapest, consume the smallest amount of electric energy and contribute the least amount of CO_2. Despite the seemingly clear-cut decisions there are some additional considerations that could be made.

COVID-19 Costs

Many costs were evaluated using RS-Means 2018 data. Due to interruptions in supply chains, many costs have significantly changed and may affect the evaluation

Changing Energy Grid in Australia

The CO_2 emissions evaluation is dependent on the current Australian electrical grid. Australian energy production is rapidly changing and over the 30-year system life

System Optimization

Due to the accelerated timeline of this project, additional time spent optimizing each of the 3 Systems is required to offer a more accurate evaluation.

Acknowledgments

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Thank you to our faculty advisor, Dr. Johnston, for the constant encouragement.

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