



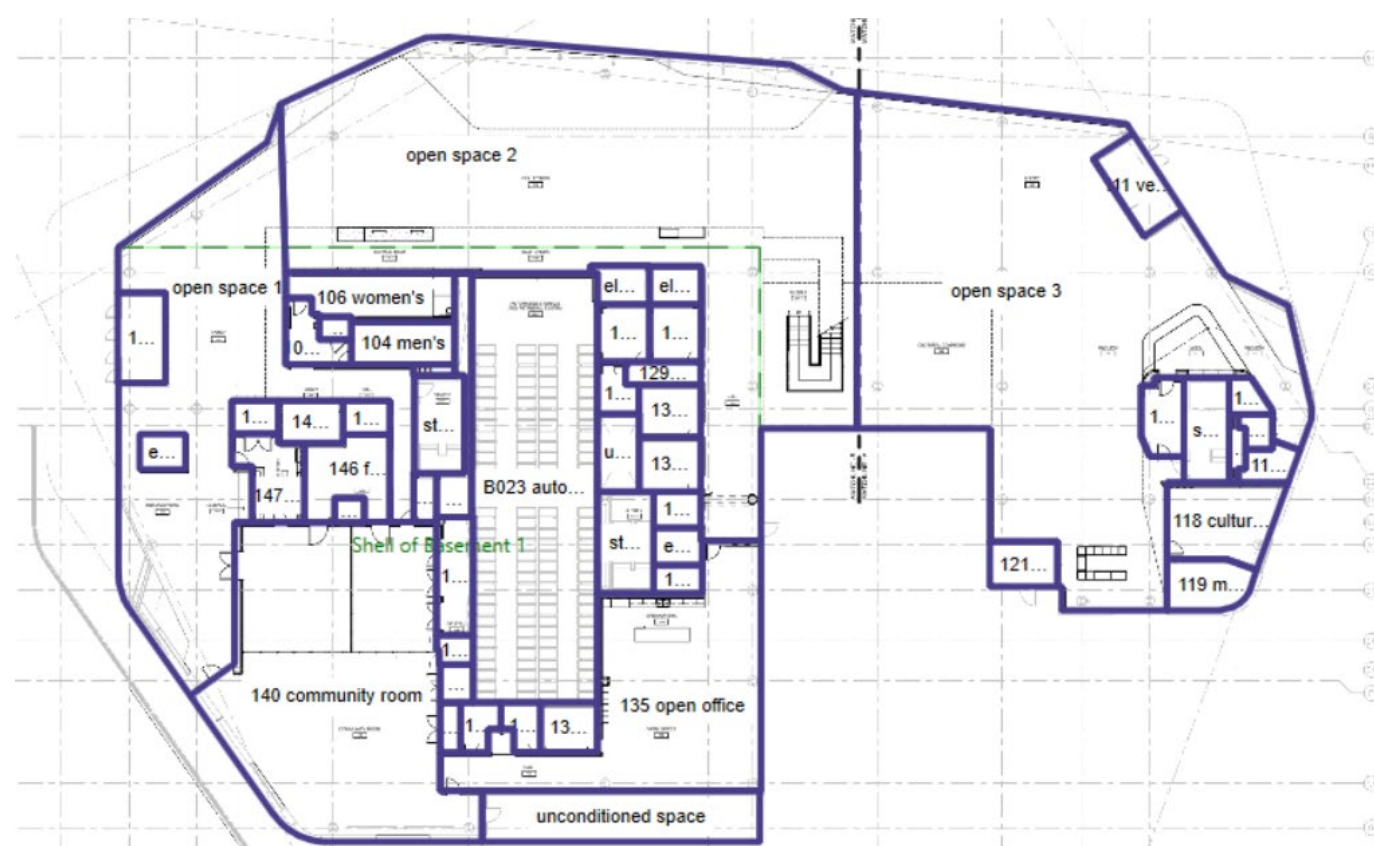
HVAC Design for Sao Paolo Brazil Library

Project Description:

The goal of our project is to design an HVAC System for a new central public library in Sao Paolo Brazil. The purpose of the library is to be a community hub to promote education, community involvement, and diversity. The building consists of open library space, retail space, café, conference and office rooms, an automated storage and retrieval system along with numerous support spaces such as restrooms, mechanical, water, electrical, telecom and storage rooms. The design of the HVAC system should be safe and have a sustainable design while considering the energy efficiency, occupant health and safety, occupant comfort, functionality, future flexibility, maintainability and a 50-year service life.

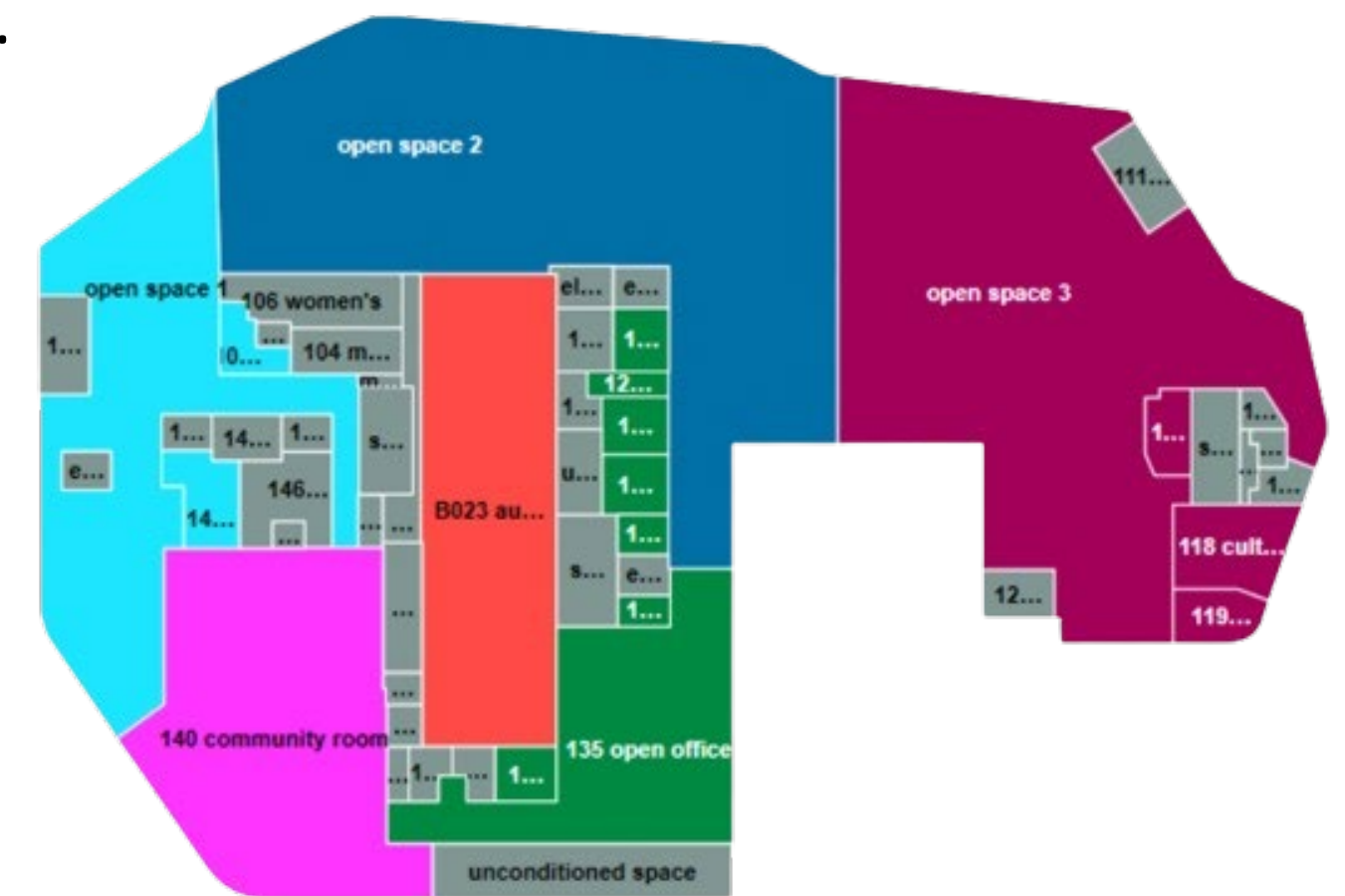
HAP

In this project, we are utilizing Carrier's Hourly analysis program (HAP). We first enter all the parameters and conditions to HAP and model the building and spaces. Then we calculate the load and test different systems, so we could choose the best one. The figure below shows our spaces for the first floor in HAP.



HAP Zoning:

We selected 7 zones (shown in the figure below) based on the proximity, ventilation needs, design temperatures and usage frequency of each room. This optimizes air distribution and energy efficiency while maintaining the owner's requirements for each space.



Ventilation Calculations:

- Our first deliverable was to determine ventilation requirement of each room to meet ASHRAE standards.
- Using AutoCAD and the floor plans of the library we determined the square footage of each room and then calculated the outside airflow required using ASHRAE 6.2.2.1 equation (Eqn. 1).

$$V_{bz} = R_p * P_z + R_a * A_z$$

Eqn. 1

R_p = Outdoor airflow rate required per person

P_z = Zone population

R_a = Outdoor airflow rate required per unit area*

A_z = Zone floor area*

*Airflow rate requirements based on ASHRAE Table 6.2.2.1 (Minimum Ventilation Rates in Breathing Zones)

U-value calculations:

We also needed to determine the U-values for walls and roofs, which is done in HAP. The layers, their thickness and R-value are inserted in HAP and then it calculates the overall U-value for walls and roofs using the following equation:

$$U = \frac{1}{R_T}$$

Eqn. 2

R_T = total thermal resistivity

Inside Space	Layer Description	Thickness in	Density lb/cuft	Specific Heat BTU / (lb F)	R-Value (hr sqft F)/BTU	Weight lb/sqft
Inside surface resistance:					0.68000	
Layer #1	5/8-in gypsum board	0.625	50.0	0.26	0.56306	2.6
Layer #2	3.5-in cavity, 16-in o.c. steel frame, no insul	3.500	2.9	0.01	0.79000	0.8
Layer #3	5/8-in gypsum board	0.625	50.0	0.26	0.56306	2.6
Outside surface resistance:					0.68000	
Totals:		4.750			3.27612	6.0
Overall U-Value:					0.305 BTU/(hr sqft F)	

Load calculation:

For load calculations, HAP will be used alongside the ASHRAE standards to calculate the cooling and heating loads for each space. It would calculate the building envelope load (walls, windows, roof, floor) and add to it people equipment, lighting and infiltration loads. This would finally give us the total load for each space, which will be used in sizing and selecting the system and equipment.

Standards used in this project:

- ☐ Standard 15 - Safety Standard for Refrigeration Systems
- ☐ Standard 55 - Thermal Environmental Conditions for human occupancy
- ☐ Standard 62.1 - Ventilation for Acceptable Indoor Air Quality
- ☐ Standard 90.1 - Energy Standard for Buildings

Semester Deliverables:

1. Reports per syllabus
2. Ventilation calculations – ventilation table
3. Load calculation - Load calculation report (HAP simulation)
4. Systems research and testing on HAP
5. System selection

Ongoing Development:

1. Finish setting up the building and spaces model in HAP
2. Finish load calculations
3. Zone off different areas of the library using HAP
4. Insert ventilation calculations for each space into HAP
5. After finishing the model with all specifications, the next step is to select systems that could support the library and owner's requirements



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