My Building Design Journey

CEE 220B

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Winter 2023

Key / Essential / Unique Design Features

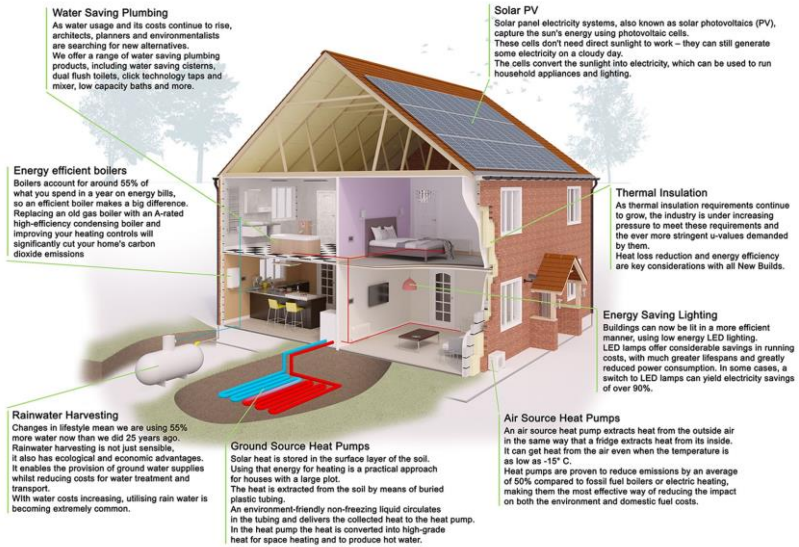
Optimize Energy Efficiency

Goal 1: Net-zero Site Energy

Measure:
Energy Use Intensity to gauge the total energy consumed by the building within a year.

Targets:
•Minimal target: reduce the overall energy consumption of the average building in San Jose, California by **at least** 25%.
•Design goal: reduce the overall energy consumption of the average building in San Jose, California by 40% **or more**.

Strategies:
•Implement PV panels on roof.
•Incorporating natural shading options such as trees to help reduce energy consumption and enhance the overall appearance of the building.
•Include energy efficient building materials such as double pane windows and self-operable windows for natural ventilation.
•Utilize energy conservation HVAC features, such as economizer mode.
•Implement plug load controls to conserve energy.
•Install energy efficient lighting systems, such as wattstopper and daylight sensors.

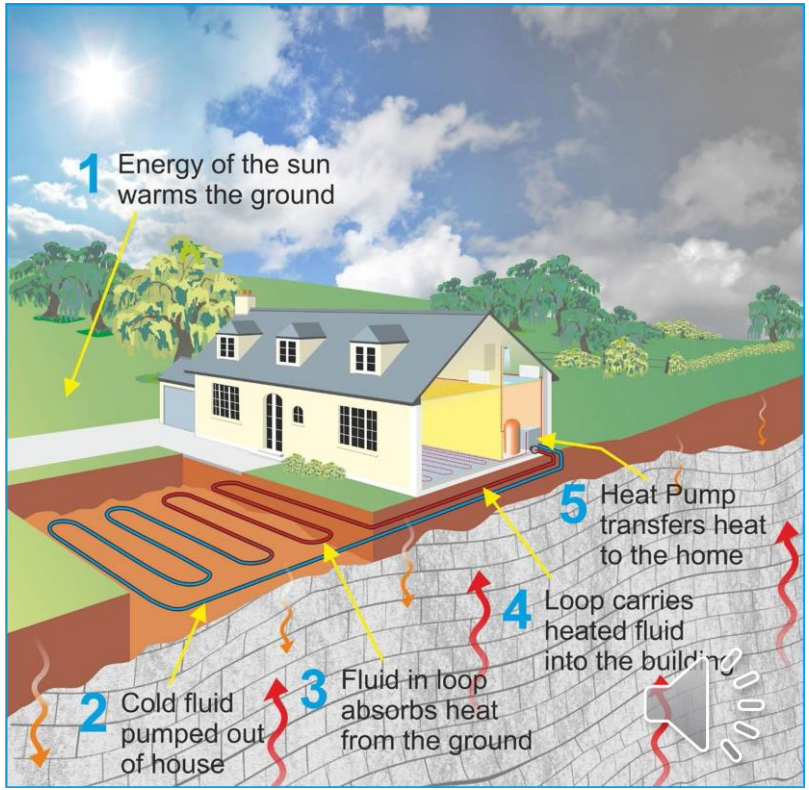


Goal 2: Ground Source Heat Pumps

Measure:
Energy Use Intensity or other energy measurement tool, such as the building automation system, to gauge the total energy consumed by the heat pumps within the building.

Targets:
•Minimal target: reduce the overall energy consumption of water heating of the average building in San Jose, California by **at least** 20%.
•Design goal: reduce the overall energy consumption of water heating of the average building in San Jose, California by 30% or more.

Strategies:
•Install heat pumps to transfer heat into the home to heat the water.
•Locate building in a warm area to ensure optimization of heat energy.



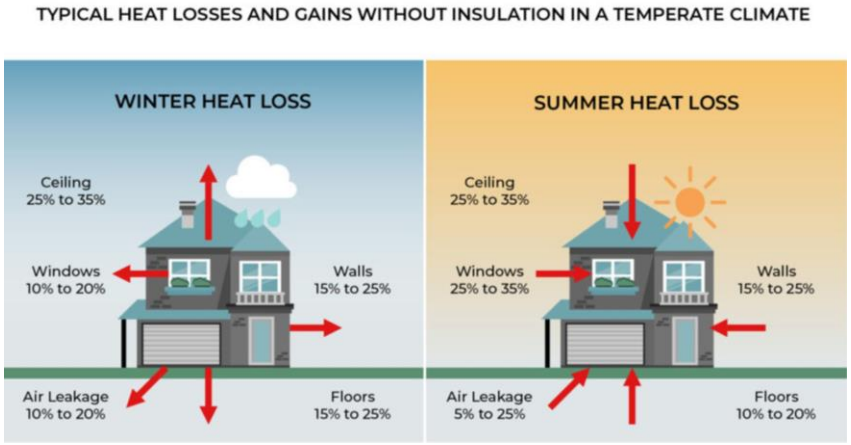
Goal 3: Thermal Insulation

Measure:
Building automation system metrics to give a more detailed overview of system performance, specifically the overall building performance.

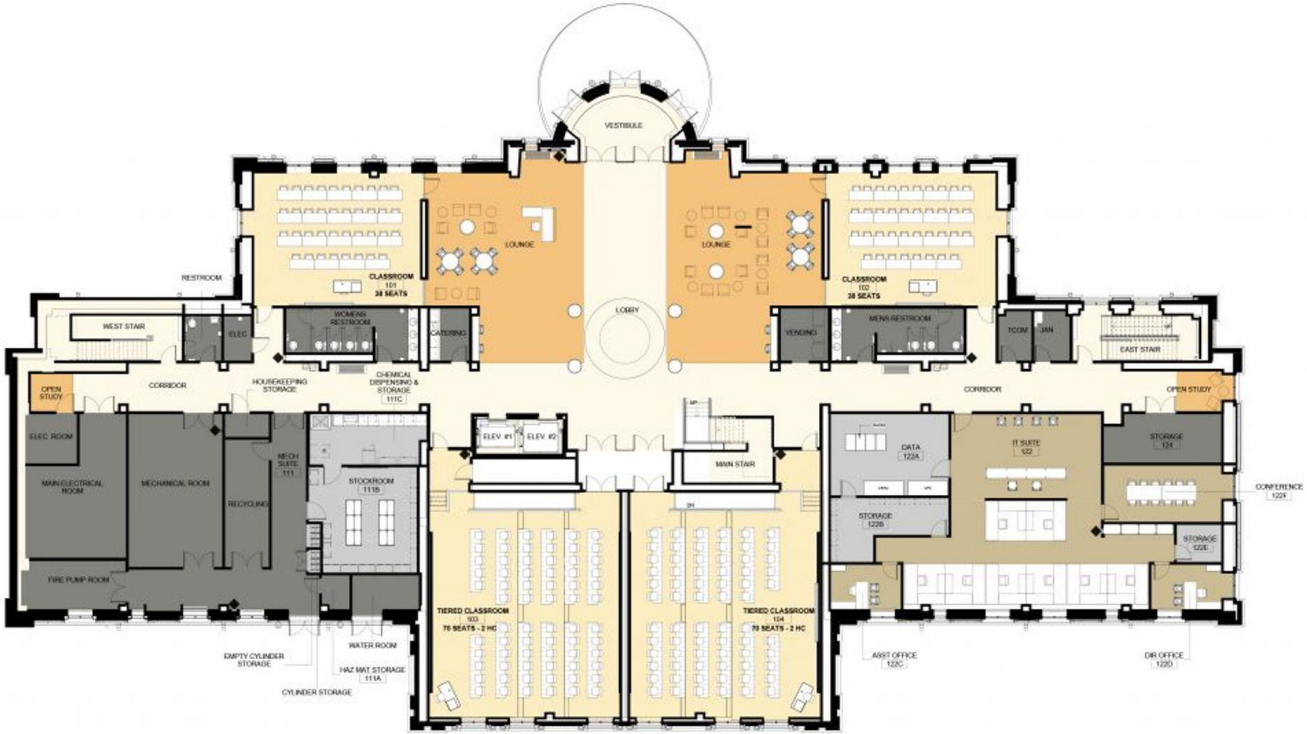
Targets:
•Minimal target: ASHRAE Standard 55 on Thermal Environmental Conditions for Human Occupancy.
•Design goal: exceed ASHRAE Standard 55 requirements on building thermal insulation by 20%.

Strategies:
•Installation of Aerogel to reduce HVAC energy consumption and create a tightly sealed building envelope since the material has a low density and thermal conductivity.
•Installation of energy efficient HVAC equipment.
•Utilize concrete as a building material due to its high heat retention properties during the summer.
•Install windows with a high R-value to reduce thermal transmittance into perimeters.

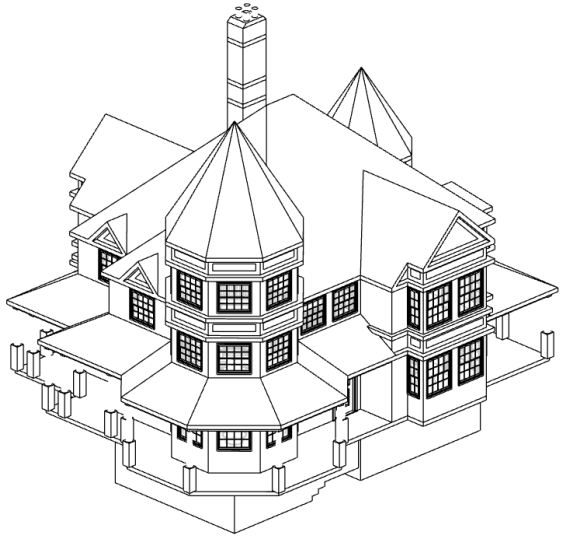
- Consider dual pane windows to further reduce thermal transmittance from the outdoors.



Design Goal Inspiration



Urban Morphology: Victorian Style



Building Site Analysis

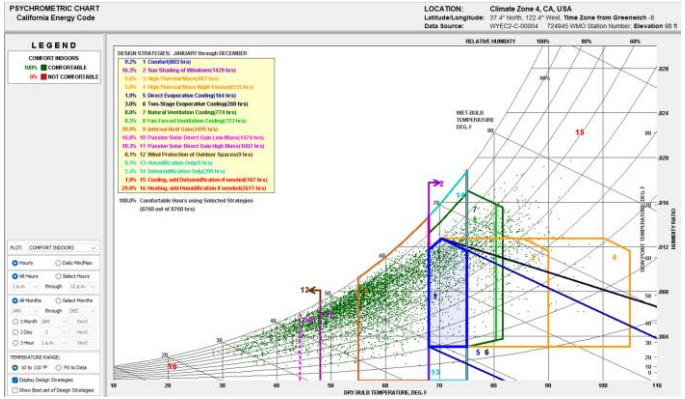
Location: San Jose, California

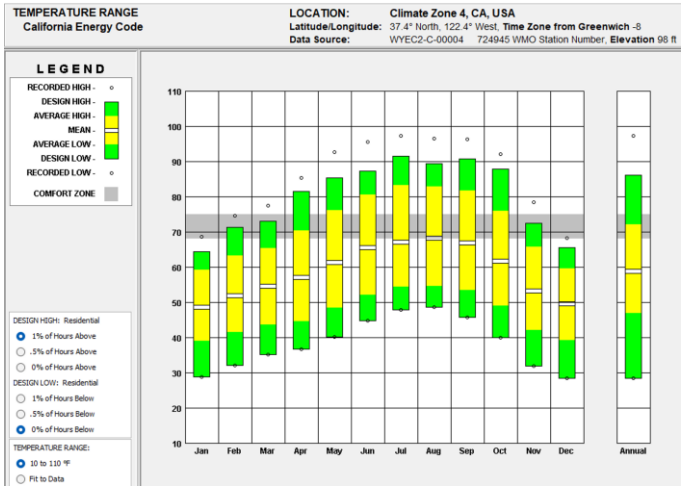
- San Jose is a major city within California and is an influential part of the Silicon Valley.
- Features many microclimates.
- Topography: the location is primarily flat land with some slight slopes.

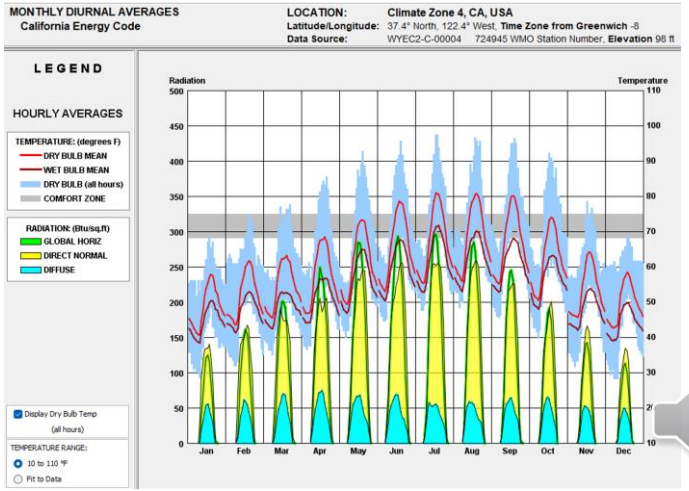
Local Climate

Summers in San Jose are usually dry and range from warm to occasionally hot with an average temperature of 82F during the months of July and August.

With a comfort temperature ranging from 68-75F, I could optimize natural ventilation and the shading of trees considering the building location is centered around nature.



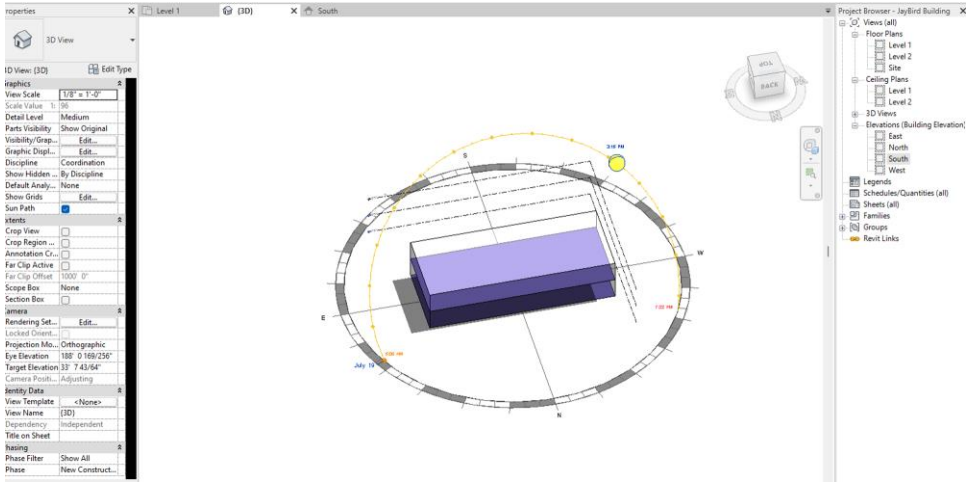




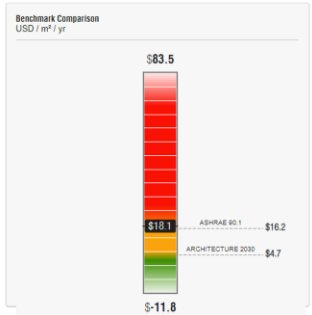
Conceptual Masses

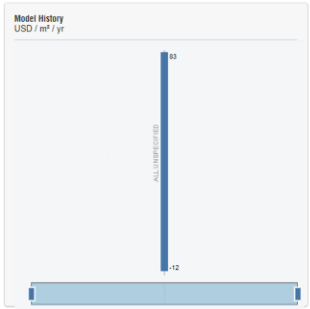
Explore Building Massing Alternatives by Creating Several Conceptual Mass Models:

The purpose of my building is to provide a nurturing environment for students to obtain additional academic resources such as tutoring, therapy, and extracurricular activities. Given the purpose of my building, it is imperative that the design embraces and promotes the main mission of the company itself — to provide additional support to students in need.



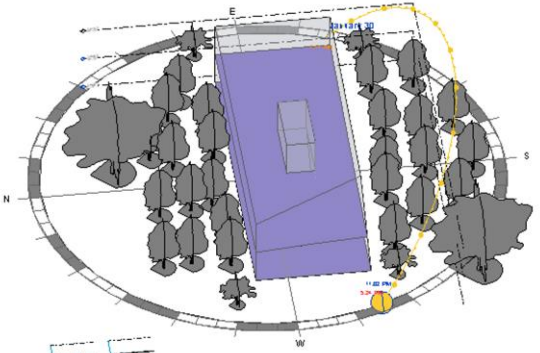
Alternative 1:
During the first attempt of designing my building, it became apparent that there are many design strategies I will need to implement in order to develop a sustainable building. I designed this initial building then applied modifications to my second alternative to enhance energy efficiency measures.

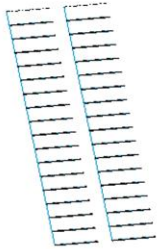


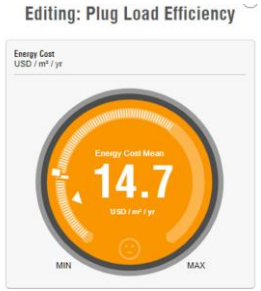


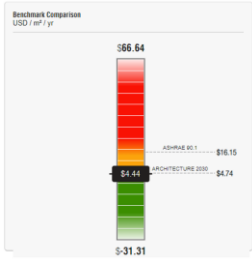
Conceptual Masses

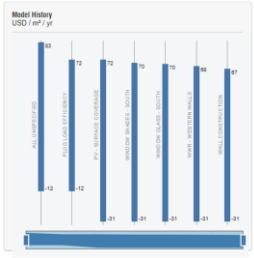
Alternative 2:
Implementing plug load efficiency features.



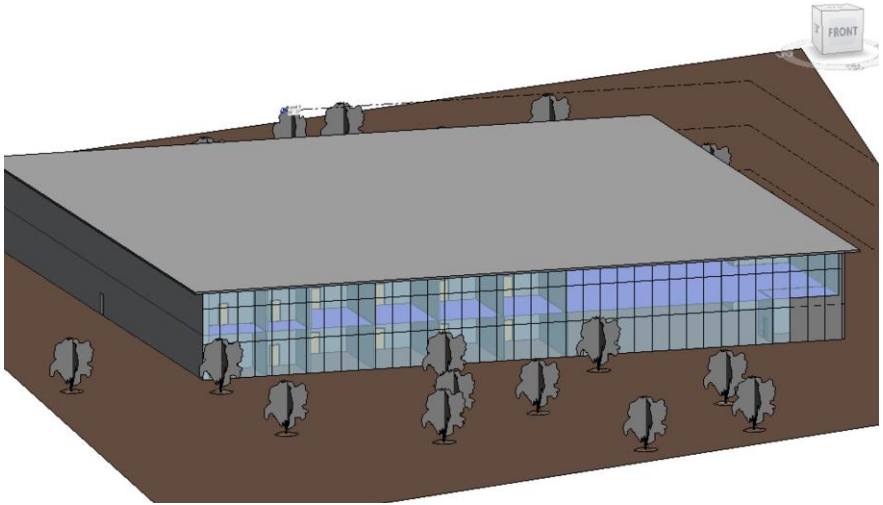


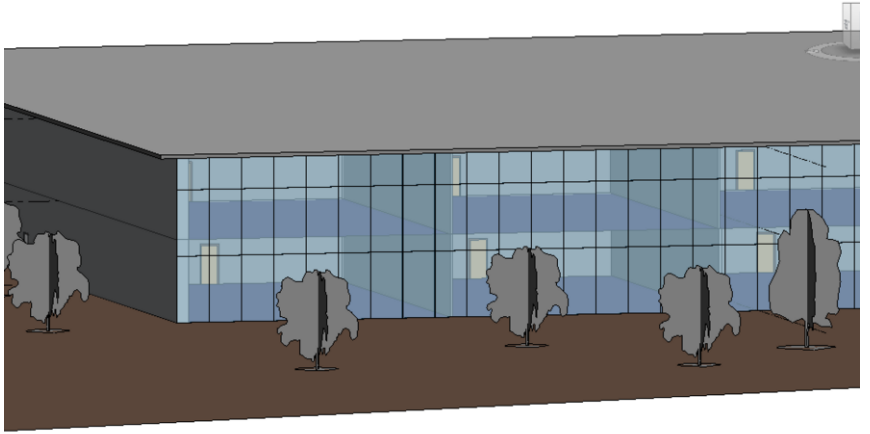






Initial Building Design





Building Design

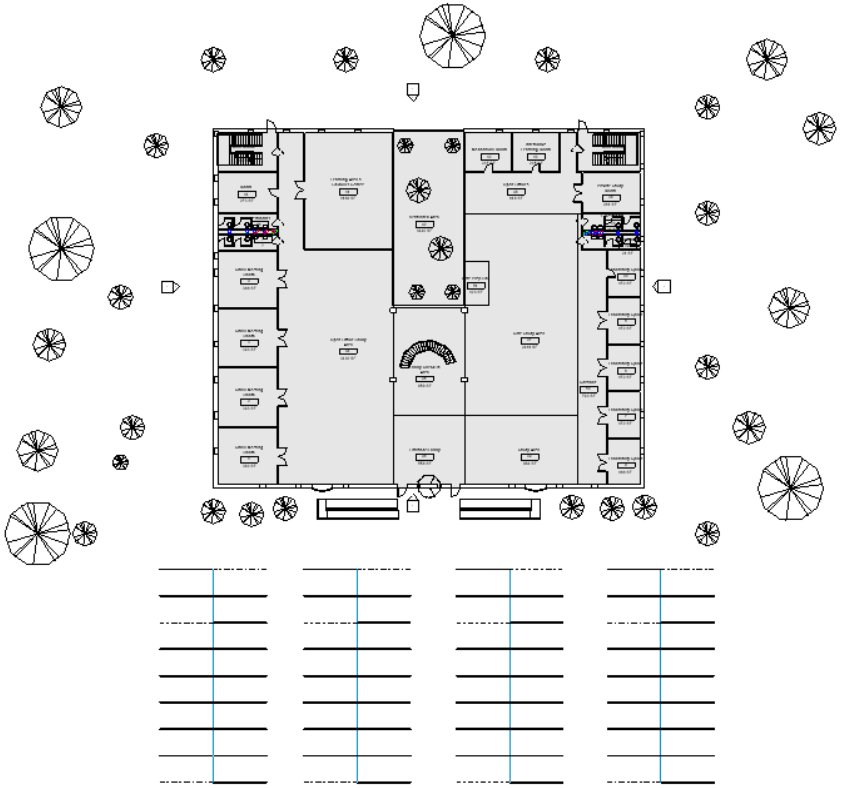
Building Design

Space Planning & Building Layout

Space Budget Spreadsheet for Interactive STEM Learning Center

	Function	Qty	Length	Width	Area	Total Area	Design Features & Key Attributes for a Thriving Space
LEVEL I							
	Small Meeting Rooms	4	20	20	400	1600	Will include a large table with 6 chairs and a projector screen for meetings
	Café Barista Area	1	8	8	64	64	This space will include a full coffee bar
	Café Eating Space	1	50	50	2500	2500	The café will feature 12 round tables with 2 chairs each
	Guest Lobby Area w/ Reception Space	1	20	25	500	500	The guest lobby area will feature a large atrium that will travel up to the second floor and will have operable windows for natural ventilation
	Large Private Office	1	18	15	270	270	This will be the CEO's office, it will be the largest office in the building
	Learning Area 1 -- Calculus Center	1	40	40	1600	1600	The exhibit spaces feature the same area and same furniture layout
	Learning Area 2 -- Physics Center	1	40	40	1600	1600	The exhibit spaces feature the same area and same furniture layout
	Learning Area 3 -- Neuroscience Center	1	40	40	1600	1600	The exhibit spaces feature the same area and same furniture layout
	Lecture Room	1	50	40	2000	2000	This lecture space will be used for orientation/informational program meetings
	Conference Rooms	2	18	22	396	792	Will fit a large rectangular meeting table to hold large conferences
	Public Restrooms	2	22	13	286	572	Large public restrooms -- one for men and another for women
	Office Restrooms	1	12	12	144	144	Private restroom for office area
	Laboratory Space	4	16	12	192	768	Laboratory space for conducting experiments
	TOTAL LEVEL I					14,010	
LEVEL II							
	Learning Area 4 -- Biology Center	1	40	40	1600	1600	The exhibit spaces feature the same area and same furniture layout
	Learning Area 5 -- Engineering Center	1	40	40	1600	1600	The exhibit spaces feature the same area and same furniture layout
	Learning Area 6 -- Chemistry Center	1	40	40	1600	1600	The exhibit spaces feature the same area and same furniture layout
	Study Area	1	80	80	6400	6400	Tuin to exhibit space 4, larger space. Near door to capture heat
	Supply Storage Room	1	15	15	225	225	Tuin to exhibit space 3, larger space. Near door to capture heat
	Laboratory Center	1	25	40	1000	1000	Laboratory space for conducting experiments
	Hallways	1	20	30	600	600	Hallways will be rectangular and wide enough to adhere to ADA design guidelines
	Mechanical Room	1	20	35	700	700	Near the Restrooms
	Restrooms	1	30	15	450	450	Near the Stairs as soon as you set foot on the second floor
	TOTAL LEVEL II					14,175	
TARGET							
	Overhead Percentage	25%				7500	
	Space Budget					30000	
	Total Space					28,185	
	Space Remaining					1,815	

Floor Plan: Level I



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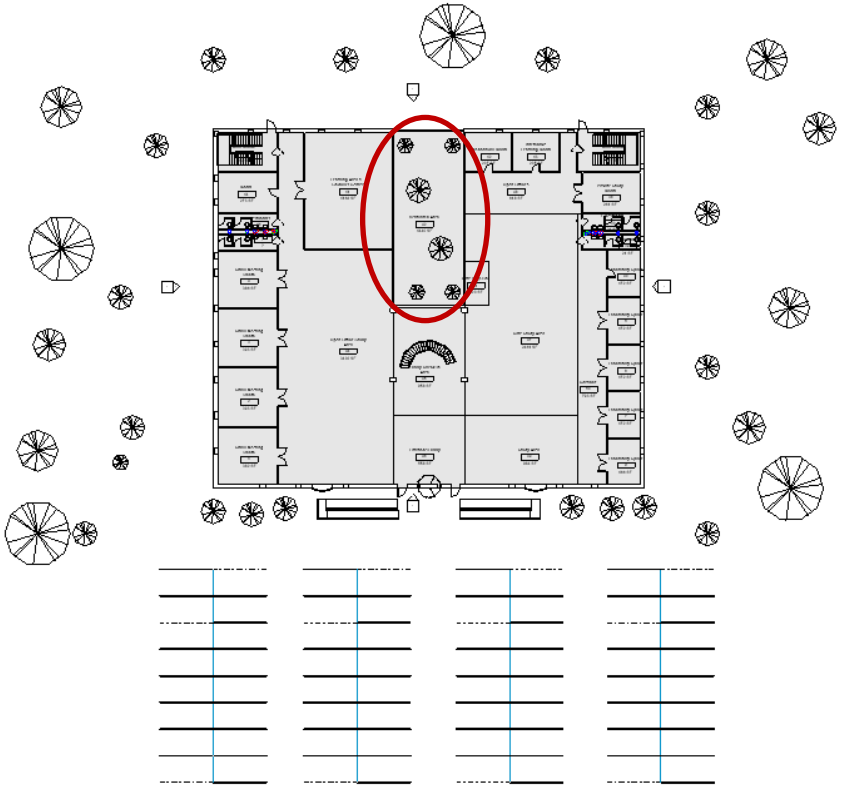
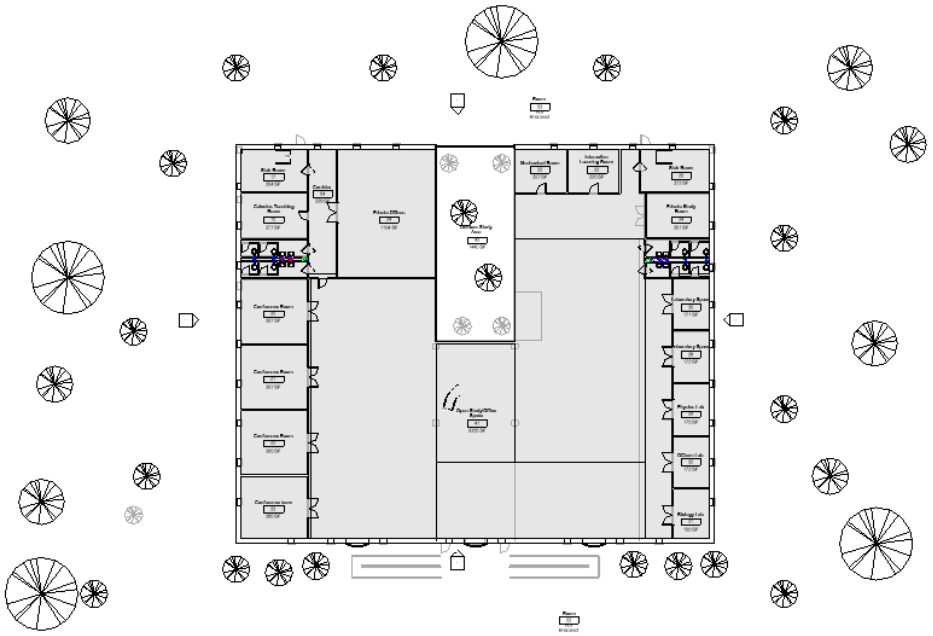
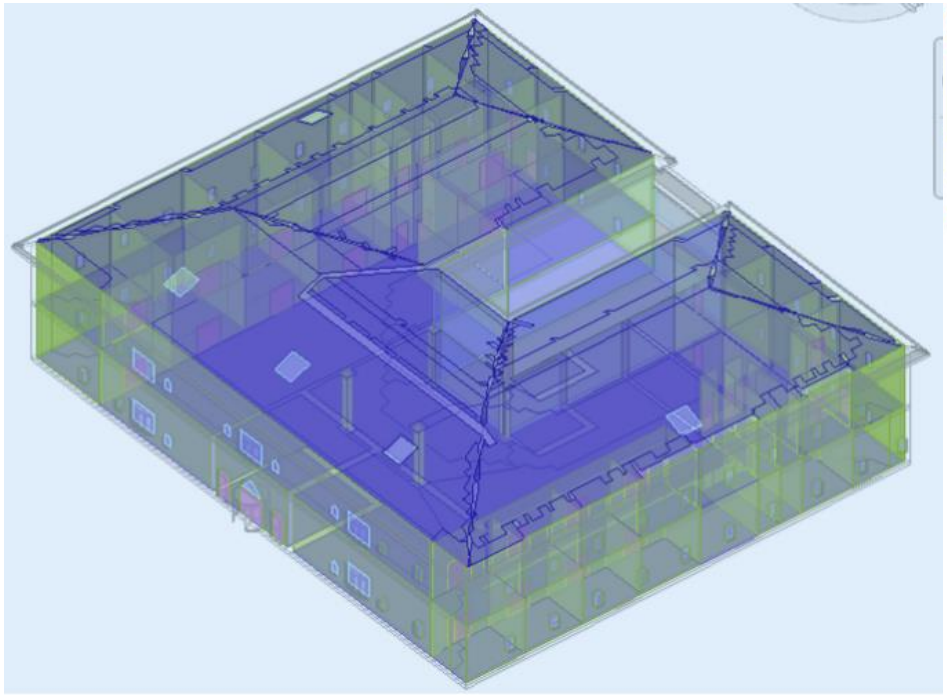
Floor Plan: Level I

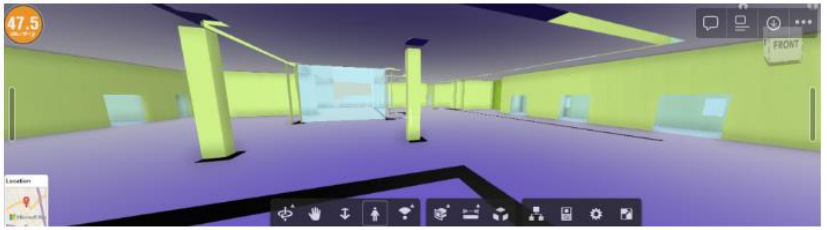


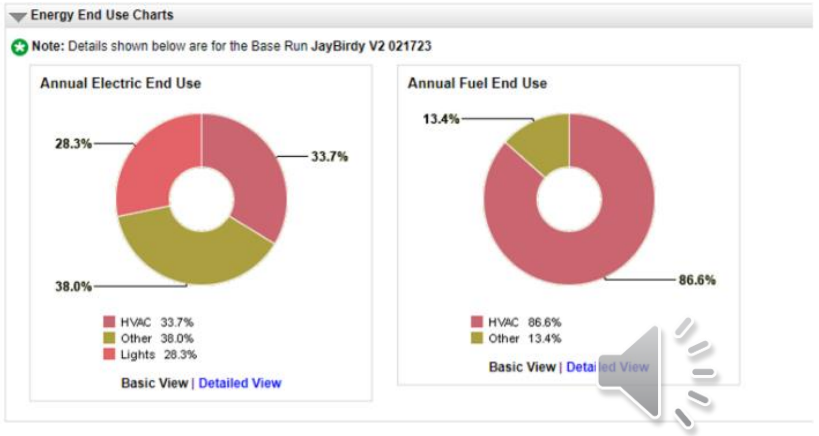
Floor Plan: Level II



Analytical Surfaces







Analytical Surfaces

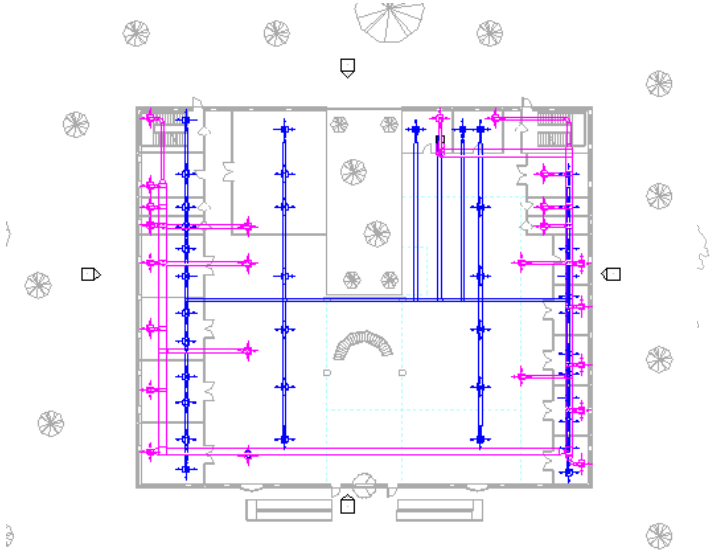
The following adjustments were made in order to attempt to decrease the EUI:

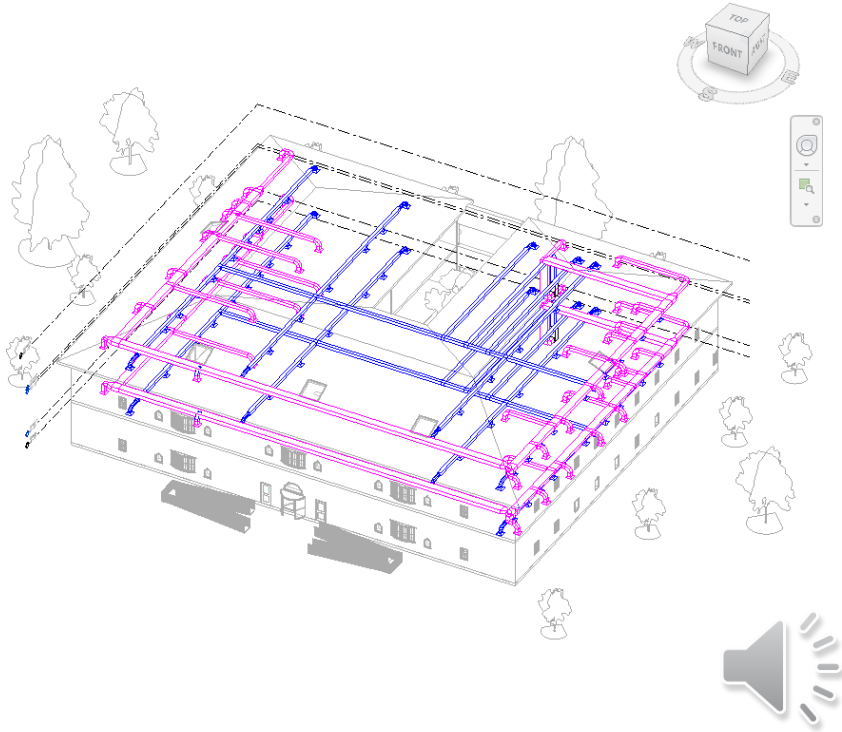
- **Building orientation**
  - Adjusting the building orientation did not reflect a change in EUI.
- **Window Shades — South**
  - Adjusting the South Window Shades to 1/2 window height lowered the overall mean EUI to 62.5 kBtu/ft2/yr.
- **Wall Construction**
  - Editing the wall construction to R38 wood resulted in a significant drop in mean EUI (58.2 kBtu/ft2/yr).
- **Roof Construction**
  - Modifying the roof construction elements to R60 resulted in a notable drop in mean EUI — 54.9 kBtu/ft2/yr.

Further Fine-tuning of the model:

- **Window Shades — North**
  - Adjusting the North Window Shades to 1/2 window height lowered the overall mean EUI to 54.4 kBtu/ft2/yr.
- **Window Shades — West**
  - Adjusting the West Window Shades to 2/3 window height lowered the overall mean EUI to 53.1 kBtu/ft2/yr.
- **Window Shades — East**
  - Adjusting the East Window Shades to 2/3 window height lowered the overall mean EUI to 52.0 kBtu/ft2/yr.
- **Lighting efficiency**
  - The greatest decrease in mean EUI occurs when modifying the lighting efficiency within the building.
  - By increasing the lighting efficiency to 0.3 W/sf, the mean EUI drops 5.36 52.0 kBtu/ft2/yr, which results in an overall mean EUI of 45.8 kBtu/ft2/yr.

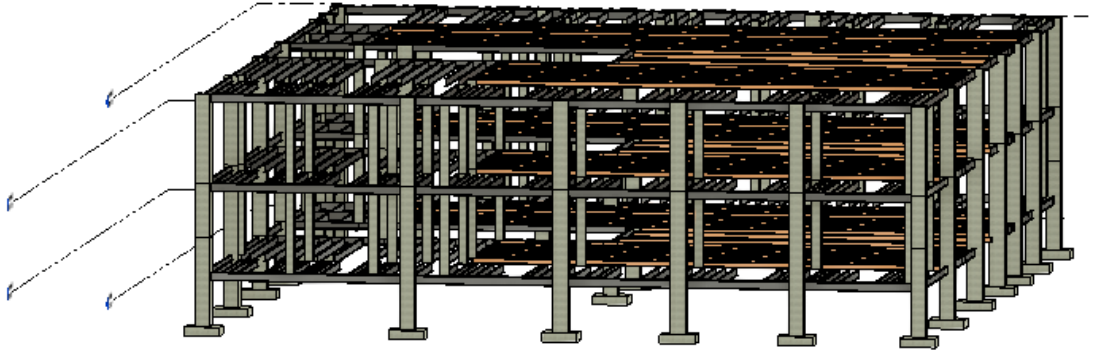
HVAC System Model

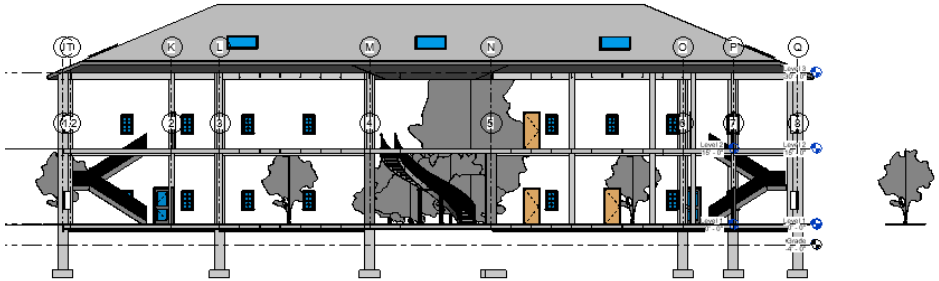




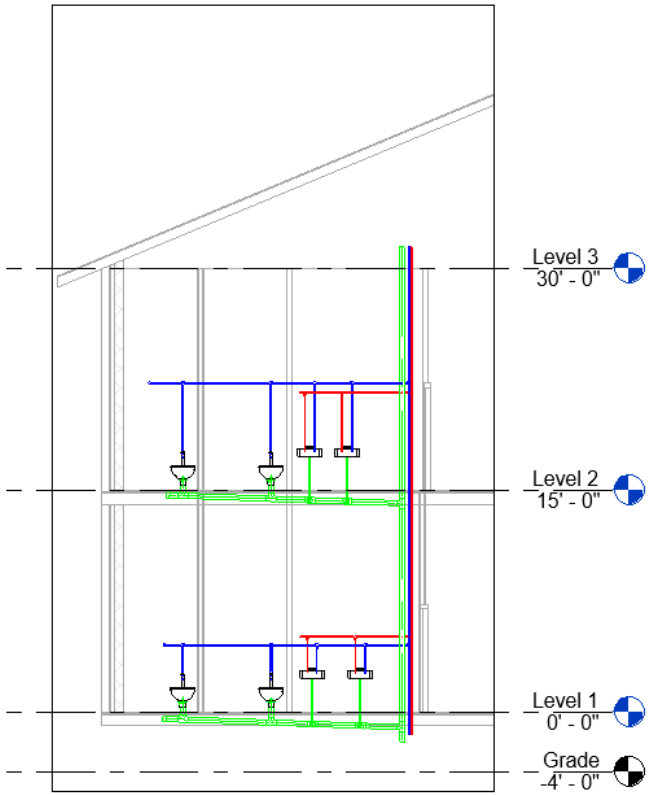
HVAC System Model

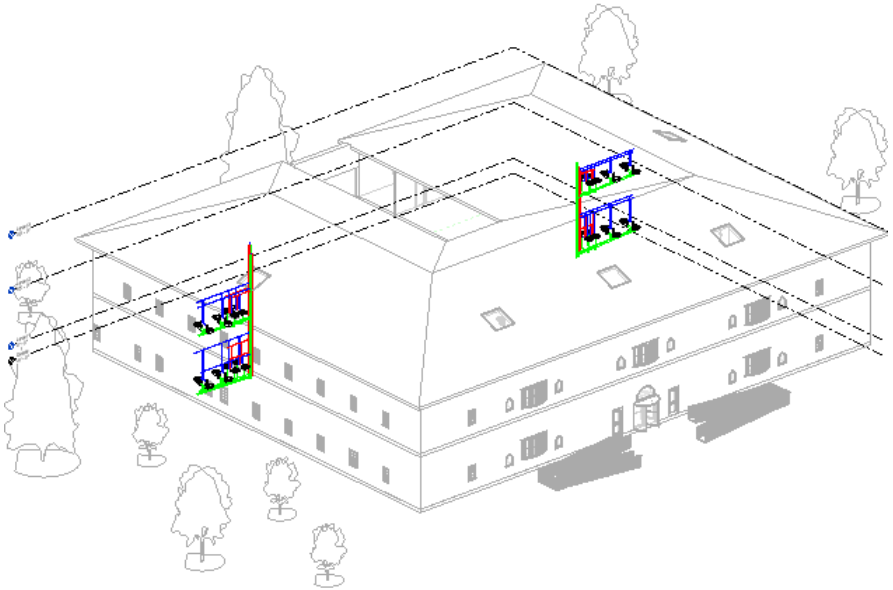
Structural System Model





Plumbing System Model





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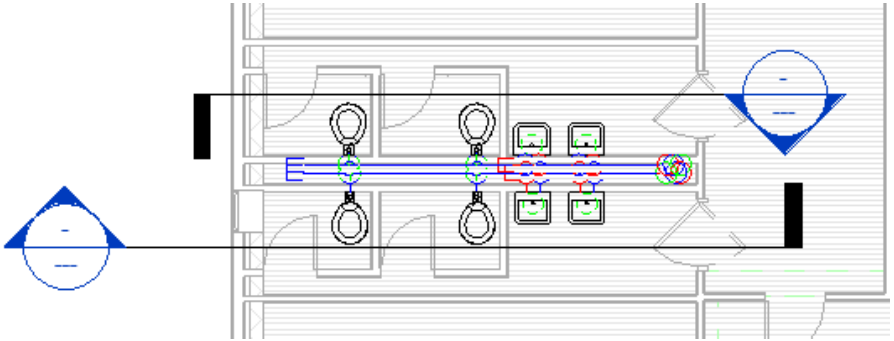
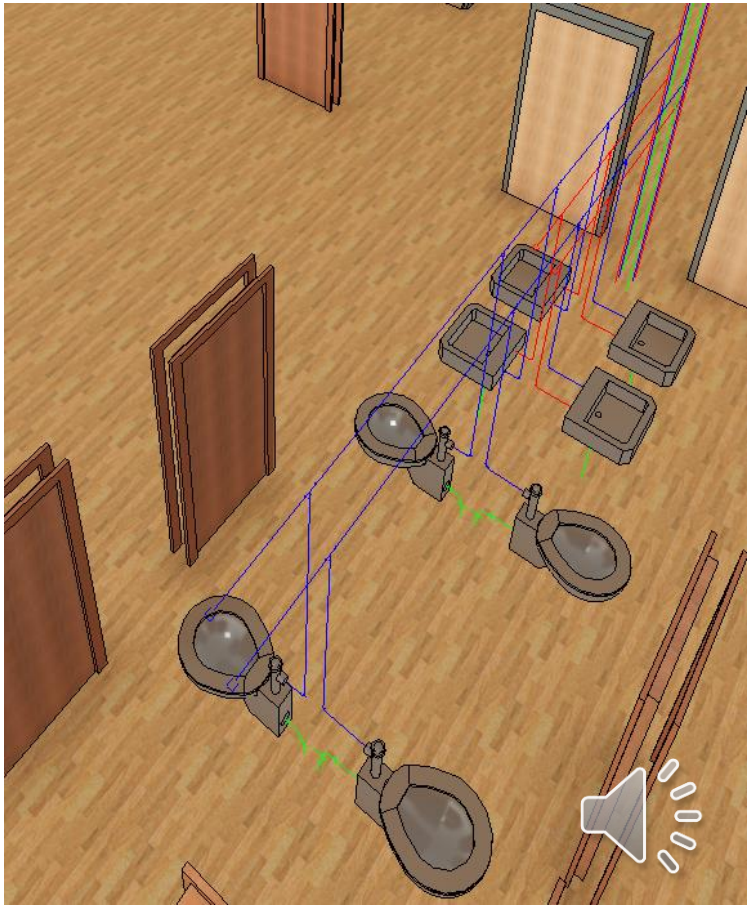
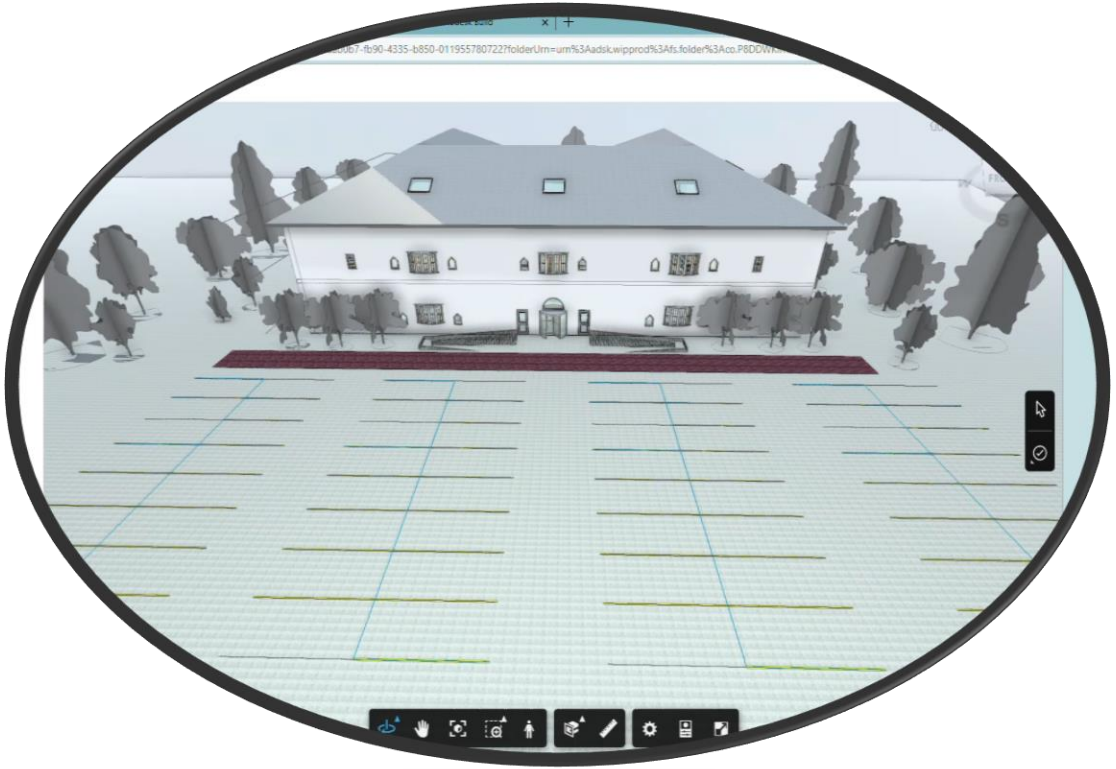




Building Model Virtual Tour



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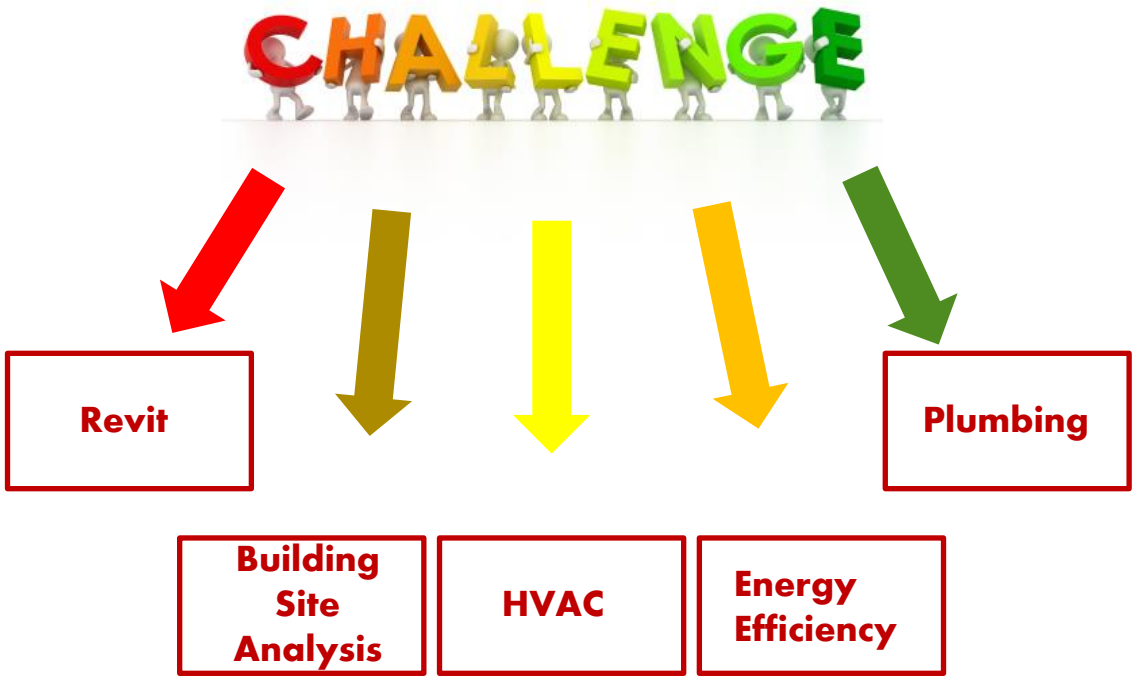
Learning Challenges



Learning Takeaways

- Do **NOT** procrastinate ☺
- Practice makes perfect ☺
- Be kind to yourself, working with Revit is not simple ☺

Thank you!