



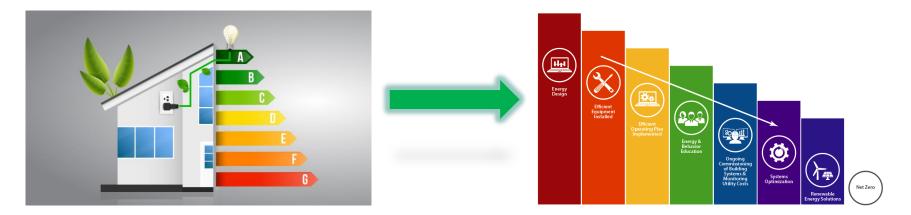
# My Building Design Journey

CEE 220B Instructor: Glenn Katz

> Jayce Martinez 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.



Energy efficient boilers Boilers account for around 55% of what you spend in a year on energy bills, so an efficient boiler makes a big difference Replacing an old gas boiler with an A-rated high-efficiency condensing boiler and improving your heating controls will adjustmenty out your home's carbon dioxide emissions

Rainwater Harvesting Changes in lifestyle mean we are using 55% more water now than we did 25 years ago. Rainwater harvesting in not just sensible, it also has ecological and economic advantages. It enables the provision of ground water upplies whilst reducing costs for water treatment and transport.

becoming extremely common

Ground Source Heat Pumps Solar heat is stored in the surface layer of the soil. Using that energy for heating is a practical approach for houses with a large plot. The heat is extracted from the soil by means of burie

pastic tubing. An environment-friendly non-freezing liquid circulates in the tubing and delivers the collected heat to the heat pump. In the heat pump the heat is converted into high-grade heat for space heating and to produce hor water.

#### Solar PV

Solar panel electricity systems, also known as solar photovollaics (PV), capture the sum sengry uning photovollaics cells. These cells don't need direct sunlight to work – they can still generate some electricity on a cloudy day. The cells convert the sunlight into electricity, which can be used to run household appliances and lighting.

> Thermal Insulation As thermal insulation requirements continue to grow, the industry is under increasing pressure to meet these requirements and the ever more stringent u-values demanded by them. Heat loss reduction and energy efficiency are key considerations with all New Builds.

Energy Saving Lighting Buildings can now be lift in a more efficient method by the second second second second Dense second second second second second costs, with much greater lifespans and greatly reduced power consumption. In some cases, a switch to LED lamps can yield electricity savings of over 90%.

Air Source Heat Pumps

An air source heat pump extracts heat from the outside air in the same way that a fridge extracts heat from its inside. It can get heat from the air even when the temperature is as low as -15° C.

Heat pumps are proven to reduce emissions by an average of 50% compared to fossil fuel boilers or electric heating, making them the most effective way of reducing the impact on both the environment and domestic fuel costs.



## **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.

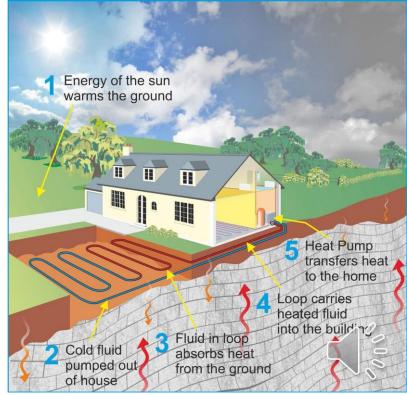
#### Targets:

•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.

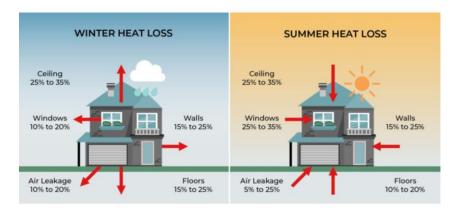
•Installation of energy efficient HVAC equipment.

•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.

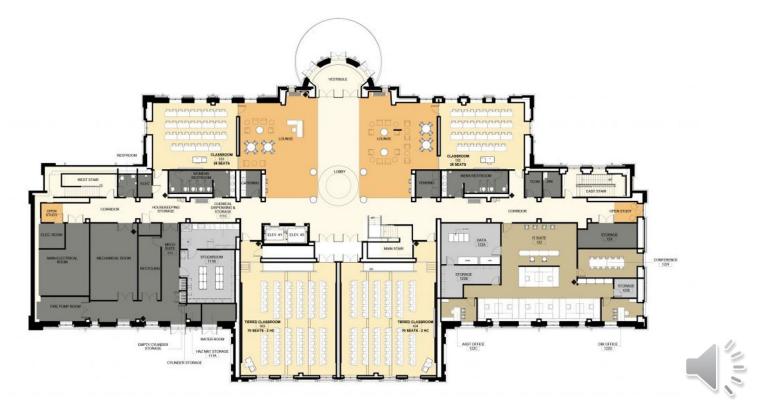
• Consider dual pane windows to further reduce thermal transmittance from the outdoors.



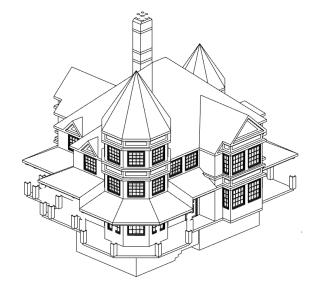




## **Design Goal Inspiration**



### **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.

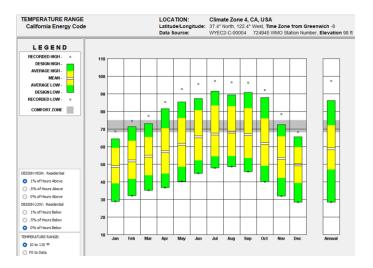


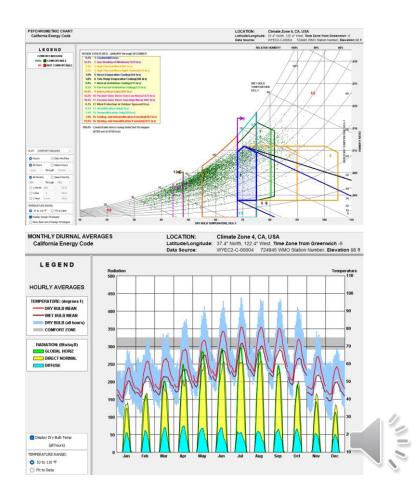


## **Local Climate**

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.





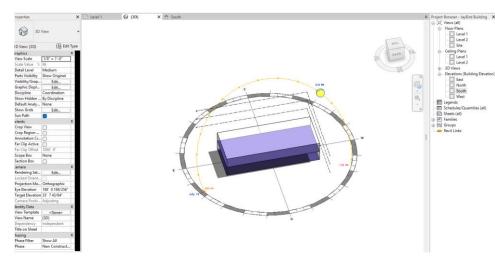
## **Conceptual Masses**

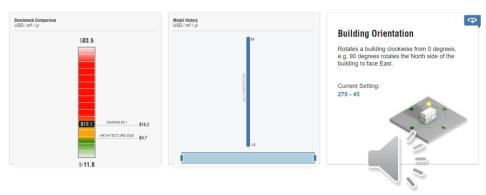
Explore Building Massing Alternatives by Creating Several Conceptual Mass Models:

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**

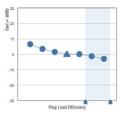
Alternative 2:

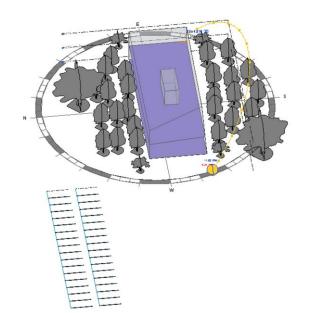
Implementing plug load efficiency features.

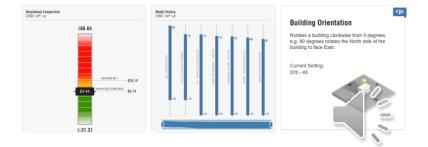
Editing: Plug Load Efficiency



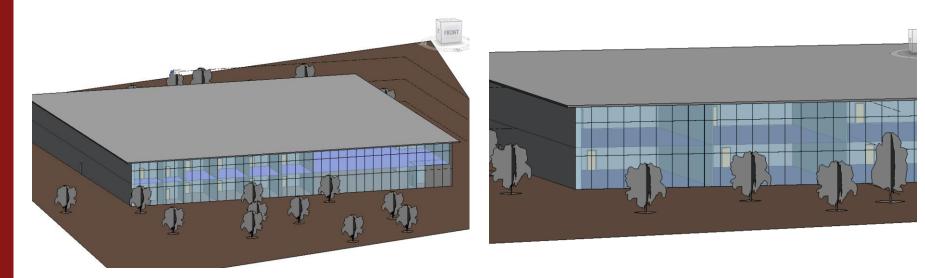
Plug Load Efficiency







## **Initial Building Design**





## **Building Design**



## **Building Design**



Stanford University

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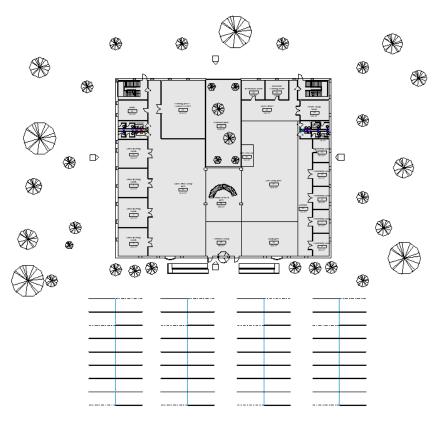
## **Space Planning & Building Layout**

Space Remaining

Space Budget Spreadsheet for Interactive STEM Learning Center Function Otv Length Width Area Total Area Design Features & Key Attributes for a Thriving Space LEVEL I 8 Small Meeting Rooms 20 20 400 1600 Will include a large table with 6 chairs and a projectors creen for meetings Café Barista Area 8 64 64 Thirspace will include a full coffee bar 8 Café Eating Space 50 50 2500 2500 The café will feature 12 round tables with 2 chairs each 20 Guart Lobby Area w/Reception Space 25 500 500. The quest labby area will be ature a large atrium that will travel up to the second floor and will have operable windows for natural ventilation. Large Private Office 18 15 270 270 This will be the CEO's office, it will be the largest office in the building Loarning Aroa 1 -- Calculur Contor 40 1600 40 1600 The exhibit spaces feature the same area and same furniture layout 1600 Learning Area 2 -- Physics Center 40 40 1600 The exhibit spaces feature the same area and same furniture layout Learning Area 3 -- Neurgraience Center 40 40 1600 1600 The exhibit spaces feature the same area and same furniture layout Locture Room 50 40 2000 2000 This locturespace will be used for orientation finformational program meetings Conference Rooms 12 22 396 792 Will fit a large rectangular meeting table to hold large conferences -21 22 13 286 Public Rostrooms 2 572 Large public restraams -- ane far men and another far wamen X Office Restrooms 12 12 144 144 Private restroom for office area X Laboratory Space 16 12 192 768 Laboratory spaces for conducting experiments - d | TOTAL LEVEL I 14,010 LEVEL II Loarning Aroa 4 -- Biology Contor 40 40 1600 1600 The exhibit spaces feature the same area and same furniture layout Learning Area 5 -- Engineering Center 40 1600 1600 The exhibit reaser feature the same area and same furniture layout 40 Loarning Aroa 6 -- Chomirtry Contor 1600 1600 The exhibit spaces feature the same area and same furniture layout 80 Study Area 20 6400 6400 Tuin to exhibit space 4, larger space. Near edges to capture heat Supply Storage Room 15 225 225 Tuin to exhibit space 3, larger space. Near edges to capture heat 25 1000 Laboratory Contor 40 1000 Laboratory spaces for conducting experiments 20 600 Hallwayz 30 600 Hallways will be rectangular and wide enough to adhere to ADA design guidelines 20 700 Mechanical Room 35 700 Near the Bestrooms 30 Restrooms 15 450 450 Near the Stairs arsoon ar youset foot on the second floor TOTAL LEVEL II 14,175 TARGET **Overhead** Percentage 25% 7500 Space Budget 30000 **Total Space** 28,185

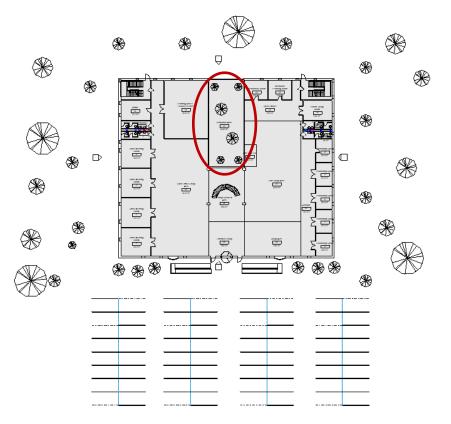
1,815

### Floor Plan: Level I



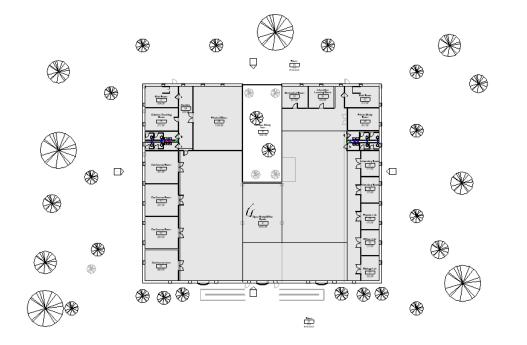


### Floor Plan: Level I



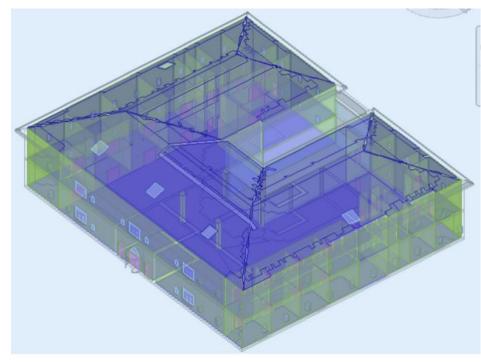


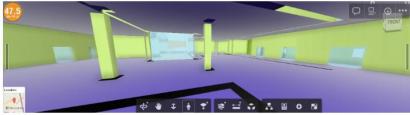
### Floor Plan: Level II





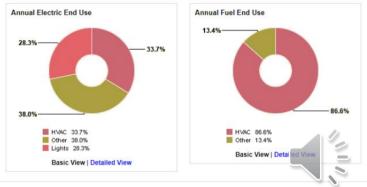
### **Analytical Surfaces**





#### The Energy End Use Charts





## **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

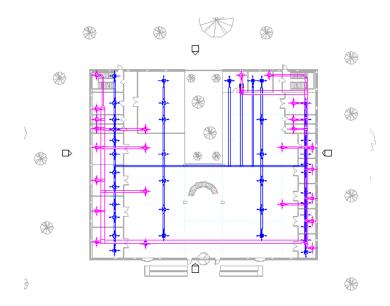
• Adjusting the North Window Shades to 1/2 window height lowered the overall mean EUI to 54.4 kBtu/ft2/yr. •Window Shades — West

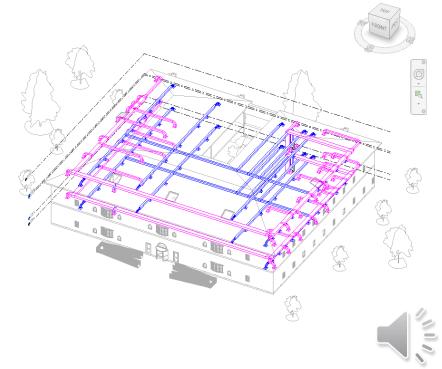
• Adjusting the West Window Shades to 2/3 window height lowered the overall mean EUI to 53.1 kBtu/ft2/yr. •Window Shades — East

• 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 anoverall mean EUI of 45.8 kBtu/ft2/yr.

## **HVAC System Model**



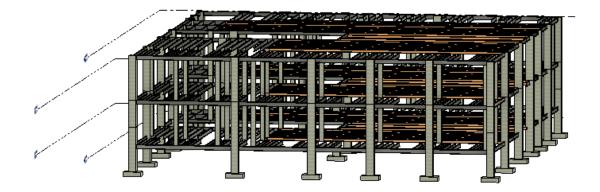


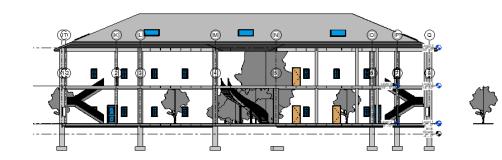
## **HVAC System Model**





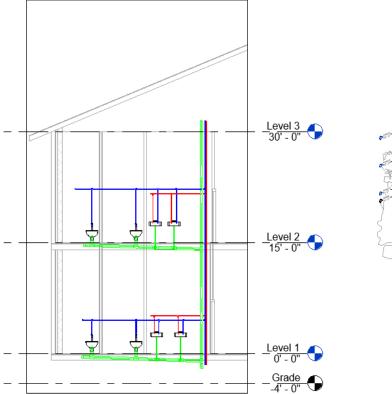
## **Structural System Model**

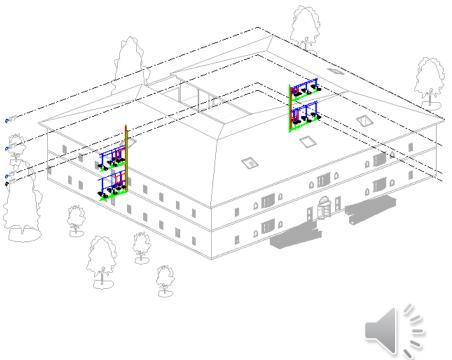




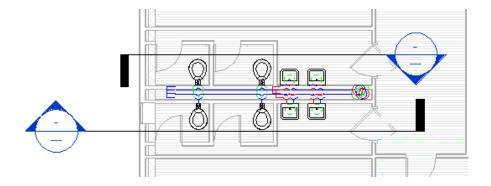


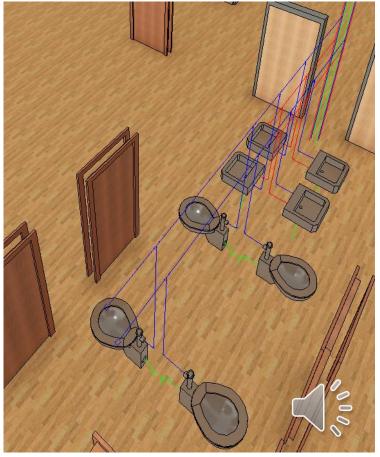
## **Plumbing System Model**



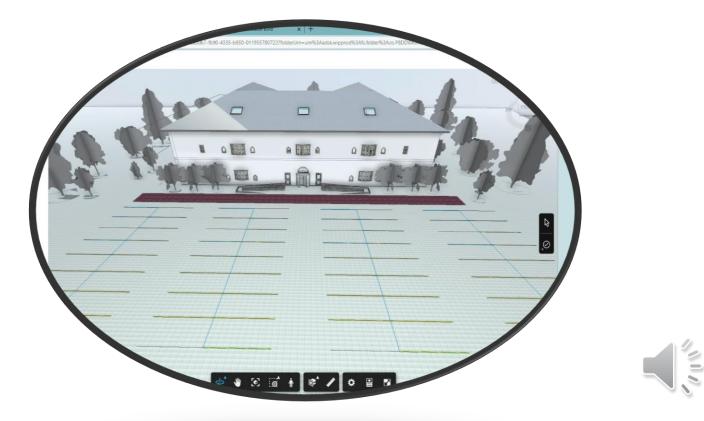




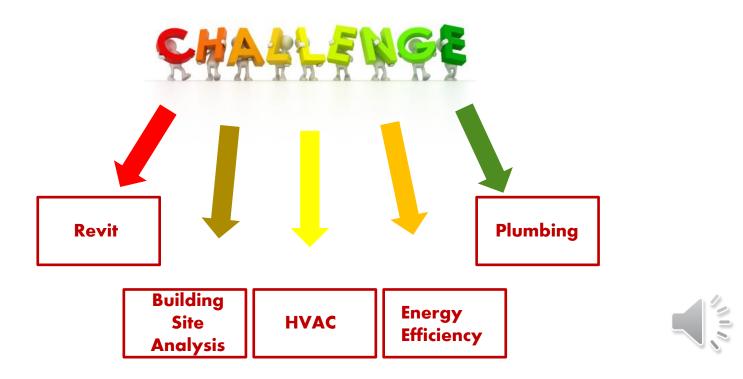




## **Building Model Virtual Tour**



## **Learning Challenges**



## Learning Takeaways



- Practice makes perfect ③
- Be kind to yourself, working with Revit is not simple <sup>(2)</sup>



