



**COACH
ENERGY SIMULATORS
ENGINEERS**

Nick Caton, Caton Energy Consulting, Kansas City
Chris Jones, WSP Toronto
Pasha Korber-Gonzalez, Korber Energy Consultants
Aaron Powers, Johnson Controls Memphis
Cara Sloat, WSP Toronto

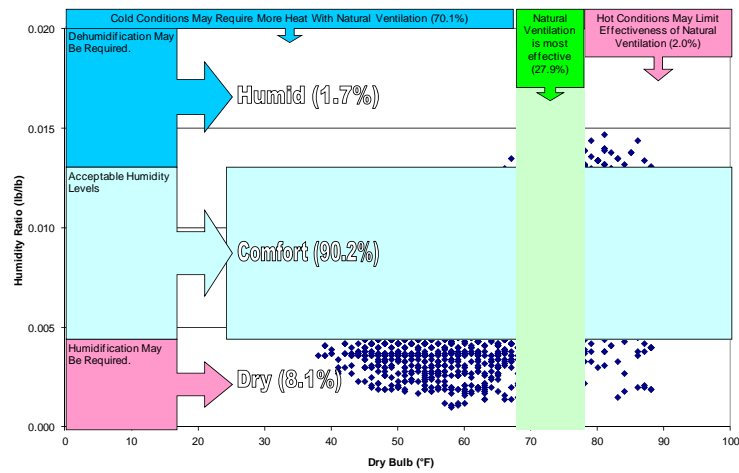
GOALS

During our 10 week design process we set out to design a building and...

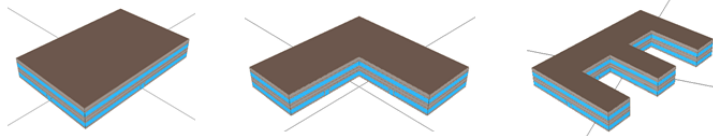
- Achieve net-zero energy and minimum carbon footprint
- Demonstrate flexibility of E-Quest/DOE-2
- Push our abilities
- Learn & share
- Have fun!

CLIMATE & GEOMETRY

We selected **San Jose, California** as the home for our new 53,000ft², 3 story office building. This climate zone allowed for innovation: based on exploration of available psychrometric data using Climate Consultant 6.0, and review of Pacific Energy Center local design strategy recommendations, San Jose has good passive energy opportunities for natural ventilation, solar shading and passive heating, and some potential for use of thermal mass strategies.



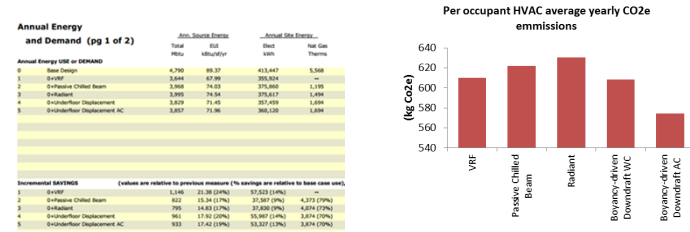
eQuest's wizard function allowed major features of the building (such as geometry) to be changed with low labour costs, providing a snapshot of the energy potential for several geometry options. We were particularly interested, due to the high insolation of the area, in investigating possibilities for different shapes to offer self-shading. On the basis of this study we selected an L-shaped footprint for the project



	Rectangle Shape	L-Shape	E-Shape
Wall Area (ft ²)	8,505	10,284	14,818
WWR	40%	40%	40%
Perimeter Access to Daylight (ft ²)	7,290	9,000	9,103

MECHANICAL SYSTEMS

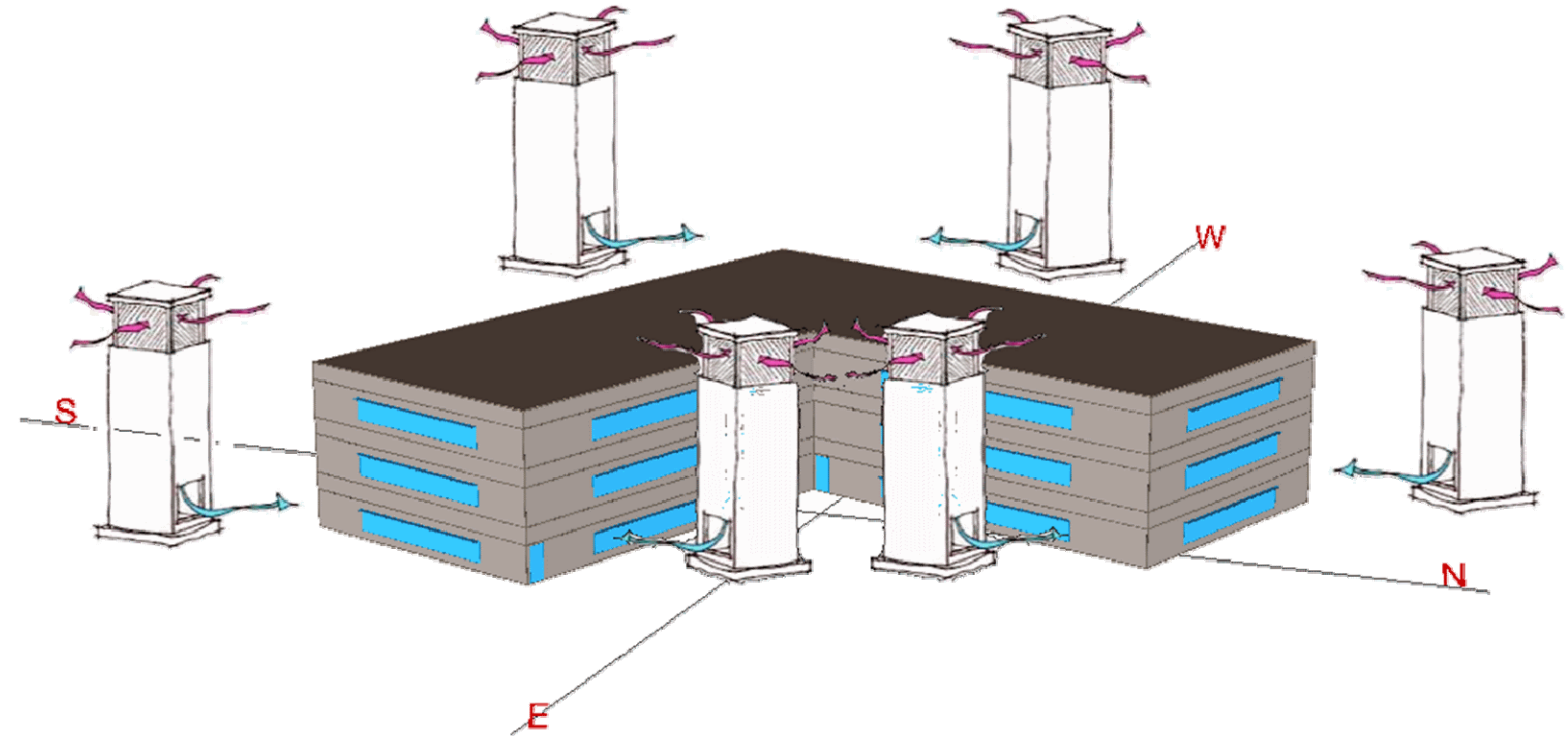
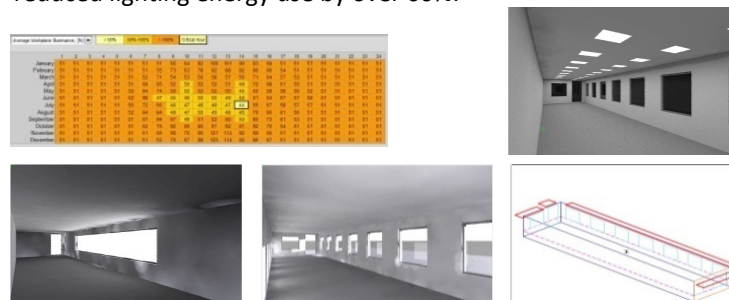
For active systems, initial investigation was driven by HVAC systems we were interested in modeling. Variable refrigerant flow systems; passive chilled beam; radiant in-ceiling heating and cooling; and buoyancy-driven downdraft supplied from underfloor were examined. Although the VRF showed the strictly lowest energy use, when lifetime climate change impact of expected fugitive F-gases are included, minimum climate impact over time was achieved by passive downdraft.



The buoyancy-driven system uses cooling coils at high level, and heating coils at the entry of the underfloor distribution system, in combination with active wind harvesting to condition and move air through the space year round, with radiant in-ceiling systems to meet auxiliary requirements. A total of 6 3'x3', 39' high towers were needed to achieve the required airflows. Both energy simulation techniques and the design were inspired by the De Anza College system, pictured above, and associated published work by the simulation team for that and other projects. (Corney, Taniguchi, 2011.)

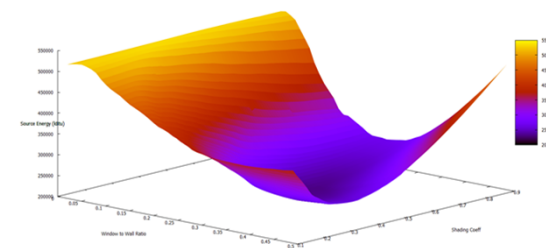
DAYLIGHT

SPOT Pro was used to optimize our design to reduce glare and maximize useful daylight throughout the year. Running on a RADIANCE engine, it also exports fractional daylighting schedules directly in DOE-2 and EnergyPlus formats. This optimization reduced lighting energy use by over 60%.

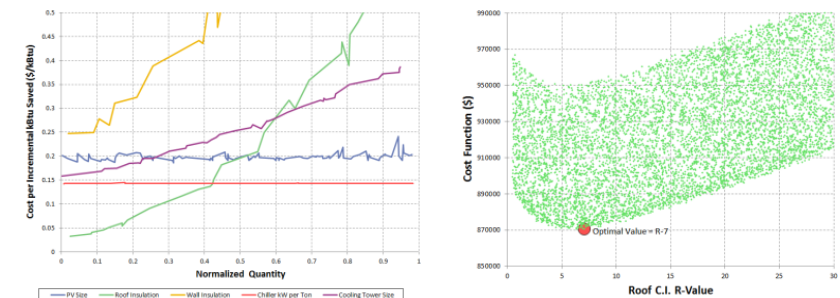


AUTOMATING OPTIMIZATION RESULTS

Multi-variable optimization algorithms were used to minimize the building consumption with respect to 24 design parameters simultaneously. These parameters ranged from building envelope characteristics to control points on the chilled water plant. Using a two-variable case for demonstration purposes, the use of simultaneous algorithms resulted in 20% less consumption vs optimizing each variable individually. The algorithmic efficiency of the DOE2 engine allowed the team to run up to 60,000 simulations overnight on an ordinary PC.



The net-zero requirement afforded our team the opportunity to modify our optimization problem to minimize the building cost while requiring all simulations to be net-zero. Using market rates for insulation, PVs, and mechanical equipment, our final optimization resulted in a balance between renewables and building side efficiency based on cost. In other words, our final design resulted in the least expensive net-zero building.



The final design for our building achieved 23kbtu/ft²/year before adding on-site power generation. This consumption was offset with a 135kW roof mounted PV system to bring the net consumption to zero. Without considering cost, our design would have resulted in a lower building-side consumption with less PV, but this would have resulted in a more expensive building with the same performance.

