Designing for Ventilation with CFD

Evergreen State College Costantino Recreation Center

Portland State UNIVERSITY

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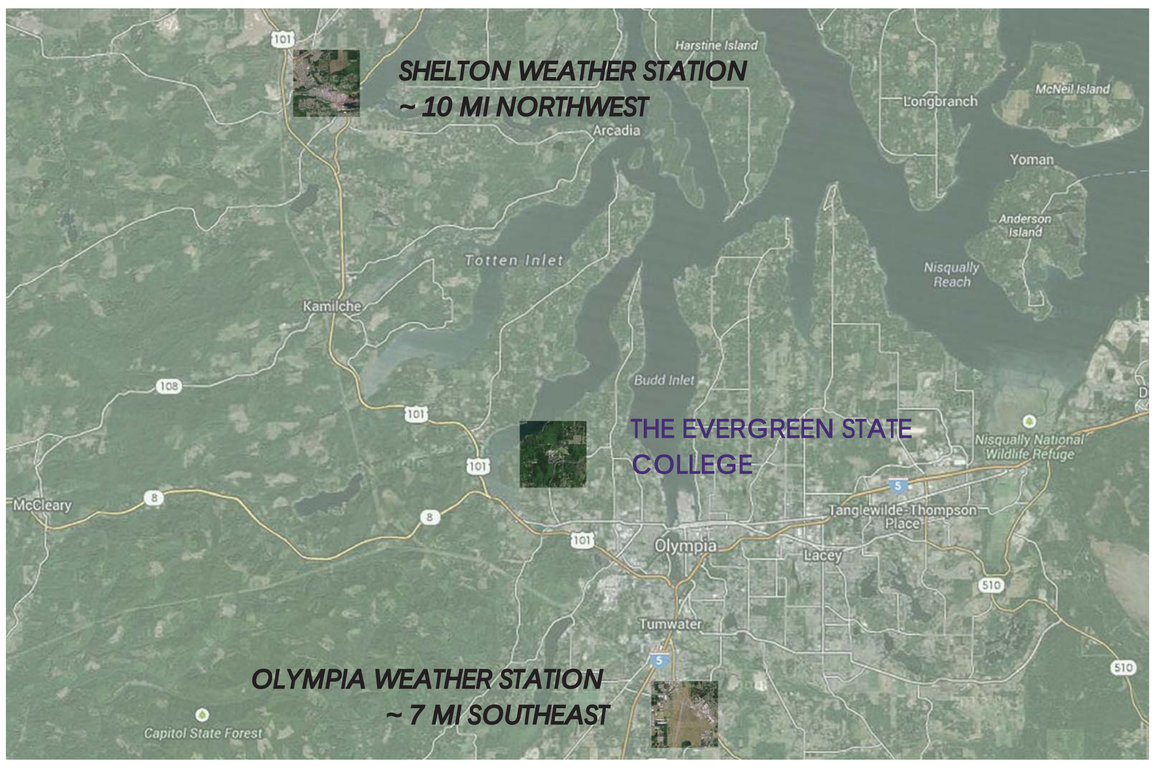
Project Background

The Evergreen State College is located in Olympia, WA. @ 46.97° N, 122.9° W elev 200 ft.

The Costantino Recreation Center (CRC) houses the offices for all head coaches, athletic training, and recreation and athletics administrative staff. The CRC gymnasium holds three full-size basketball courts and four full-size volleyball courts, and can seat up to 1,500 for events. It was last re-modeled in 1990 to add a gymnasium, multi-purpose exercise room, office space and wellness center, and general recreation use by students, faculty, staff and members of the community.



Project Goals

Working with Yost Grube Hall Architects (YGH), our team was trying to determine the viability of natural ventilation as part of the design and renovation of the CRC. To that end our goals were:

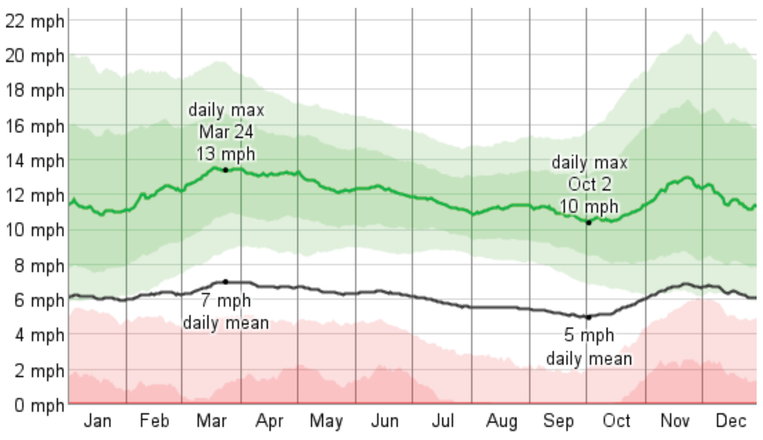
- Determine optimum air flow and ventilation.
- Determine how High Volume Low Speed fans effect ventilation.
- Provide comparison between 'optimal' design and standard priced design.

Assumptions

We made the following assumptions in setting up this iterative testing process:

- Use wind data from Olympia, WA
- Extremely simplified model
  - Missing complex model elements (Bleachers, Trusses, etc.)
  - Missing surrounding context (Buildings, Trees, etc.)
  - Only modeled operable openings
- No forced air or buoyancy driven air flow data
- Incomplete heat transfer and radiation data
- Trust the software (Autodesk CFD 2015)

Wind Data



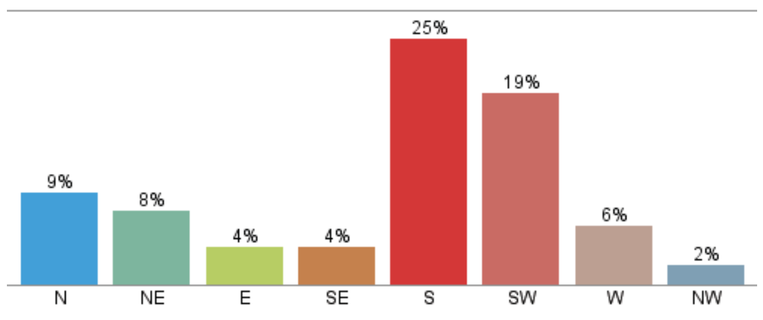
Beaufort Wind Scale

Calm: >2 km/h (1.2 mph)
Smoke rises vertical

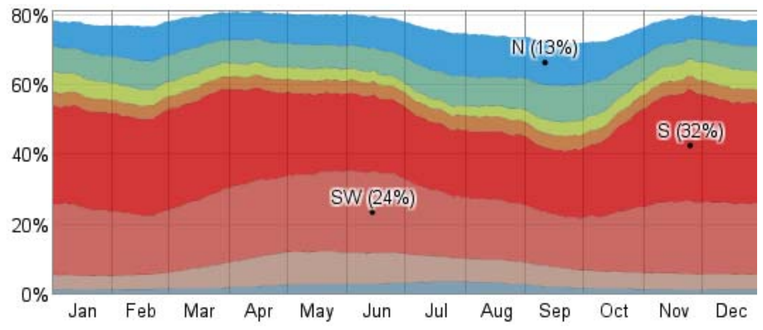
Light Air 2 – 5 (1.2-3.1)
Smoke doesn't rise vertical

Light Breeze 6 – 11 (3.7-6.8)
Wind felt on face

Left: Average Wind Speed
Below: Wind Direction Average per Annum



Below: Wind Direction per Month



Method

Our method was to start simple and add complexity. We started with our very basic gym model, then added fans and occupancy and re-evaluated the results. These results were then compared to the results from the priced design.

1. **Determine optimum air-flow.**
   We ran iterative designs to determine the optimum air flow. We used a graphical representation of air speeds in the occupied zone to determine which designs produced the best airflow.

2. **Run Simulations with Fans and Occupancy in Parallel.**
   After determining the optimal design, we added the same amount of people and fans to the space a ran the results again.

3. **Compare Priced and Optimal Designs.**
   Once the second set of tests were complete we compared the two designs and determined which option provided the best ventilation.

Conclusions

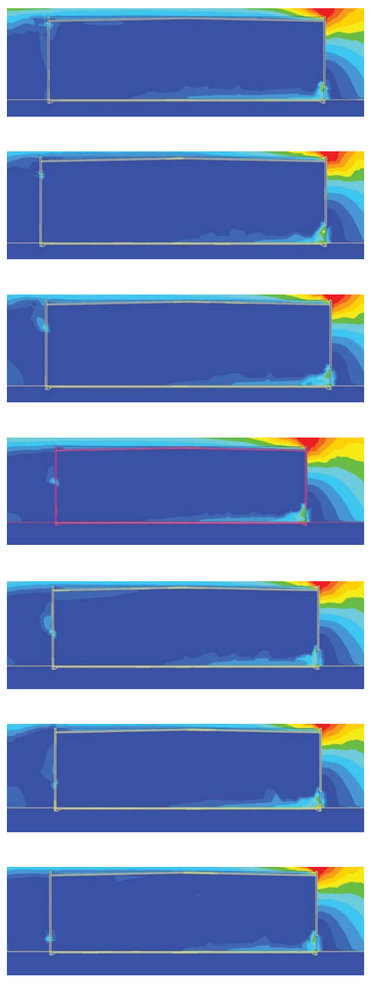
Ultimately we ran out of time to complete our goals and were unsuccessful in fully determine the best use of ventilation. Our biggest challenge was the software integration and our understanding of CFD principals. With more time, we could have figured CFD out and produced more accurate and relevant results.

When comparing the our optimal design and the design priced-out by YGH. Both preformed similarly, although the optimal design showed consistently more uniform mixing of air. Further testing is required to determine if the optimal design performs better in buoyancy driven scenarios.

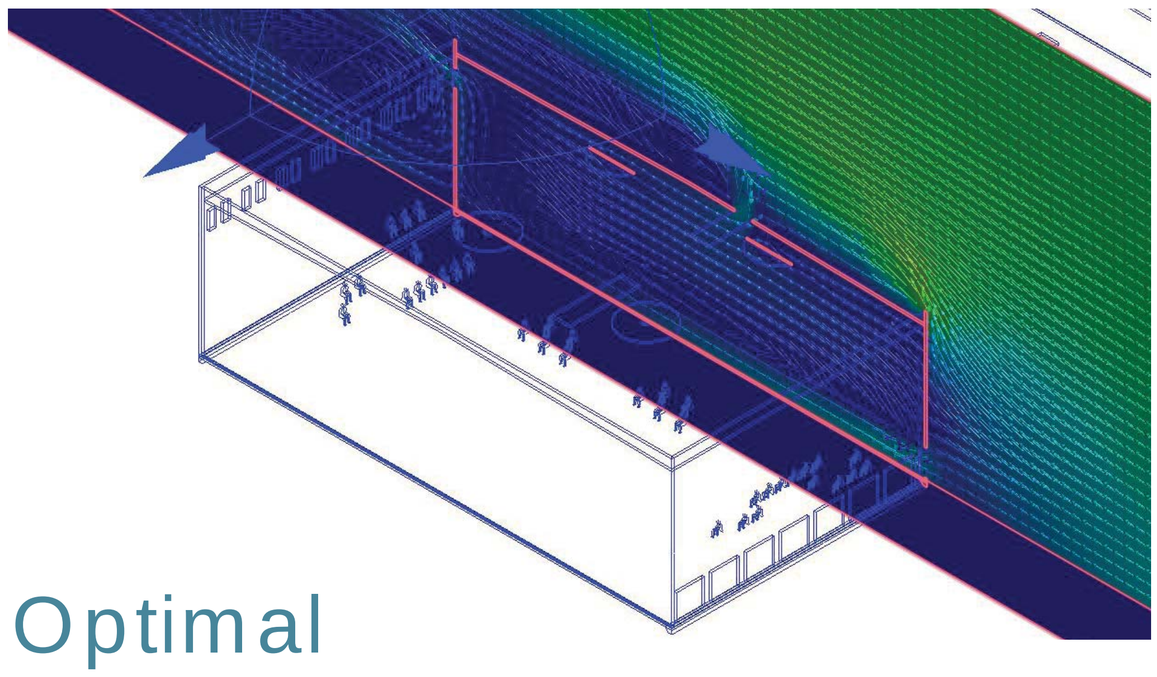
Results

Wind Speed Scale (Km/h)

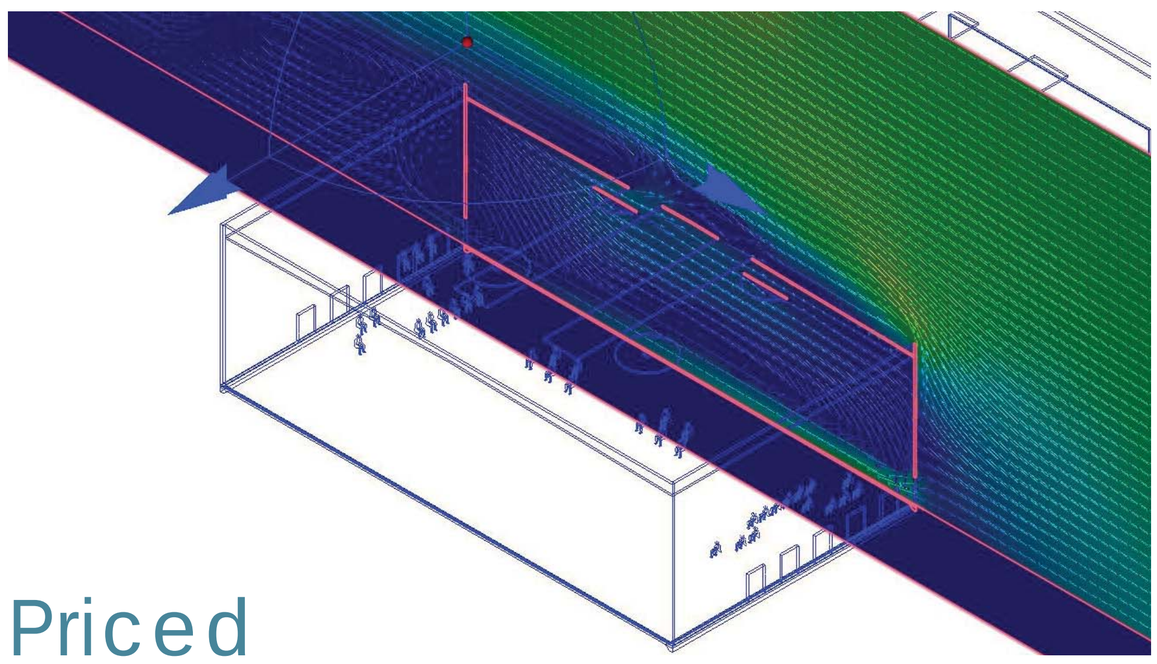
5 - 6
4 - 5
3 - 4
2 - 3
Calm
10 - 12
9 - 10
8 - 9
7- 8
6 - 7



Sample Iterative Testing.
Looking at height differences in opening placement.



Optimal



Priced