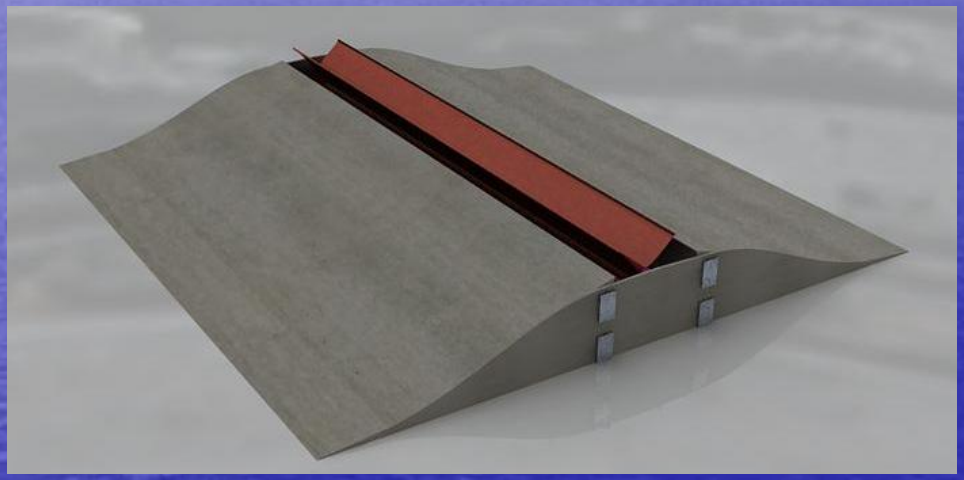
IPRO 323: Modeling of Building-Integrated Wind Turbine Modules



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IPRO Program Team Mission Statement

Provide IIT students with an exemplary experience in making contributions as part of a high-performance multidisciplinary team by applying professional methods in a rigorous fashion to develop viable solutions that create value

This IPRO:

Bring together students from Aerospace, Mechanical, and Electrical Engineering to work, collectively, on a practical wind energy design problem

Team Organization

Leader: Antonio Gonnella

Wind Tunnel

Jonathan Swanson

Nyla Husain
Jose Amodio Leon
Antonio Gonnella
Tom McManus
Lucas Pfiffner
Taylor Dizon

CFD

Taylor Dizon

Nyla Husain
Jose Amodio Leon
Antonio Gonnella
Tom McManus

Research

Edward Ciciora

Corey Bushcott
Thiago Jardim
Lucas Pfiffner
Jaeyoung Kim
Kent Hoffman

Architectural R&D

Corey Bushcott

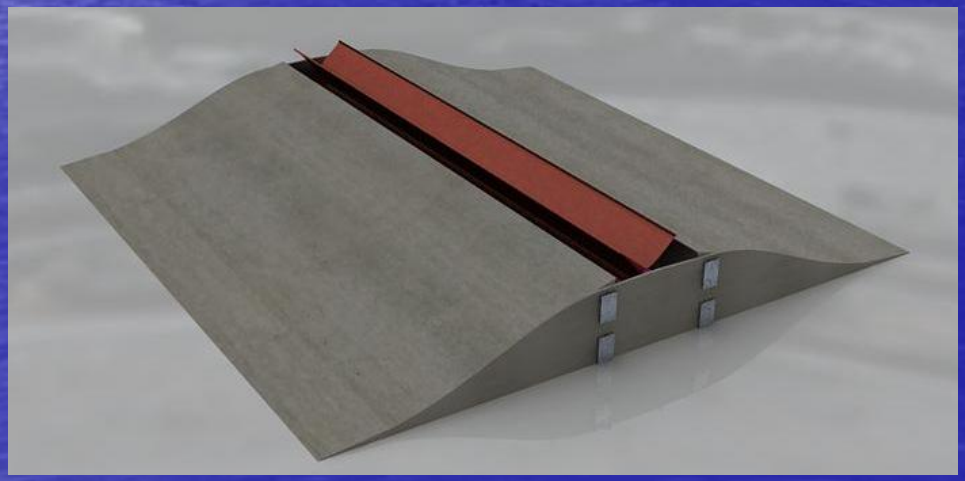
Edward Ciciora
Thiago Jardim
Jaeyoung Kim
Kent Hoffman

Building-Integrated Wind Turbine Modules

Team Purpose and Goals

The long-term goals of this IPRO are:

- Optimization of the power output of a small-scale wind turbine system
- Design and development of a custom turbine system
- Integration of the system into buildings and cityscape

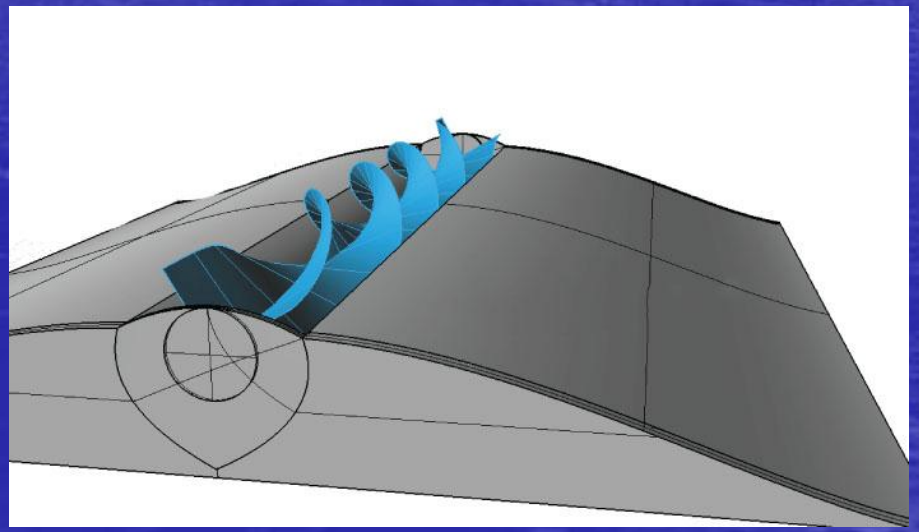


Building-Integrated Wind Turbine Modules

Team Purpose and Goals

The team for this spring's IPRO was working on the following semester objectives:

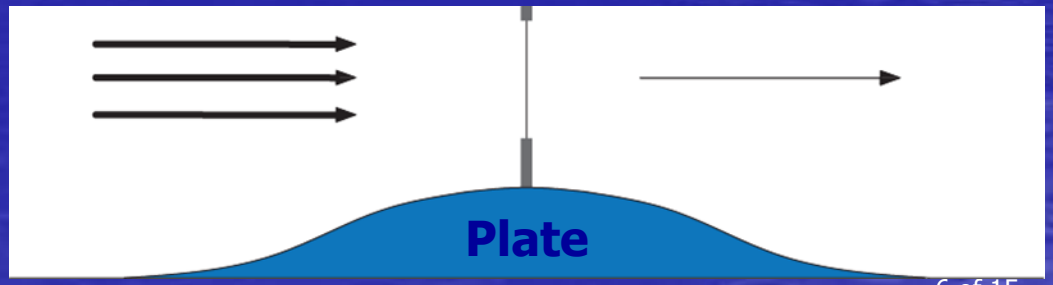
- Measure the effects of surface shape on power output
- Digitally model a building with the surface design
- Estimate the costs versus the benefits



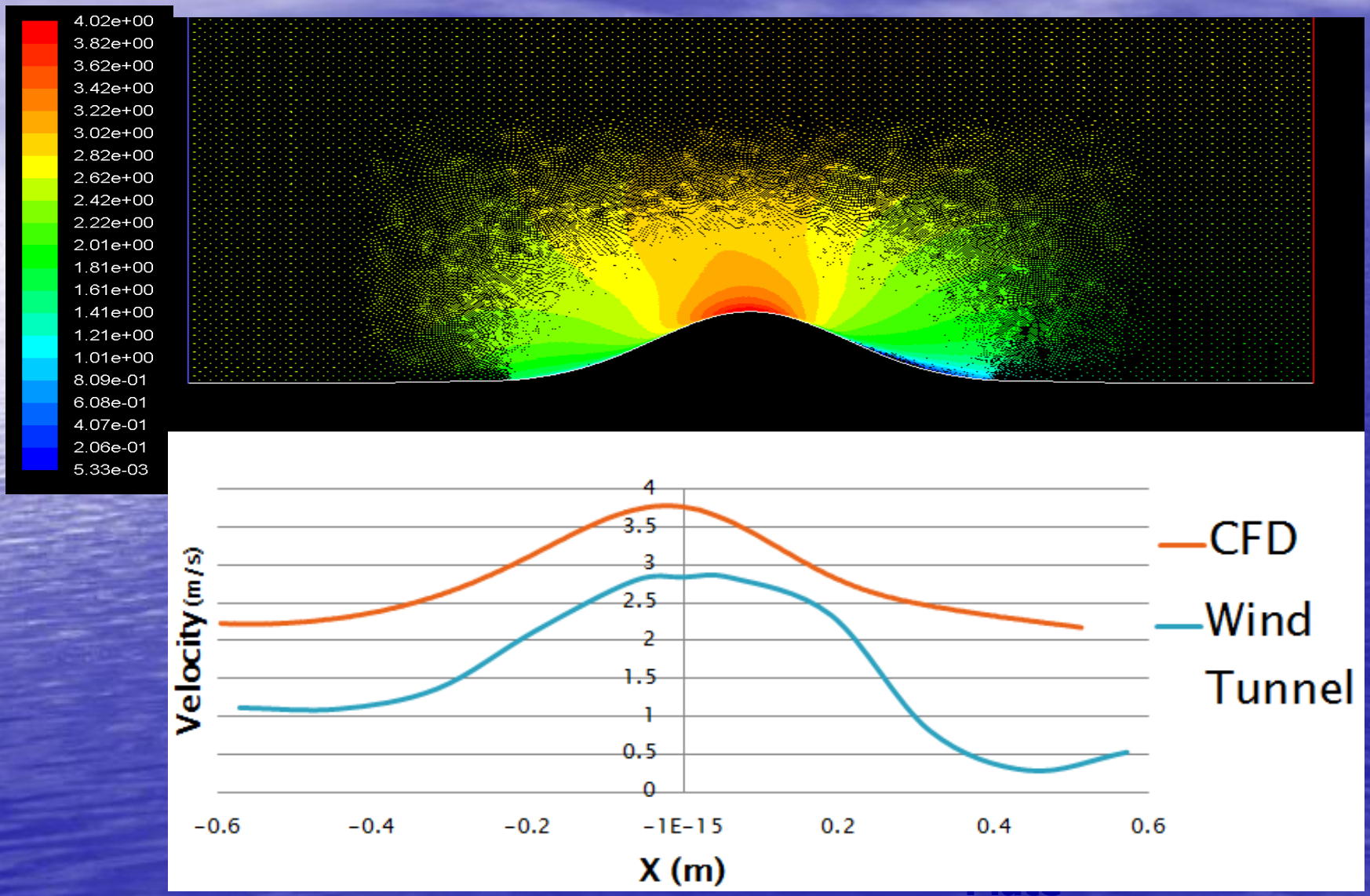
Building Integrated Wind Turbine Modules

Spring 2011 Focus:
Surface Design for Building Integration

- Develop a surface shape that maximizes the output of the turbine
- Turbine is simplified to a principle model: Perforated Plate
- Perforated plate simulates the effects of a wind turbine



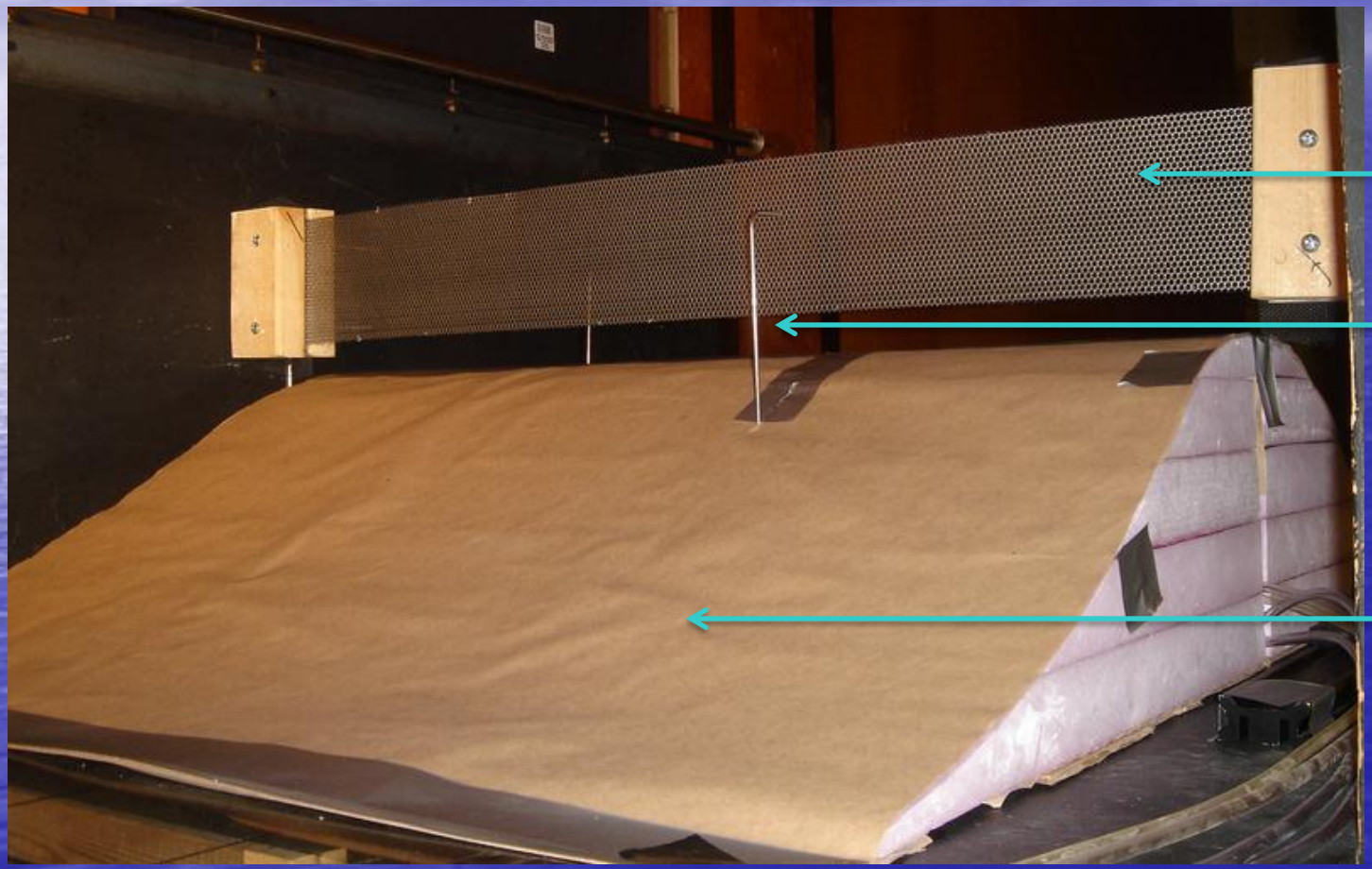
Computational Fluid Dynamics



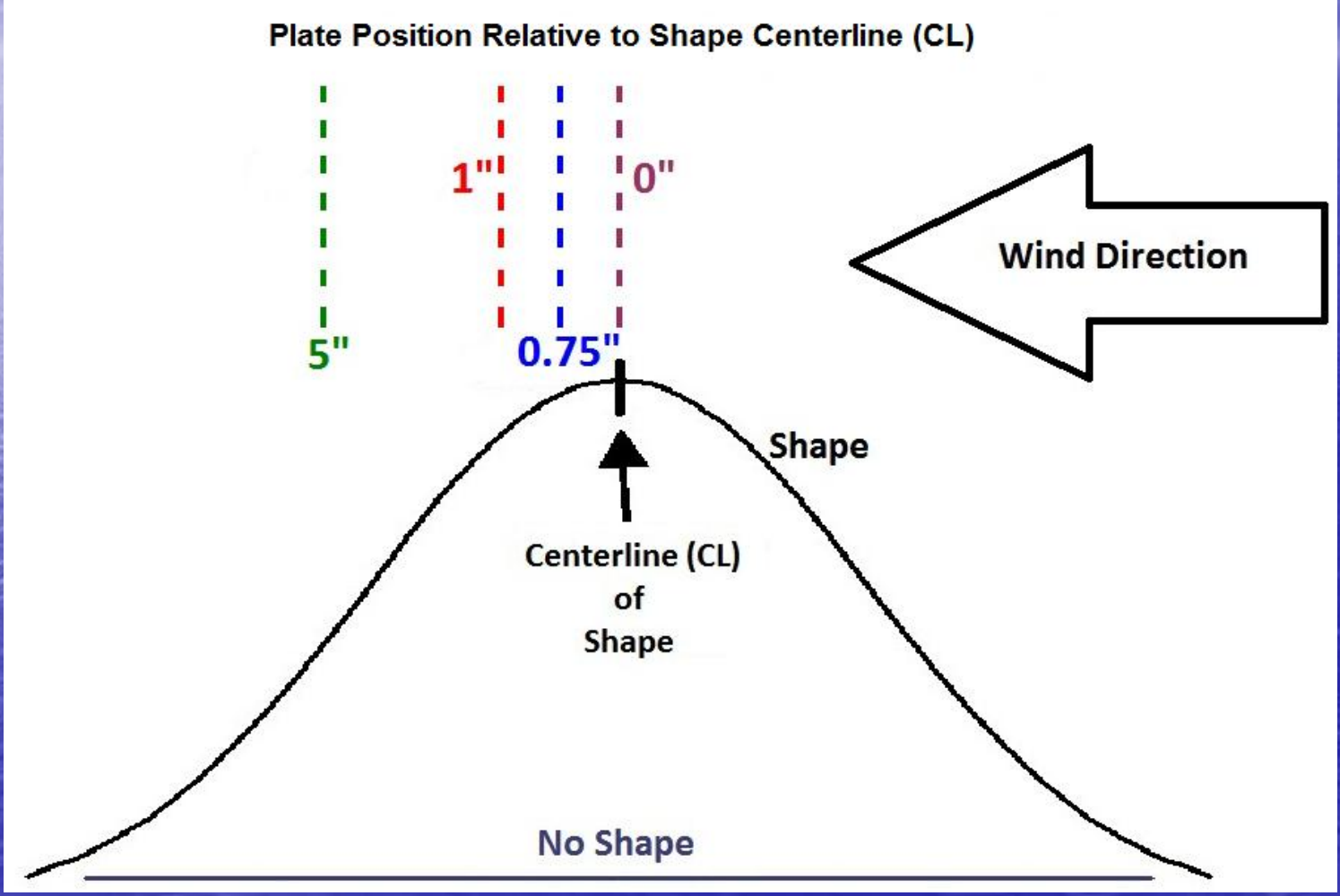
Wind Tunnel Team Accomplishments

- Wind tunnel instrumentation and software
- Methods for measuring velocity and pressure distributions

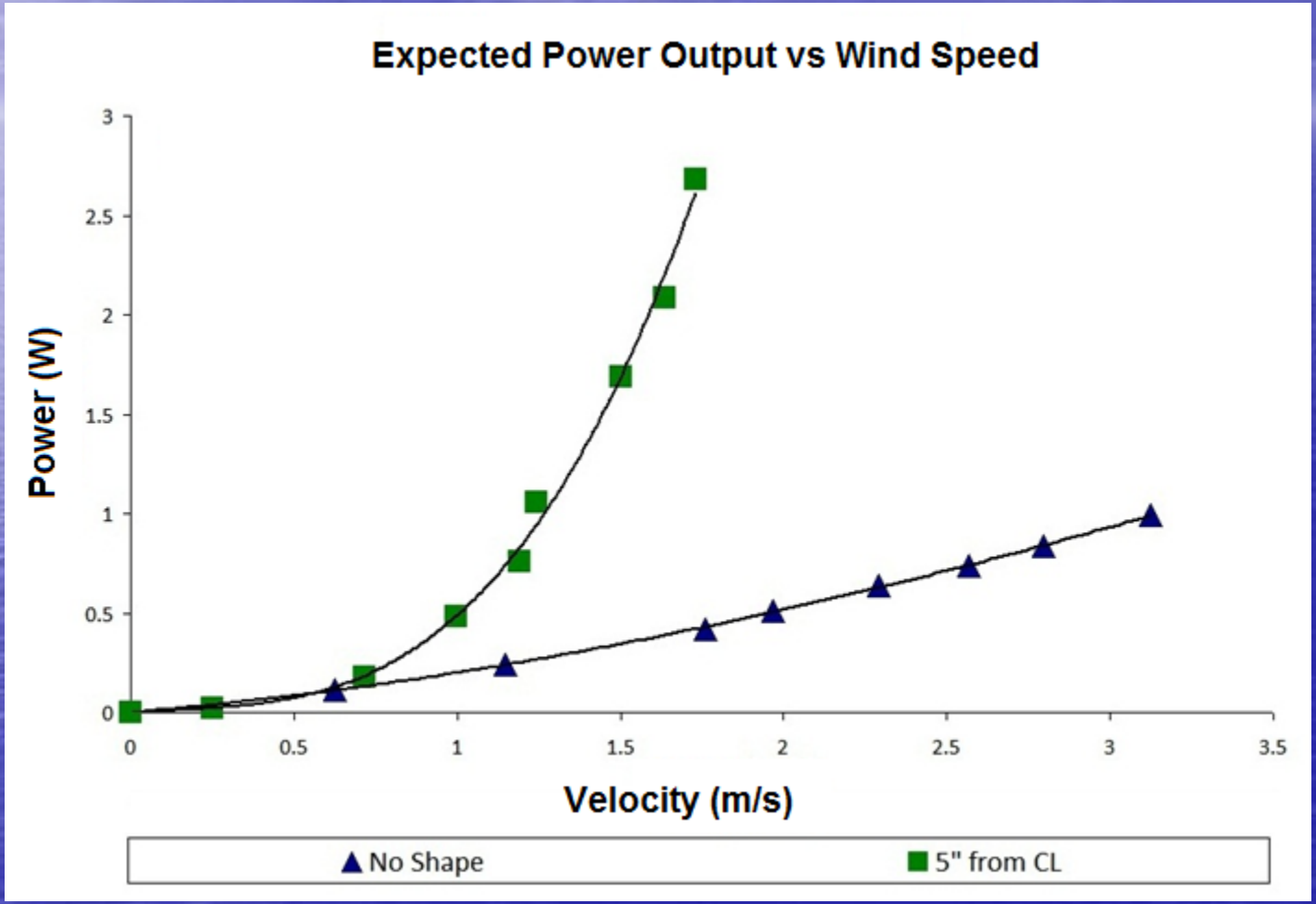
Wind Tunnel Set-Up



Wind Tunnel Set-Up

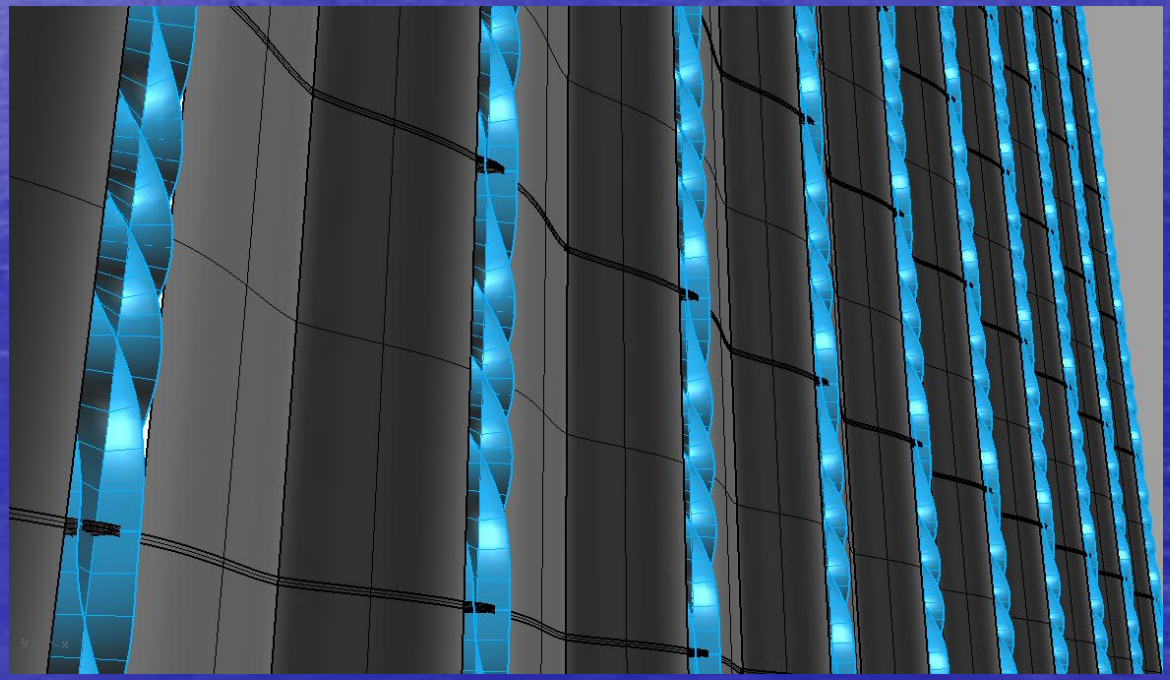


Results


Expected Power Output vs Wind Speed
Power (W)
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
3.5
Velocity (m/s)
No Shape
5" from CL

Architectural R&D Team Accomplishments

- Modeled buildings
- Estimated cost
- Estimated power



Building Power Consumption Estimation

- Mid-sized office building uses 167 kWh/m^2 annually
- Initial tests estimate:
  - 67.5 kWh/m^2 annually for 5 m/s
  - 536.6 kWh/m^2 annually for 10 m/s

Cost Estimation

Tubular aluminum frame	
Approx. 45′ of ¾″ sq. tubing	**$50**
Welded	
$50	
Molded plastic upper	**$500/100**
Foam insulation	**$20**
Turbine body	
Solid paddle	**$10**
Solid savonius	
$20	
Membrane paddle/savonius	**$30**
Magnetic generator	
$100	
Transformer	**$65**
Total	**$315**

Future Work

- Optimize power output
- Test multiple surface designs
- Turbine considerations
- Integrate system