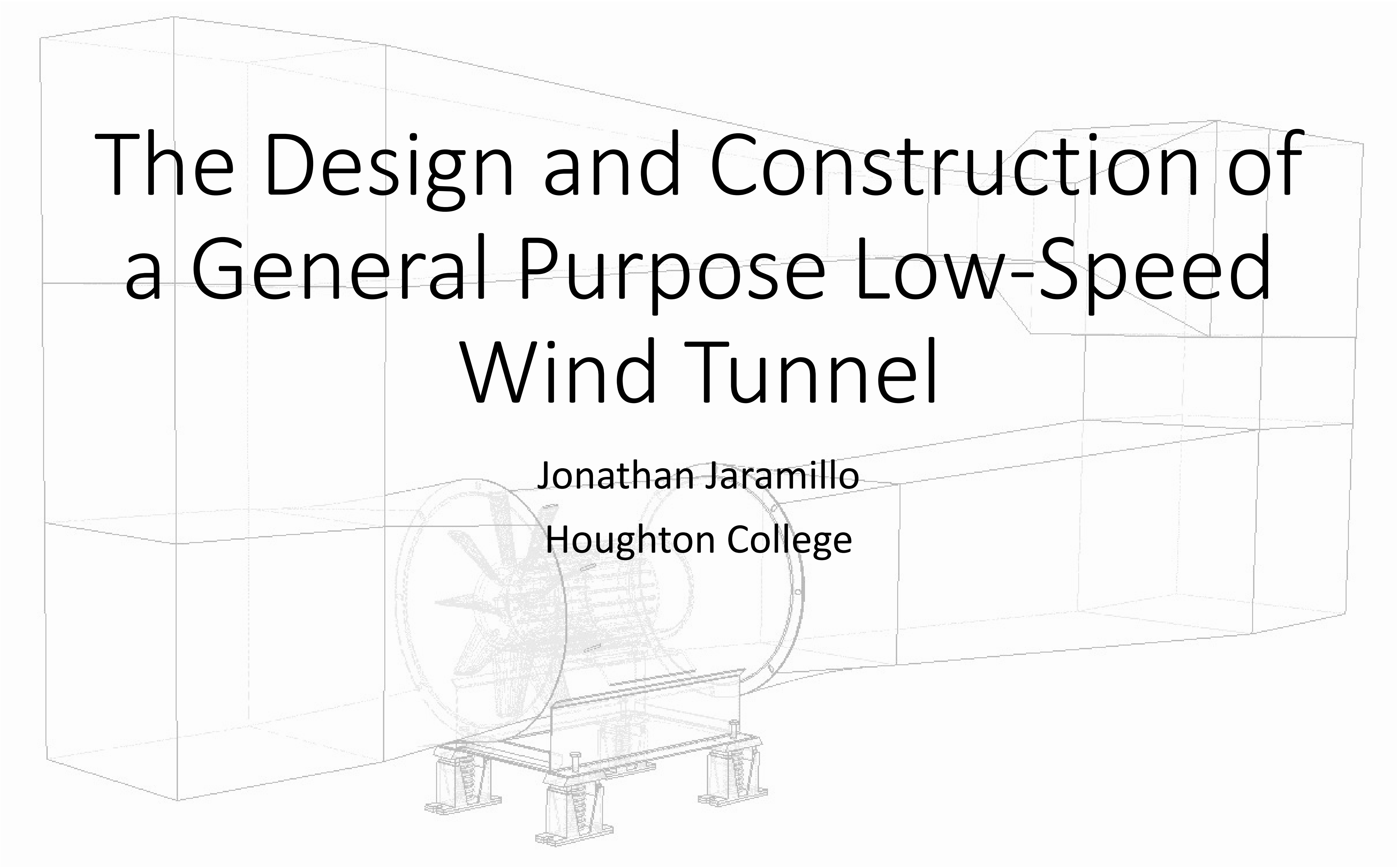


The Design and Construction of a General Purpose Low-Speed Wind Tunnel

Jonathan Jaramillo

Houghton College

Outline

- The goal and background
- Theory
- Wind tunnel overview
- Design process
- Progress
- Future work

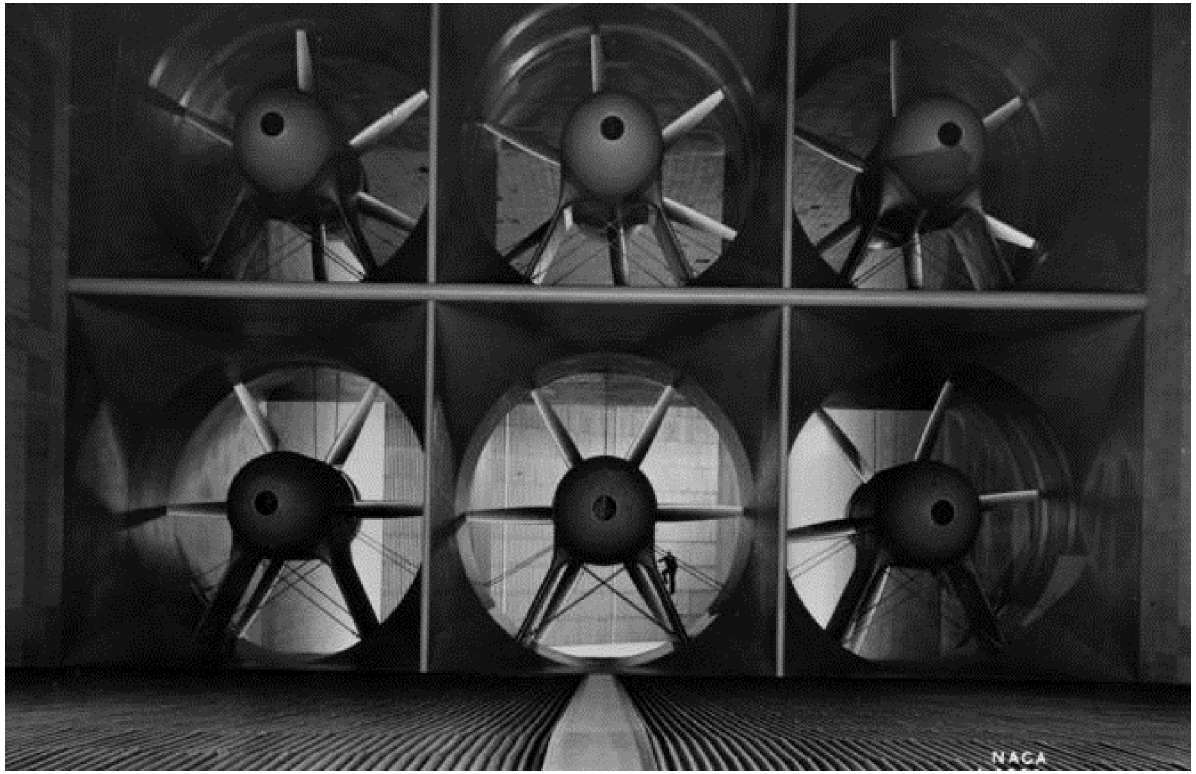


Photo credit. National Advisory Committee for Aeronautics. Harry S. Truman Library & Museum

The Problem

$$\rho\left(\frac{\partial u_j}{\partial t}+\frac{\partial}{\partial x_k}(u_j u_k)\right)=-\frac{\partial p}{\partial x_j}+\mu\frac{1}{Re}\frac{\partial}{\partial x_i}\left\{\left(\frac{\partial u_i}{\partial x_j}+\frac{\partial u_i}{\partial x_j}\right)-\delta_{ij}\frac{2}{3}\left(\frac{\partial u_k}{\partial x_k}\right)\right\}$$

- Often no exact solutions
- Wind tunnels are vital to the aerodynamic design process
- Houghton wants to increase experimental aerodynamic capabilities

Approximate Theory

$$p + \frac{1}{2}\rho v^2 + \rho g h = \text{Constant}_1$$

$$\rightarrow p + \frac{1}{2}\rho v^2 = p_o$$

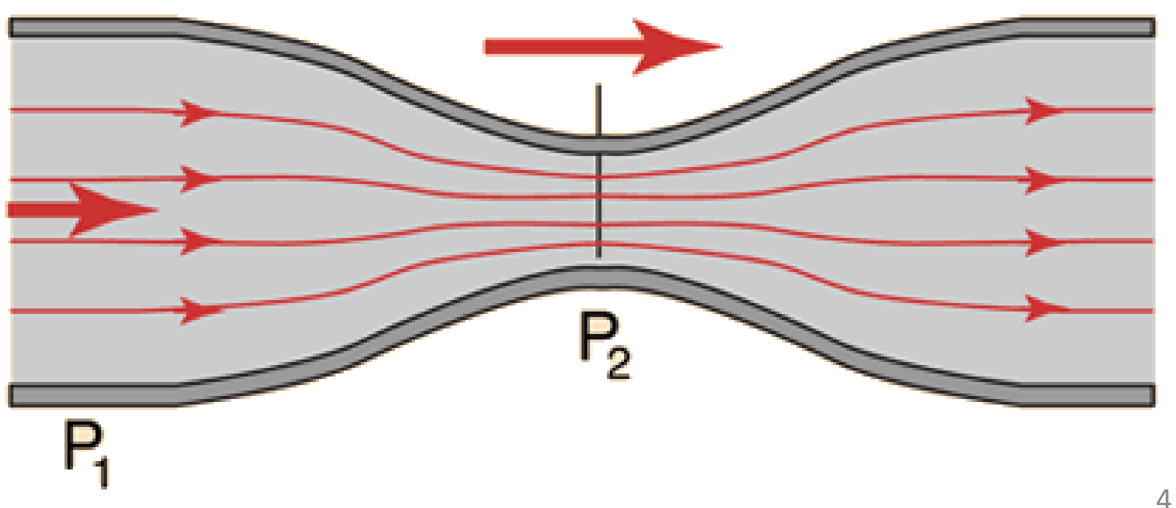
Cons. of energy

$$Av = \text{Constant}_2$$

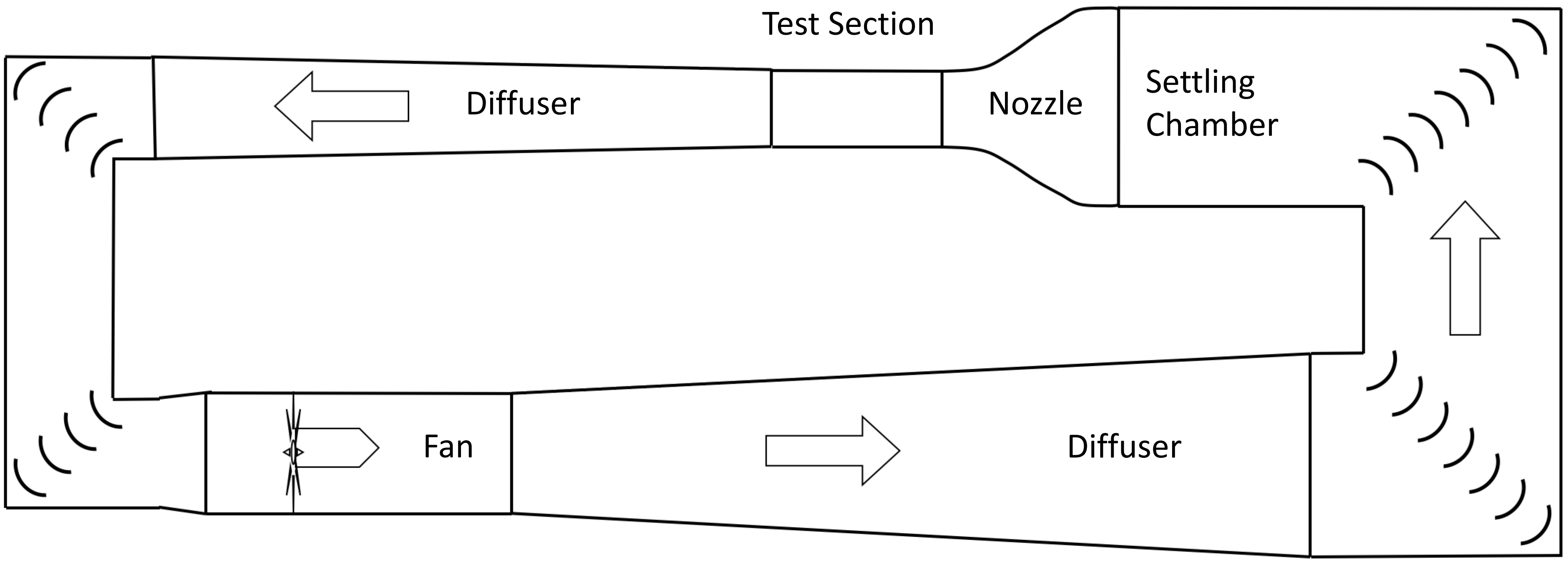
Cons. of mass

- Inefficiencies cause pressure drops

http://www.wikilectures.eu/images/7/77/Bernoul.gif



Closed Circuit



Efficiency Theory

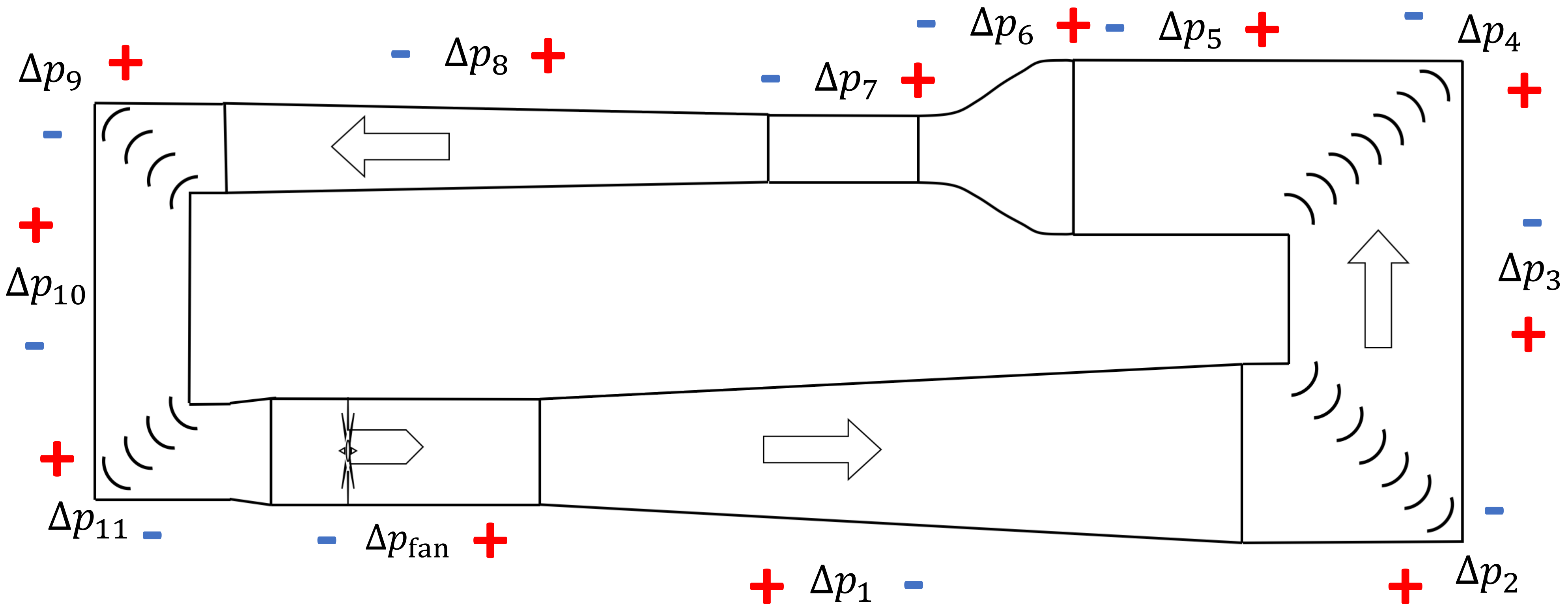
$$p + \frac{1}{2}\rho v^2 = p_o$$

$$\Delta p_{0i} = k_i\left(\frac{1}{2}\rho v^2\right)$$

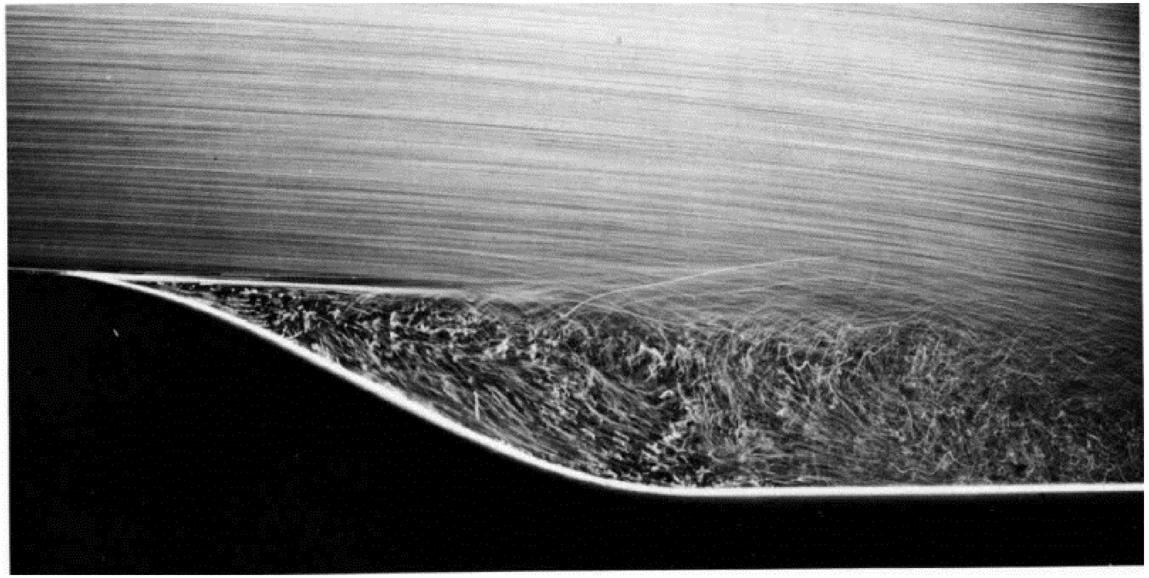
- k_i calculated using semi-empirical equations
- Approximate stagnation pressure drop for each component

Closed Circuit

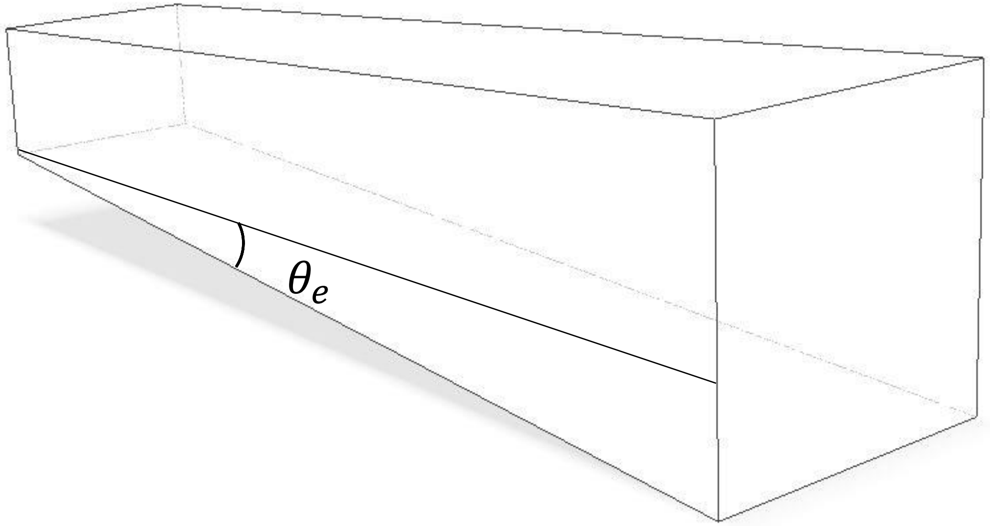
$$\Delta p_i = k_i \left(\frac{1}{2}\rho v^2\right) \qquad \Delta p_{\text{fan}} = \sum \Delta p_i$$



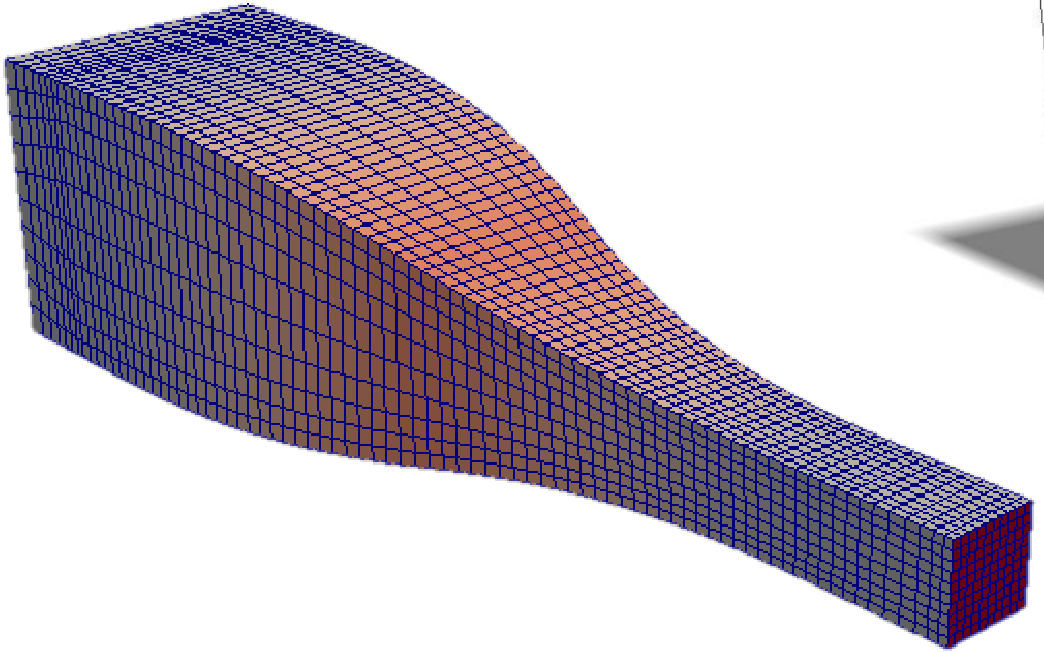
Constraints – Size of Room

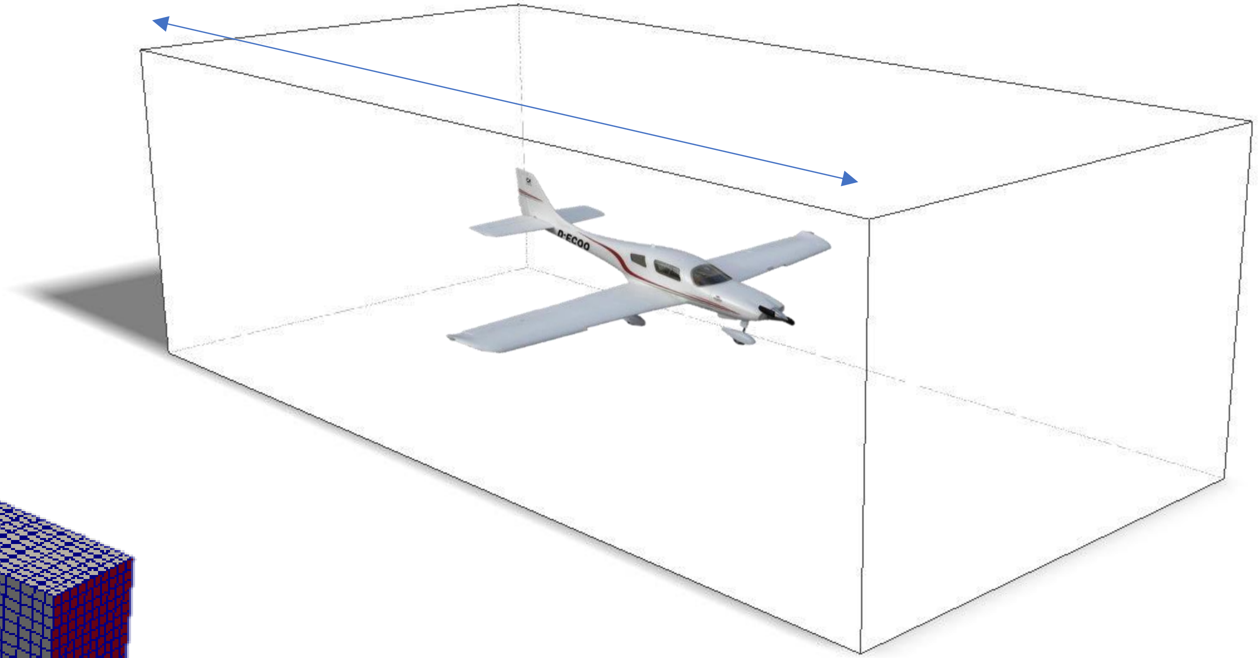


Separation
(Photo Credit)
Milton Van Dyke



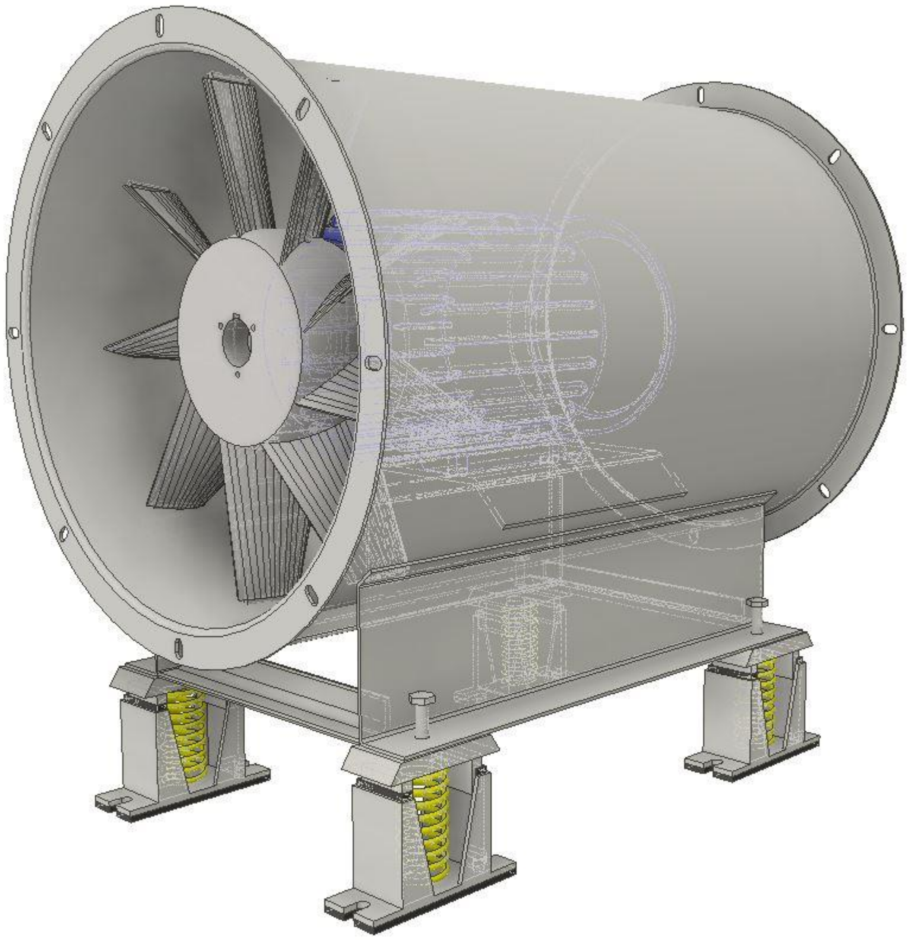
Additional Choices



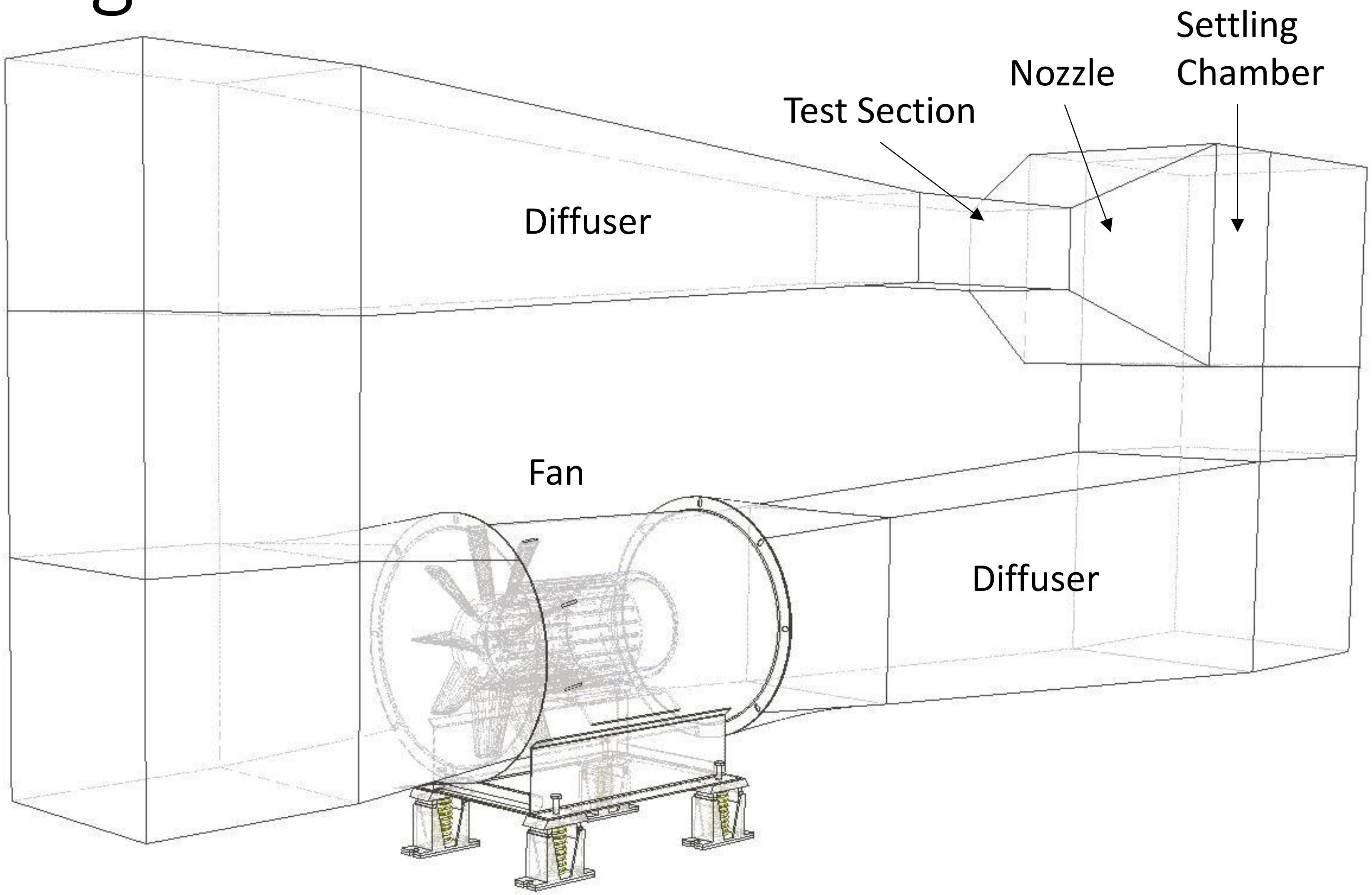


Design Process

- Script Calculates the size of each component
  - Estimate building materials
- Estimates the losses of each component
  - Estimate fan requirements

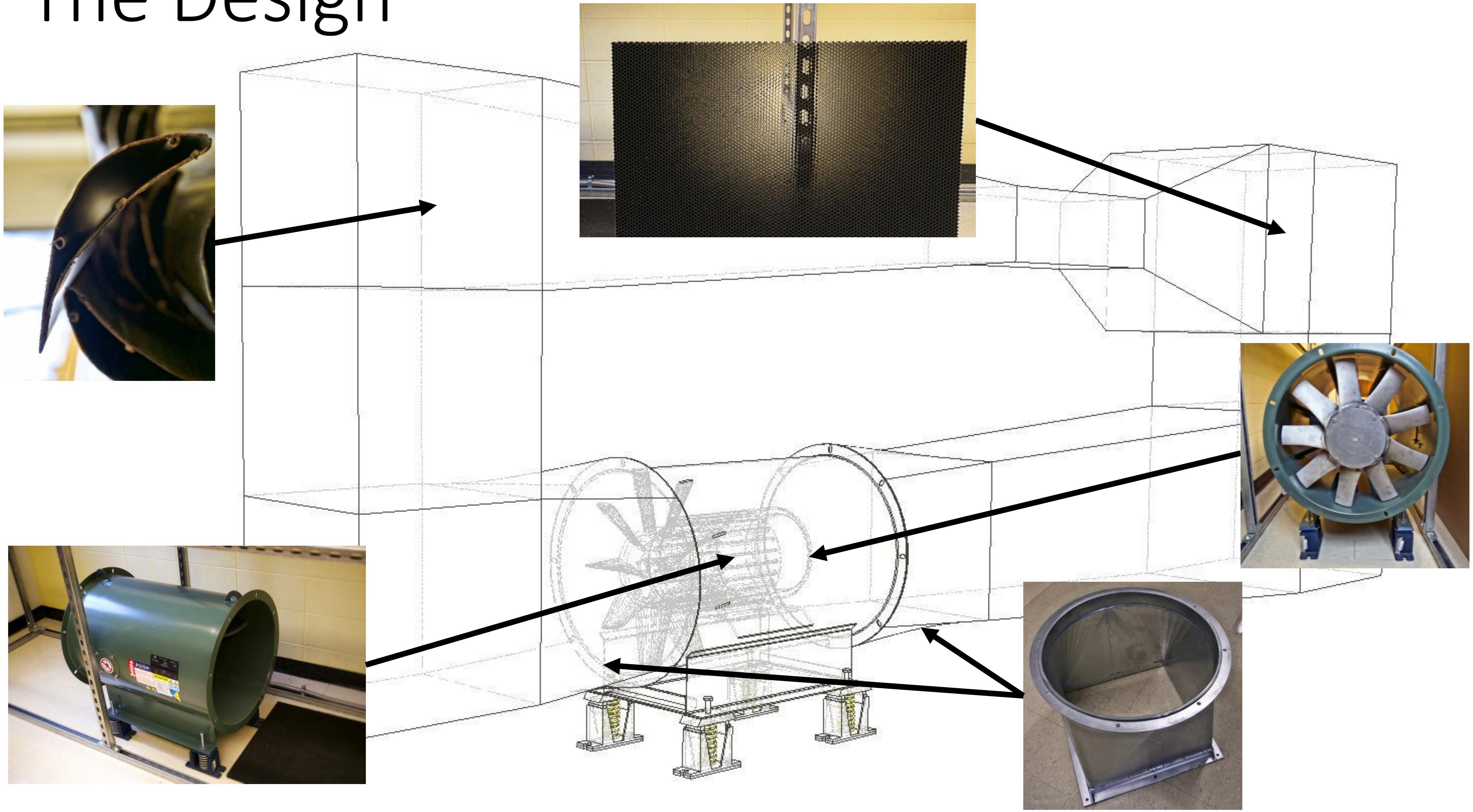


The Design


Settling
Chamber
Nozzle
Test Section
Diffuser
Fan
Diffuser

The Design

18 HOUGHTON COLLEGE 83



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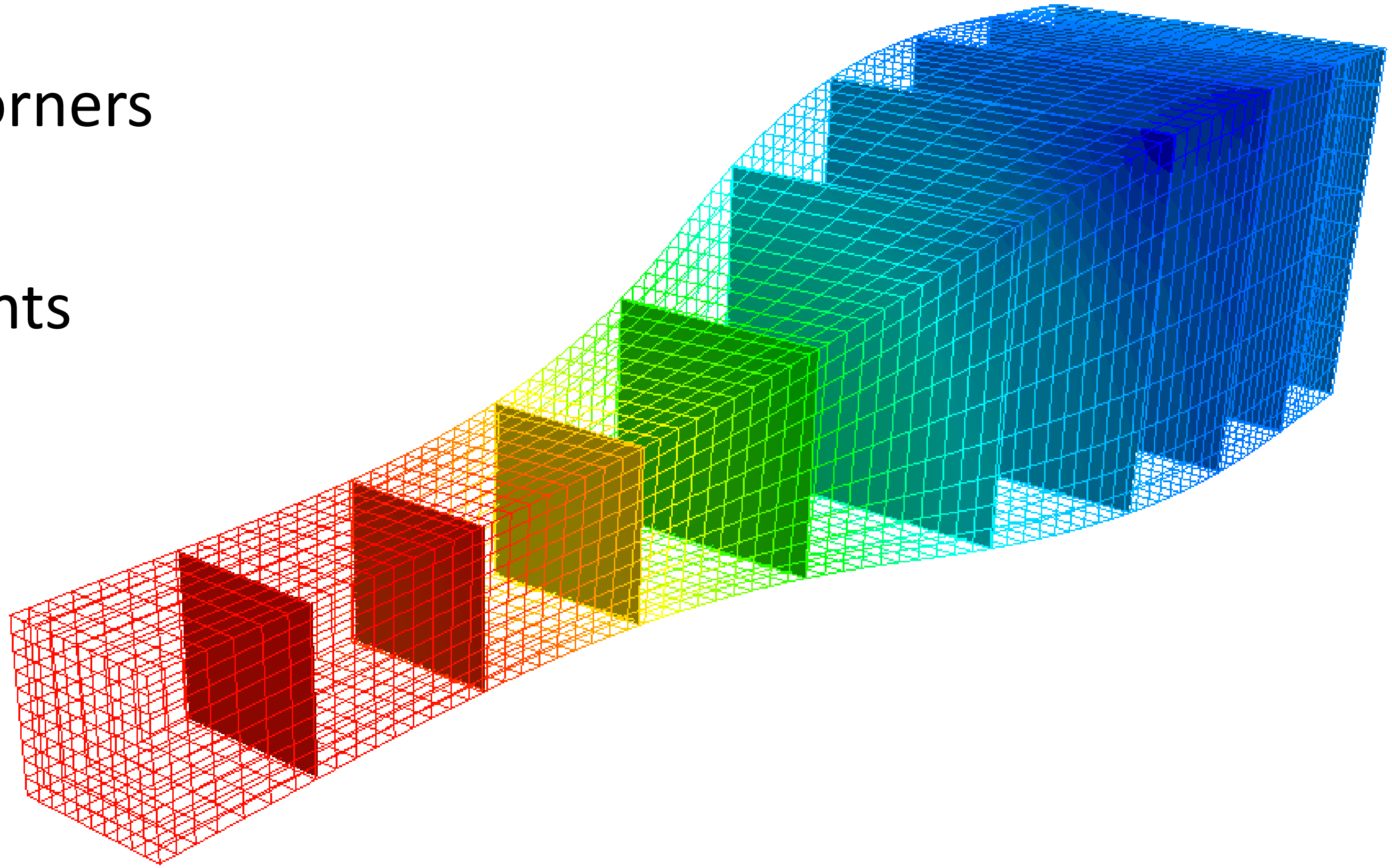
Future work

- CFD on nozzle and corners
- Construction
- Purchasing instruments
- Future research



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&

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Thank You

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