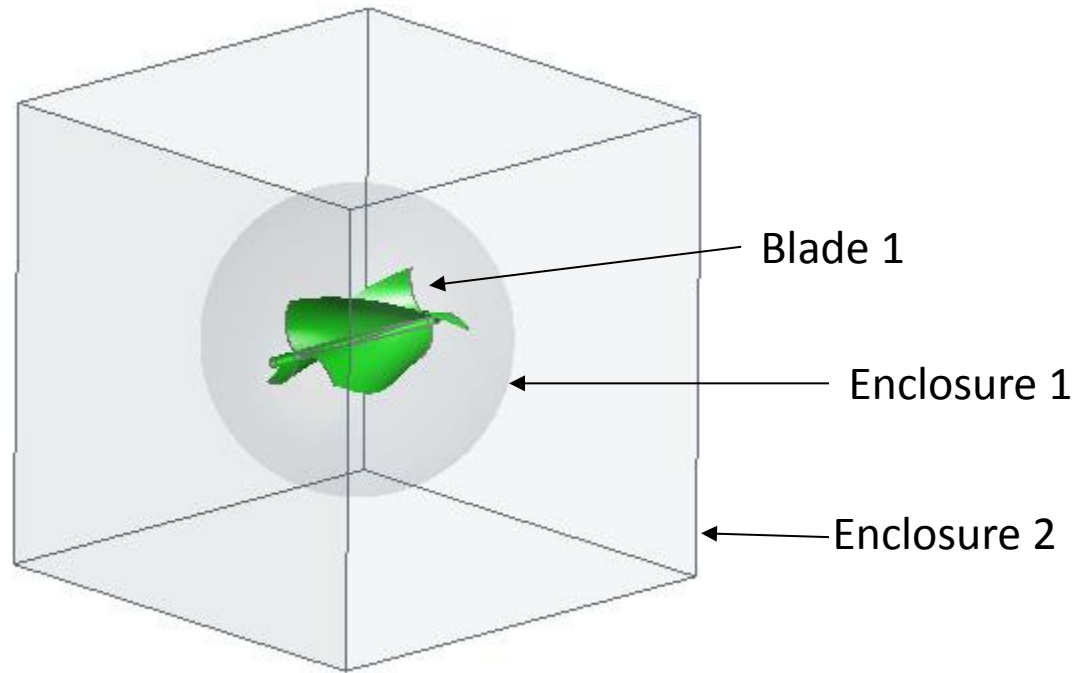


CFD Analysis of Wind Turbine Designs

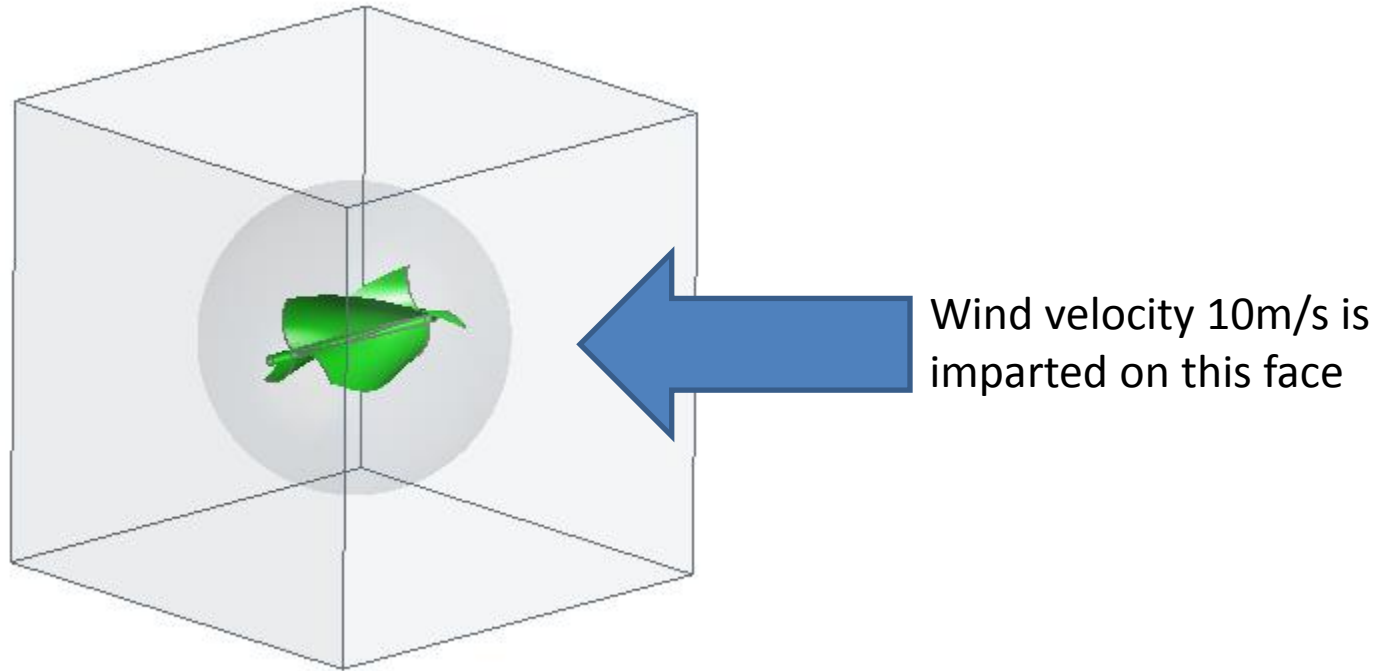
Model-1



- Blade 1 is incorporated within Enclosure 1 as void space
- Enclosure 2 is created in order to simulate wind flow

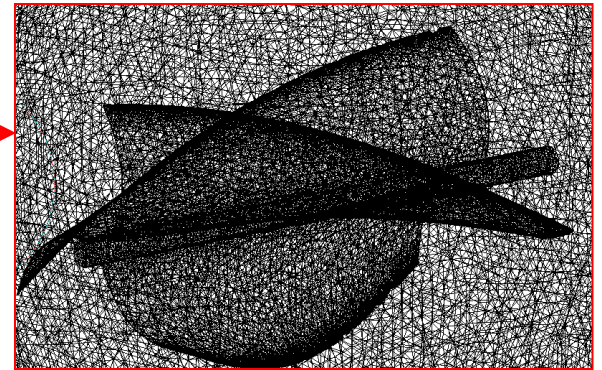
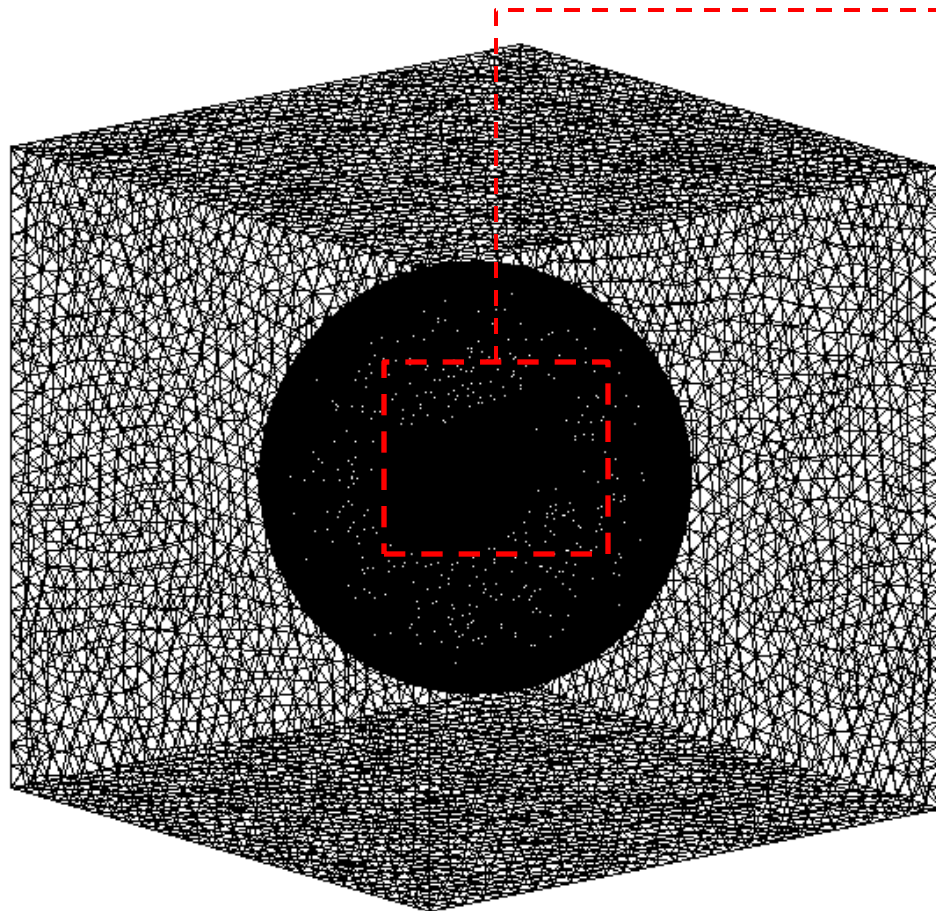
Model-1 Loading And Boundary

1 atm pressure is simulated on walls



- Blade 1 is incorporated within Enclosure 1 as void space
- Enclosure 2 is created in order to simulate wind flow.

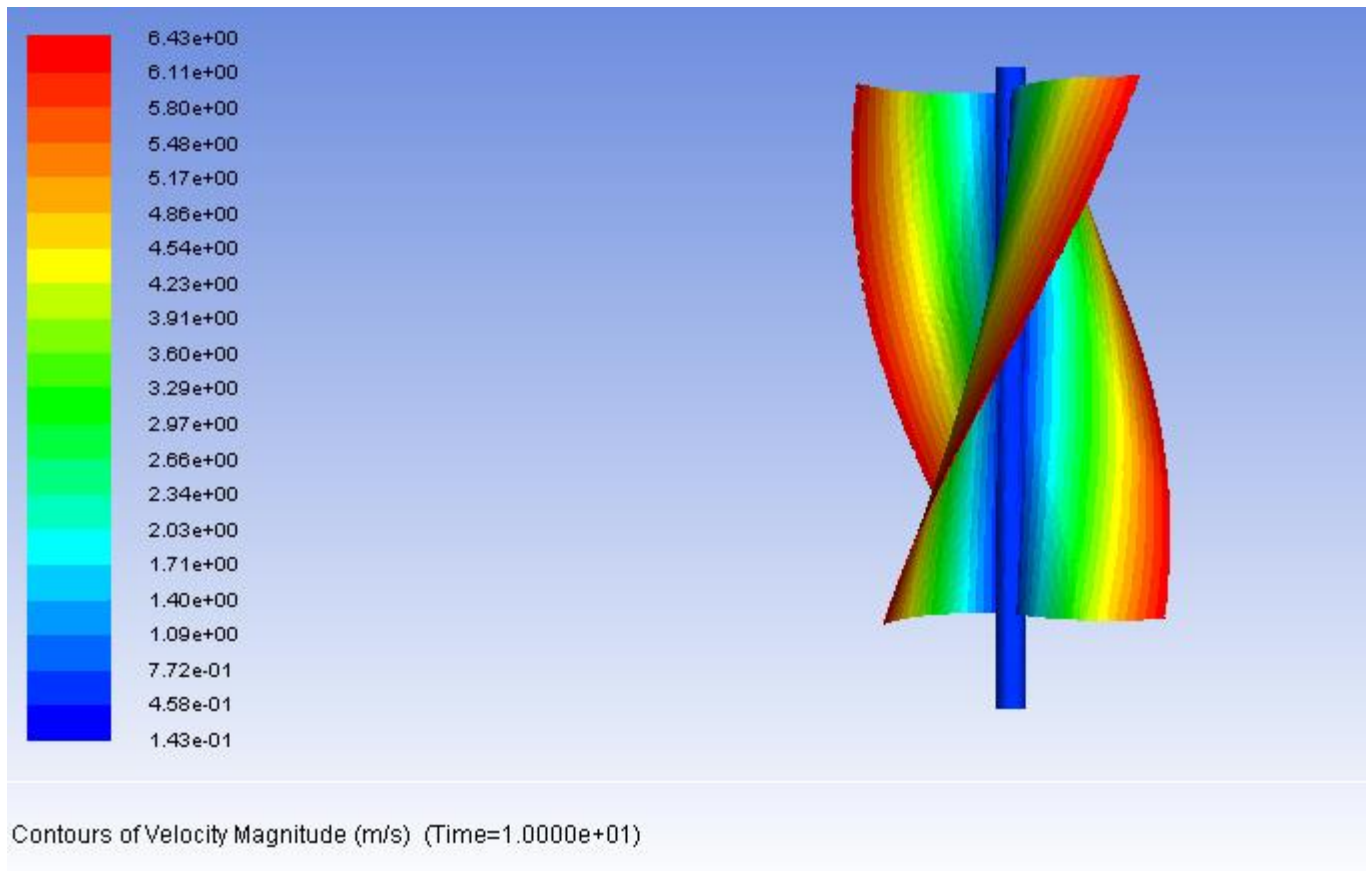
Meshing



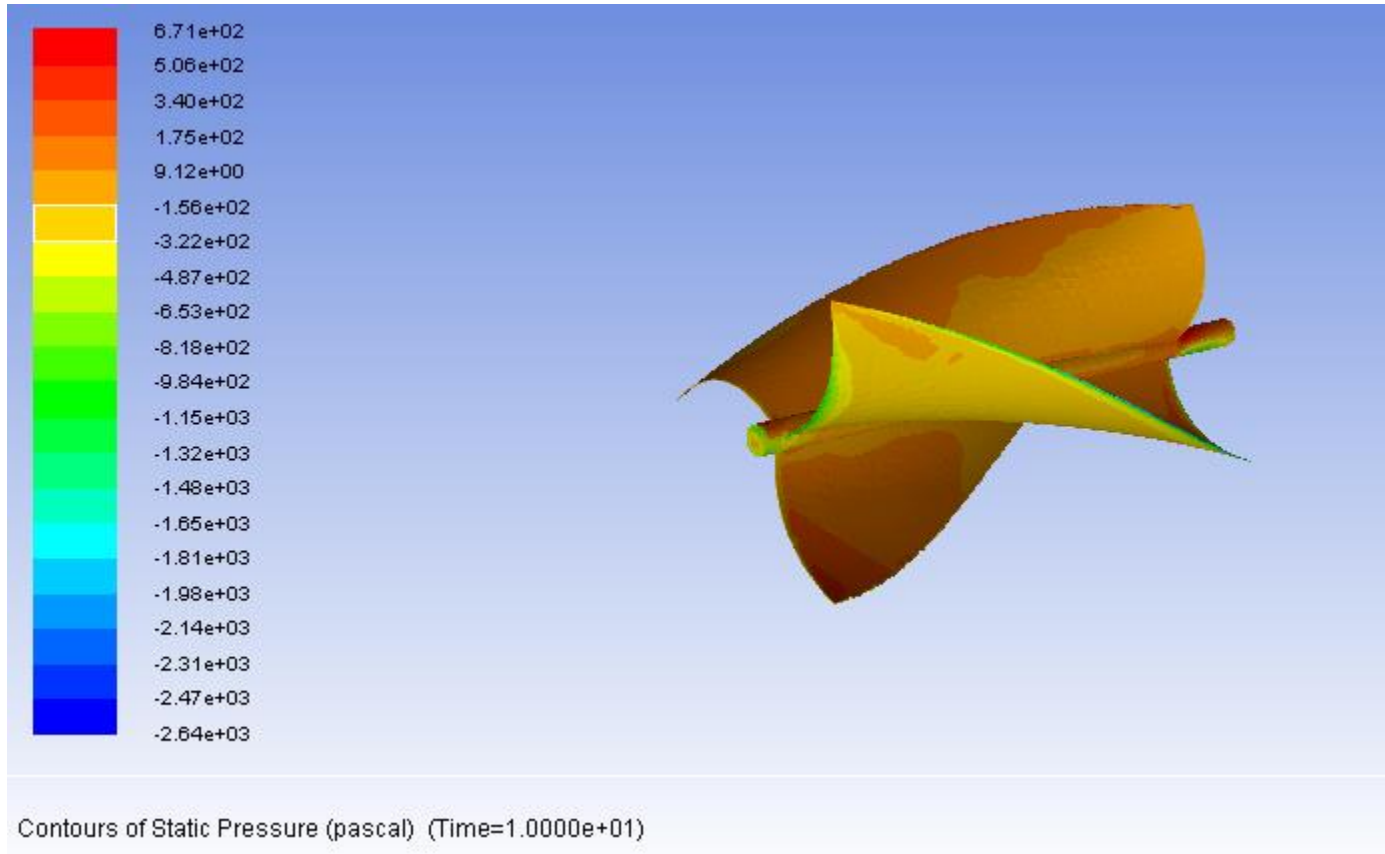
- Statistics

<input type="checkbox"/> Nodes	548995
<input type="checkbox"/> Elements	3135081
Mesh Metric	None

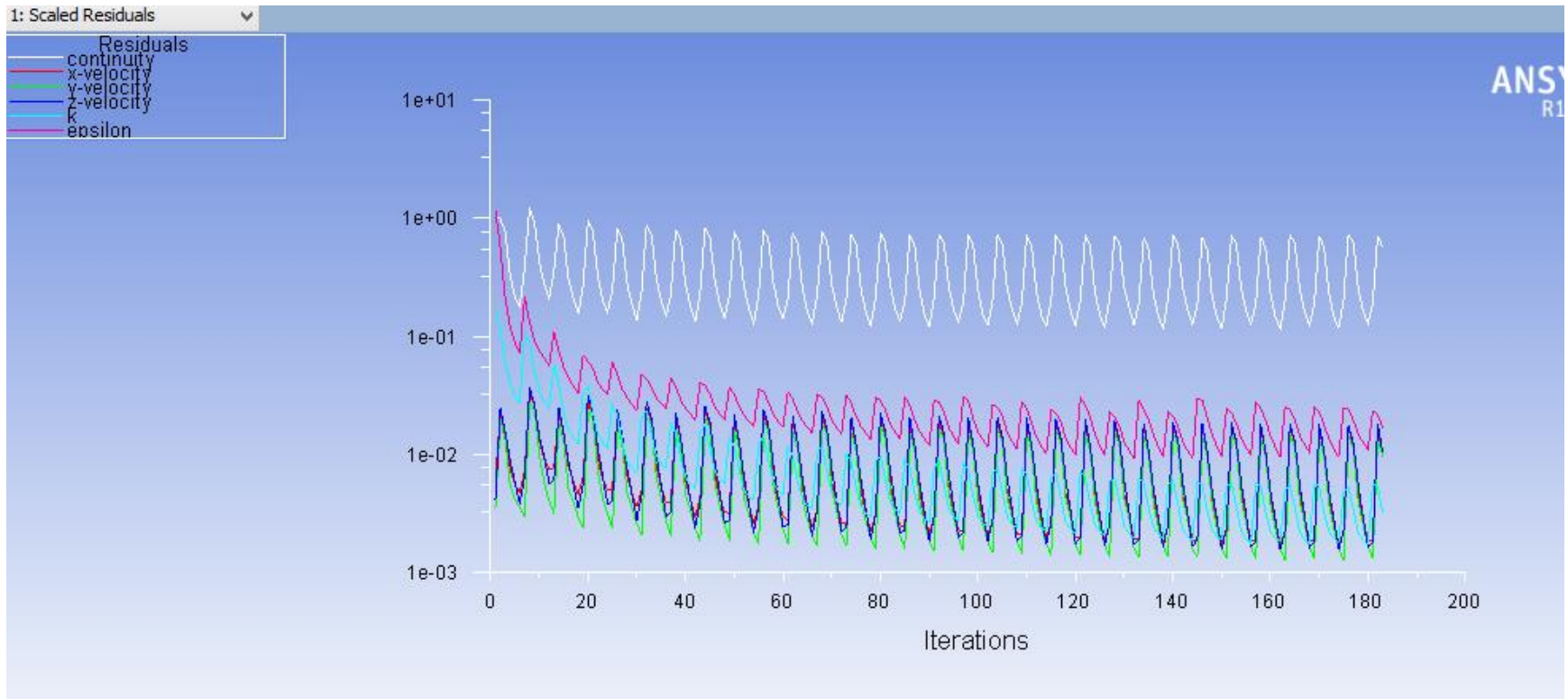
Model 1: Velocity Plot



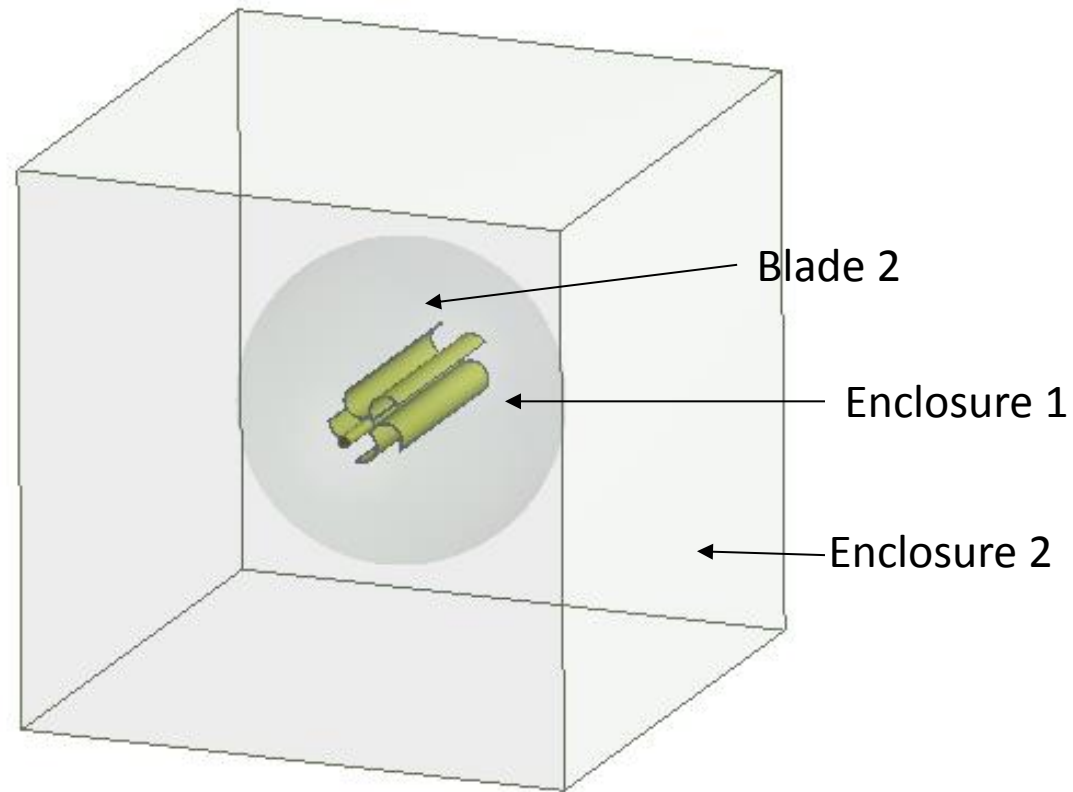
Model-1 Pressure Plot



Convergence Plot



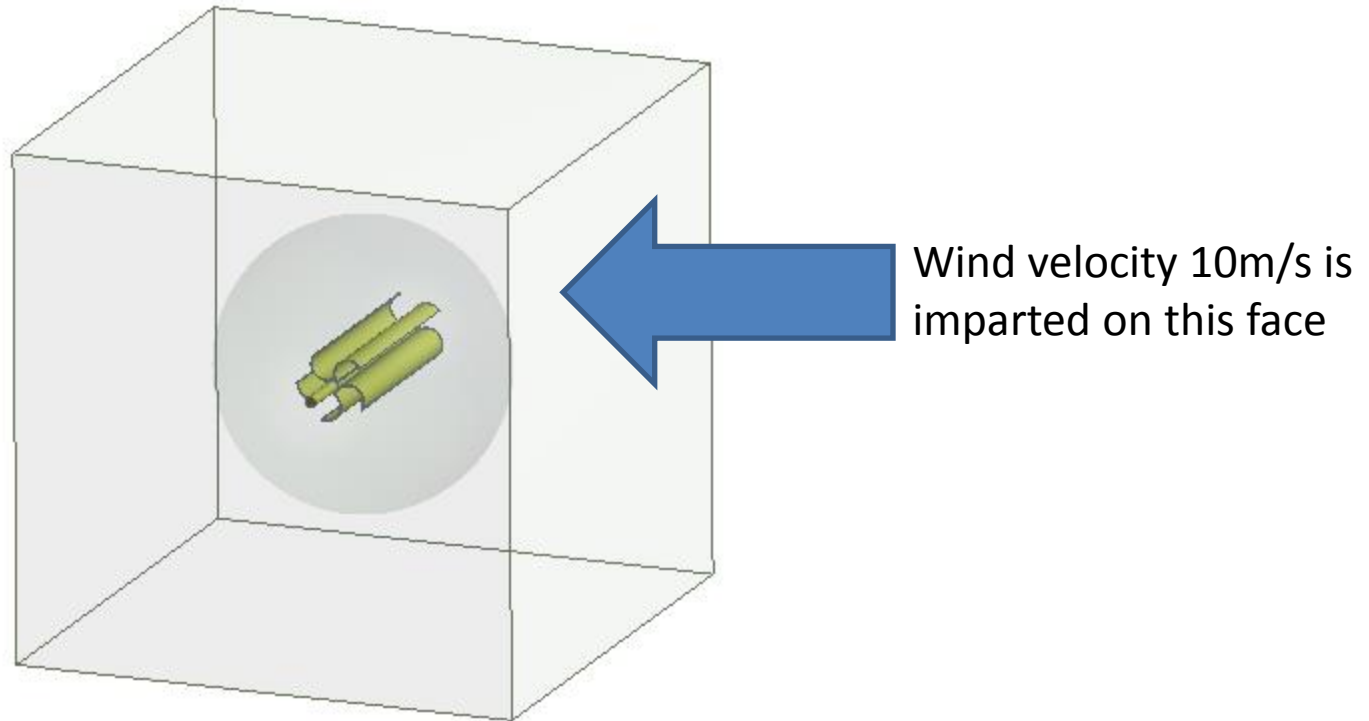
Model-2



- Blade 2 is incorporated within Enclosure 1 as void space
- Enclosure 2 is created in order to simulate wind flow

Model-2 Loading And Boundary

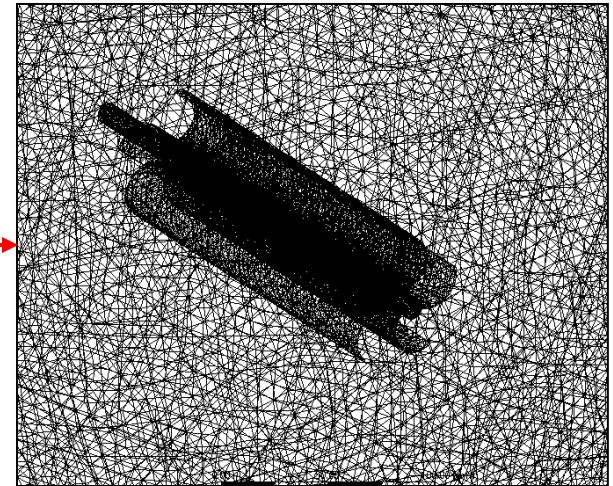
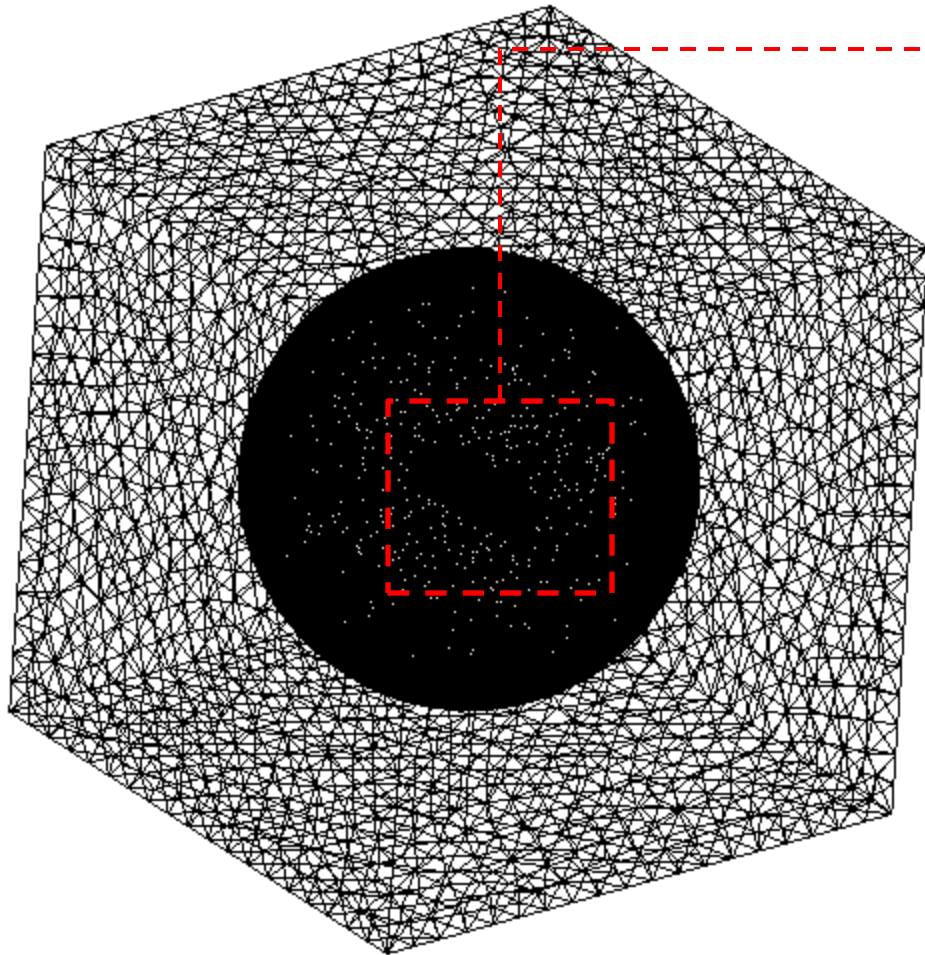
1 atm pressure is simulated on walls



Wind velocity 10m/s is imparted on this face

- Blade 2 is incorporated within Enclosure 1 as void space
- Enclosure 2 is created in order to simulate wind flow.

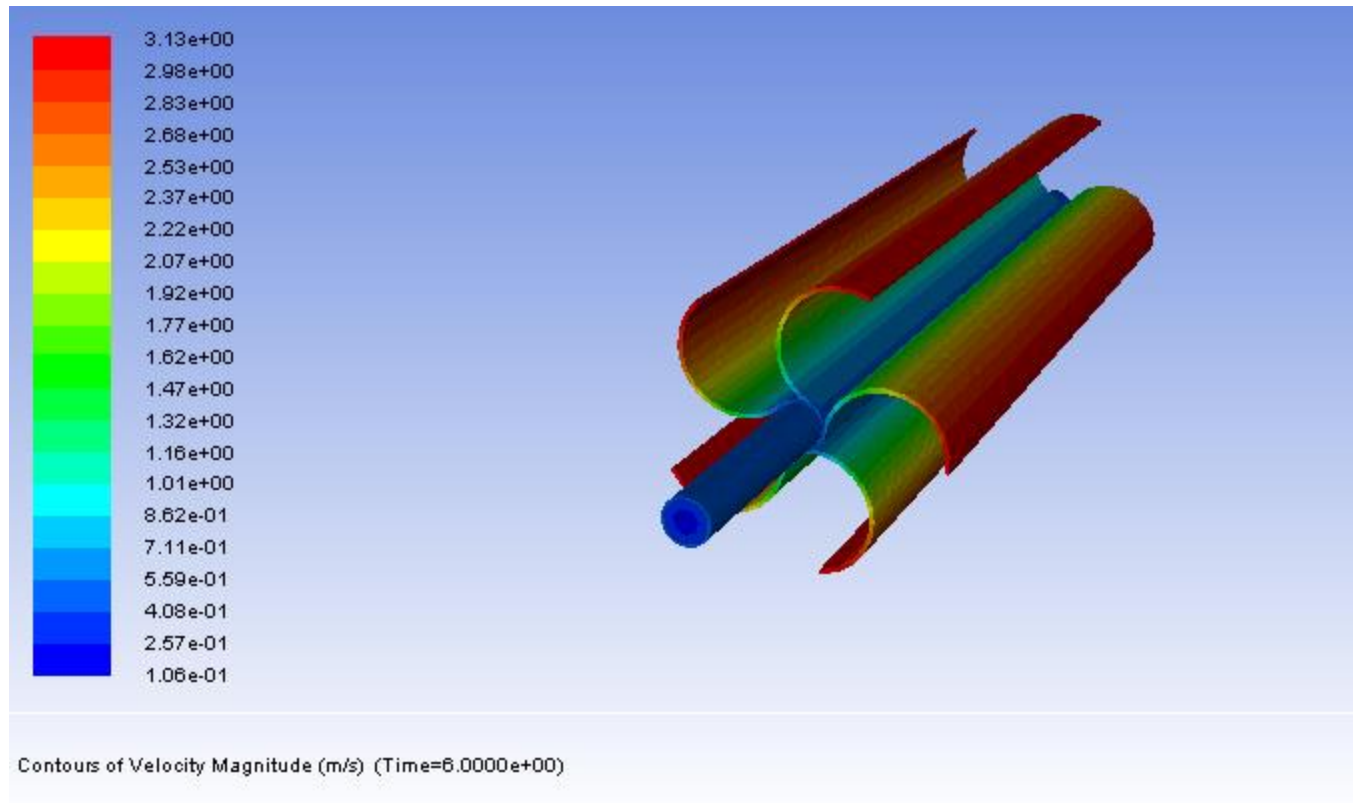
Meshing



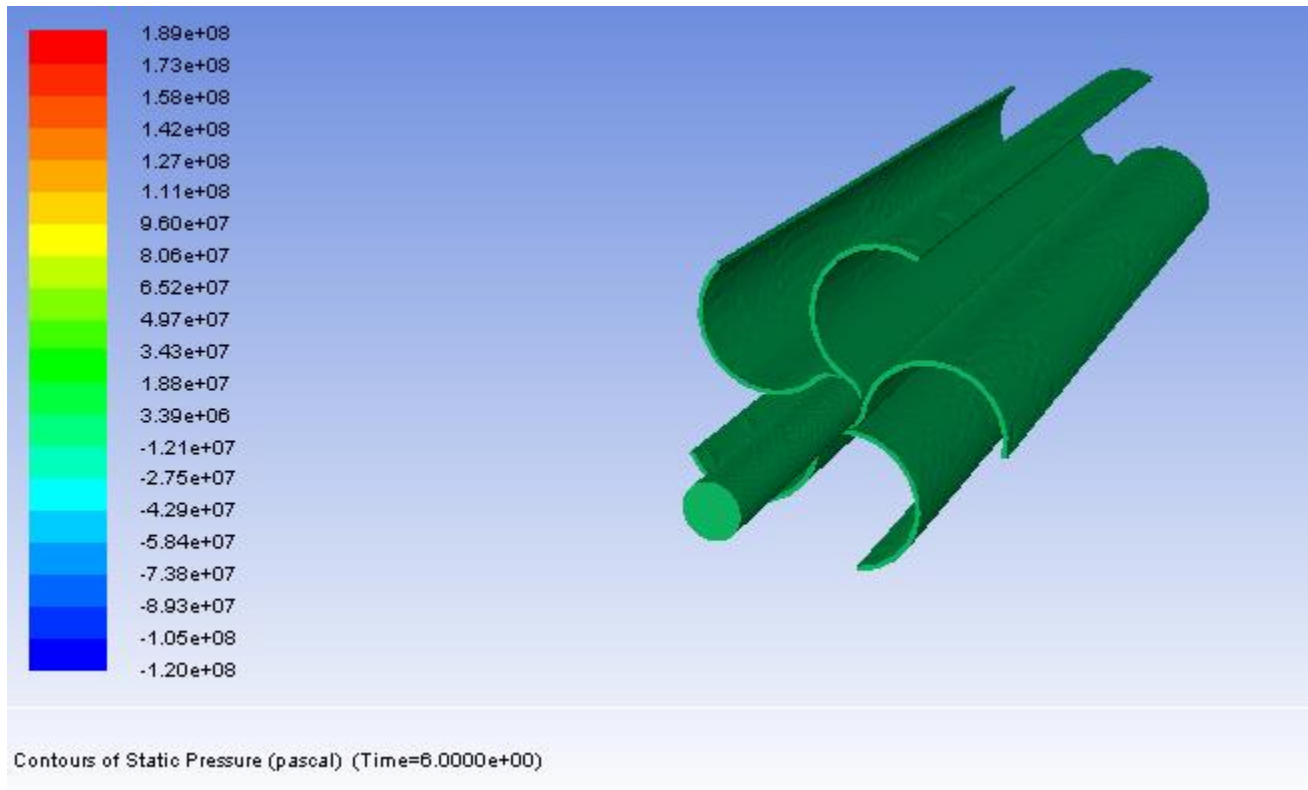
Statistics

<input type="checkbox"/> Nodes	412145
<input type="checkbox"/> Elements	2341496

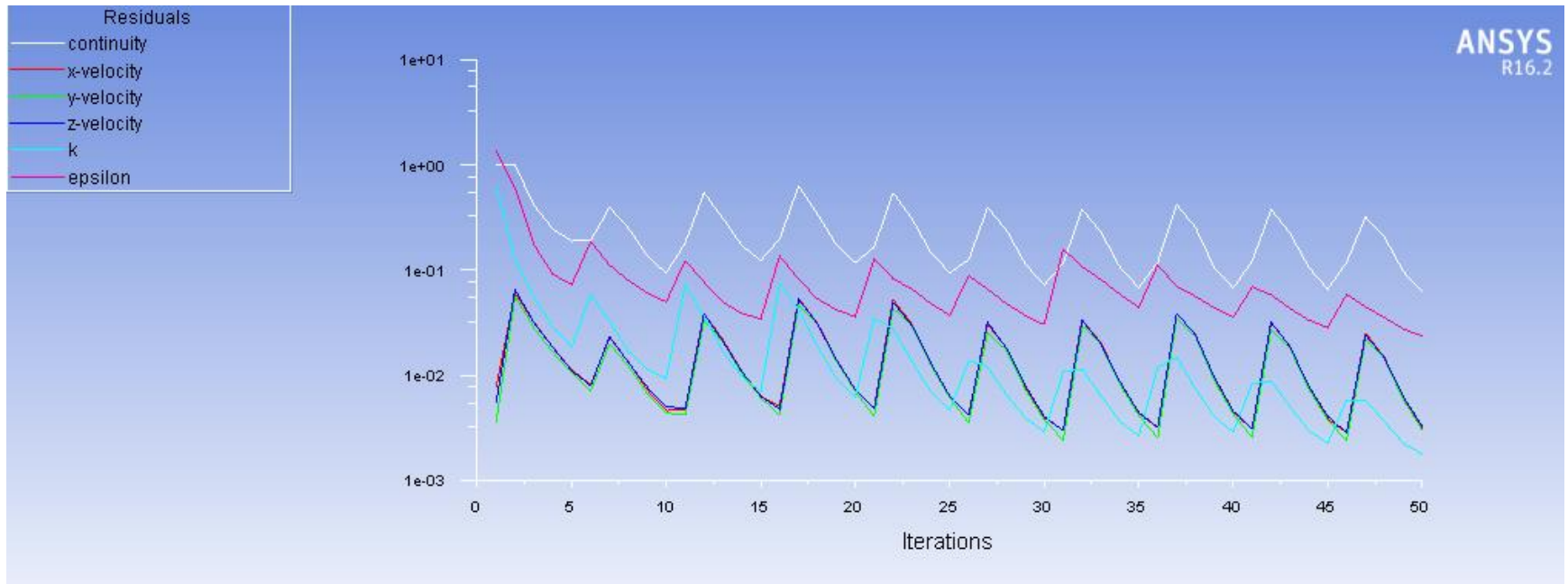
Model 2: Velocity Plot



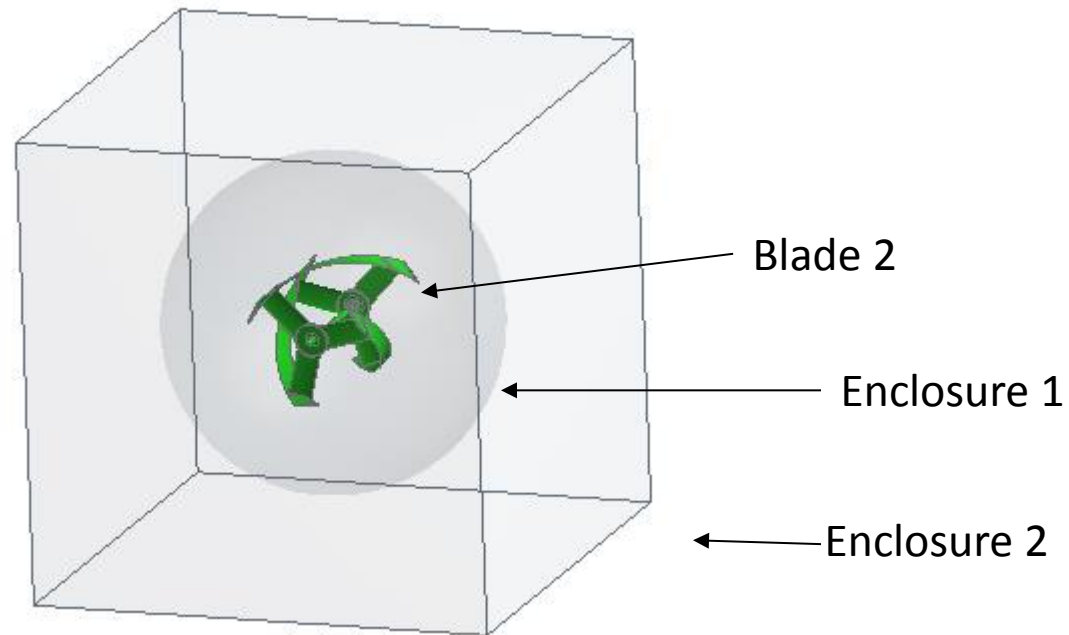
Model-2 Pressure Plot



Convergence Plot



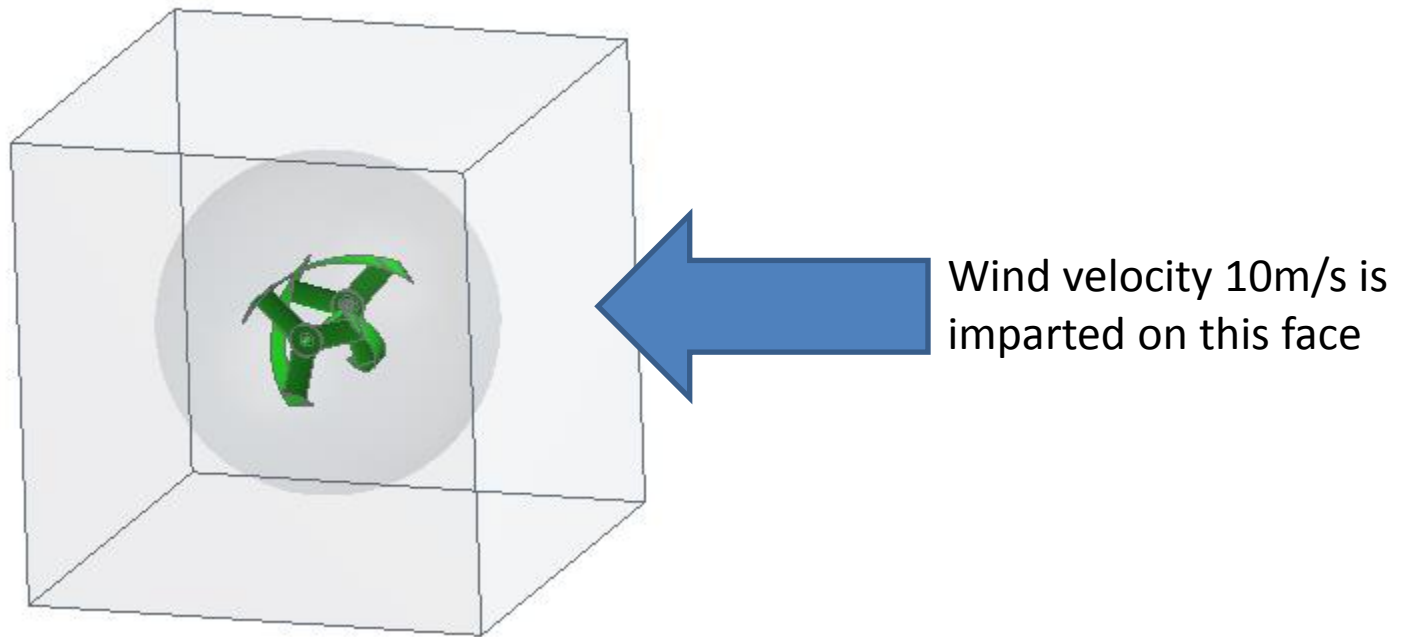
Model-3



- Blade 3 is incorporated within Enclosure 1 as void space
- Enclosure 2 is created in order to simulate wind flow

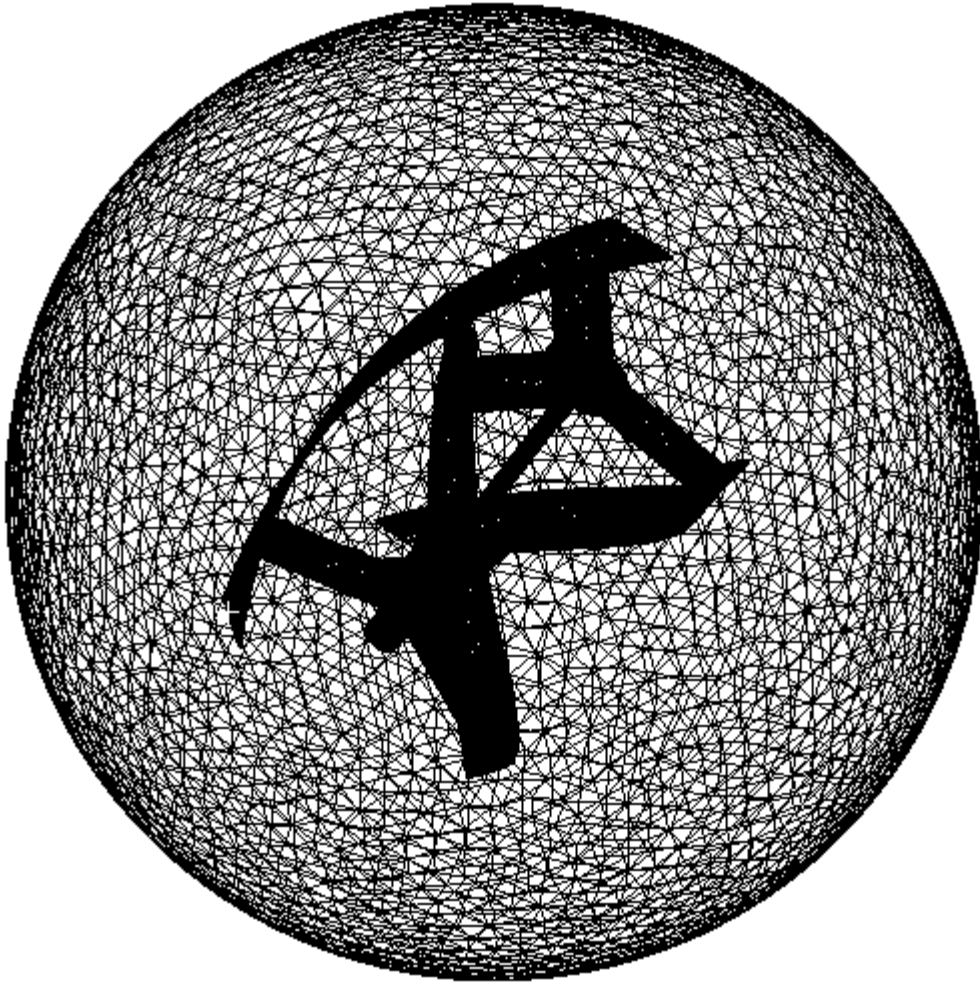
Model-3 Loading And Boundary

1 atm pressure is simulated on walls



- Blade 3 is incorporated within Enclosure 1 as void space
- Enclosure 2 is created in order to simulate wind flow.

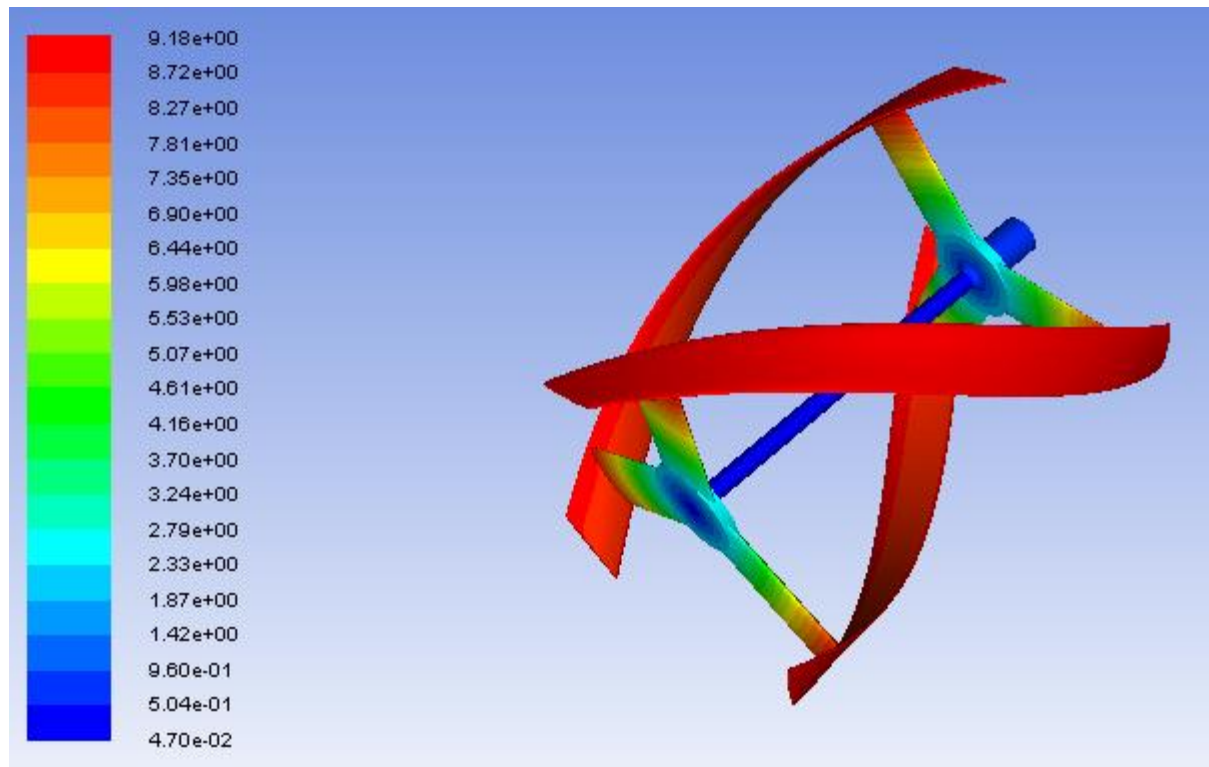
Meshing



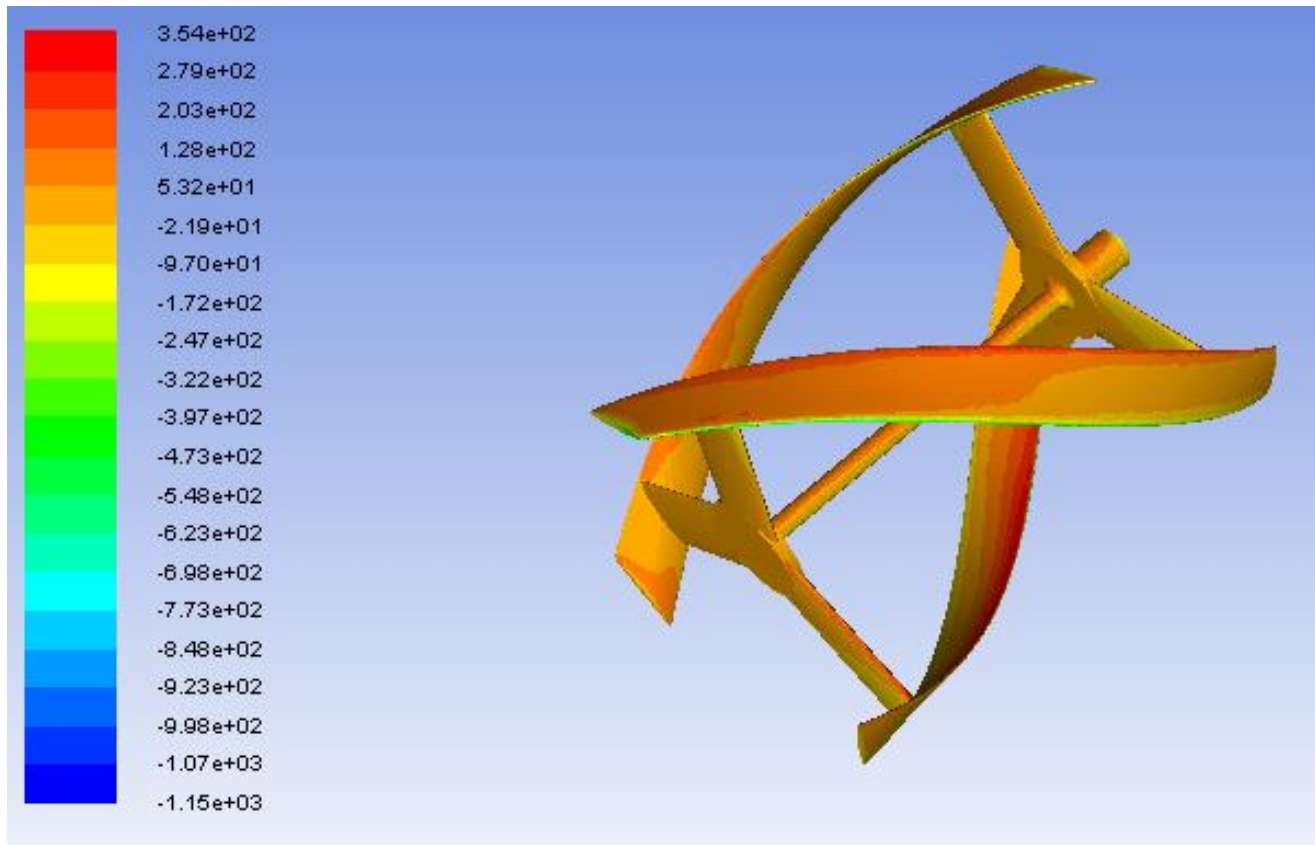
Statistics

<input type="checkbox"/> Nodes	566991
<input type="checkbox"/> Elements	3204312

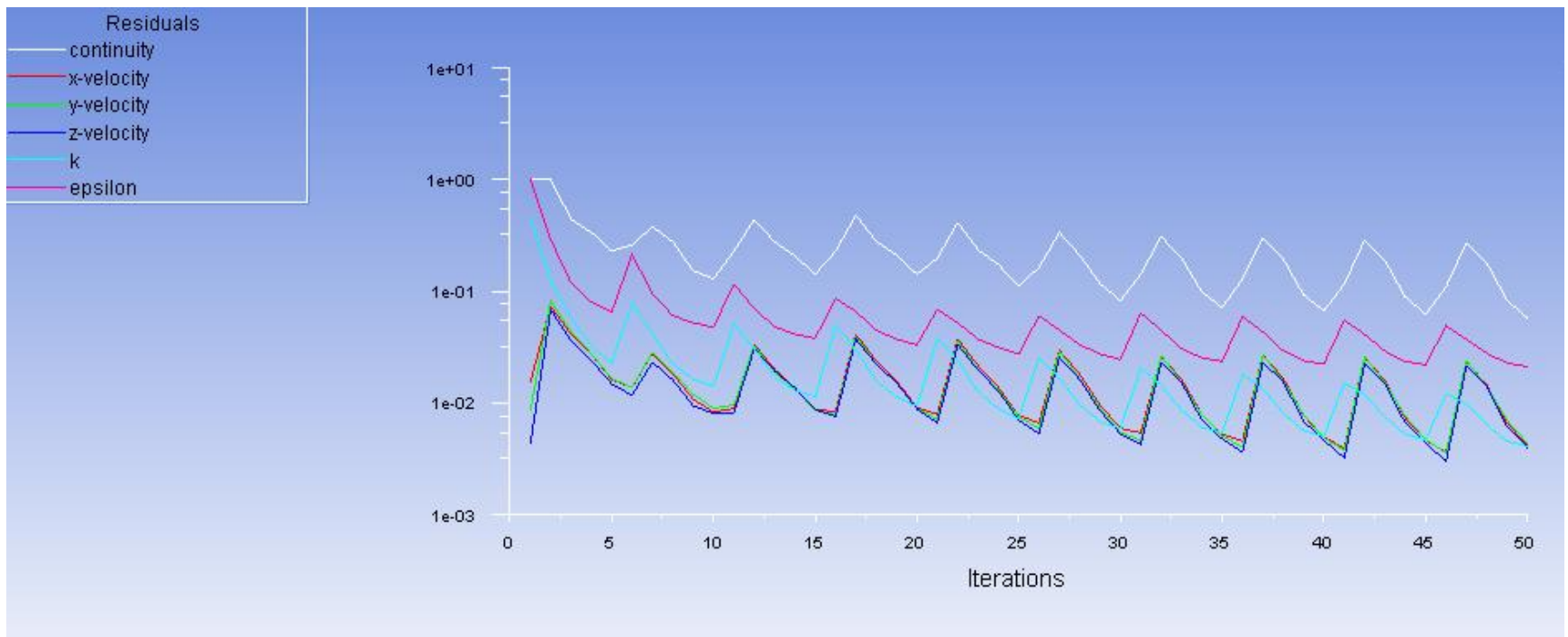
Model 3: Velocity Plot



Model-3 Pressure Plot



Convergence Plot

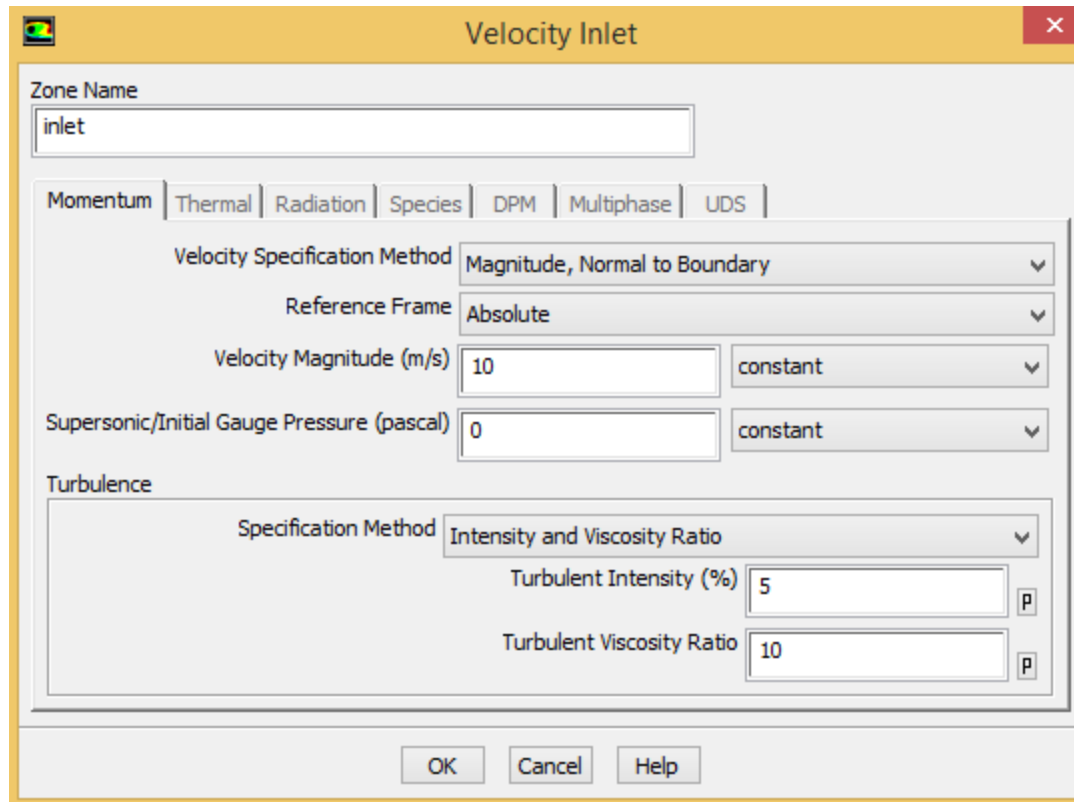


Comparative Analysis

Design	Maximum Torque	RPM	Power produced	Efficiency wise Rank
Model 1	0.32	10	30.57	2
Model 2	1.98	10	189.16	1
Model 3	0.23	10	21.85	3

Appendix

Settings for wind velocity



The image shows a software dialog box titled "Velocity Inlet". It has a yellow title bar with a close button (X) on the right. The dialog is divided into several sections:

- Zone Name:** A text input field containing the word "inlet".
- Physics Models:** A row of tabs: "Momentum" (selected), "Thermal", "Radiation", "Species", "DPM", "Multiphase", and "UDS".
- Velocity Specification Method:** A dropdown menu set to "Magnitude, Normal to Boundary".
- Reference Frame:** A dropdown menu set to "Absolute".
- Velocity Magnitude (m/s):** A text input field with "10" and a dropdown menu set to "constant".
- Supersonic/Initial Gauge Pressure (pascal):** A text input field with "0" and a dropdown menu set to "constant".
- Turbulence:** A section containing:
 - Specification Method:** A dropdown menu set to "Intensity and Viscosity Ratio".
 - Turbulent Intensity (%):** A text input field with "5" and a "P" button.
 - Turbulent Viscosity Ratio:** A text input field with "10" and a "P" button.

At the bottom of the dialog are three buttons: "OK", "Cancel", and "Help".

Setting for 10RPM blade speed

The screenshot shows the 'Fluid' dialog box in ANSYS Fluent. The 'Zone Name' is 'enclosure' and the 'Material Name' is 'air'. The 'Mesh Motion' checkbox is checked. The 'Reference Frame' tab is selected, and the 'Mesh Motion' sub-tab is active. The 'Relative Specification' section shows 'Relative To Cell Zone' set to 'absolute' and 'Zone Motion Function' set to 'none'. The 'Rotation-Axis Origin' section has X (m) = 0, Y (m) = 0, and Z (m) = 0, all set to 'constant'. The 'Rotation-Axis Direction' section has X = 0, Y = 1, and Z = 0, all set to 'constant'. The 'Rotational Velocity' section has 'Speed (rad/s)' set to 95.49, set to 'constant'. The 'Translational Velocity' section has X (m/s) = 0, Y (m/s) = 0, and Z (m/s) = 0, all set to 'constant'. A 'Copy To Frame Motion' button is present. The 'OK', 'Cancel', and 'Help' buttons are at the bottom.

Zone Name: enclosure

Material Name: air

Frame Motion 3D Fan Zone Source Terms
 Mesh Motion Laminar Zone Fixed Values
 Porous Zone LES Zone

Reference Frame | **Mesh Motion** | Porous Zone | 3D Fan Zone | Embedded LES | Reaction | Source Terms | Fixed Values | Multiphase

Relative Specification: Relative To Cell Zone: absolute; UDF: Zone Motion Function: none

Rotation-Axis Origin: X (m): 0, constant; Y (m): 0, constant; Z (m): 0, constant

Rotation-Axis Direction: X: 0, constant; Y: 1, constant; Z: 0, constant

Rotational Velocity: Speed (rad/s): 95.49, constant

Translational Velocity: X (m/s): 0, constant; Y (m/s): 0, constant; Z (m/s): 0, constant

Copy To Frame Motion

OK Cancel Help

Model Definition

The screenshot shows the 'Viscous Model' dialog box with the following settings:

- Model:** k-epsilon (2 eqn)
- Model Constants:**
 - C2-Epsilon: 1.9
 - TKE Prandtl Number: 1
 - TDR Prandtl Number: 1.2
- k-epsilon Model:** Realizable
- Near-Wall Treatment:** Standard Wall Functions
- User-Defined Functions:**
 - Turbulent Viscosity: none
 - Prandtl Numbers:
 - TKE Prandtl Number: none
 - TDR Prandtl Number: none
- Options:**
 - Curvature Correction
 - Production Limiter

Buttons at the bottom: OK, Cancel, Help