Mission

• 14 students
• 20 weeks of fluids background
• Can they intelligently use CFD within a 10 week period?
• New Course MECH 407 – Computational Fluid Dynamics
Method

- Each week meets for one 2 hour session and one 3 hour session
- STAR-CCM+ training guide (weeks 1-5) (388 pages, their text for the course)
- S-bend simulation (week 2)
- Woven in lessons learned and examples
- Project (weeks 6-9)
- Presentations (week 10)
STAR-CCM+ training guide (weeks 1-5)

• Excellent push button approach, many examples, clear
• Many CFD principles are taught (boundary layer, meshing, models)
• However, the manual’s directions are explicit (take away the manual and they won’t remember where boundary layers are defined)
• The manual remains the basis for many specific cases in their project (e.g. go back to the manual to see how wind tunnels are modeled)
• Combining clear training materials and project – better overall learning (theory and hands-on must meet)
S-bend simulation (week 2)

- Students CAD the pipe
- Follow step-by-step CFD
- Process is observed
- Manual becomes real
Woven in lessons learned and examples

• What not to do (CFD of the ‘80s)
• Best practices
  – Meshing
  – Boundary conditions
  – Convergence
• Examples
  – Peak interest
  – Gives artificial experience
• Introduce ideas for project
Project (weeks 6-9)

• Over-eager students
• Real problems
• Marries theory to reality
• Helps students digest theory

(Examples shown later)
Presentations (week 10)

- Communication skills
- Converts data dump into useful values
- Keeps students focused on the point
Motorcycle Venturi – Kai Anderson

- Downforce makes you faster
- $F_f = F_n \times \mu$
- Only acts in the downward direction
- Based on a 52 degree lean angle
Physical Models

- Diffuser acts like half of a nozzle – increased velocity leads to a low pressure zone
Variable

• Wanted to study the effects of ground clearance between splitter and ground
  • .25” to 1” in .25” increments
• Effects of “skirts”
• Center strake
## Results

<table>
<thead>
<tr>
<th>Ground Clearance</th>
<th>Diffuser Version</th>
<th>Pounds of Down!</th>
<th>Velocity at Neck (M/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25 no skirt</td>
<td></td>
<td>-41.47</td>
<td>*81.862</td>
</tr>
<tr>
<td>0.5 no skirt</td>
<td></td>
<td>-42.16</td>
<td>66.85</td>
</tr>
<tr>
<td>0.5 full skirt</td>
<td></td>
<td>-52.87</td>
<td>80.132</td>
</tr>
<tr>
<td>0.75 no skirt</td>
<td></td>
<td>-44.54</td>
<td>67.067</td>
</tr>
<tr>
<td>0.75 full skirt</td>
<td></td>
<td>-66.56</td>
<td>84.77</td>
</tr>
<tr>
<td>1 no skirt</td>
<td></td>
<td>-41.11</td>
<td>65.75</td>
</tr>
<tr>
<td>1 half skirt</td>
<td></td>
<td>-47.78</td>
<td>73.568</td>
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<tr>
<td>1 full skirt</td>
<td></td>
<td>-64.12</td>
<td>82.044</td>
</tr>
<tr>
<td>1.25 full skirt</td>
<td></td>
<td>-55.74</td>
<td>75.996</td>
</tr>
</tbody>
</table>
SunCooler Unit – Jesse Robertson
CFD Analysis
Meshing

- Base Size: 0.5 Ft.
- Prism Layer Thickness: 10% Base Size
- Full 3-D model
+X, 50 mph
Results

Wind Force on Front

Wind Force on Side
Knee Joint (rotary) – Sean O’Brien
Knee Joint (rotary)

• Not all are complete successes
• Difficulties in capturing both the gap flow and bulk flow
• Ran out of time
• Got enough data to warrant the next method (orifice dampening)
CFD analysis of orifice dampening

Components of project:
• Given: Damper needs to allow a 2lb weight on a 14in lever to fall 90 degrees in .5s.

Steps:
• Create realistic CAD model
• Analyze fluid flow in STAR-CCM+
• Use STAR-CCM+ to find resistance to motion (Damping)
• Relate damping to real-world factors
• Improve design by finding the best internal geometry (Using STAR-CCM+)
STAR-CCM+ Analysis (Preliminary)
Results:

Two different fluid viscosities were considered: 1000cSt and 2000cSt.

Fluid flow was simulated using the known initial velocity.

STAR-CCM+ can produce a moment (torque) report about any axis. This was used to retrieve the torque produced in the simulation.
Formula Car intake - Mach Number – Joe Walters
Learning CFD

• Oregon Tech teaches (not presents)
  – Hands-on works together with theory
  – Students must work through their problems (with guidance)
• Project based helps
• Tutorial manual is used as a fallback
• Next time: incorporating heat X-fer demo
Contact info

• To hire students
• To take a class(es)
• To talk about CFD or pedagogy
• To come teach at Oregon Tech
• E-mail me:
  – Sean Sloan
  – sean.sloan@oit.edu