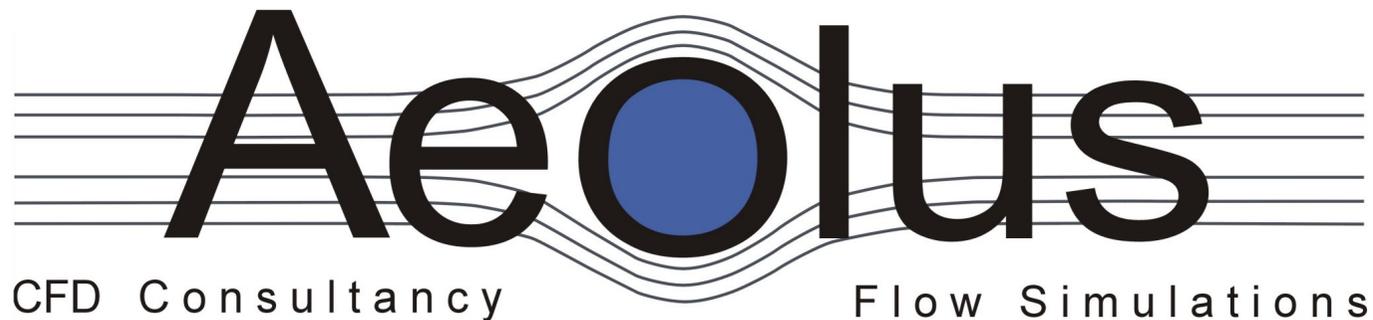
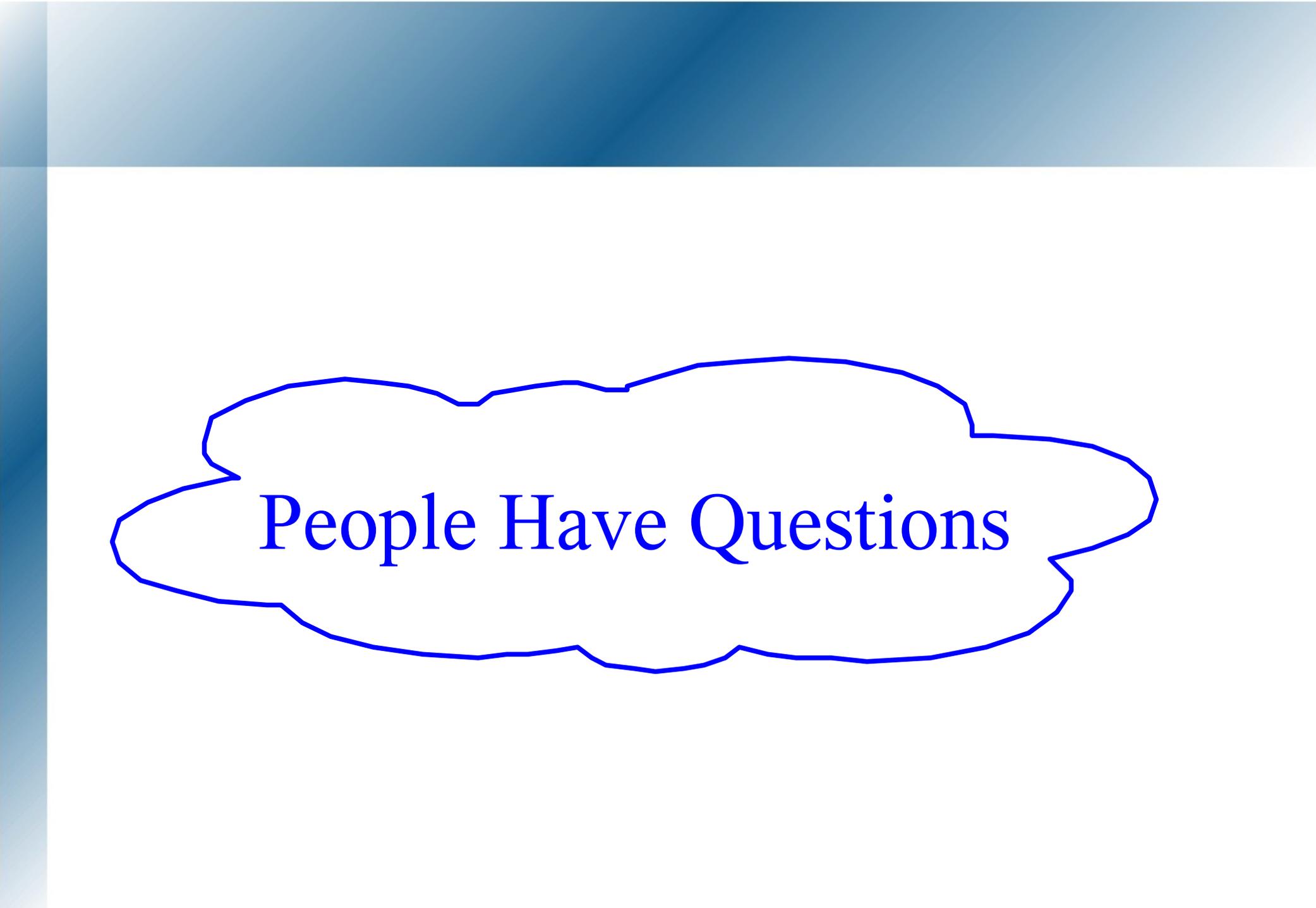


Mesh Based Guessing

ir. Joeri Wilms

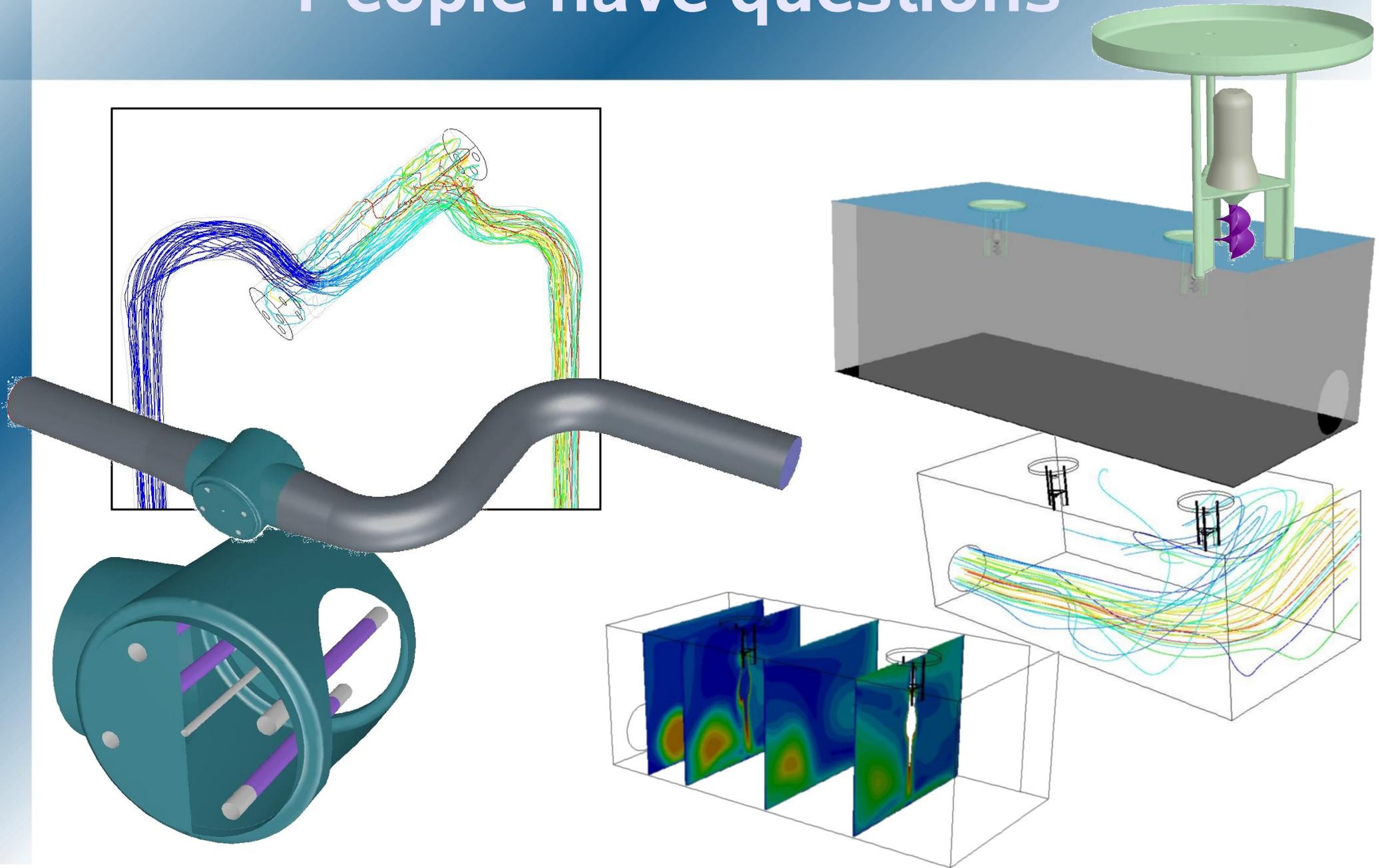
jw@aeolus-consulting.be



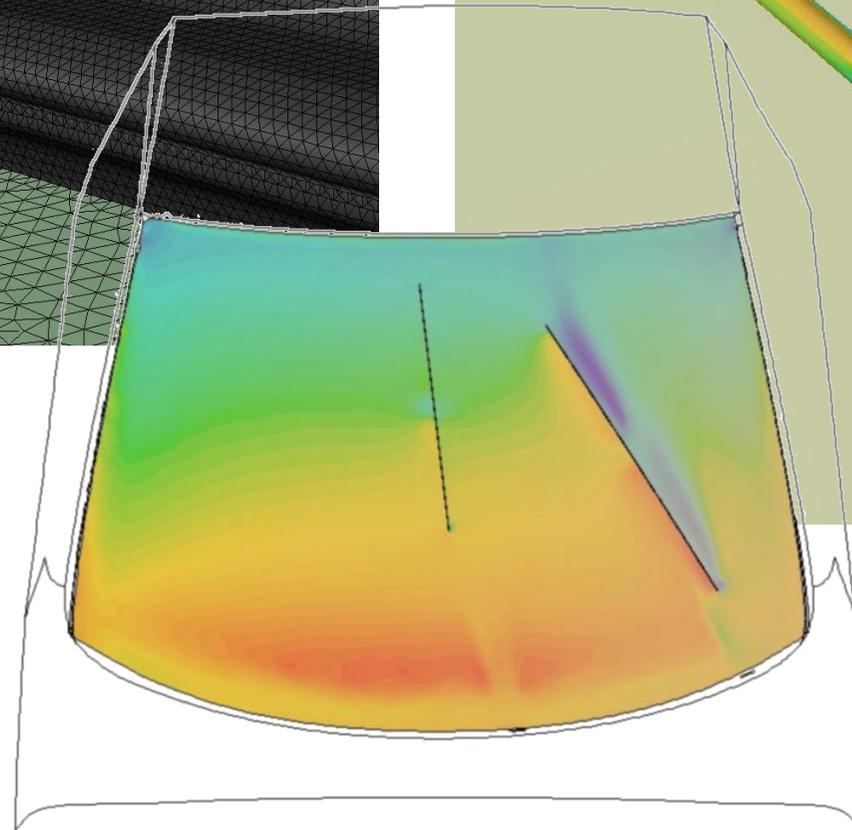
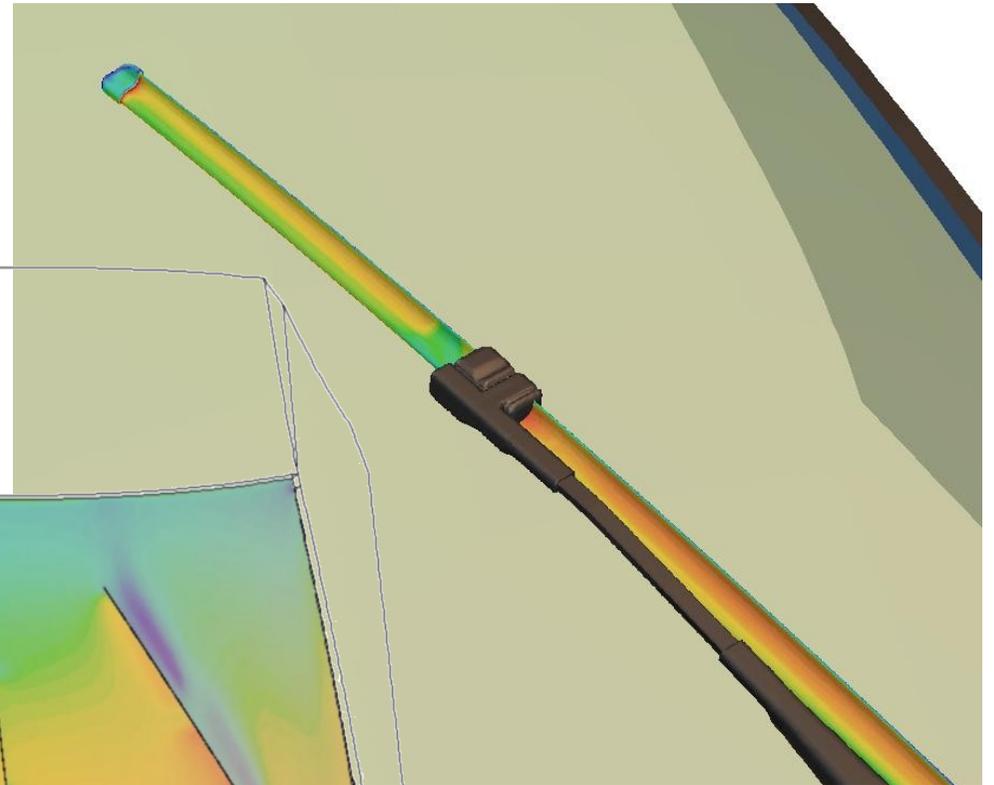
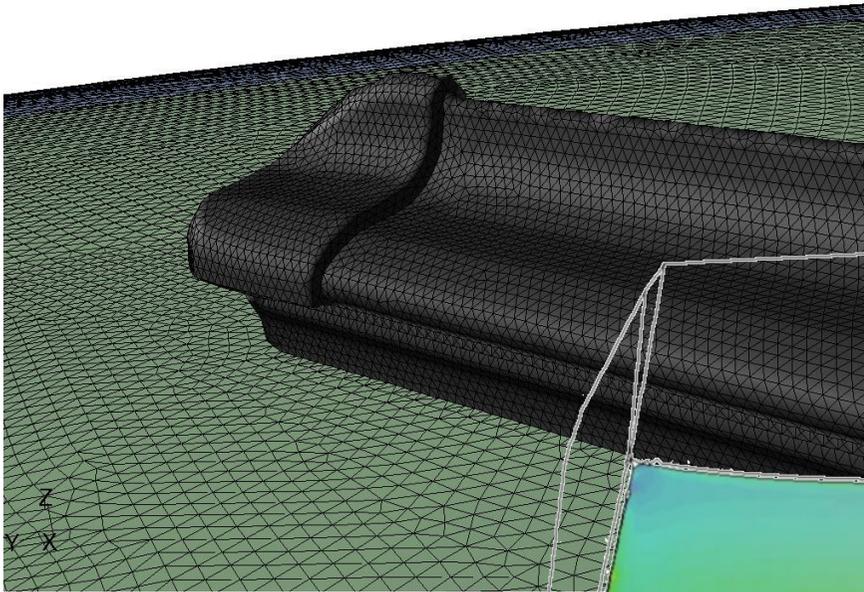


People Have Questions

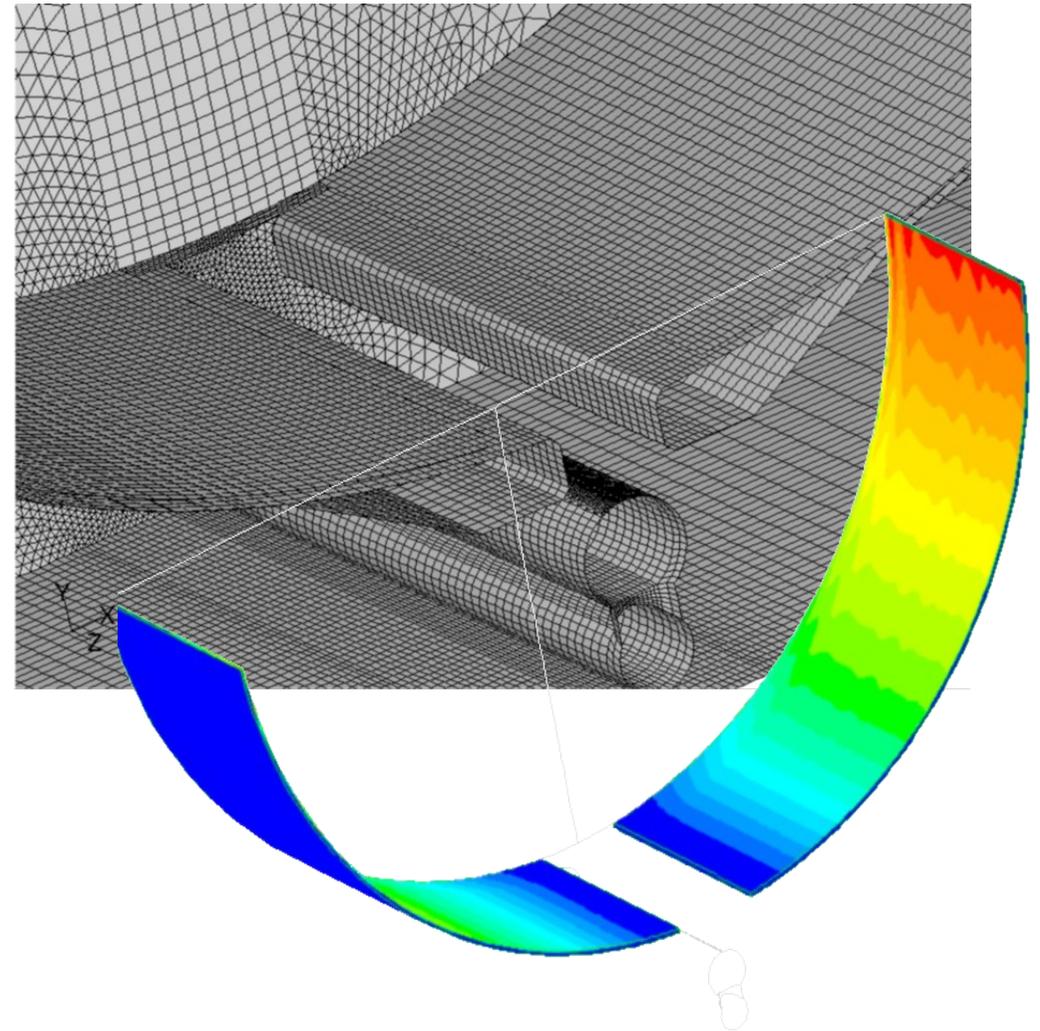
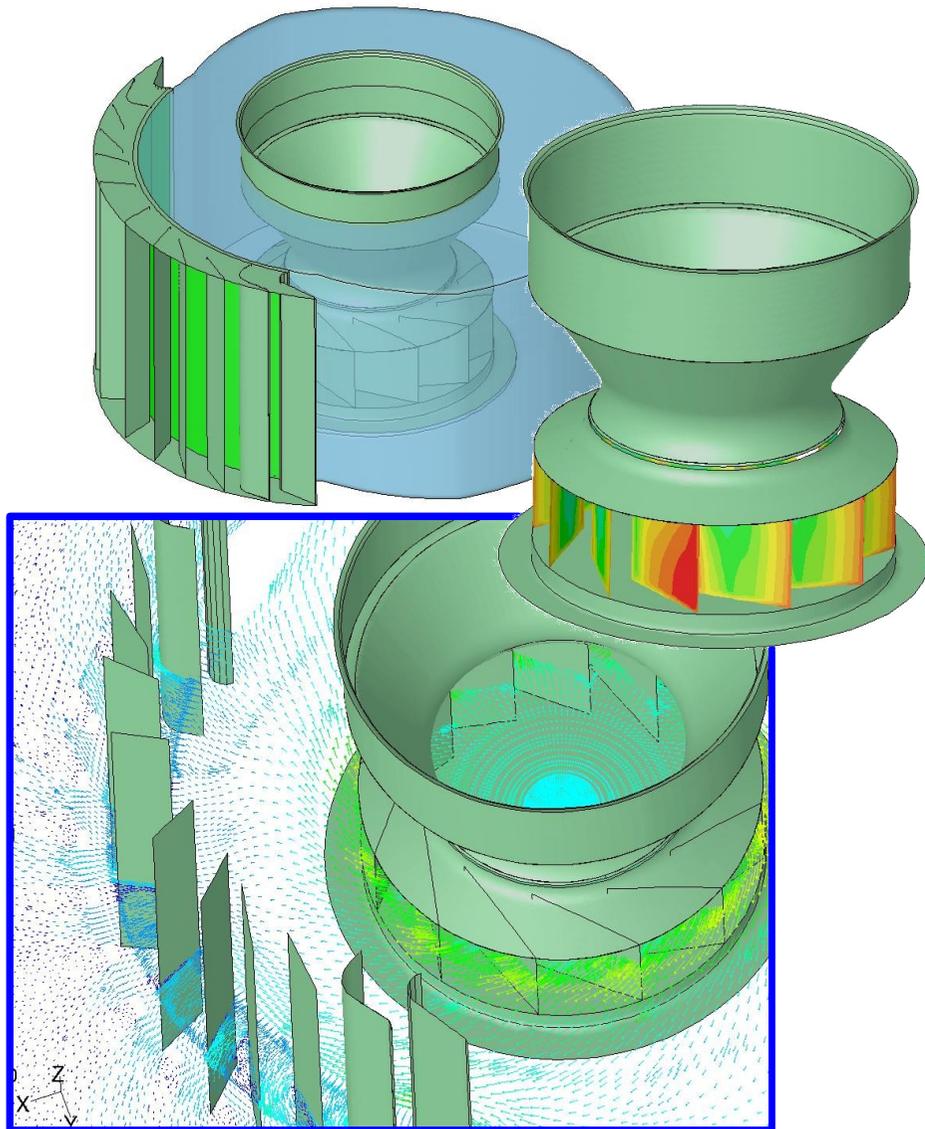
People have questions



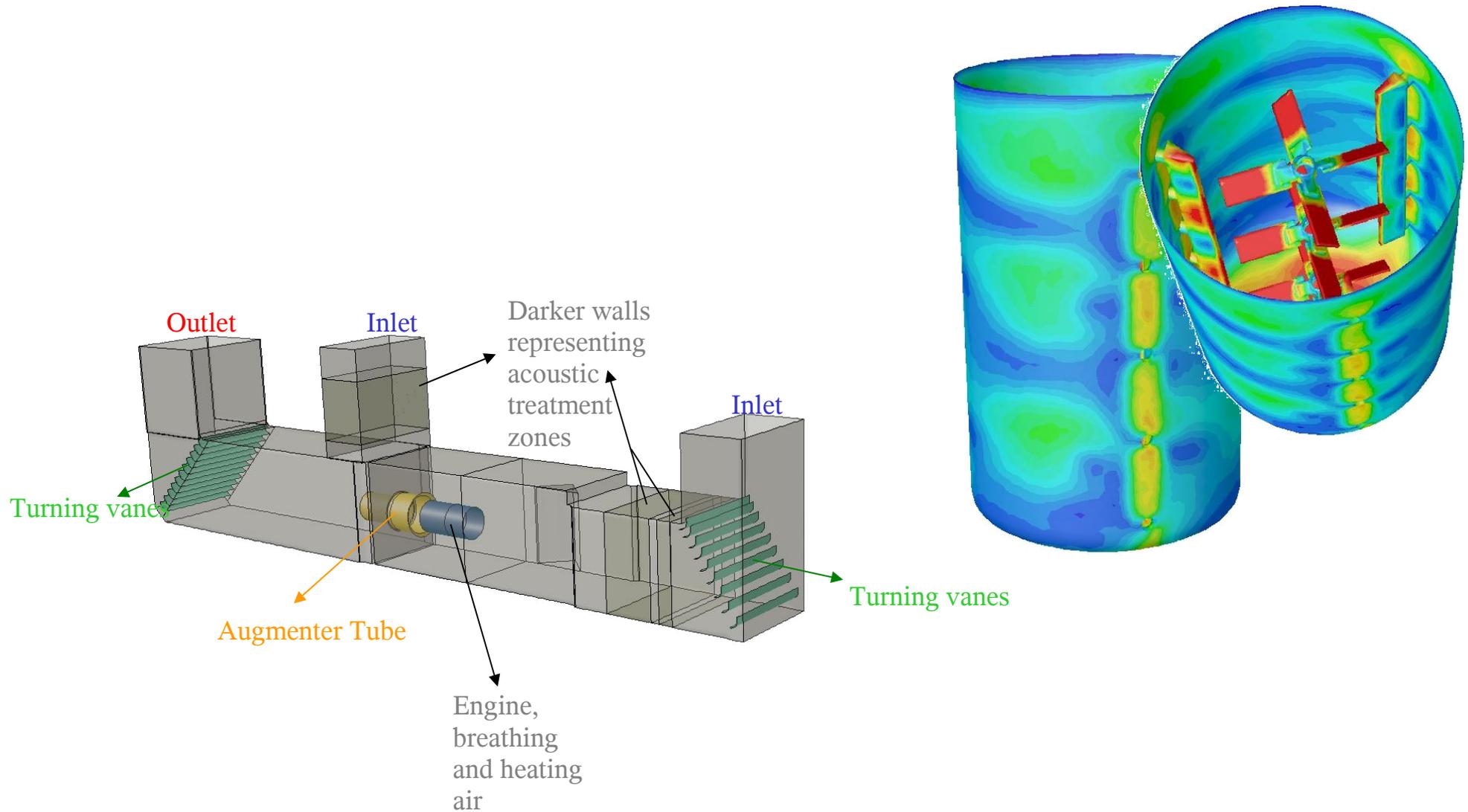
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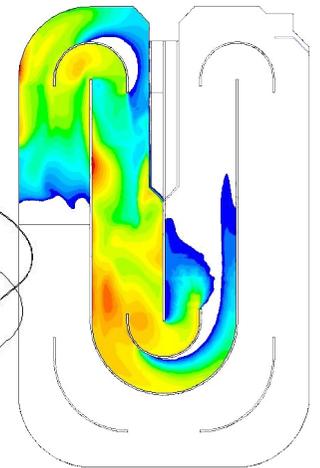
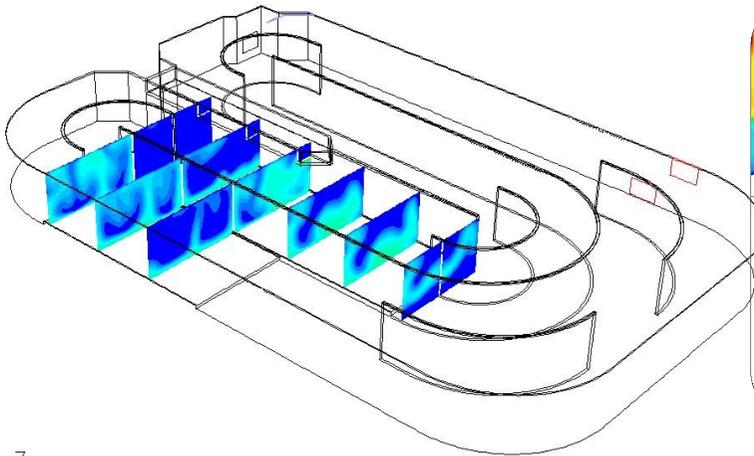
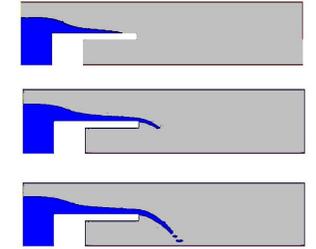
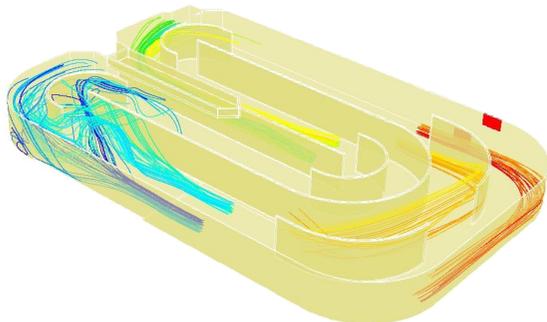
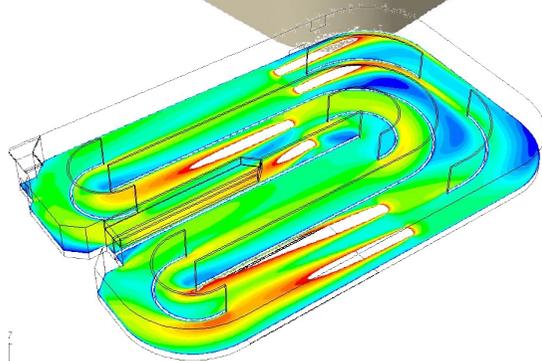
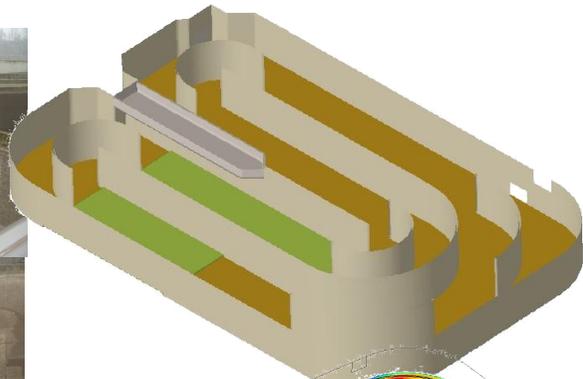
People have questions



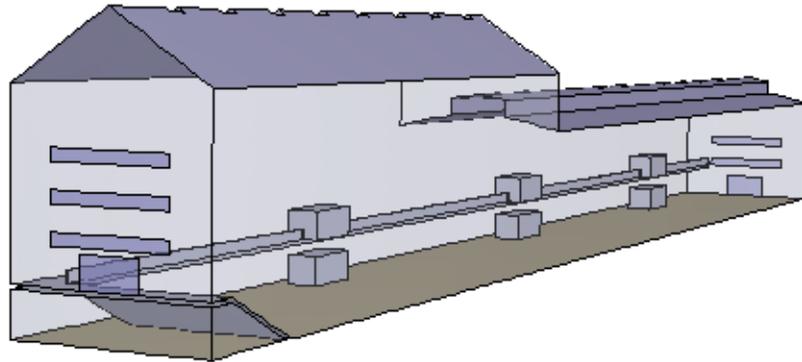
People have questions



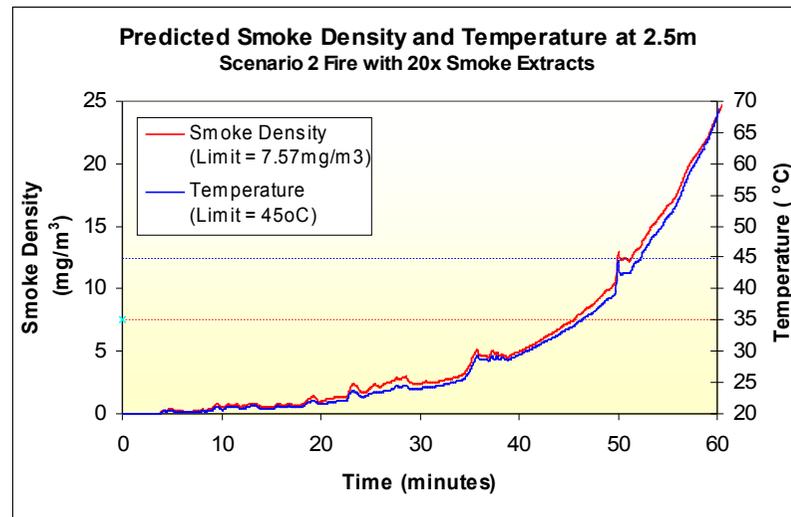
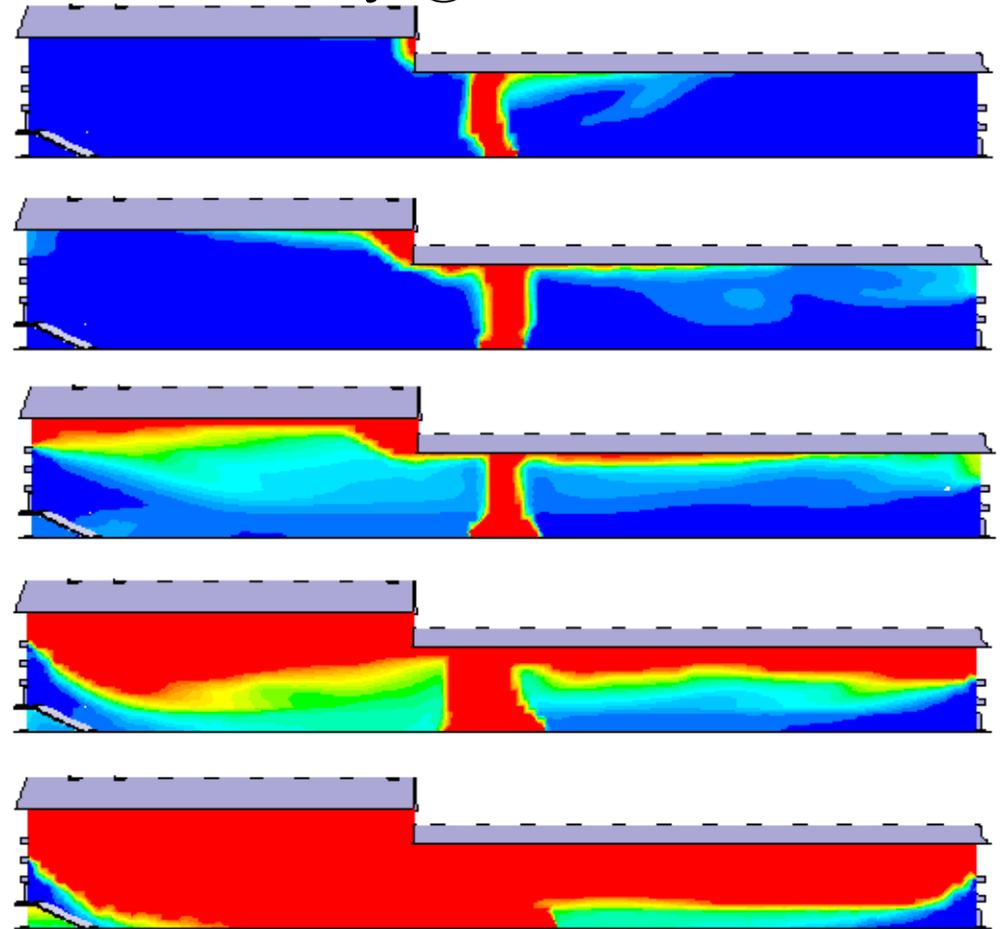
People have questions



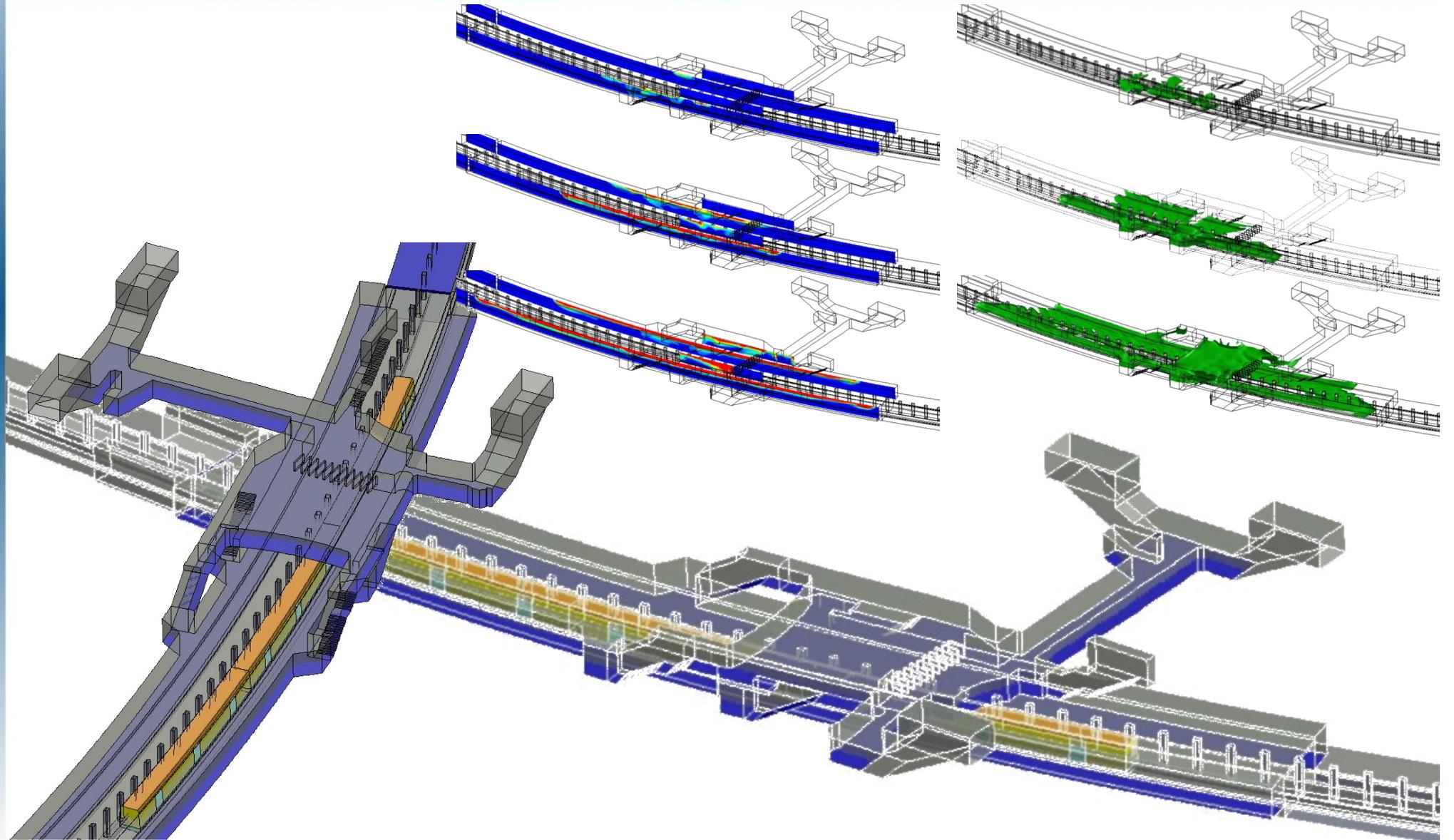
People have questions



Smoke density @ 10, 20, 3, 40, 50 min



People have questions



People have questions

"Nobody trusts a computer simulation except the guy who did it, and everybody trusts experimental data, except the guy who did it."

But this is changing!

Paradox: this is changing because end-users want to assure quality by standardizing CFD modeling.

CFD: the process

- ◆ Problem Identification and model Set-Up
 - ◆ 1. Define your modeling goal & ask the questions
 - ◆ 2. Identify the domain
 - ◆ 3. Create the grid
- ◆ Solver Execution
 - ◆ 4. Set up the numerical model (including submodels and BC's)
 - ◆ 5. Compute (discretisation scheme and convergence)
- ◆ Post-Processing
 - ◆ 6. Examine the results: the answers
 - ◆ 7. Consider revisions to the model

1. Define modeling goals

- ◆ What results are you looking for?
- ◆ How will they be used, and by who?
- ◆ What physical models do I need to include?
 - ◆ Turbulence, Radiation, Chemical reaction, Particle dynamics, ...
- ◆ What is the required level of accuracy?
- ◆ How quickly do I need results?

2. Identify the domain

3. mesh

- ◆ Which part of the entire world will I include?
 - ◆ What boundary conditions are known?
 - ◆ What boundary conditions are needed?
 - ◆ The software's defaults may not be appropriate
 - ◆ Can we make simplifications (symmetry, 2D)?
-
- ◆ What mesh/cell-types to use?
 - ◆ Resolution? Refinement? Skewness, aspect ratio, cell growth
 - ◆ Near wall requirements?

4. setup the model

5. calculate

- ◆ Select physical models (a lot of implicit assumptions!)
 - ◆ Boussinesq or fully buoyant flow
 - ◆ Radiation or not? Which model?
 - ◆ Turbulence
- ◆ Material properties
- ◆ BC's

- ◆ Choose solver (implicit assumption about steadiness)
- ◆ Iterate until convergence

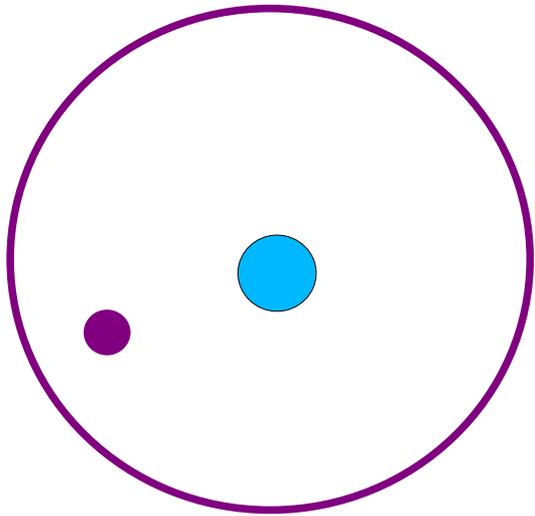
6. review the model + postprocessing

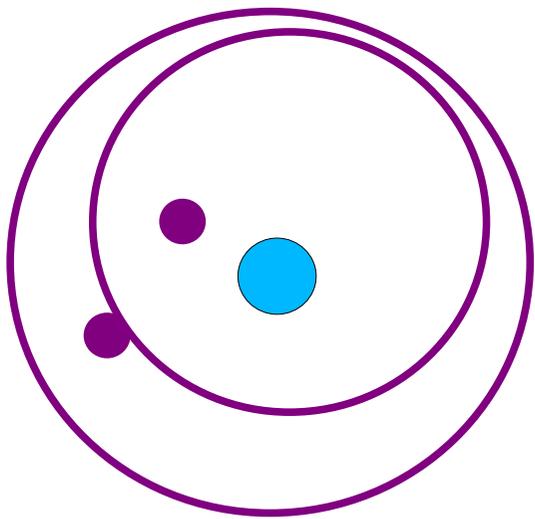
7. consider revisions

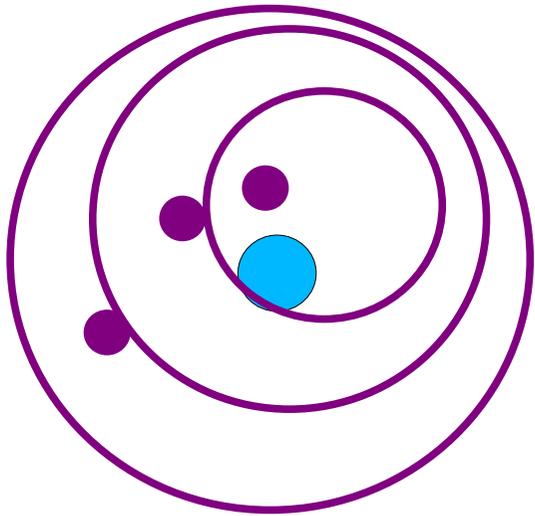
- ◆ Using visual and numerical output:
 - ◆ What is the overall flow pattern?
 - ◆ Are the important flow features resolved?
 - ◆ Is there separation?
 - ◆ Are the BC's appropriate?
- ◆ Consider modifications of every part of the modeling work.
 - ◆ Are the physical models appropriate?
 - ◆ Are boundary conditions correct?
 - ◆ Is the grid adequate?

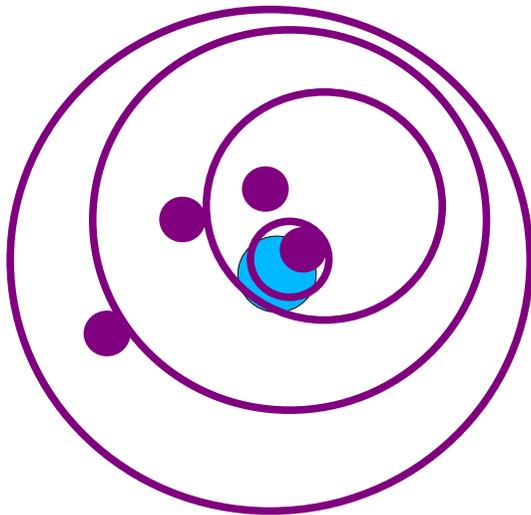




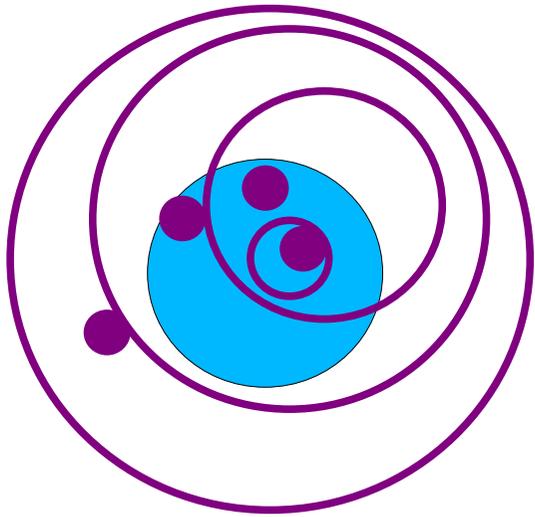


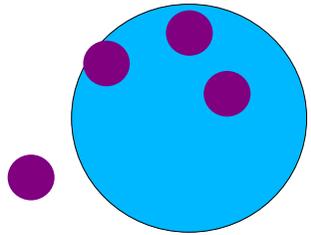
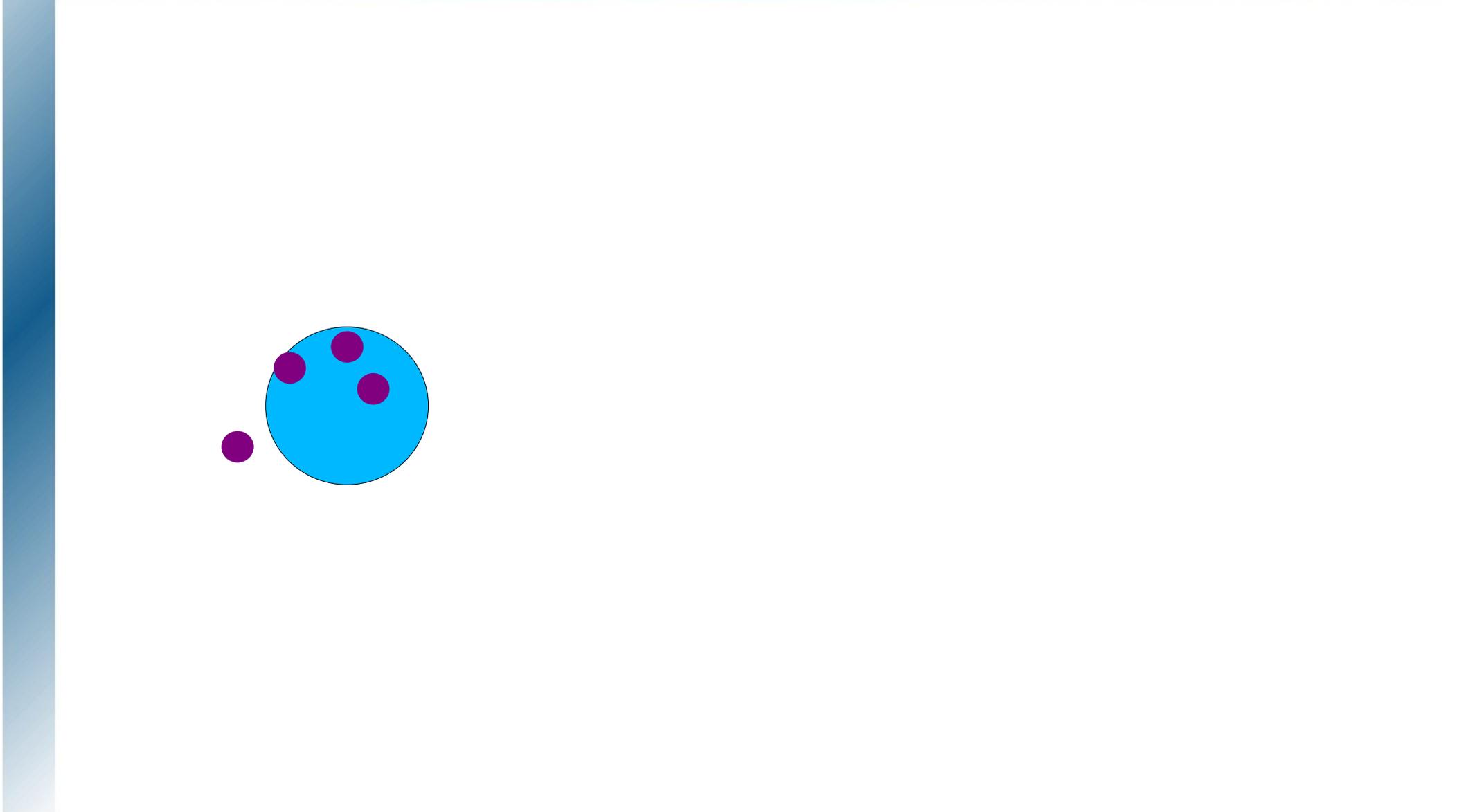


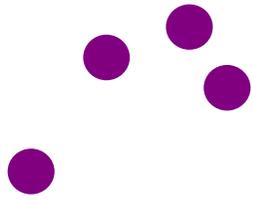




- Grid
- BC's
- Time-step
- Turbulence, Radiation, ...
- Discretisation









If you don't know what's behind the dot, and you extract data from a model, you are mesh based guessing!



There they are again with the mythical grid-independent solution.

- If the model is a converged and grid-independent solution of a well-posed problem, the results are meaningful.
- It's not very useful to calculate more accurately than the variability of the BC's allows --> better to do a sensitivity analysis on the important assumptions, on a reasonably fine mesh.

Using results: extracting answers from the model

- ◆ Question: was the model set-up to answer this question?
 - ◆ Y: if we trust the analyst did a good job --> ok, we have the answer
 - ◆ N: would the model be any different if this particular question was asked upfront?
 - ◆ So I need to know and understand all the details of the model? Yes!
 - ◆ N --> ok, we have the answer
 - ◆ Y --> we need a new model
- ◆ How do these results relate to the good old CFD-less rules of thumb?
 - ◆ e.g. Velocity must be 1.5m/s everywhere
 - ◆ e.g. Visibility must be >10m

Using results

- same problem
- same software
- different user



Different answers



Tendencies in use of CFD

- ◆ Software takes over a lot of the work:
 - ◆ Users tend to become less expert in flow modeling
 - ◆ Can be OK
- ◆ CFD becomes 'regulated', but using rigid requirements, and without getting a grip on the CFD process --> attempt to exclude analyst variability
 - ◆ e.g. Underground car parks

To conclude

- ◆ Know the model, know the uncertainties, know the limitations, know the options not chosen.
- ◆ For analysts: keep educating the people with the questions