CAD to Mesh: How to Get Your Model Ready for Simulation

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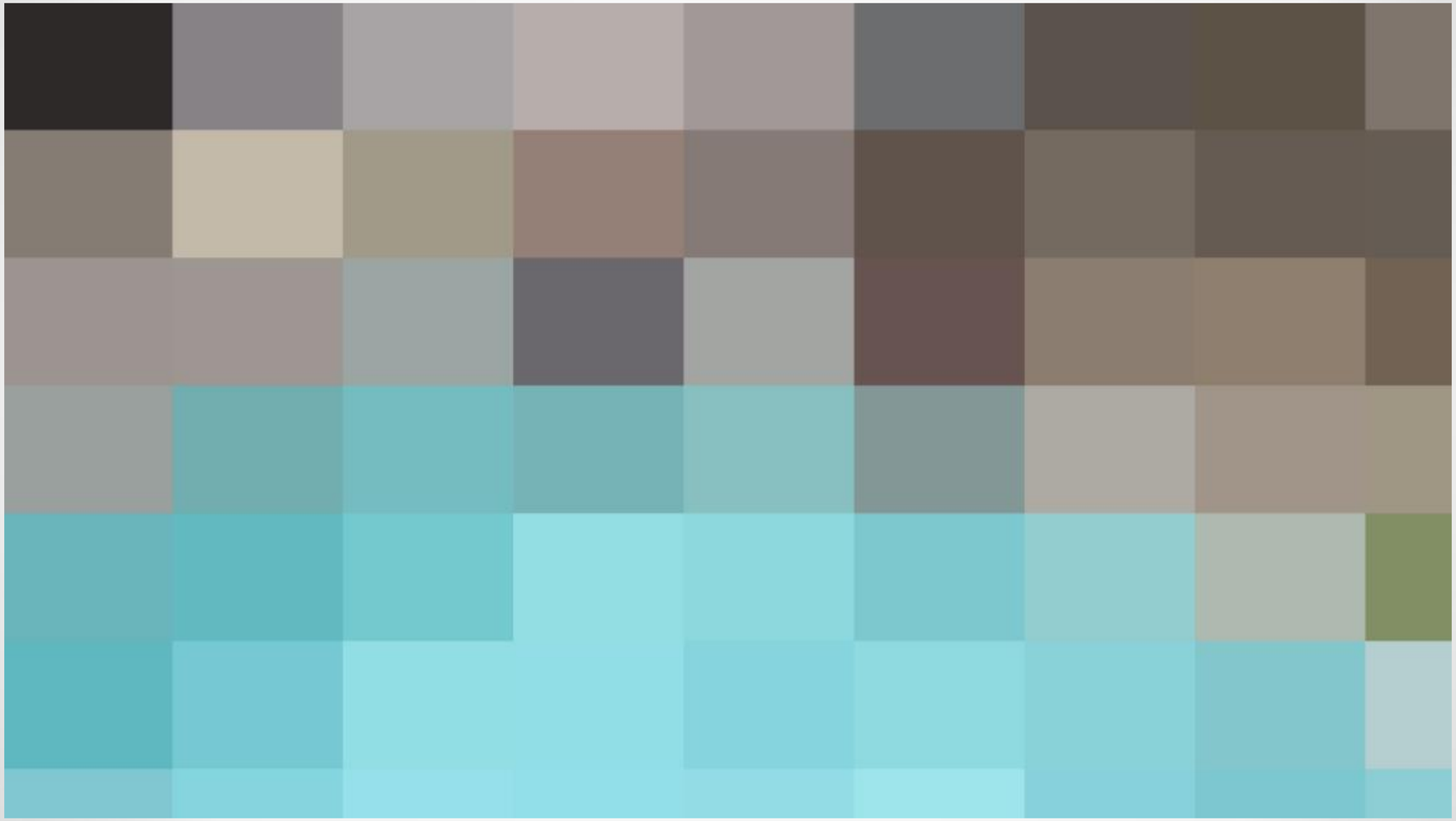
Class summary

This class will walk though techniques for preparing geometry for simulation. We'll cover hints that will help you to identify potentially problematic areas, and then we'll show you how to quickly repair models, remove unneeded detail, and optimize the geometry in a way that will help you to create a high-quality finite element analysis (FEA) or computational fluid dynamics (CFD) mesh.

- Learn how to identify areas in a model that will be problematic for meshing
- Learn how to repair models that have poor integrity
- Learn how to remove unneeded features that have adverse effects on a mesh
- Learn how to pass the geometry to an FEA or CFD simulation software

How Much Data Do You Need?



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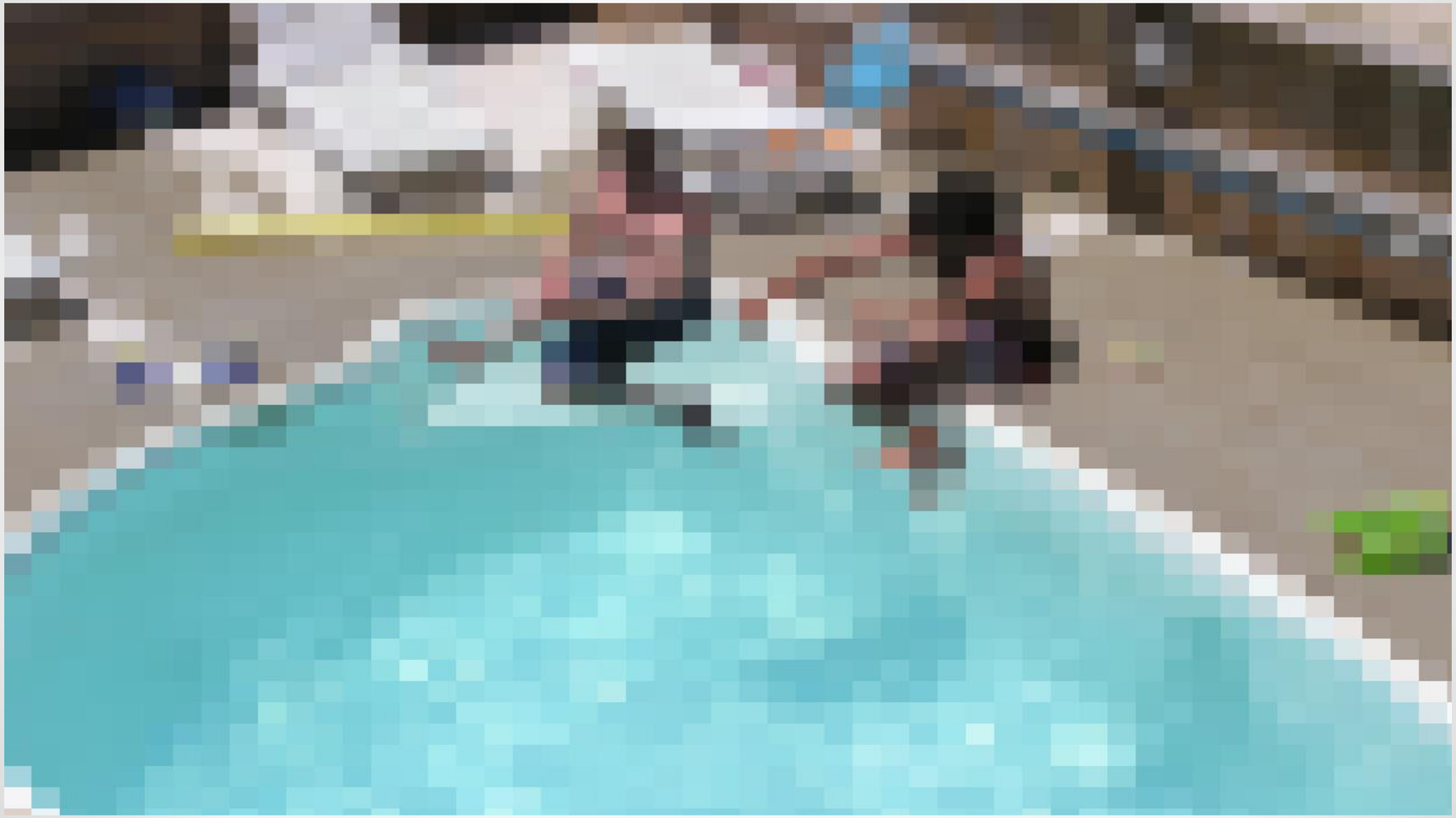

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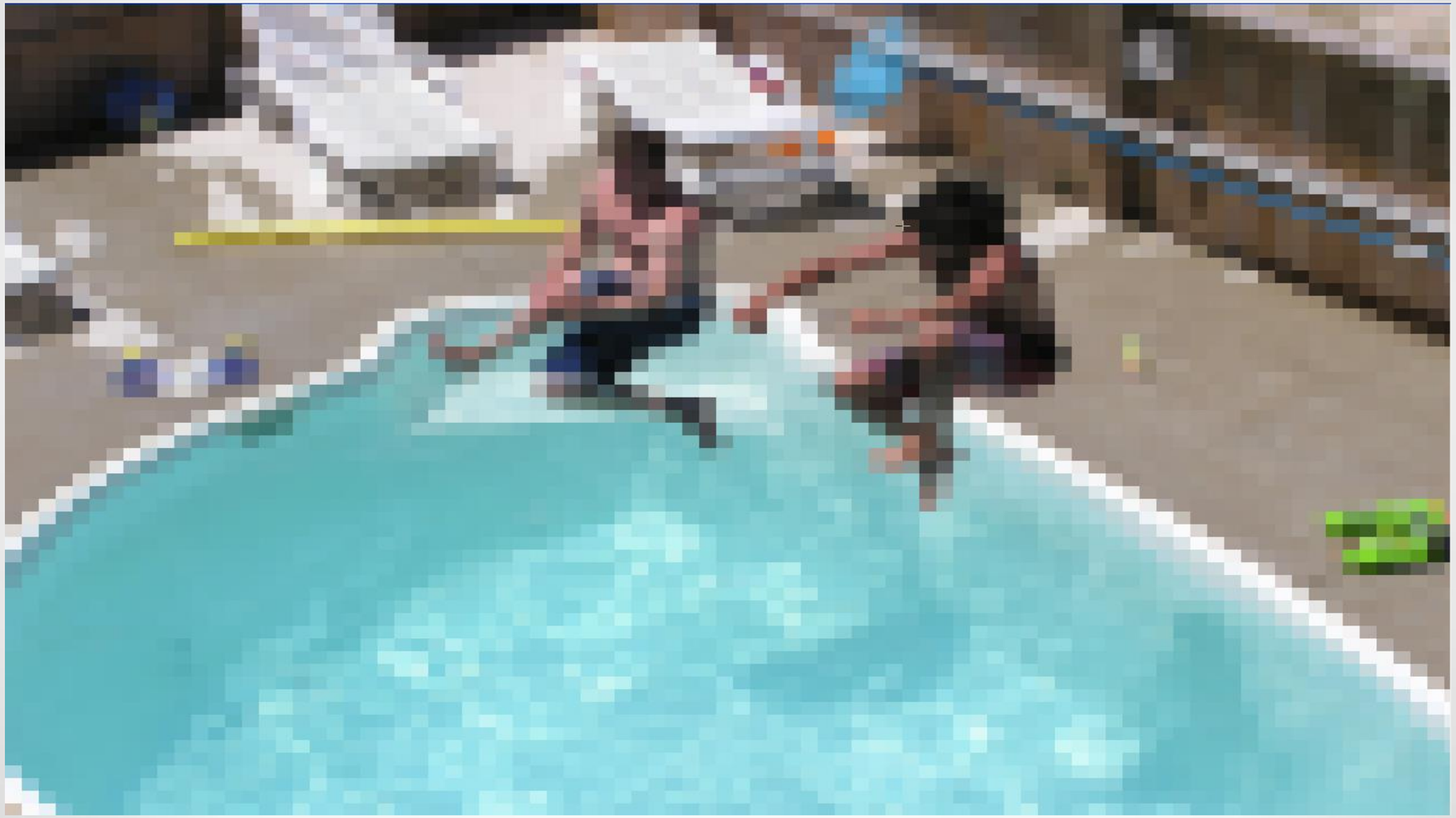

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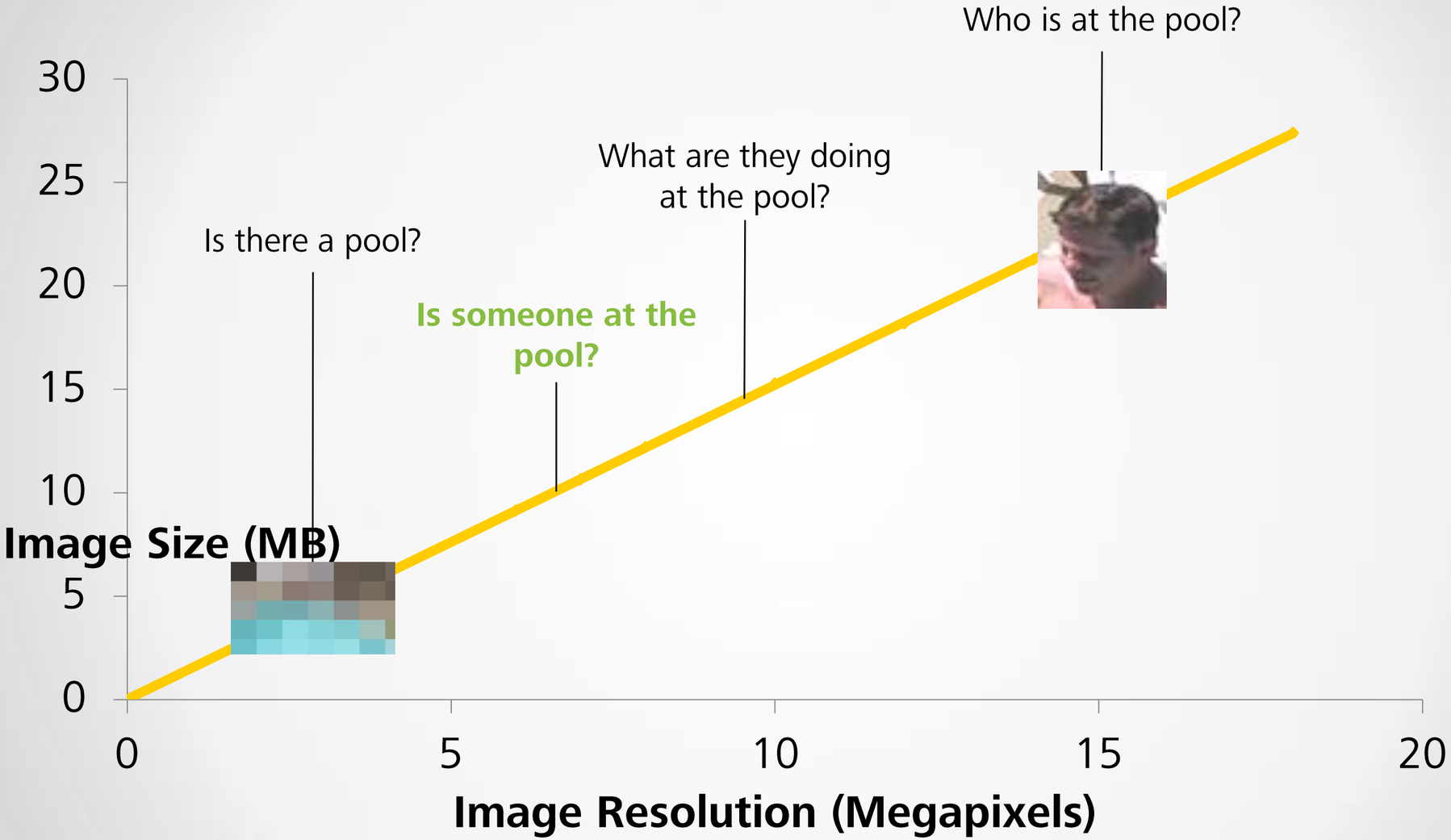
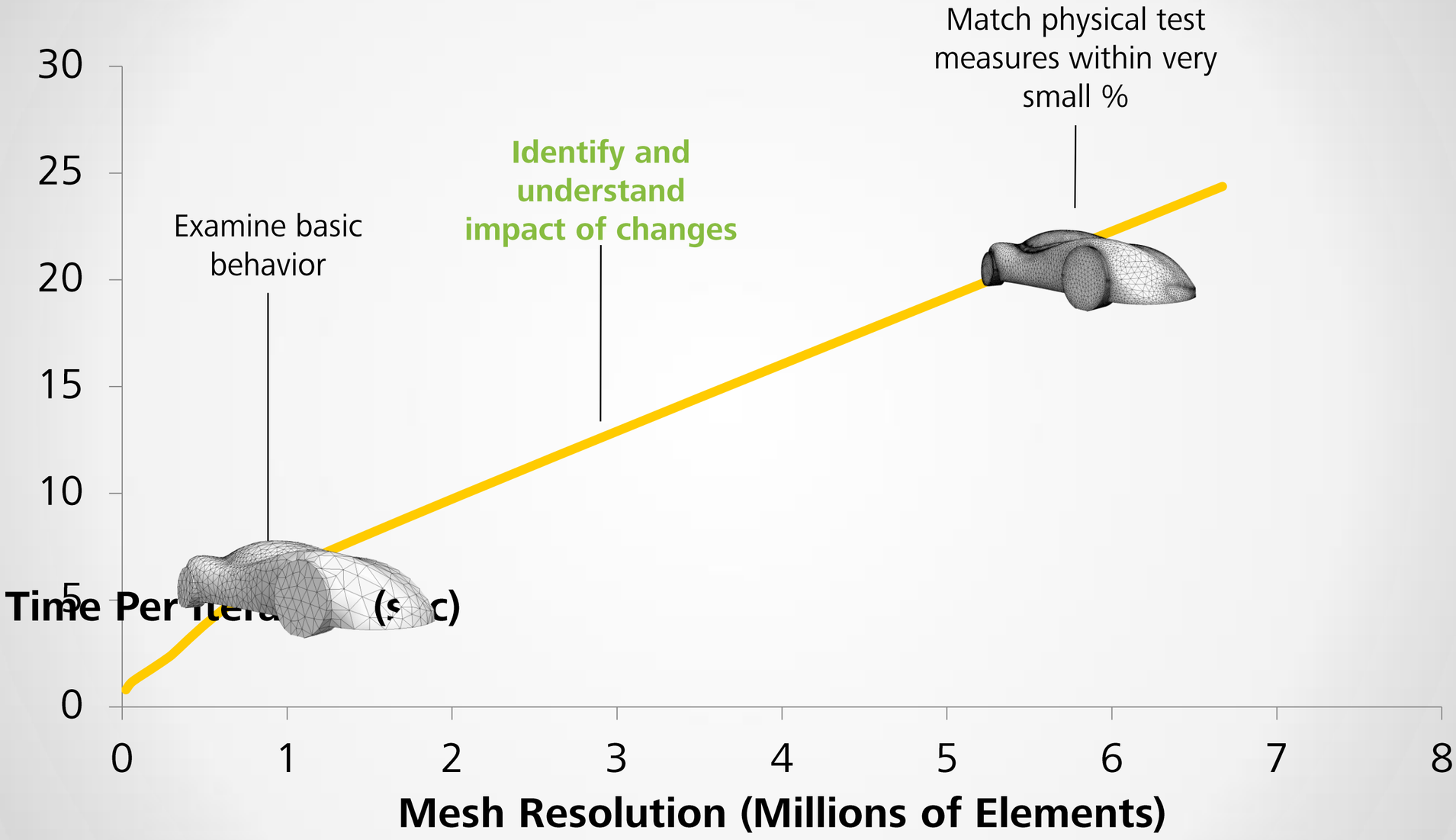
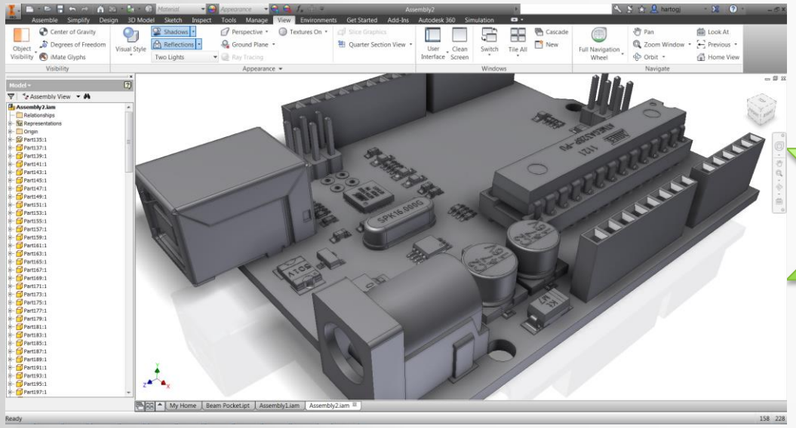


How Much Detail Do You Need?



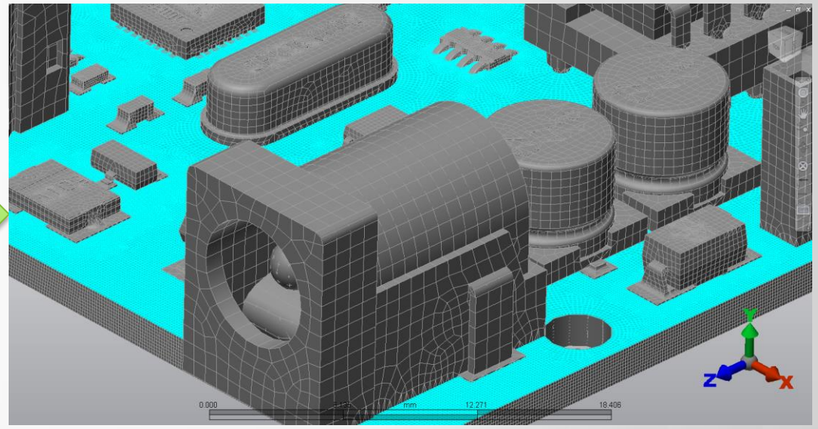
How Much Detail Do You Need?

Detailed CAD



"CAD cleanup"
"CAE prep"
"defeaturing"
"healing and repairing"

Sim Mesh

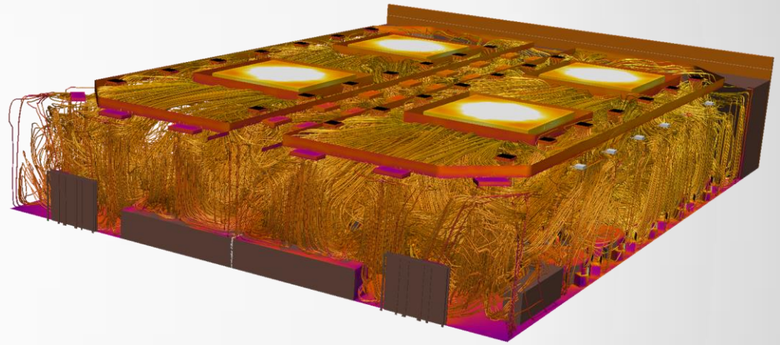


Background

Product Development

- CAD & CAE
- Tech research and design
- Testing, mfg, bringing products to mkt

Simulation



- Customer support and consulting
- Simulation product team
- Emerging tech and new offerings

Agenda

- Introduce basic CAD to mesh concepts
- CAD prep checklist
- Review some examples

Quality foundation

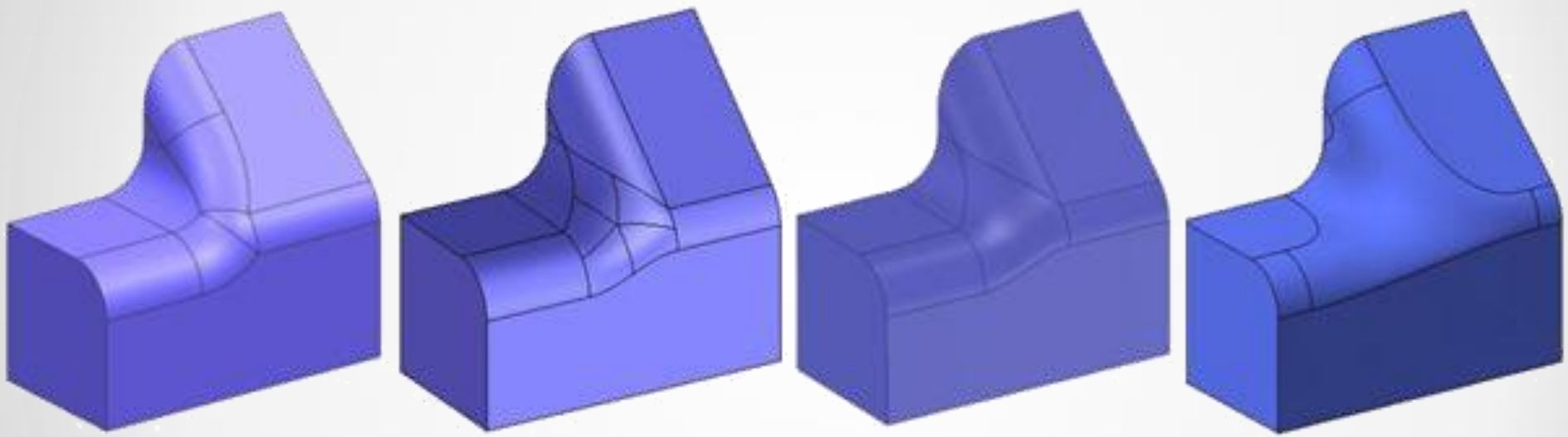


Image from Paul Hamilton, The Geometry Kernel and What it Means to Product Development. 23 January 2013. Accessed at http://p-hamilton.blogspot.com/ 30 September 2014.

Good integrity

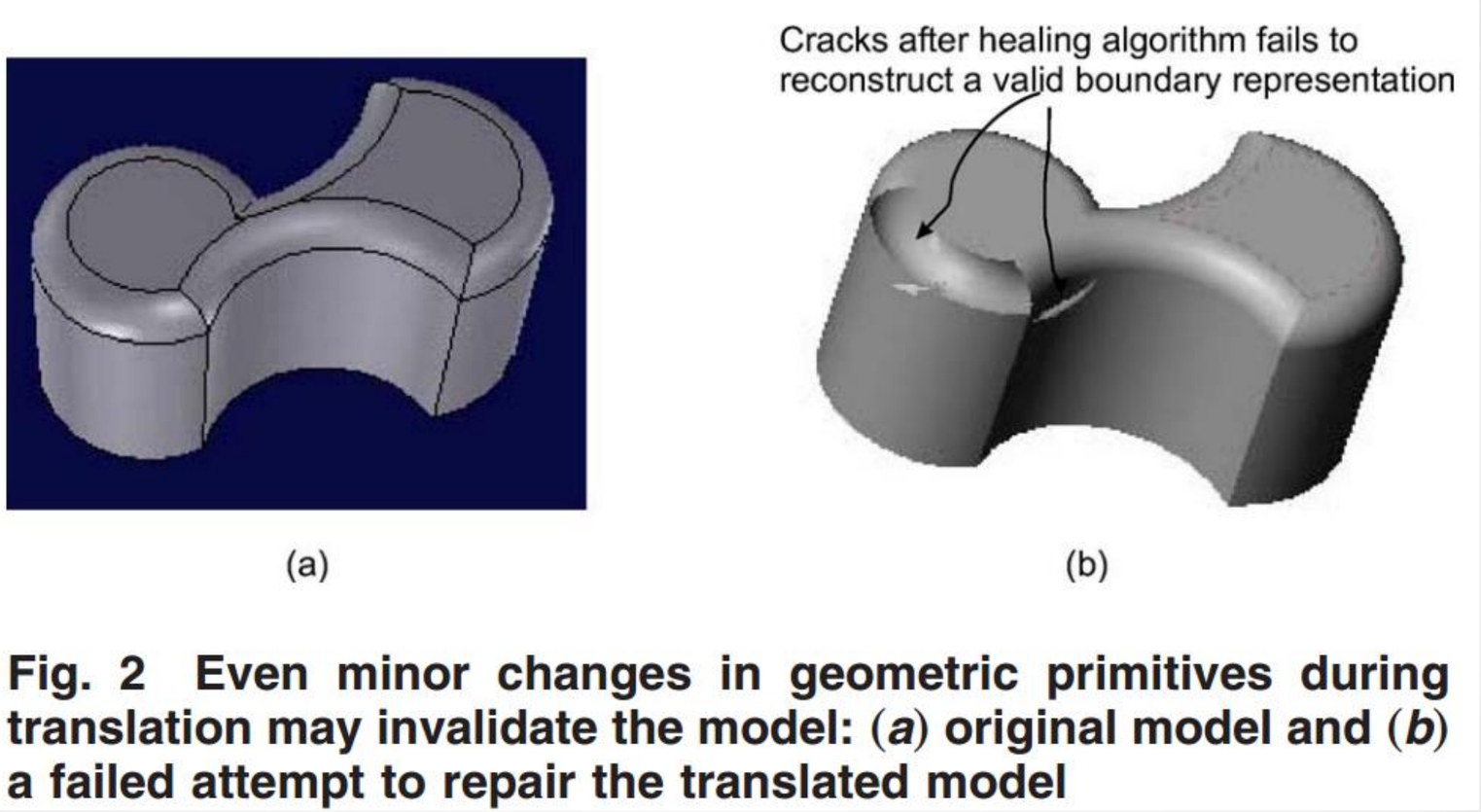
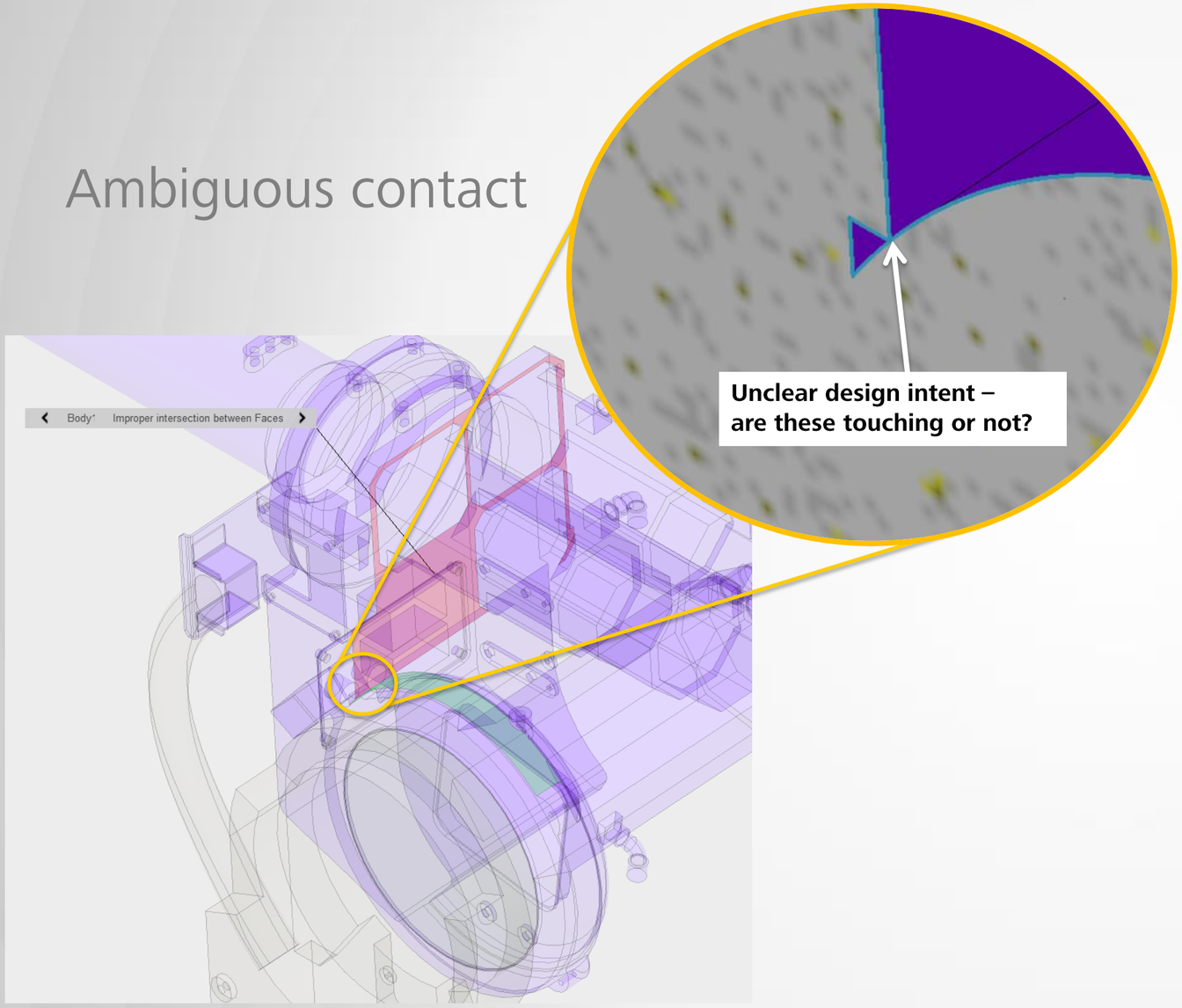


Fig. 2 Even minor changes in geometric primitives during translation may invalidate the model: (*a*) original model and (*b*) a failed attempt to repair the translated model

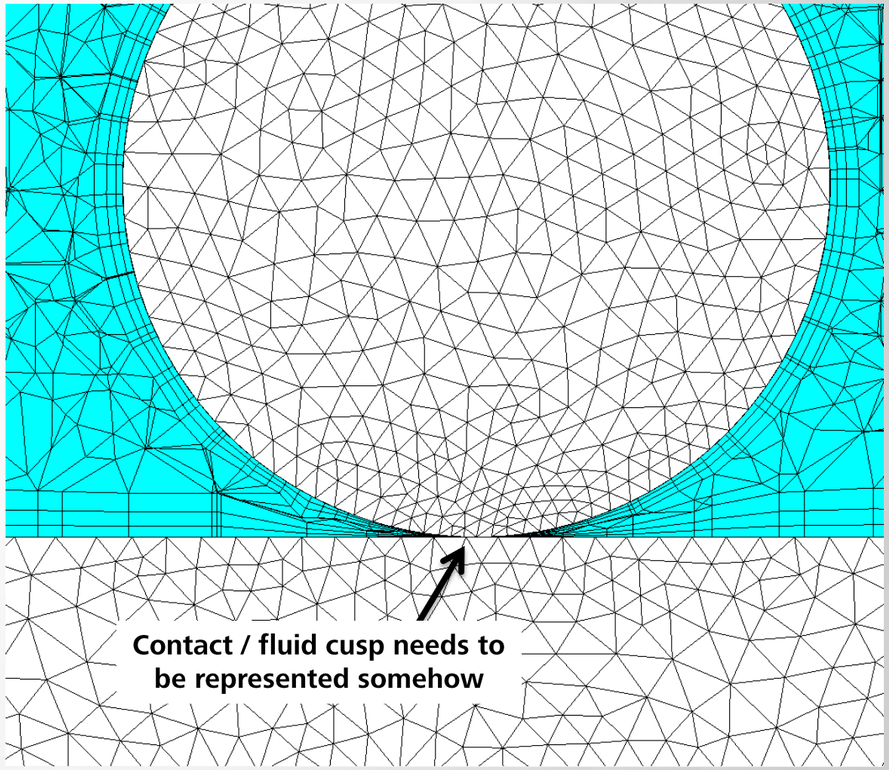
J. Qi and V. Shapiro. "Geometric Interoperability with epsilon-solidity" in *Transactions of ASME, Journal of Computing and Information Science in Engineering, Vol. 6, No. 3, September 2006.*

Design intent correctly represented

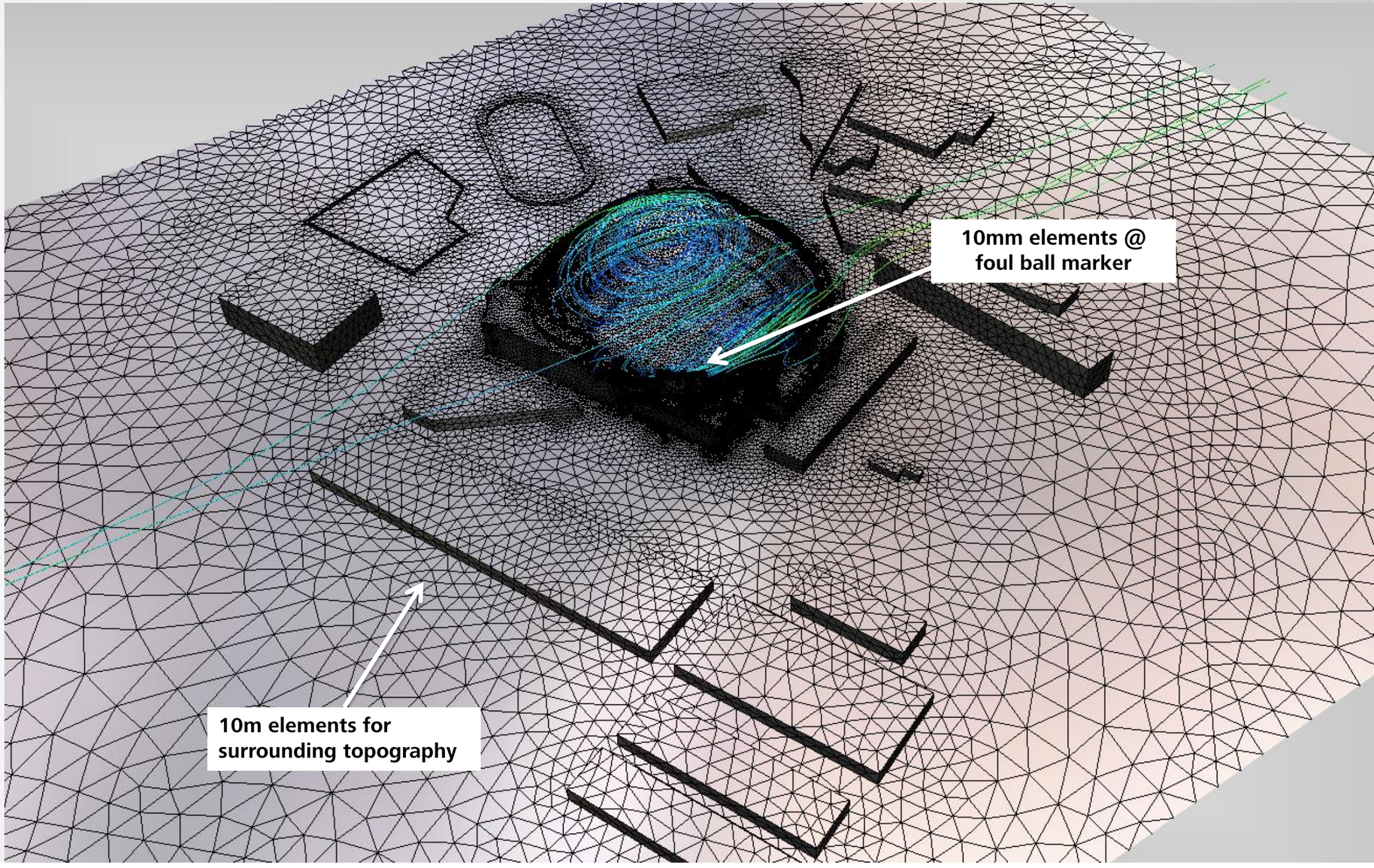
Ambiguous contact



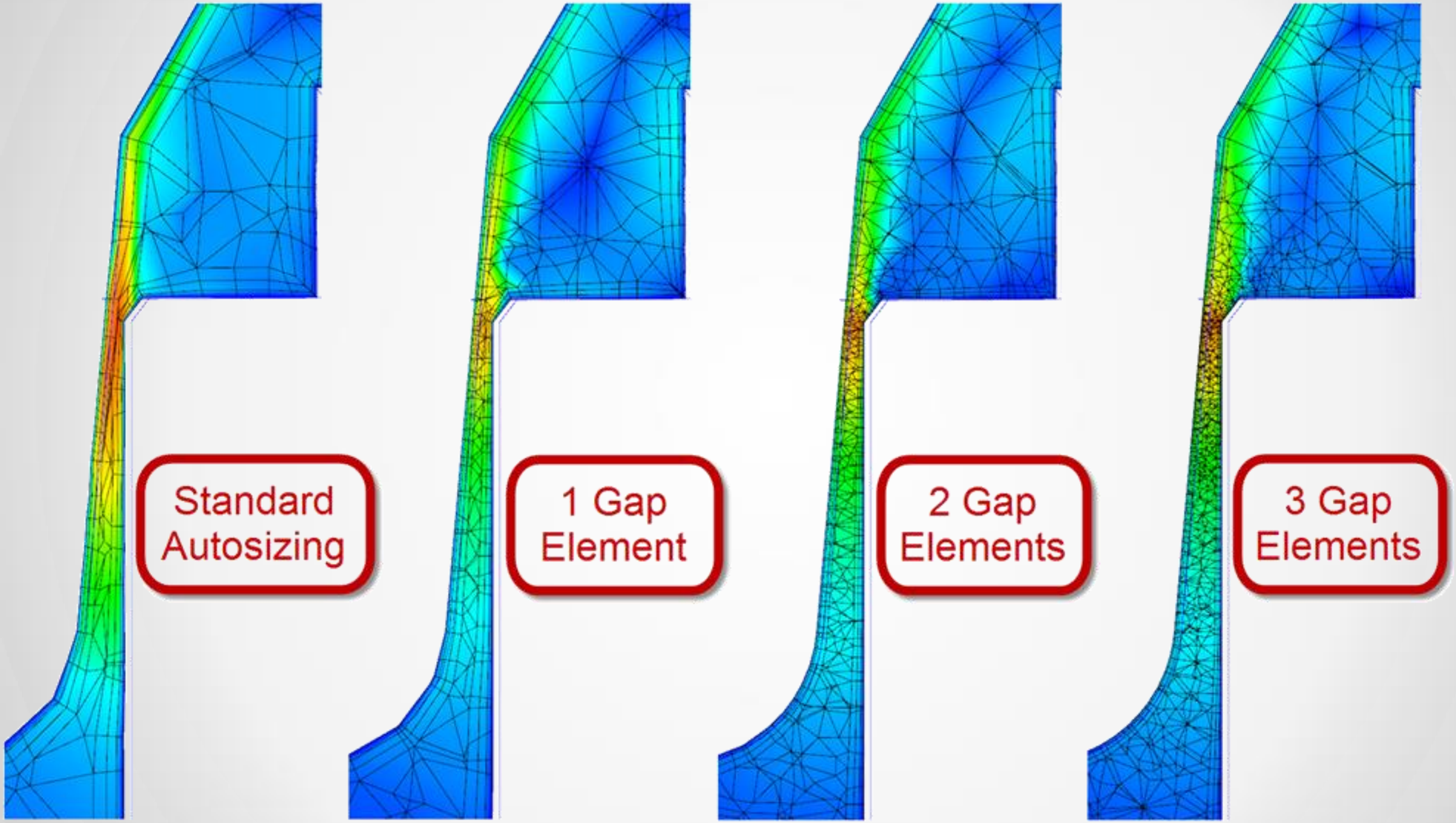
Cusp geometry



Handling radical differences in length scale



The right resolution



Workflow Options

Advantages
- A tool you already know
- Record of change

Advantages
- Tools for simplification
- Isolated from design model
- Direct modeling

Geom Prep Tool Example : SimStudio

- Goal: help you prepare CAD for simulation
  - **A**nalyze
  - **R**epair
  - **R**emove
  - **O**ptimize

- Connects to Simulation Mechanical, CFD, and Moldflow 2016 products

- Now entering beta as “SimStudio” –
  email simstudio.beta@autodesk.com if interested

Checklist for Getting Your Model Ready

1. Remove unnecessary parts
2. Consider symmetry & 2D
3. Ensure it has good integrity / heal
4. Simplify by defeaturing
5. Add setup features (contact area, fluid vol)
6. Idealize it (shells, point masses)
7. Specify mesh details
8. Inspect it (use sim tool diagnostics)
9. Test it (mesh it in the sim app)
10. Update it (design changes)

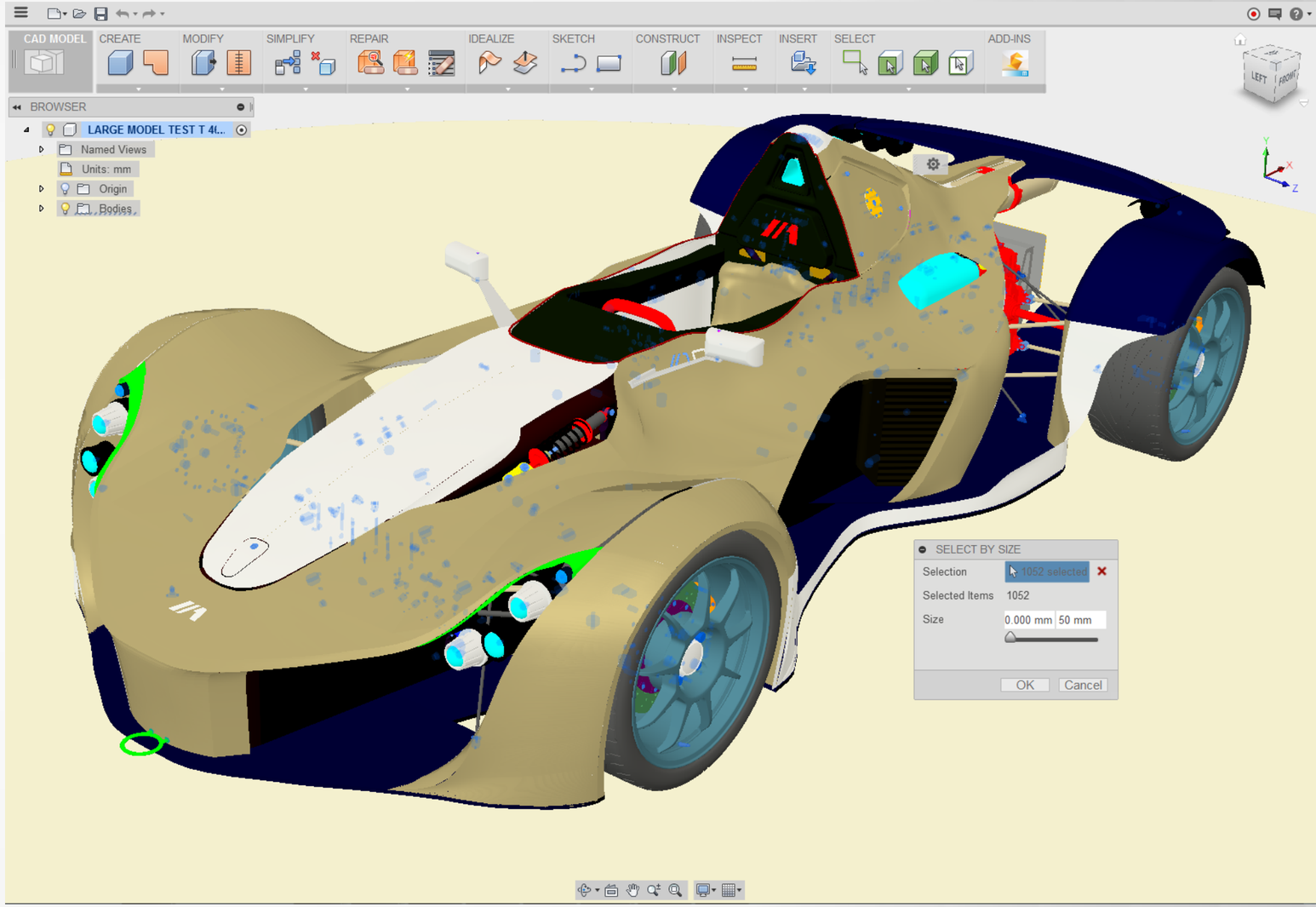
Primarily done in sim app

Bonus : Wrap it

1. Remove unnecessary parts

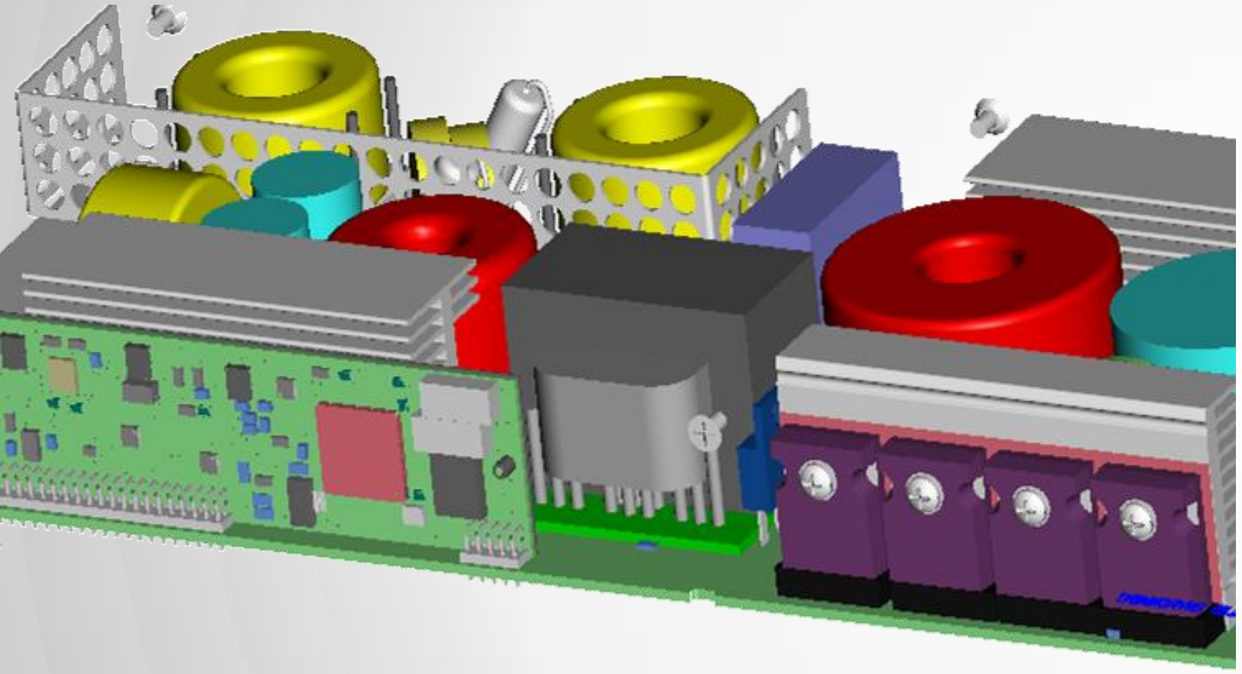
- Nuts, bolts, washers, gaskets, clips (fill holes afterwards)

- Non-participating parts
  - Don’t affect flow (CFD)
  - Don’t transport heat (CFD, FEA)
  - Don’t carry load (FEA)
  - Can be replaced by pt mass (FEA)

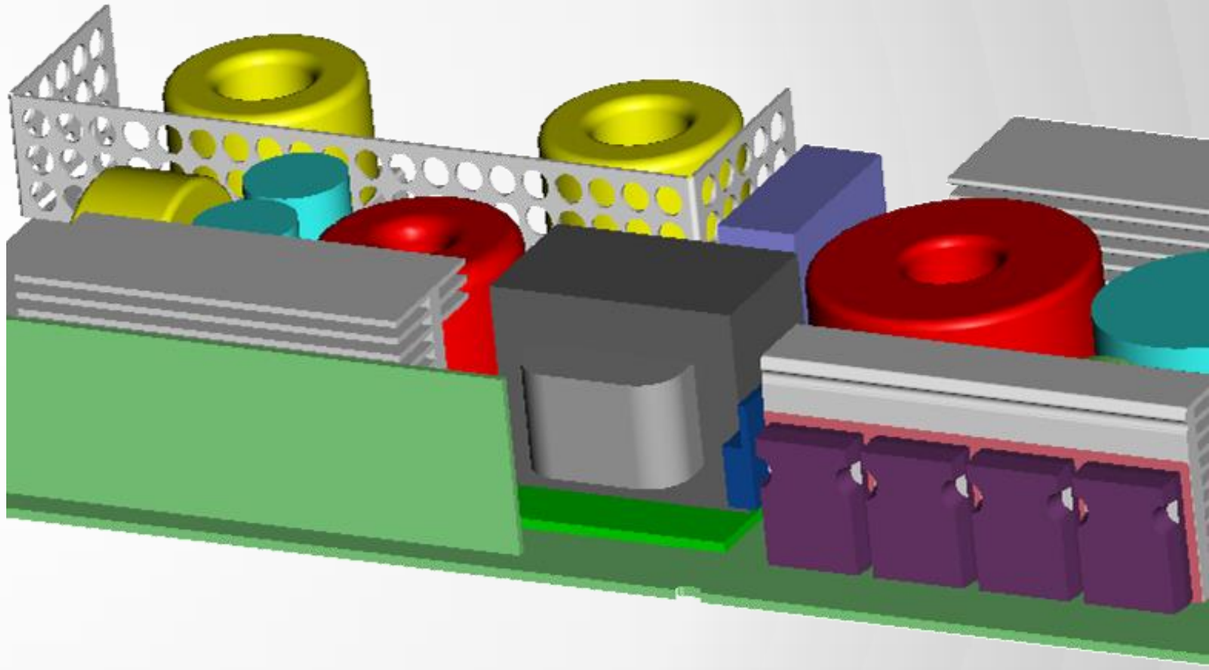


1. Remove unnecessary parts

Production Ready

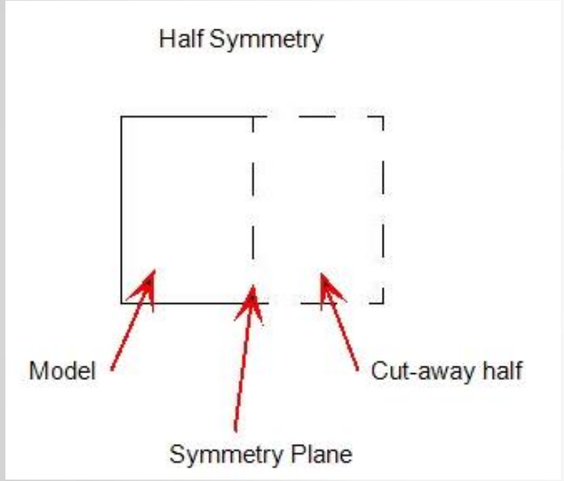


Simulation Ready

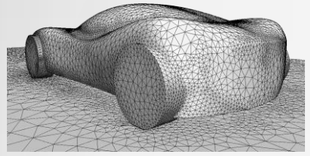


2. Consider symmetry

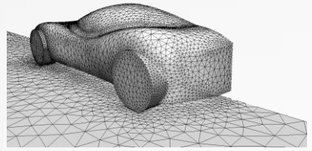
- Half Symmetry



2. Consider symmetry

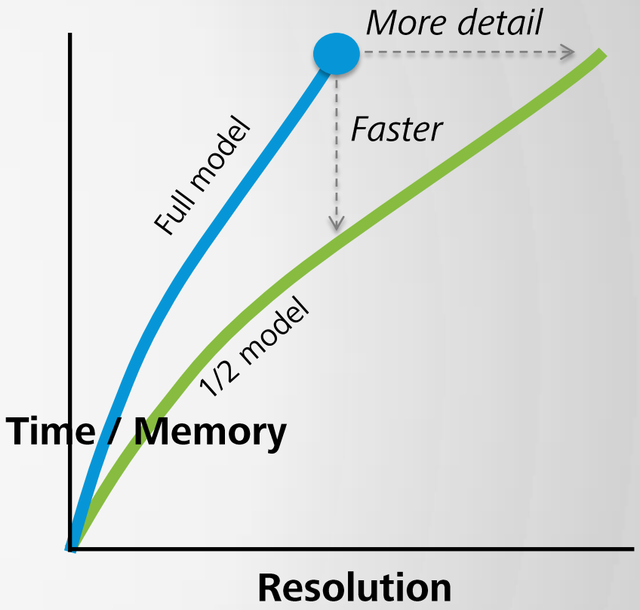


Full Model



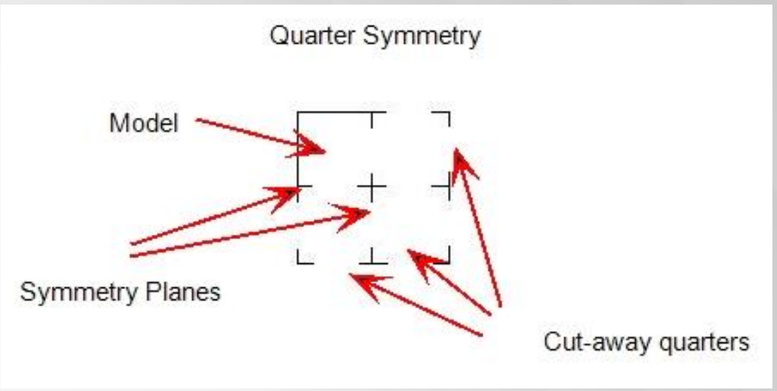
½ Model

Elements	586,513	286,908	-51%
Solve Time	64 minutes	39 minutes	-38%

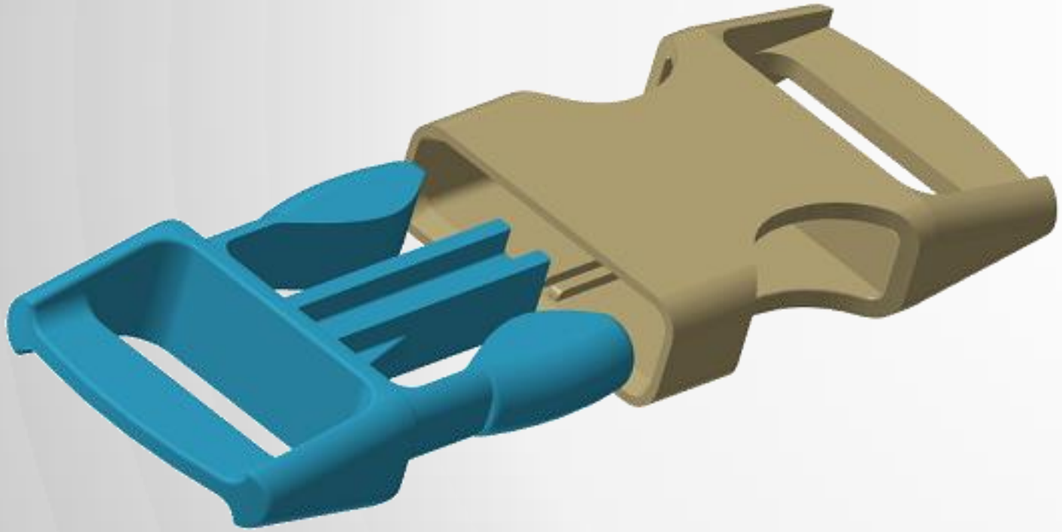


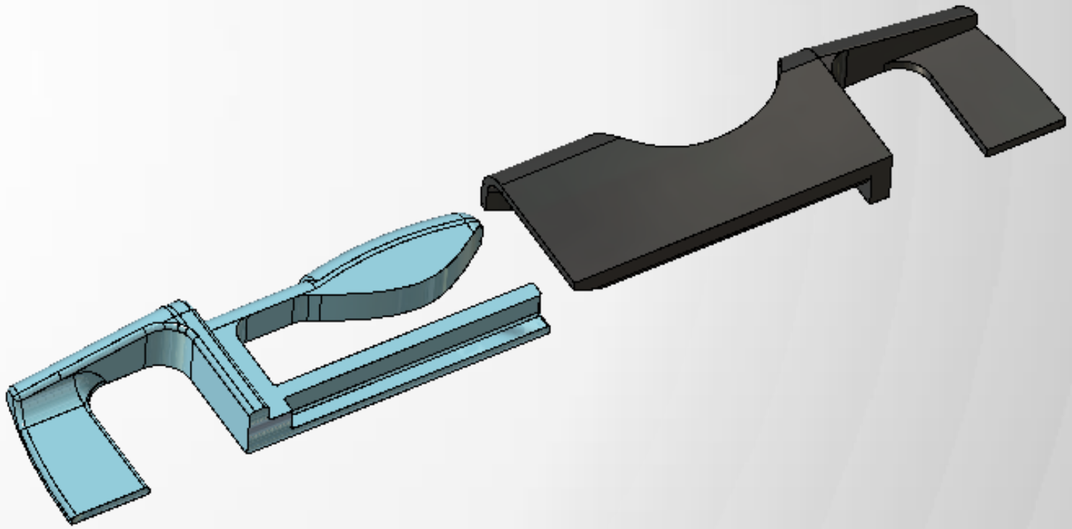
Allows you to put more mesh in places where it is important!

2. Consider symmetry



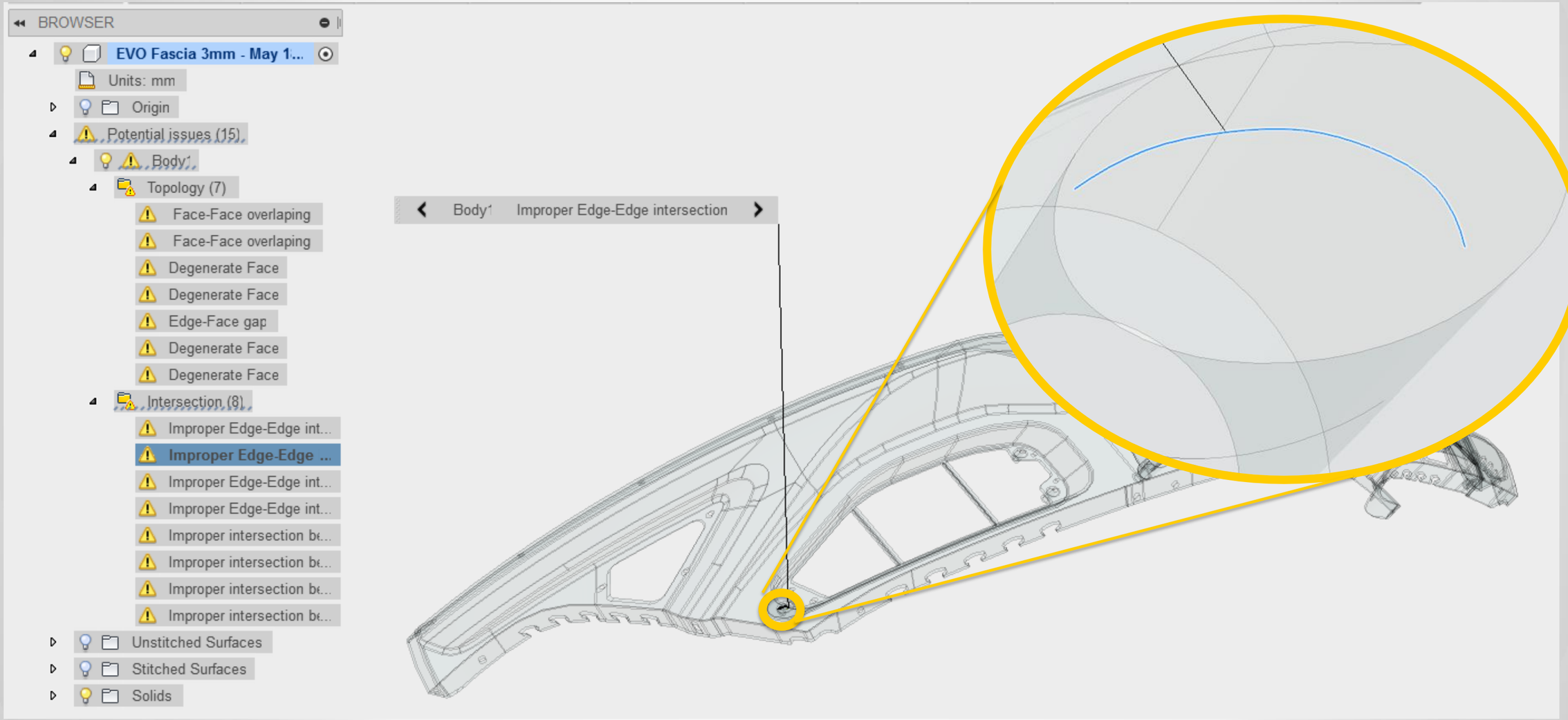
- Quarter symmetry, radial, axisymmetric, etc





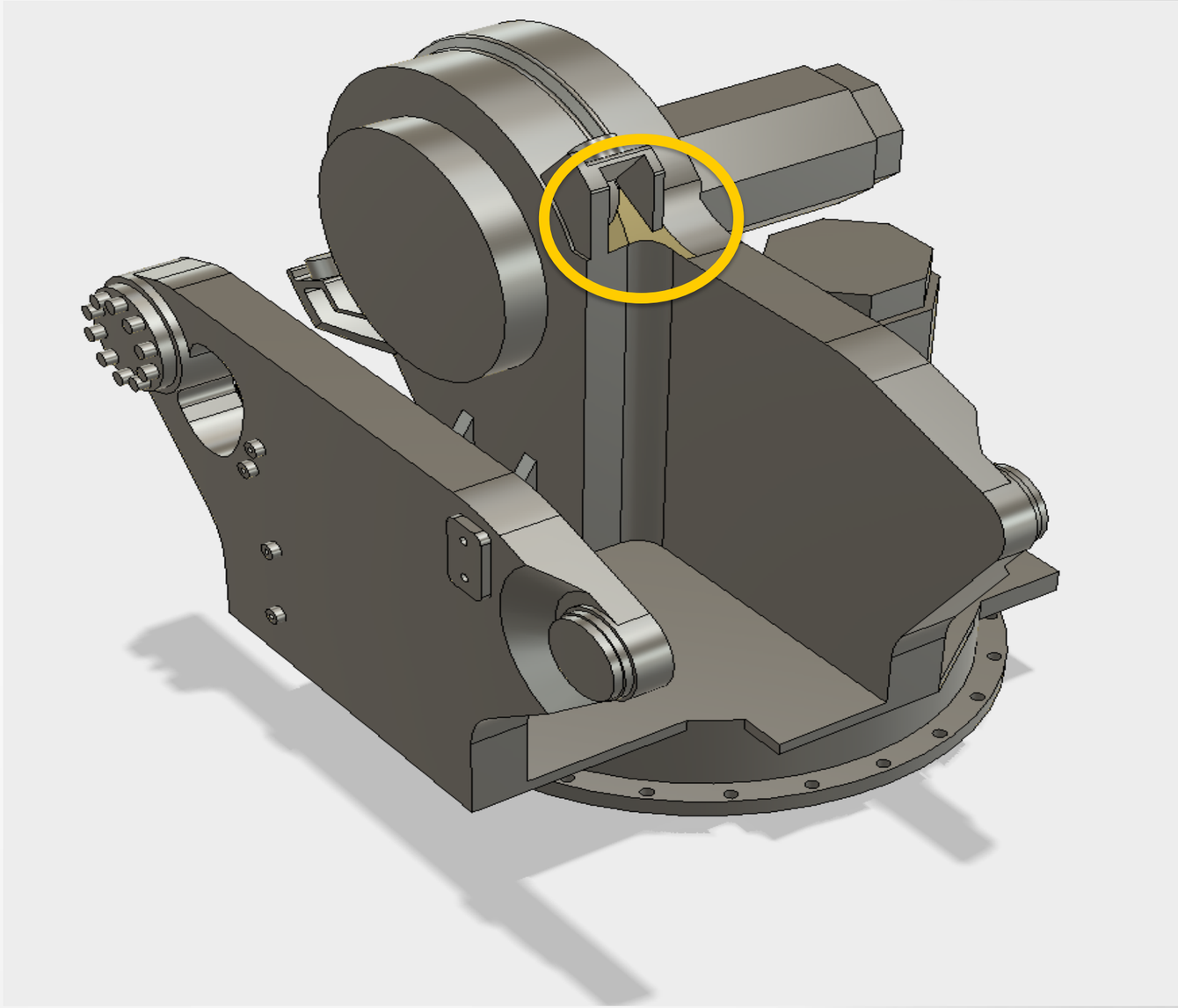
3. Make sure it has good integrity

Improperly defined surfaces / edges

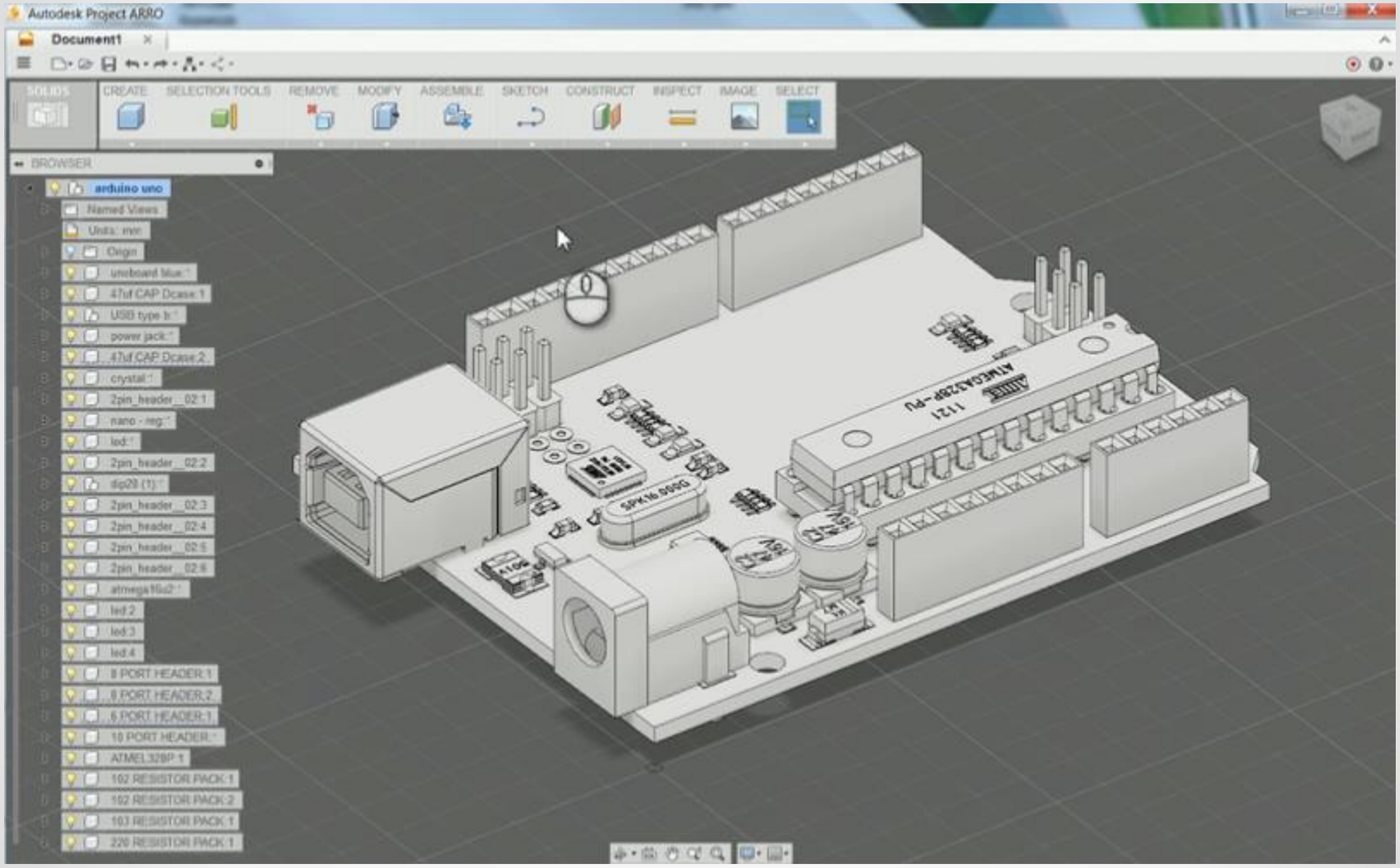


3. Make sure it has good integrity

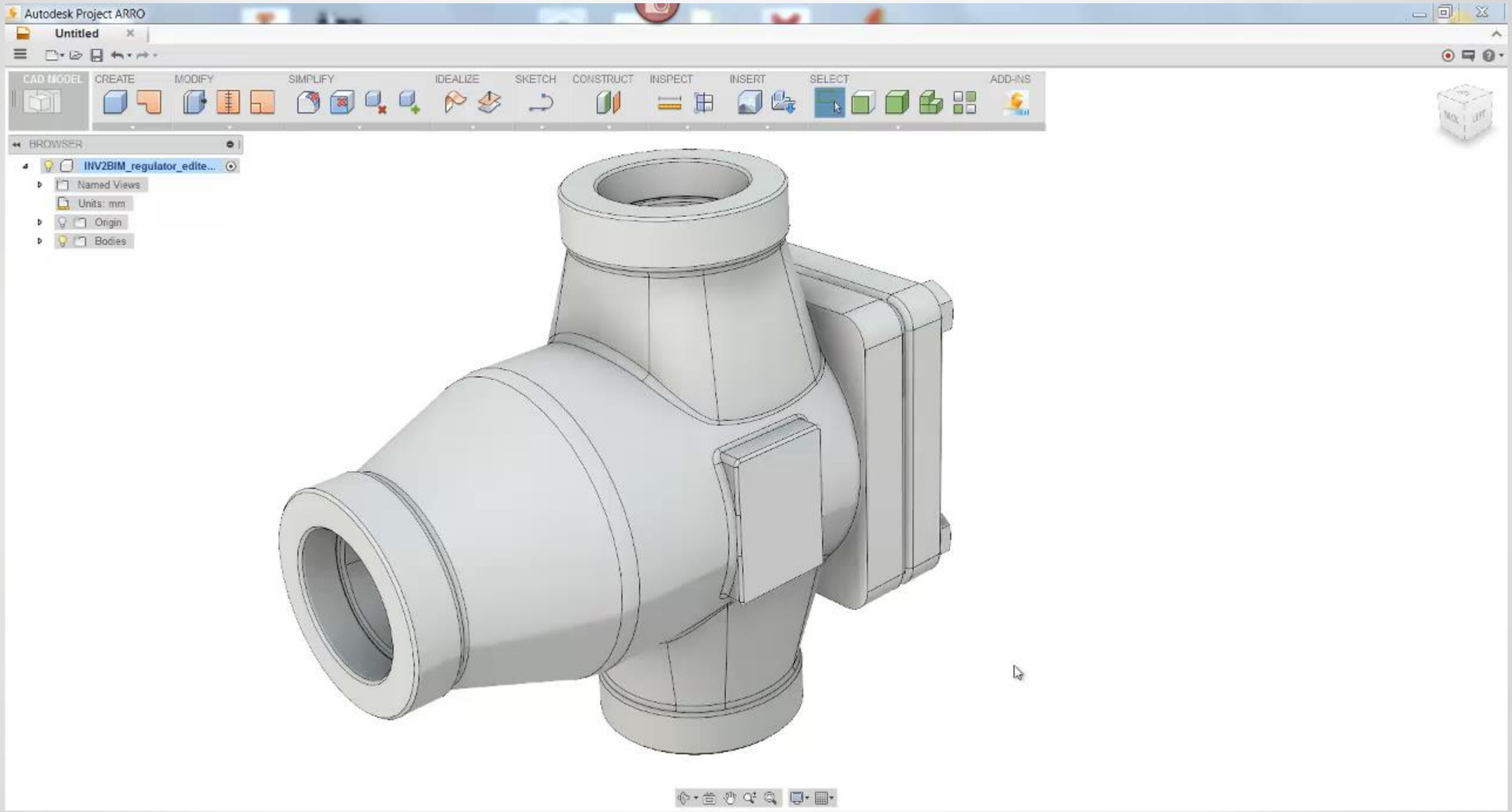
Missing surfaces



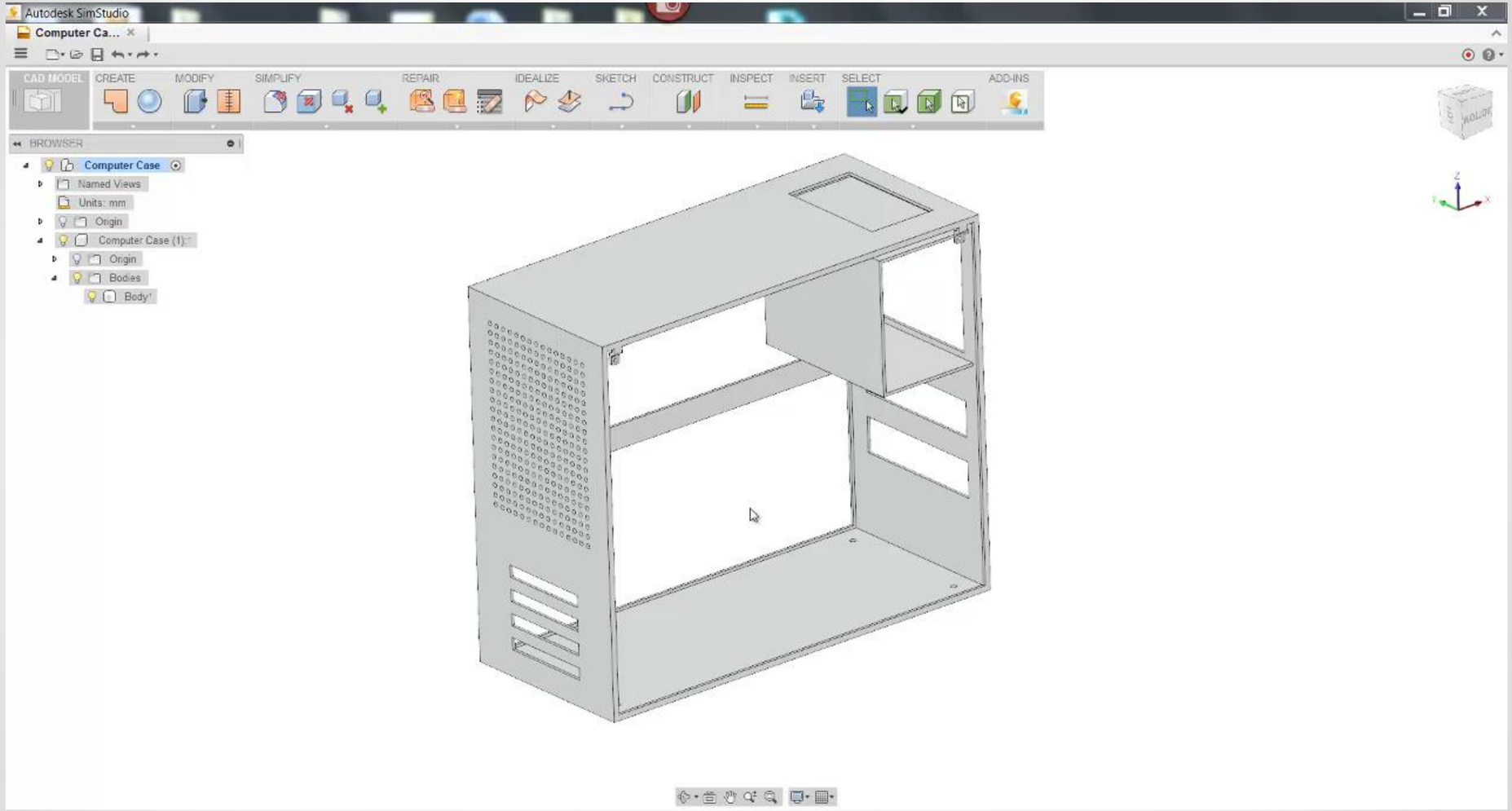
4. Simplify by defeaturing



5. Add setup features

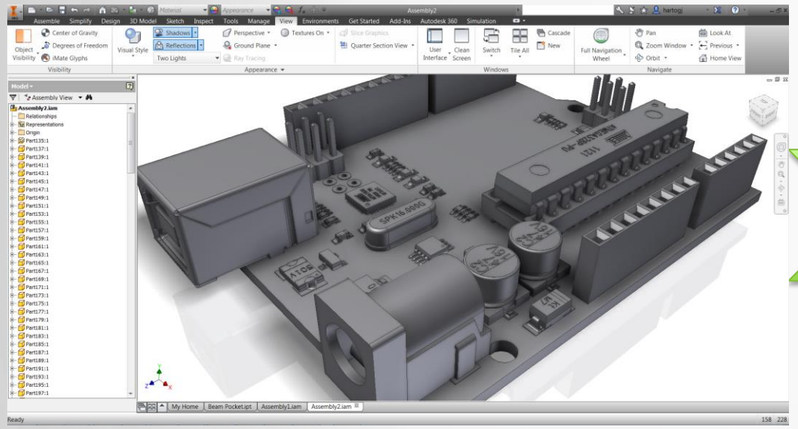


6. Idealize it



Bonus: Wrap it

Detailed CAD



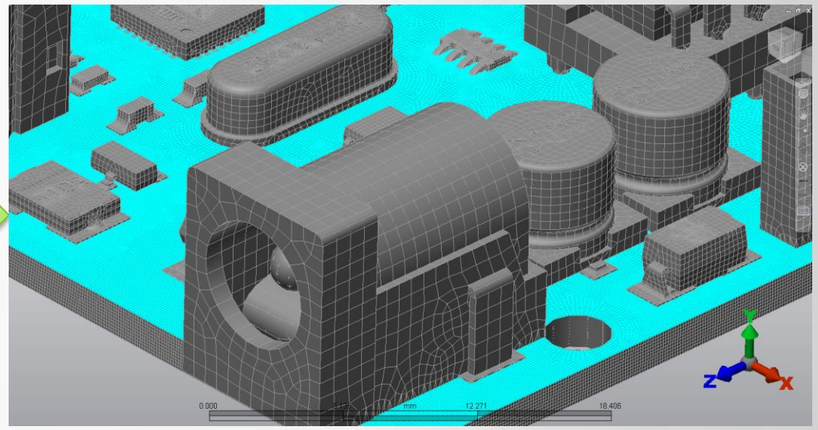
“CAD cleanup”

use geom directly for sim mesh
for maximum precision, control

“Shrinkwrapping”

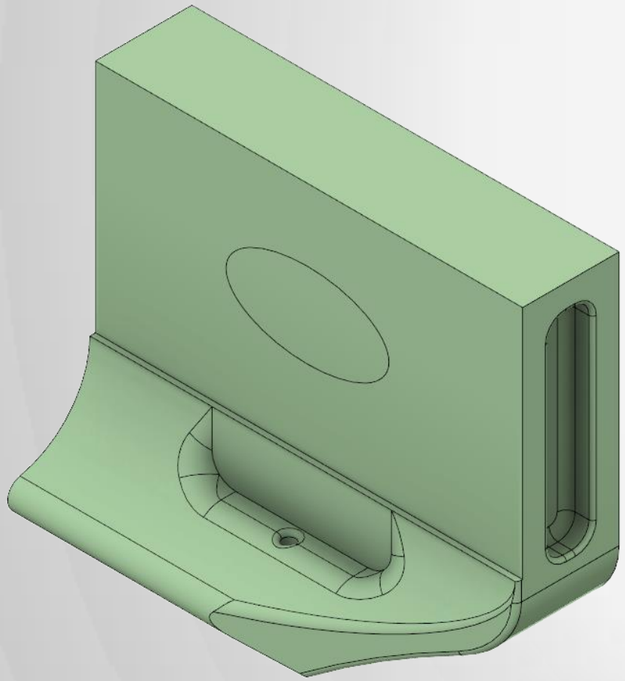
smooth over geometry with a wrap
build simulation mesh off of the wrap

Sim Mesh

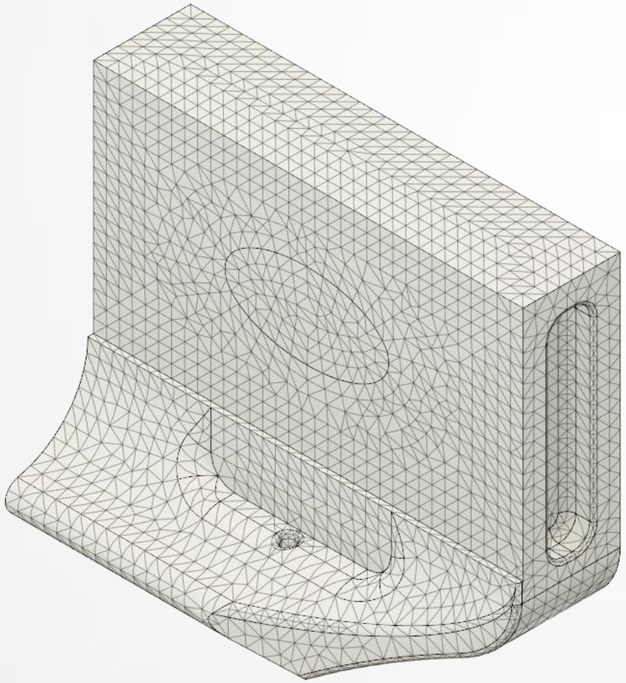


Bonus: Wrap it

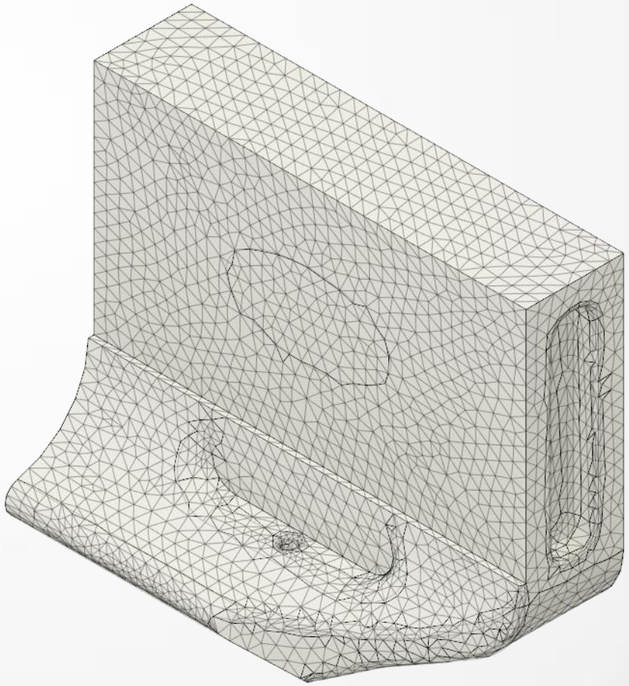
Original Model



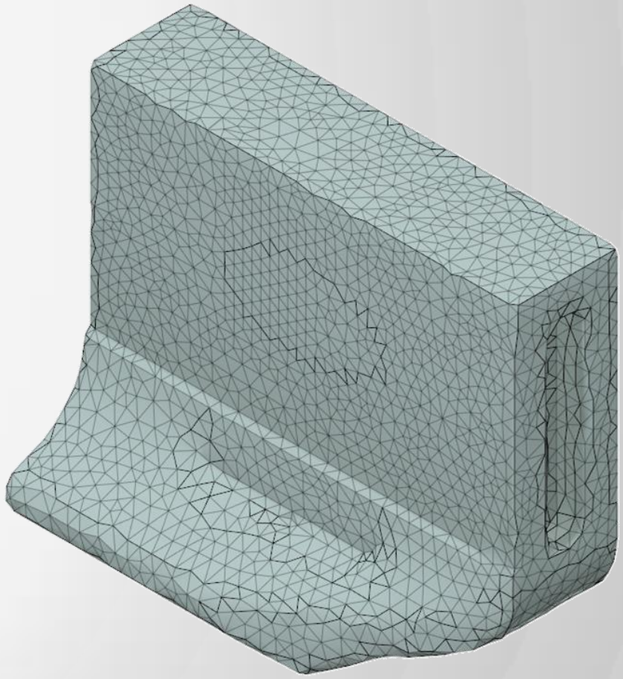
Normal Mesh



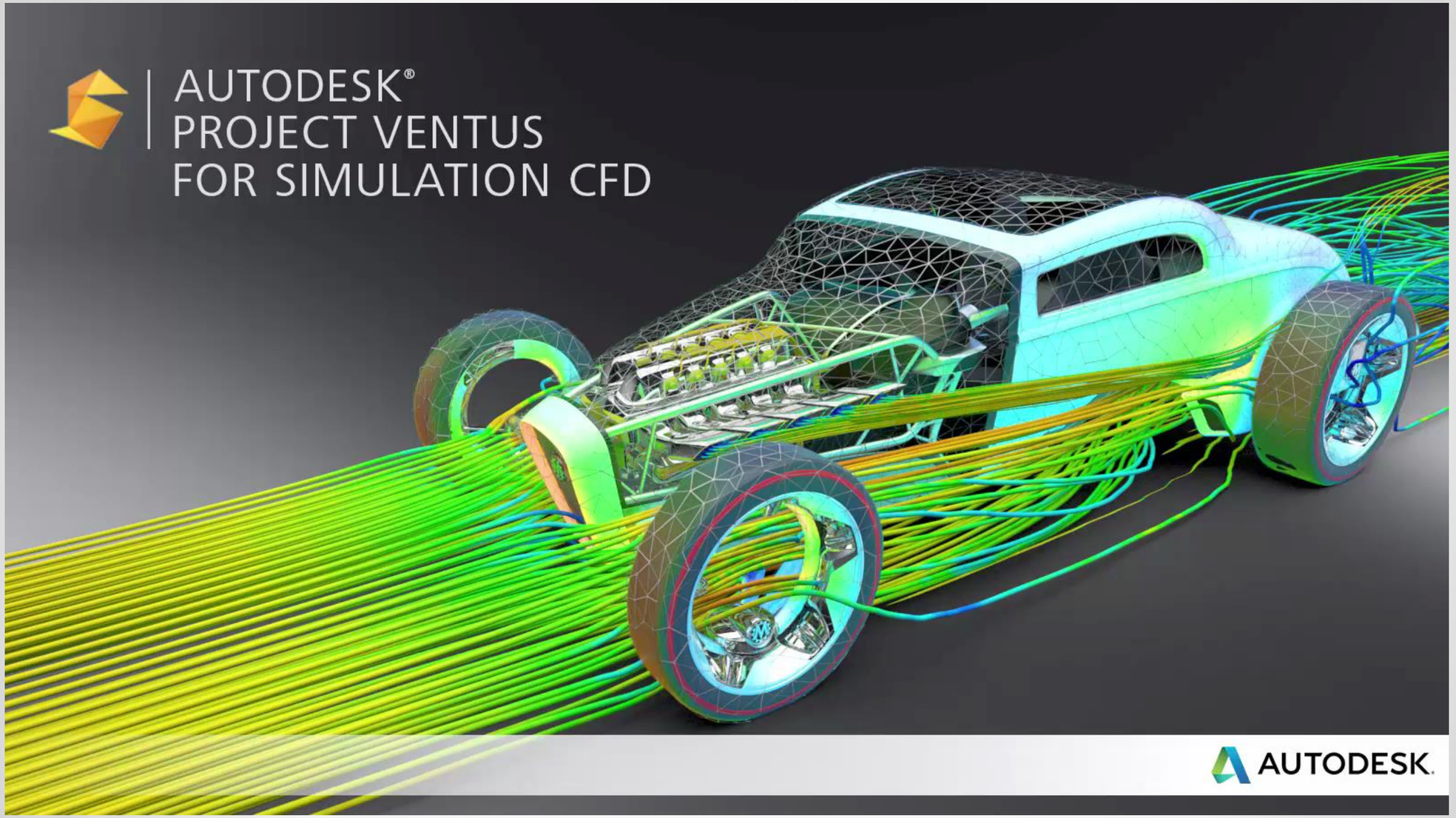
Level 1 Re-Mesh



Level 2 Re-Mesh



Bonus: Wrap it with Labs Project Ventus



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