McCORMICK STEVENSON
ENGINEERING+DESIGN

# CAD Model Simplification for Analysis

The following slides are a quick and dirty summary of how and why we simplify CAD models for analysis. There is a lot of thought and experience that goes into the simplification decision making process, but this presentation covers the basics.

# What is a “Simplification”?

McCORMICK STEVENSON
ENGINEERING+DESIGN

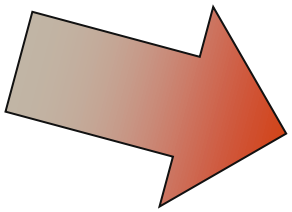
- **Simplifications are changes to the CAD model that reduce the number of nodes, and therefore, degrees of freedom, and therefore, solve time in the analysis model.**
- **Typical changes in Structural Analyses**
  - Delete unnecessary rounds, fillets, holes, and other small features
  - Turn sheet metal (or other long, thin parts) into surface bodies
  - Turn fasteners into beam elements
  - Turn parts that are not concerning from a stress standpoint into point masses
  - Turn bearings, bushings, slides, etc. into mathematical representations of those joints
- **Typical changes in Thermal Analyses**
  - Delete unnecessary rounds, fillets, holes, and other small features
  - Eliminate vias (physically)
  - Convert significant CCA components into cuboid parts representing theta Jc and theta Jb
  - Turn small air gaps into solid parts (still air) or contact resistance

# What Tools do we use?

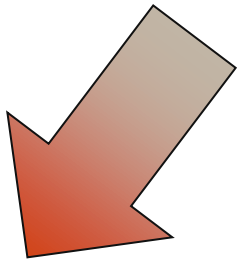
McCORMICK STEVENSON
ENGINEERING+DESIGN

## CAD / Analysis Workflow

**From Creo or Solidworks…**
- Feature based modelers
- Dependency of features on previous features
- Suppression of features (simplification) could cause failures downstream



**… to SpaceClaim…**
- Direct modeler
- NO dependency of features on previous features
- Elimination of features has no effect on other features

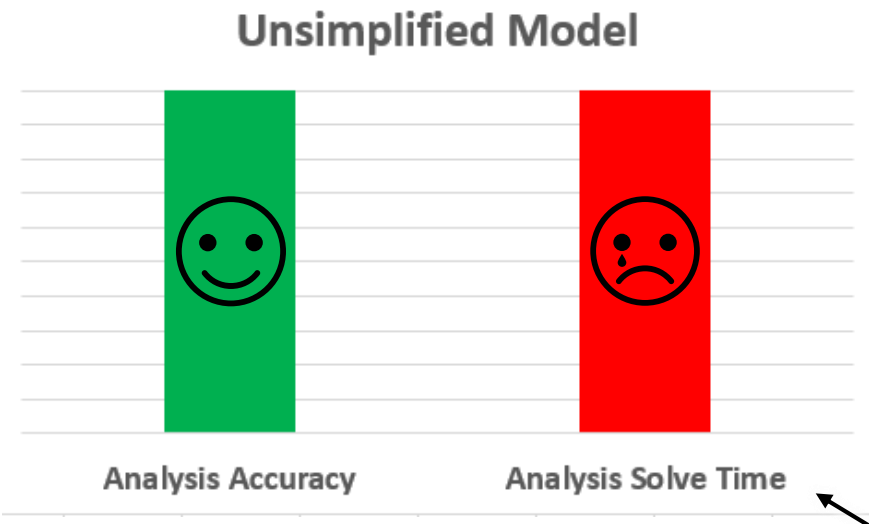


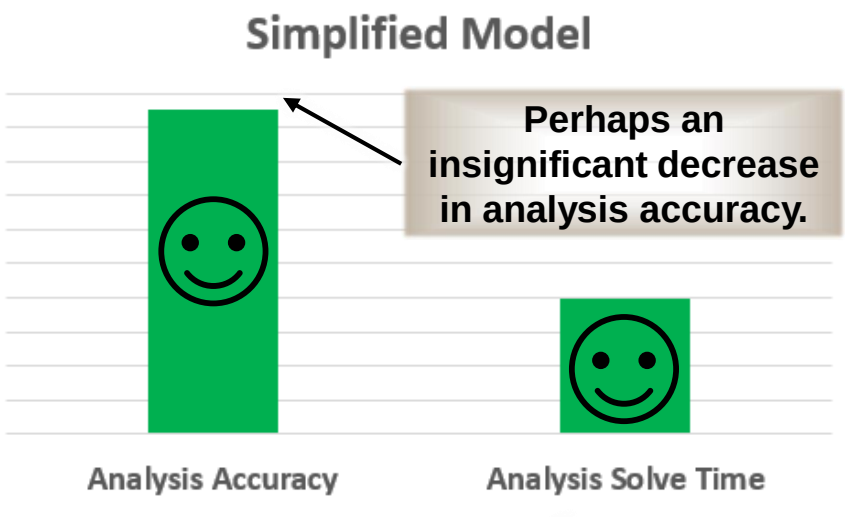
**… to ANSYS!**
- ANSYS and SpaceClaim have seamless integration.
- Allows for very easy parametric solutions

# Why Simplify Analysis Models?

McCORMICK STEVENSON
ENGINEERING+DESIGN

**Properly simplified models provide equivalent accuracy in much less time.**



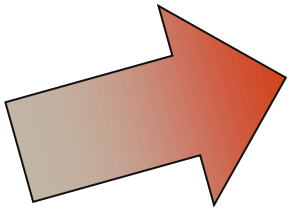

**Analysis solve time is heavily dependent upon the number of degrees of freedom in the FEA model**

# When and how much do we Simplify?

McCORMICK STEVENSON
ENGINEERING+DESIGN

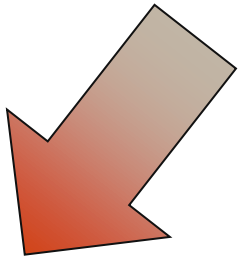
**WHEN?**

- Ideally, multiple analyses are performed during the design phase, to make sure the design is on track to survive environmentals.
- The analysis team uses a snapshot of the CAD model at specific points in the project.
- This allows the design team to continue work while analysis is performed.



**HOW MUCH?**

- The level of simplification is dependent upon the acceptable margin of error in the results.
- For first pass analyses, early on in the design, heavy simplification is acceptable.
- For CDR level analyses, judicious use of simplification is required.



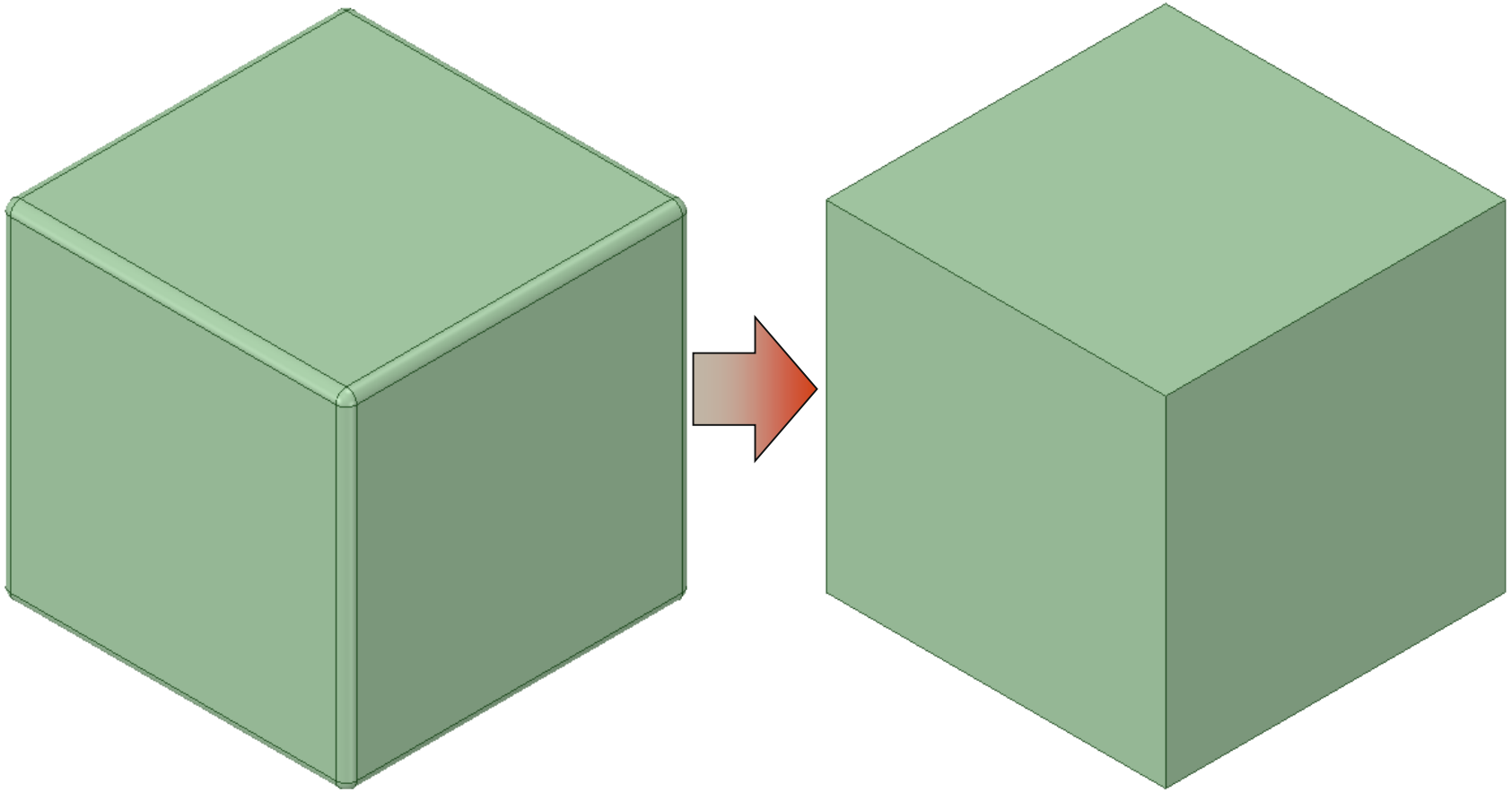
**BOTTOM LINE**

- The analyses should be completed quickly (especially the early analyses), so that, if changes need to be made, design has not progressed too far down the road.
- The need for speed leads to…..SIMPLIFICATION!
- There is also the efficiency gained by setting up your analyses so that early analyses can be modified for use in the later analyses, but that is another lunch and learn!

# A simplification example…

McCORMICK STEVENSON
ENGINEERING+DESIGN

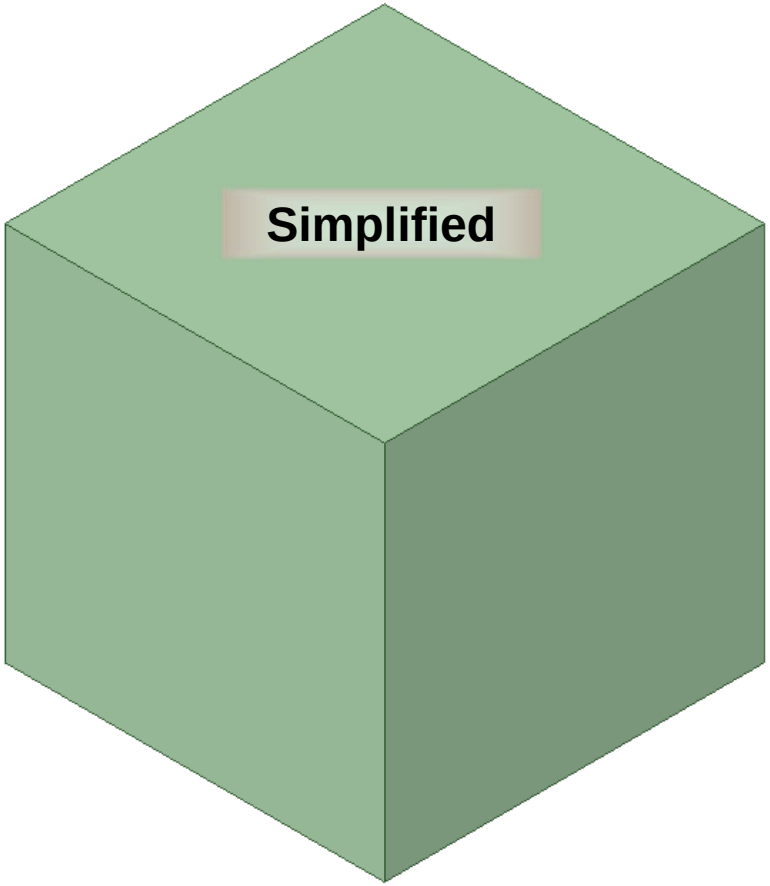
**What happens if we remove the small rounds from the cube?**

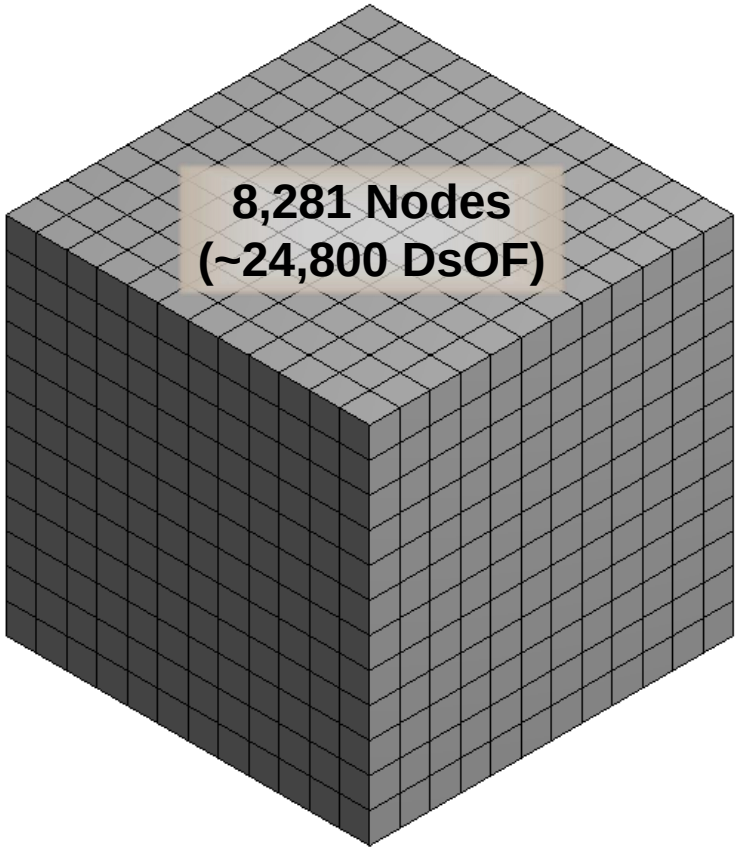


# Simplified Mesh

McCORMICK STEVENSON
ENGINEERING+DESIGN

**Without the rounds, we have 8,281 nodes on nicely shaped elements.**

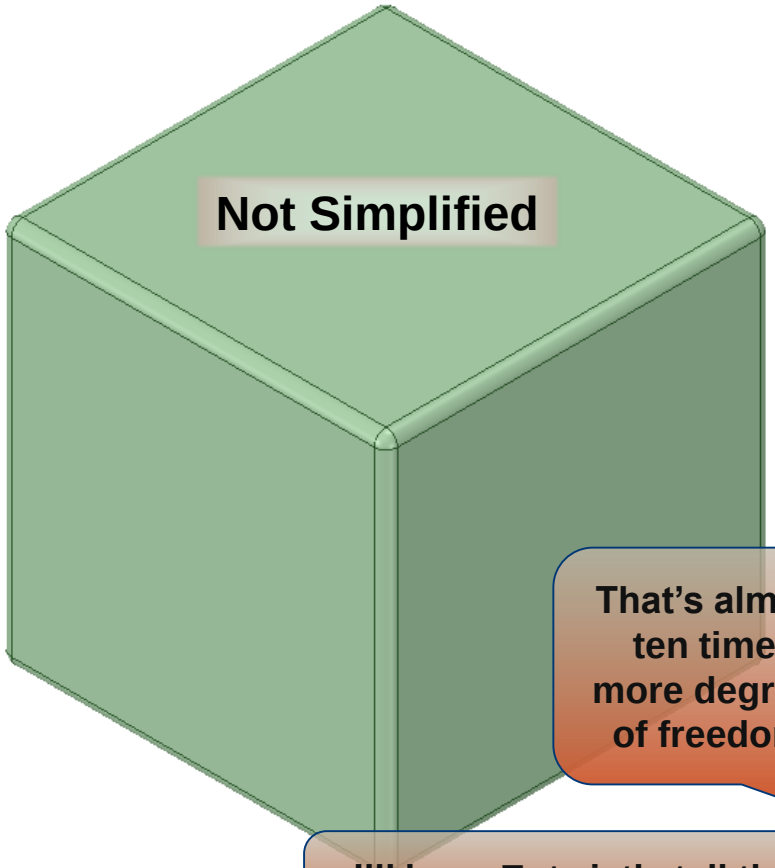


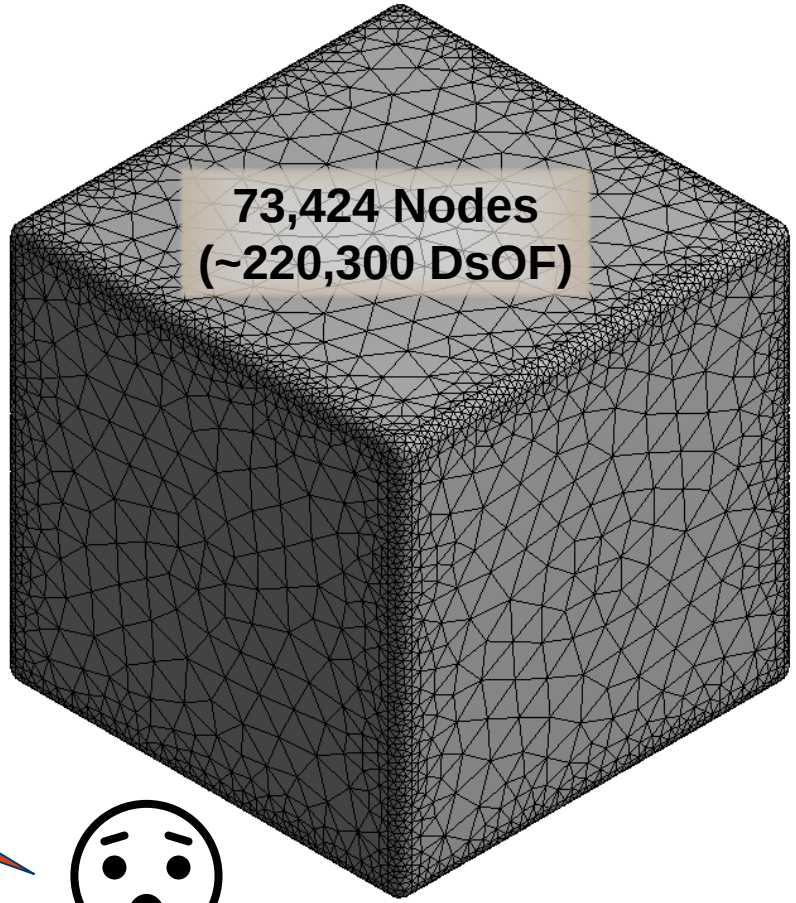



# Non-Simplified Mesh

McCORMICK STEVENSON
ENGINEERING+DESIGN

**With the rounds, we need to resolve the curves and have many more (not as nicely shaped) nodes.**



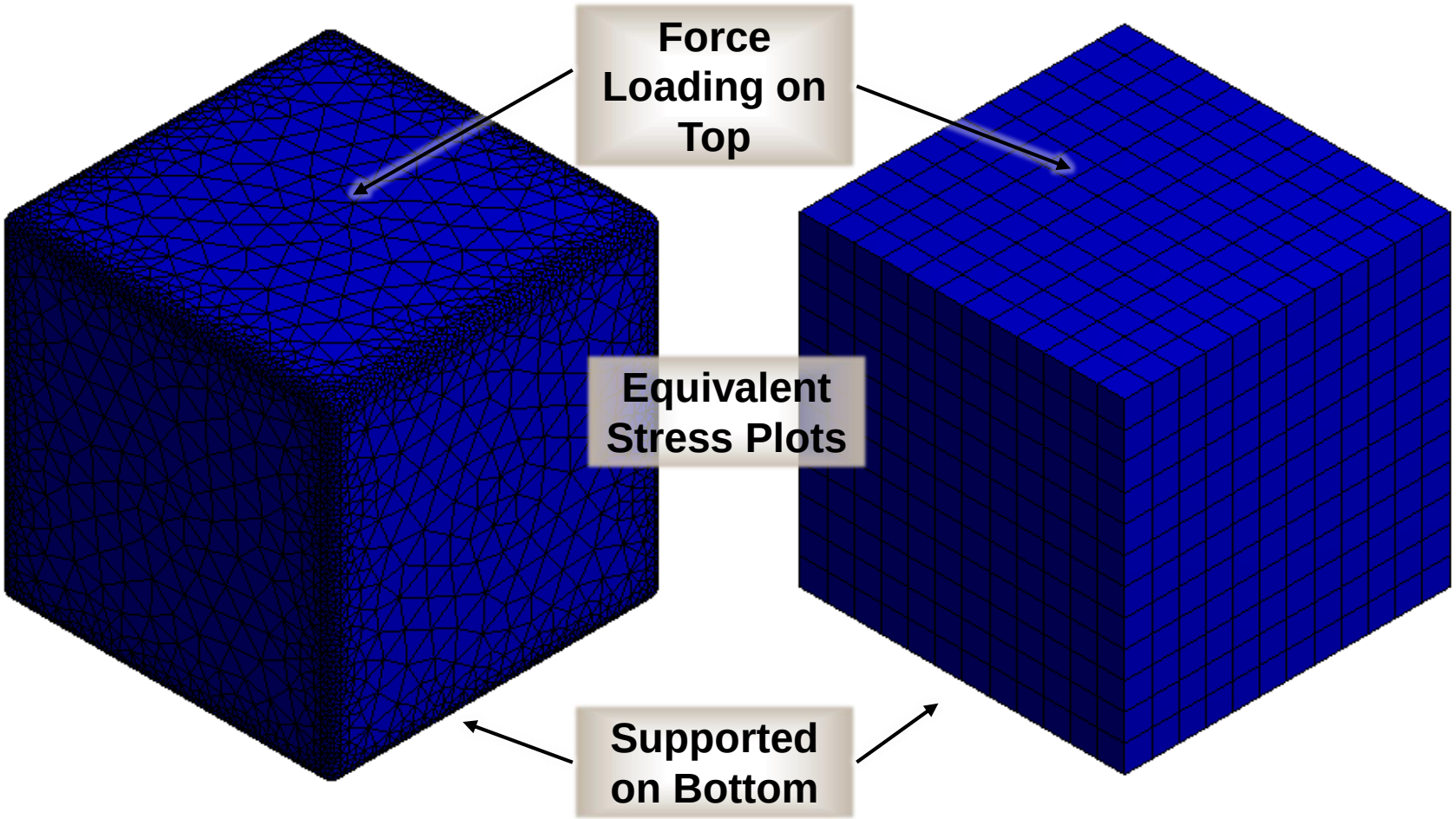

That's almost ten times more degrees of freedom!

I'll have Entwistle tell the PM about the solve time…

# Analysis Results

McCORMICK STEVENSON
ENGINEERING+DESIGN

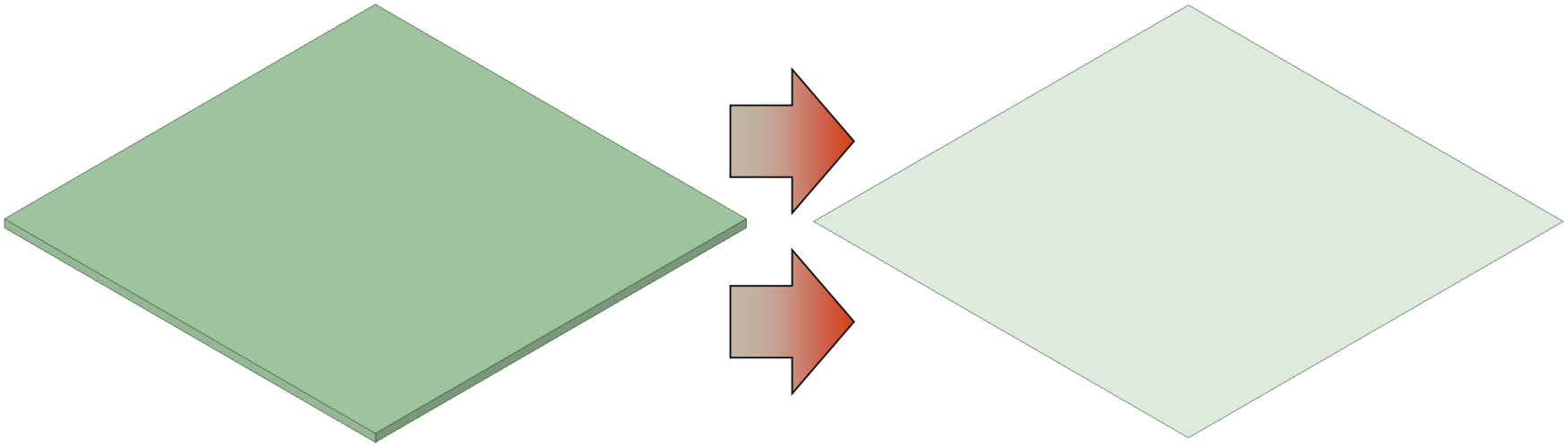
**Equivalent results, but almost *6x solve time* for non-simplified model.**



# Another (more dramatic) simplification example…

McCORMICK STEVENSON
ENGINEERING+DESIGN

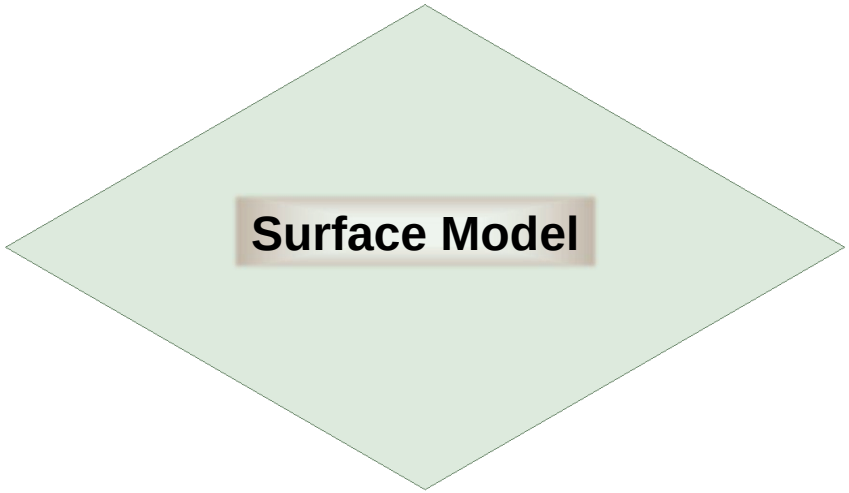
**What happens if we convert the thin plate from a solid to a surface?**

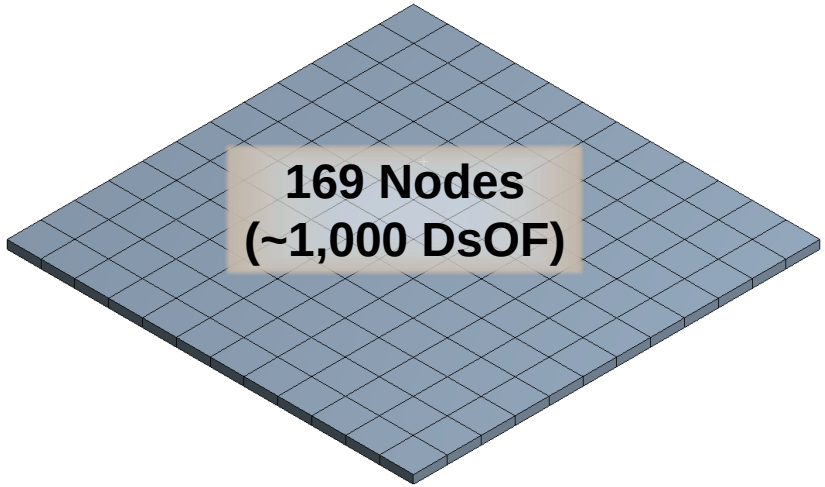


# Simplified Mesh

McCORMICK STEVENSON
ENGINEERING+DESIGN

**With the surface model, we have 169 nodes on nicely shaped elements.**

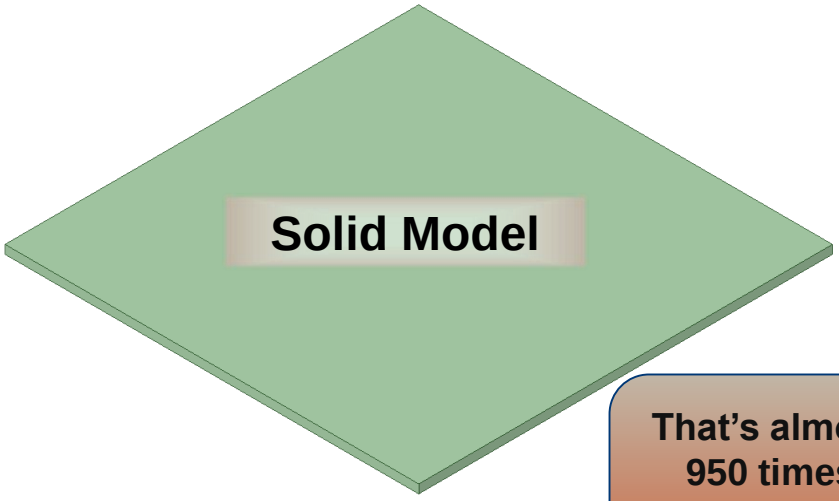


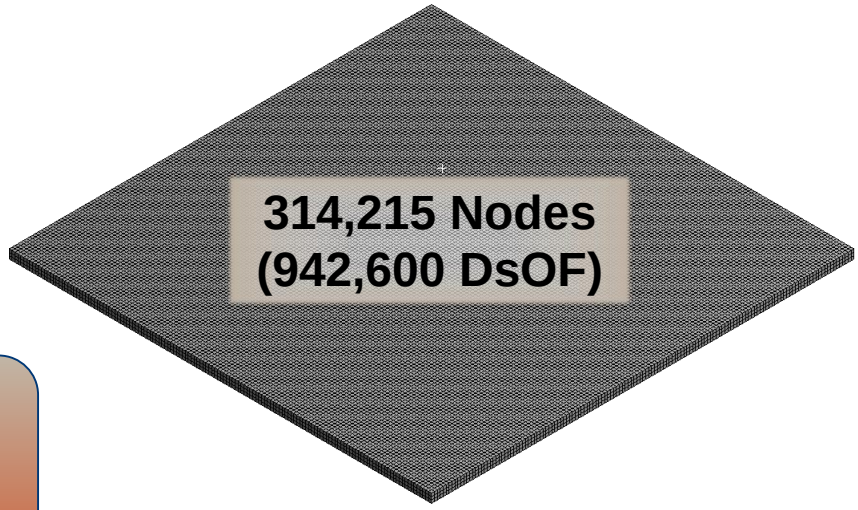



# Non-Simplified Mesh

McCORMICK STEVENSON
ENGINEERING+DESIGN

**The solid model needs resolution through the thickness, so it has many more nodes.**



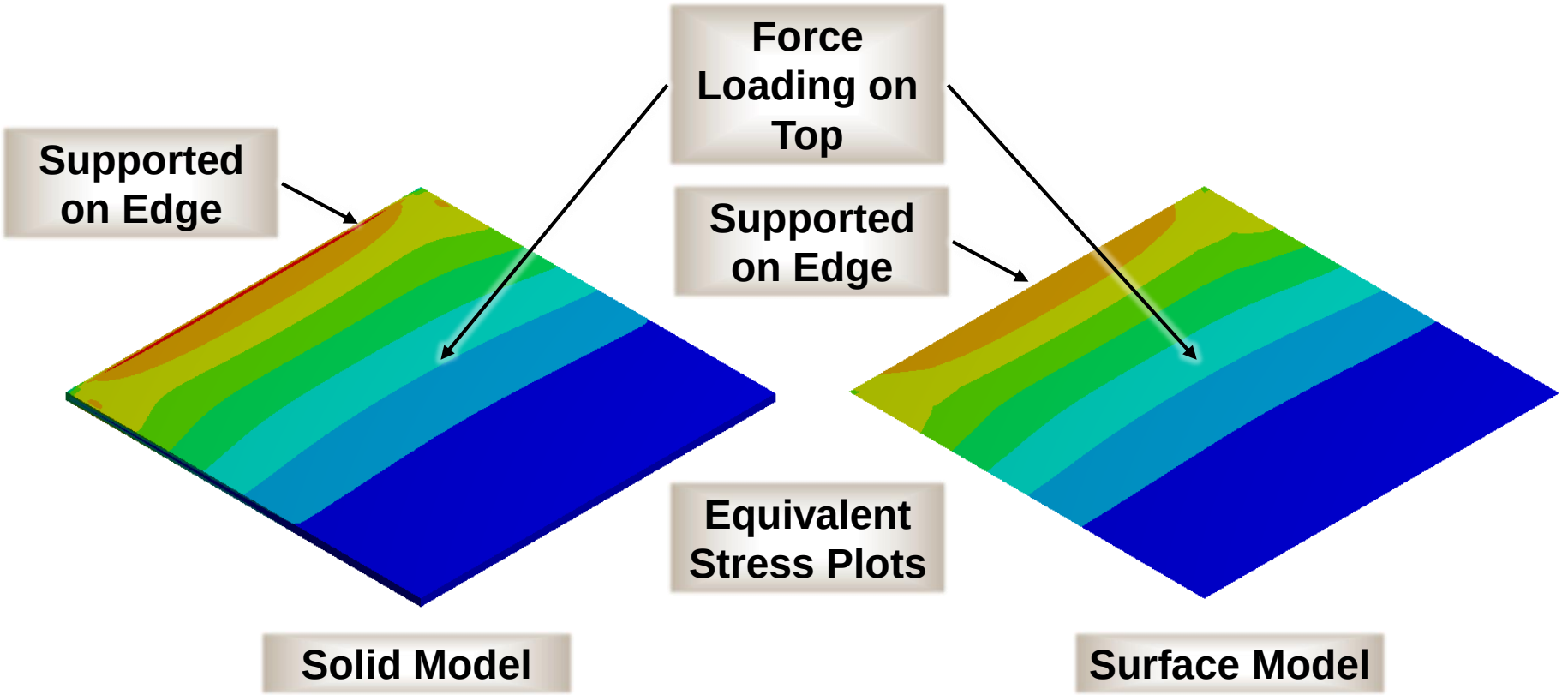




That's almost 950 times more degrees of freedom!

Andrew…

# Analysis Results

**Equivalent results, but almost *74x solve time* for non-simplified model.**



# Bottom Line

McCORMICK STEVENSON
ENGINEERING+DESIGN

- **An important part of MCCST's business is to provide high quality analysis results to our external clients and internal team members.**
- **We ALWAYS strive to provide the quality, but cannot sustain the business if we do not make money at the same time.**
- **The best way to do that is to be efficient. Performed properly, simplification of our analysis models can be a huge time saver for us, allowing us to provide quality results and sustain the business at the same time!**