Solid Modeling Tips and Tricks

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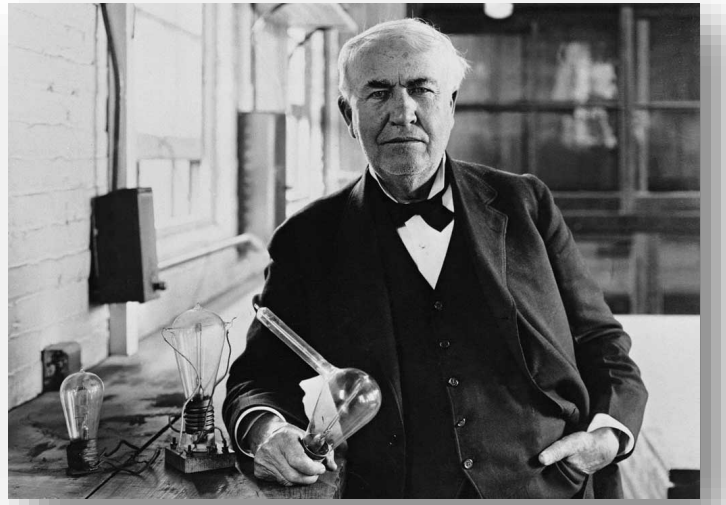
ME 481 Fall 2021

Why create Solid Models?

Not every design problem can be solved by trial and error…

"I have not failed. I've just found 10,000 ways that won't work."
Thomas Edison

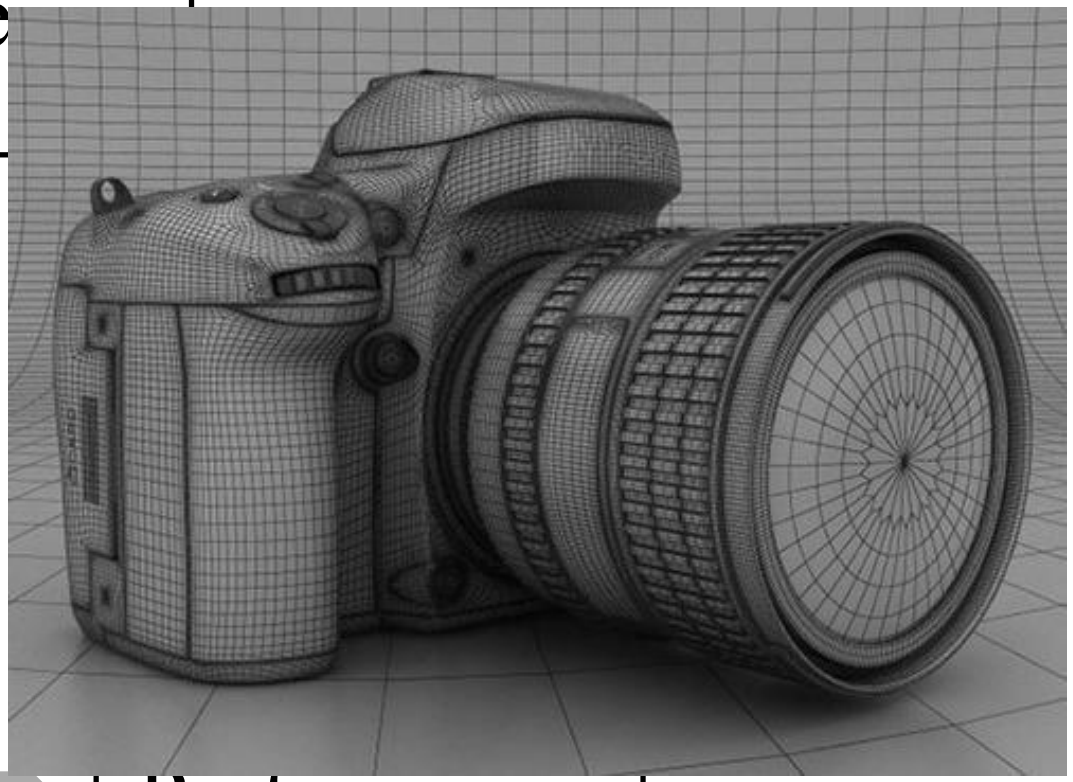


Instead, we must use **engineering**:

"the application of scientific and mathematical principles to practical ends…"
American Heritage Dictionary, 4th Ed.

In many projects, you only get a single chance to implement your solution due to your constraints (*e.g.,* time, money) and failure is not an option.

Why create Solid Models?



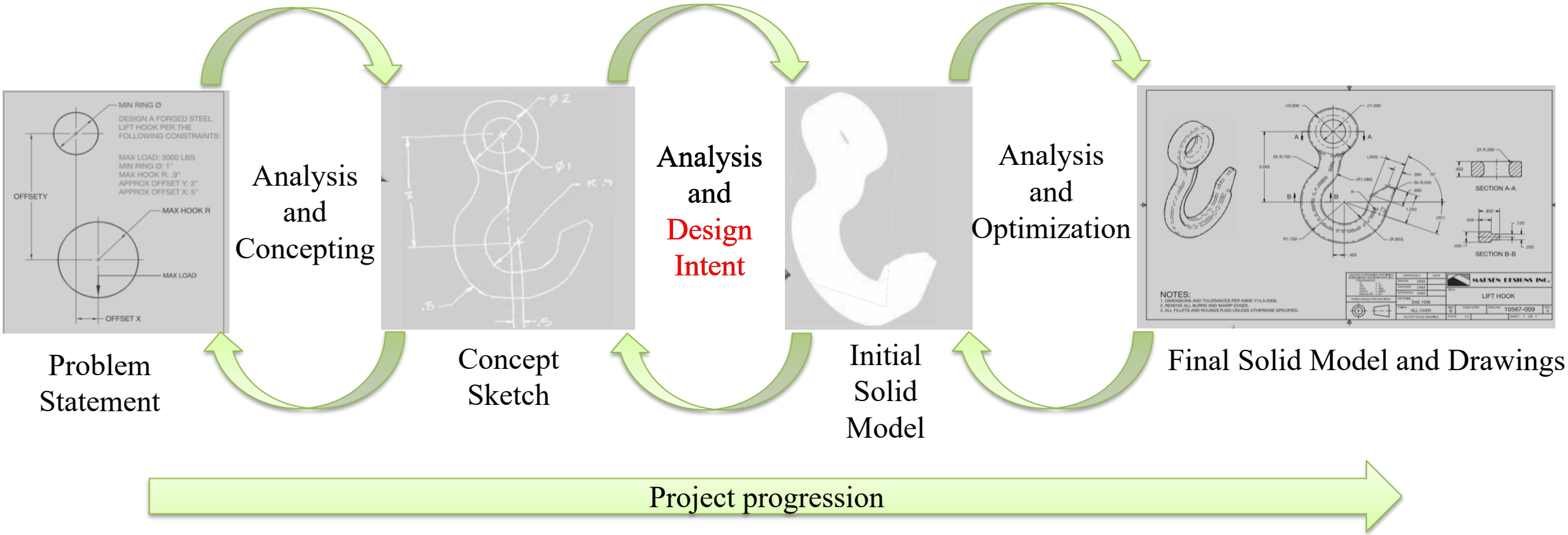
Time

Money

Performance

Why create Solid Models?

- Solid Models are part of the modern design (CAD) and analysis (CAA) process

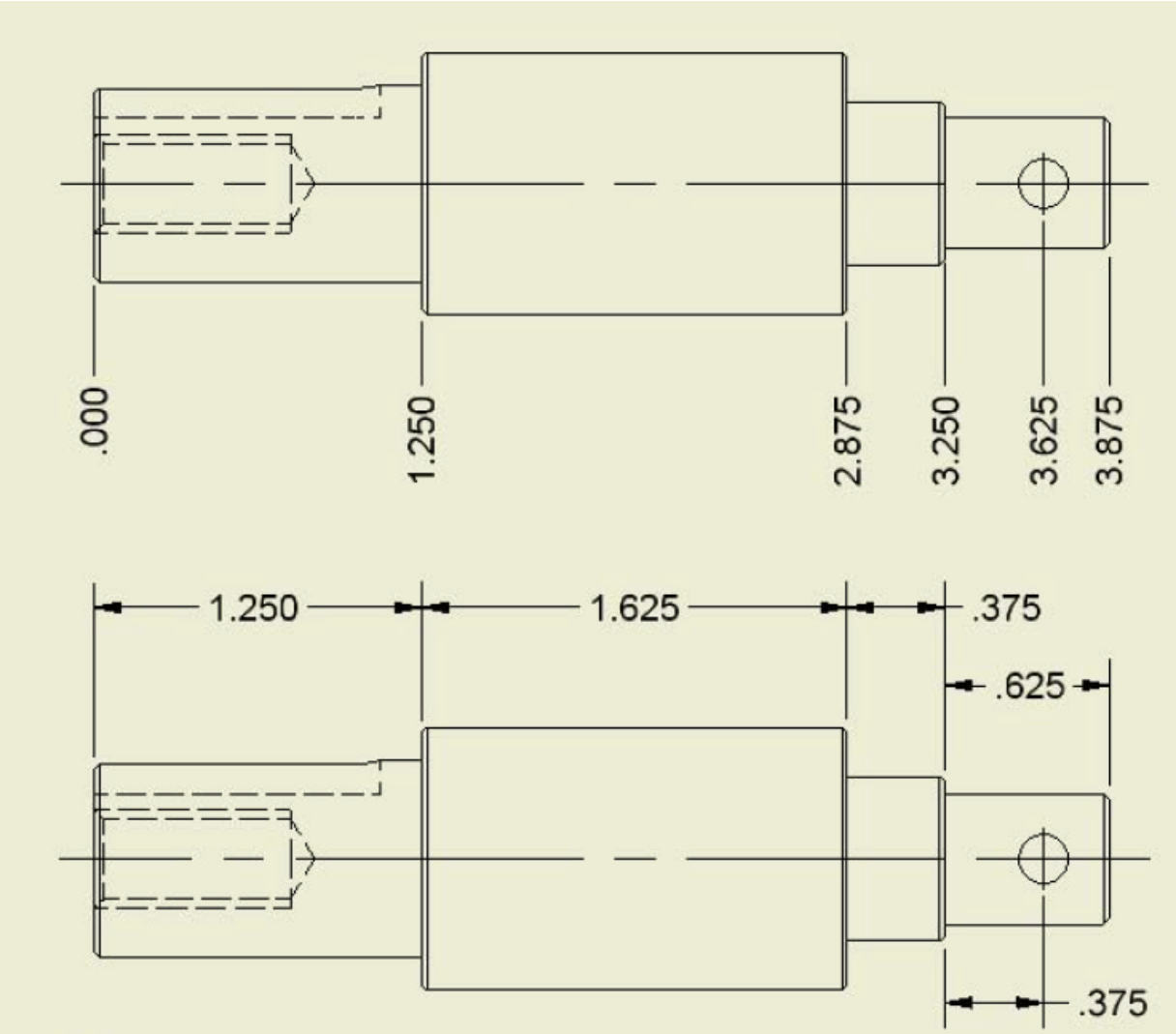


What is design intent?

Art of imbedding intelligence into a model in order to convey more information about its nature and purpose than is possible by simply defining it dimensionally.

"In the rush to learn what to do, the question of why is often pushed aside to be answered later."

W. Jaquith, "Sounds Sketchy – Design Intent in Autodesk Inventor," in *Autodesk University 2007*, 2007, pp. 3.



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Capturing Design Intent - Theoretical Analysis

Generic 7 Step Problem Solving Process

Step 1: Define the Problem and Objectives
Step 2: Determine the Critical Variables
Step 3: Apply Governing Equations (Constraints/Dimensions)
Step 4: Solve the Mathematical Equations
Step 5: Interpret Your Results
Step 6 Apply Your Results
Step 7 Test Against Reality

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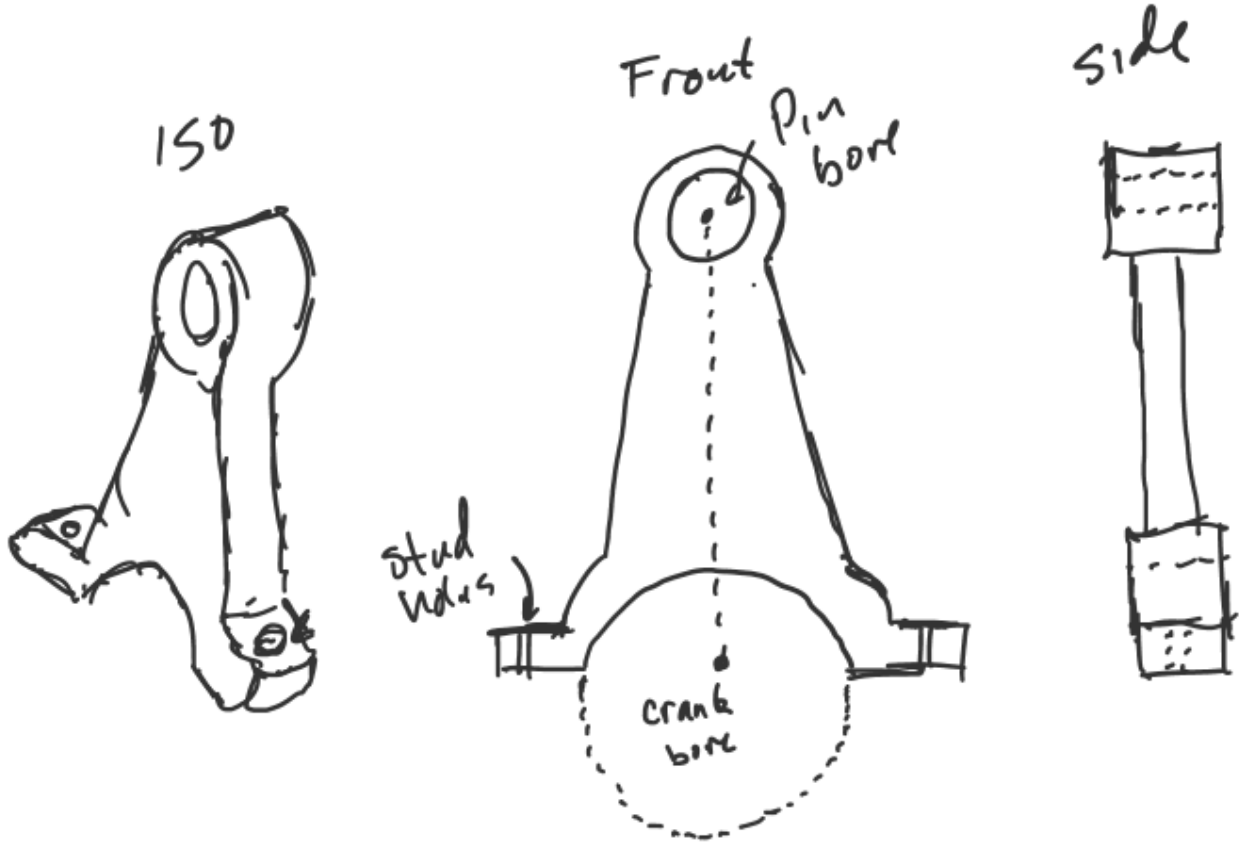
Capturing Design Intent - Theoretical Analysis

Step 1: Define the Problem and Objectives

Functional decomposition helps here. Isolate just the part of your system that you want to analyze.

- Initial sketch
- Requirements



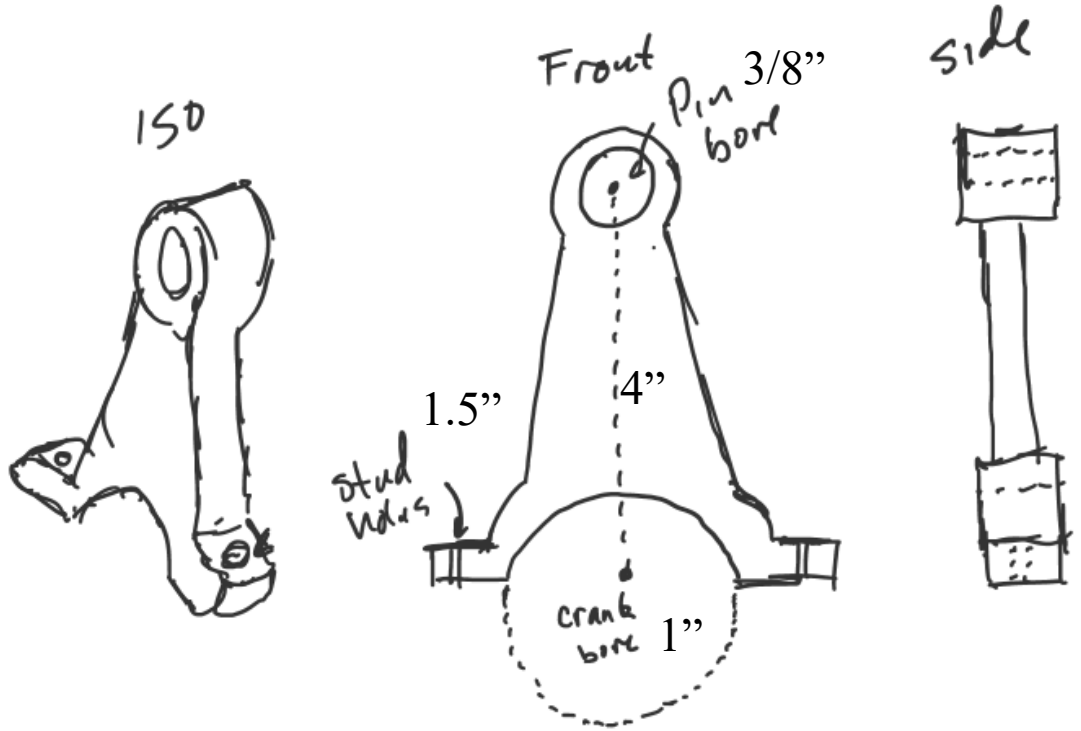
Connecting Rod Concept

Capturing Design Intent - Theoretical Analysis

Step 2: Determine the Critical Variables

Start applying **reasonable** assumptions to simplify what parts of your system you want to include/exclude and allow to change. What inputs can you control with your design choices? What outputs do you care about for the performance of your solution?

- critical dimensions
- critical relationships
- How should the first sketch be arranged?
  - Part orientation
    - Assembly?
    - Manufacturing?
    - Symmetry?
  - First sketch should capture all "primary" design intent.



Connecting Rod Concept

Capturing Design Intent - Theoretical Analysis

Stage 3: Apply Governing Dimensions, Constraints, and Equations

Define the relationships between your key inputs (set by you as part of your design choices) and the key outputs (which relate to performance in meeting one or more project requirements) using appropriate mathematical equations.

- To SolidWorks…

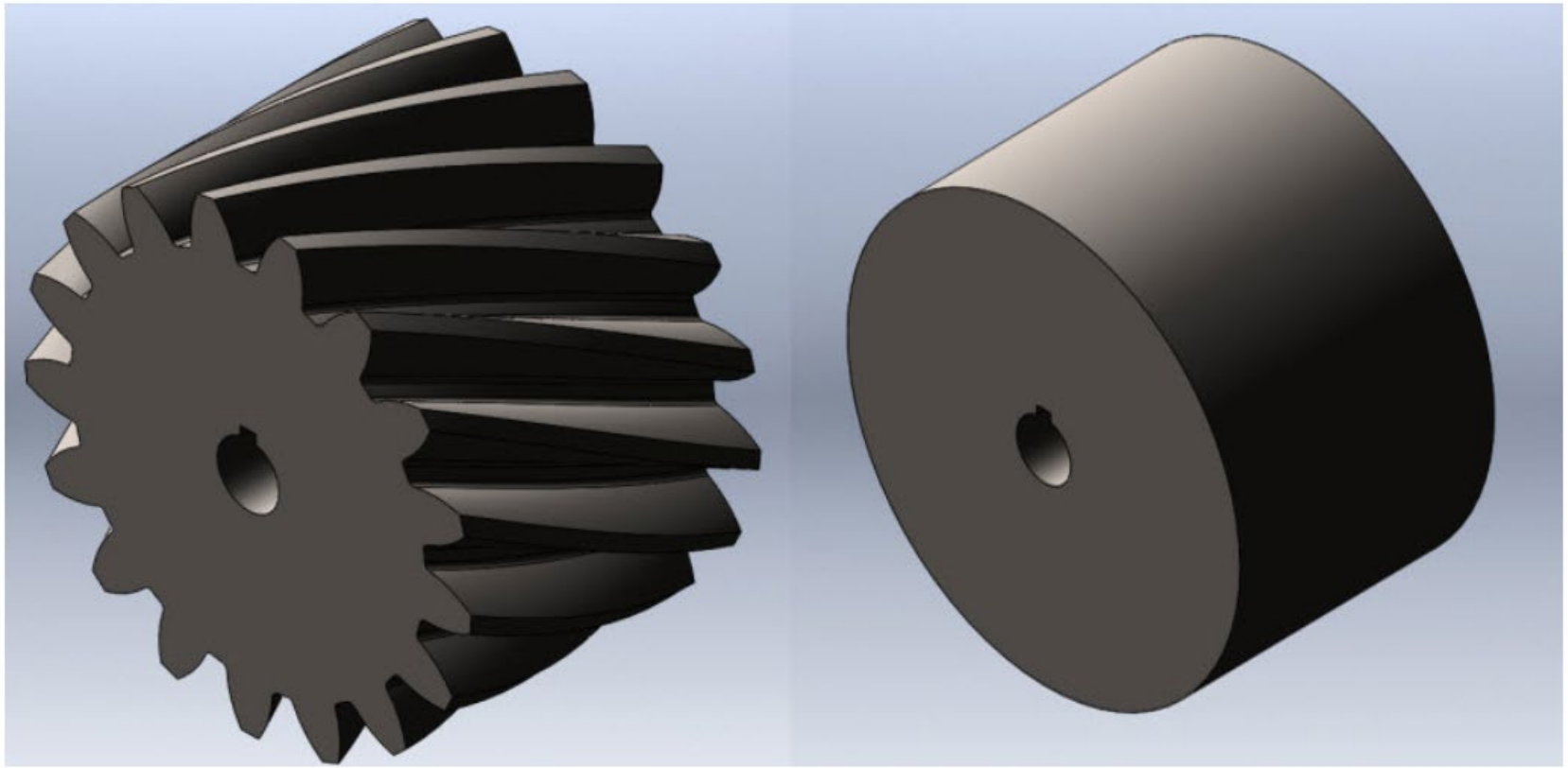
Where we will also cover these steps:
Step 5: Interpret Your Results
Step 6 Apply Your Results

Perform a "sanity check". The model should show the system responding in a **reasonable** manner to your selected inputs. All changes in behavior should be directly explainable by the physics governing your system.

Additional thoughts and pitfalls

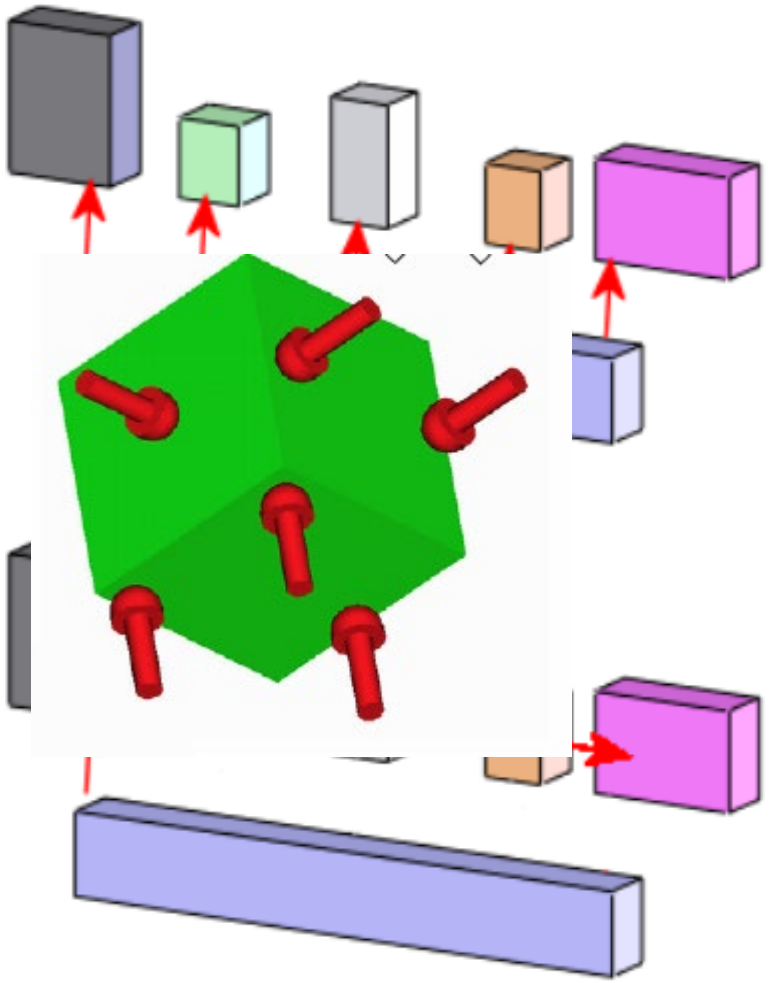
- When creating your sketches, try to capture your design intent with sketch **relations** or *equations*.
  - A good design has only a few key dimension that will update all related sketch entities or model features.
  - The more dimensions that need to be edited in order to complete a model update, the greater the chance that one will be forgotten. This can lead to costly manufacturing errors.
- When sketching, Blue is "of the devil"
- Dependencies - Features build on each other.
  - Build shape and form first
  - Add details last
    - Should details go in the sketch or as features?
  - If a feature earlier in the feature tree is deleted or modified it likely effects later features.

Consider the detail needed

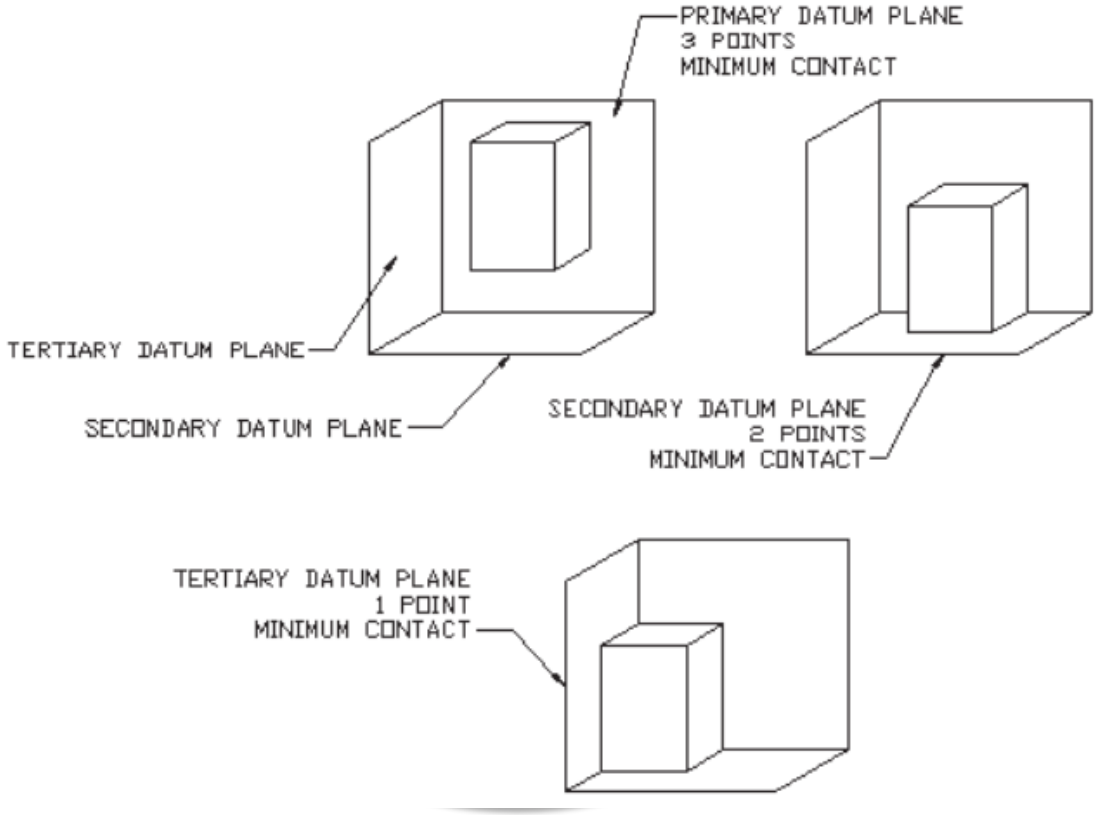


Left: Fully detailed gear from the Toolbox. Right: Simplified gear.

Assembly Mates



Mate scheme to avoid



Conclusion

- "There are many ways to produce a 3D model, but build Design Intent into the model and it becomes so much more than a pretty picture, than simple geometry – intelligence is placed into the model"
  - A. Slocum
- Design intent should be built into all levels of the parametric modeling process
  - sketches,
  - parts,
  - Assemblies
- Bonus!
  - Capturing design intent allows making changes easier. Makes the model more flexible. Makes inevitable iterations much easier.
    - You will often spend significantly more time editing and iterating your model than you do creating it.
  - The techniques for capturing design intent and the techniques for building stable, easily editable models are often the same.
- **Follow The Solid Modeling Tutorials on SolidWorks Software (check with TA if have Qs)**
- **To the RIP Website for the SolidWorks Workshop Assignment…(check with TA if have Qs)**