Robotics Design in Fusion 360

Anne Pauley

Mechanical Engineer, FATHOM

AUTODESK. UNIVERSITY

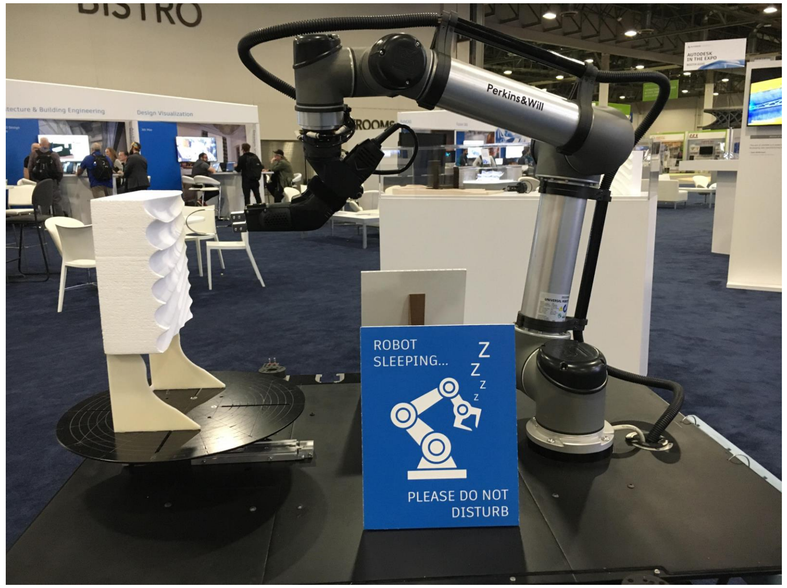
About the speaker

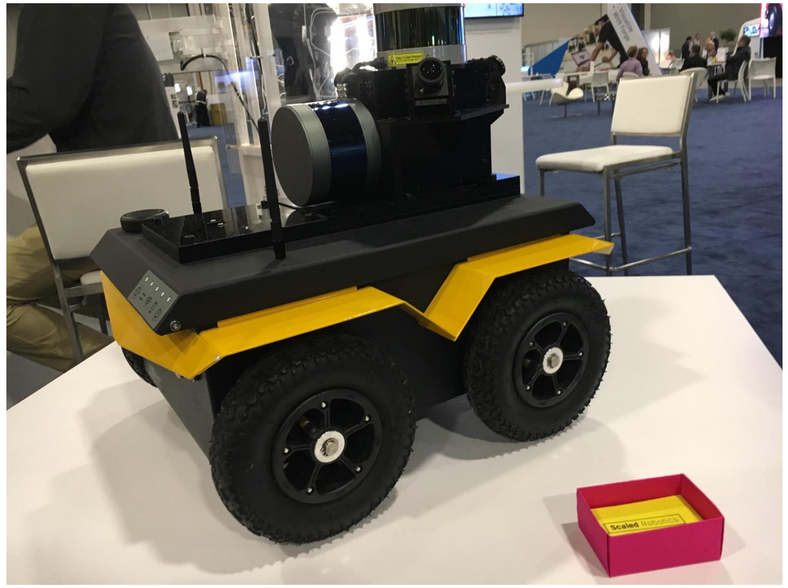
Anne Pauley

- Mechanical Engineer at FATHOM in Oakland, CA
  - *“FATHOM is driven by advanced technologies and methods that enhance and accelerate today’s product development and production processes”*
- Specialties include robotics, DfM, and DfAM

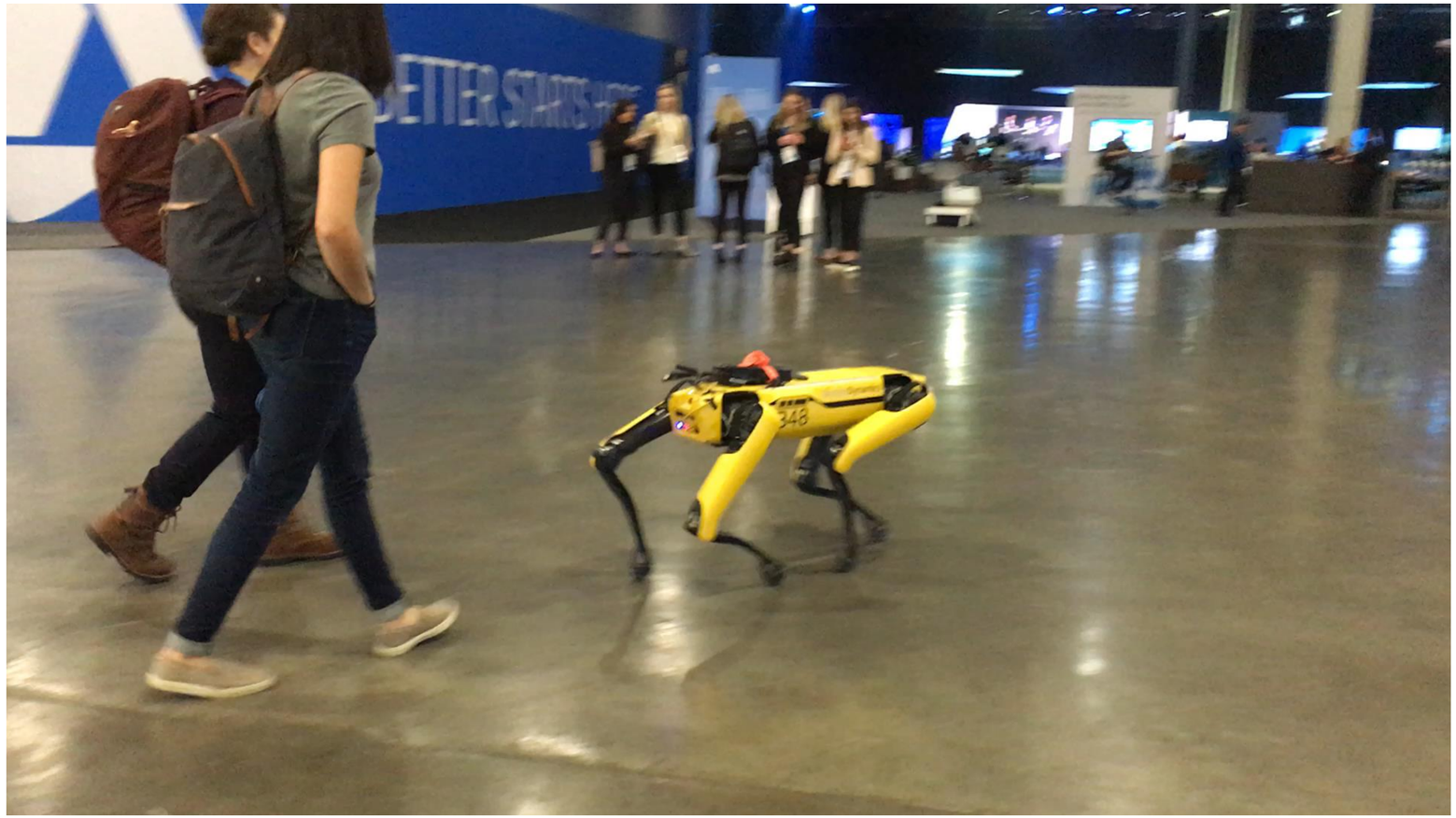
Robots at AU

Sands
BISTRO


BISTRO
Perkins&Will
ROBOT
SLEEPING...
Z
Z
z
z
PLEASE DO NOT
DISTURB



Also this good boy…

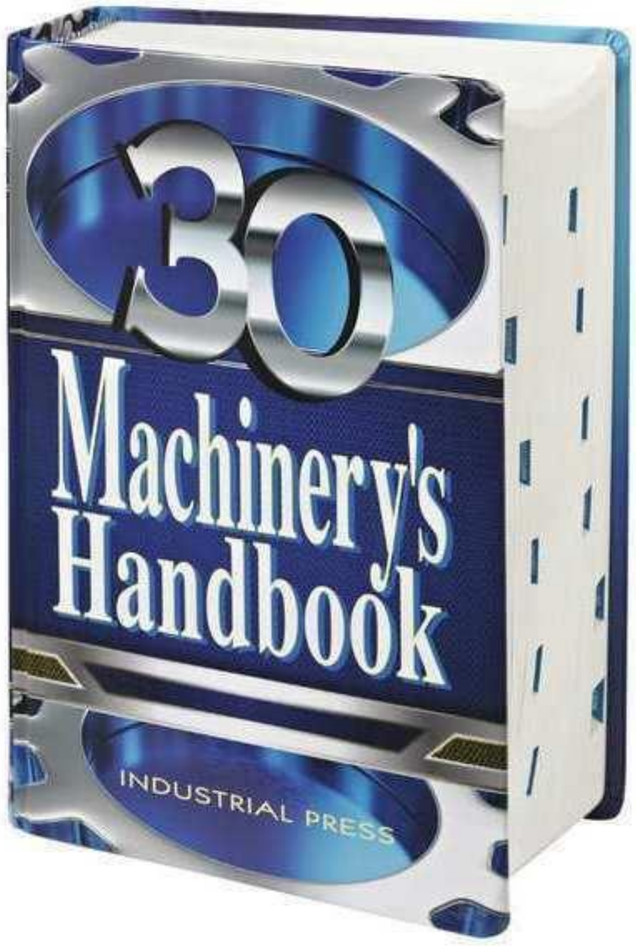


The Basics

Don’t Design Alone.

Tolerances are important.

Tolerances are important.
^
very



Add this book to your holiday shopping list.

Fusion 360 Quick Tips & Tricks for Robotics

Selection Sets and Filters

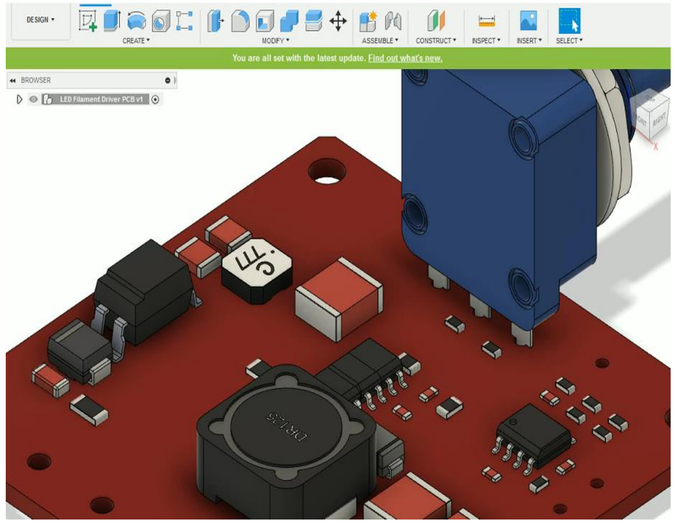
WHY THEY'RE HELPFUL:

Model faster.

Look smarter.

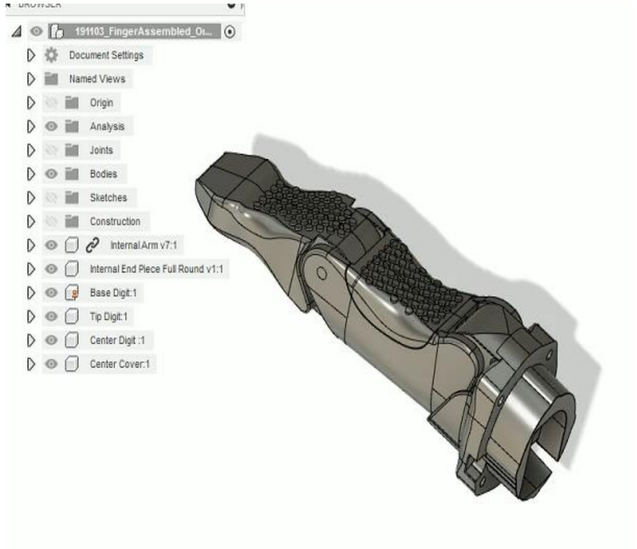
SELECTION TOOLS

"Select by Size" is very handy for cleaning up PCBs!



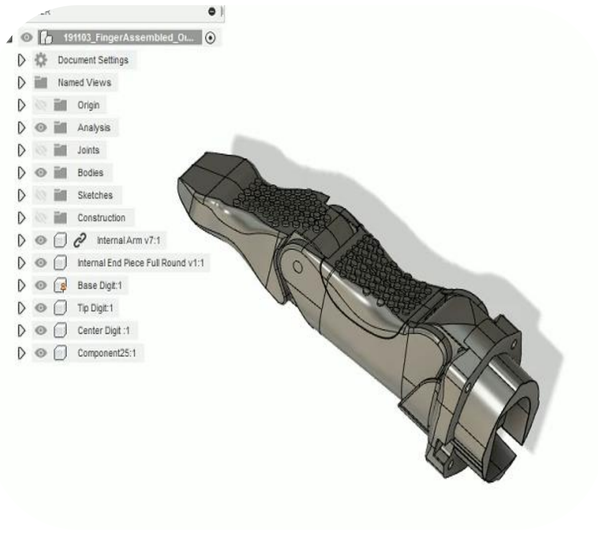
SELECTION SETS

Group components such as shells to make them easier to show/hide



"SELECT OTHER"

Hold left mouse button to select different levels



Large Assemblies

GIVE SUBSYSTEMS THEIR OWN DESIGN

Linked components/assemblies do not update/rebuild

MINIMIZE USE OF “CAPTURE POSITION”

Use joints where possible.

MAKE SKETCHES AS SIMPLE AS POSSIBLE, AND AVOID SVG/DXF

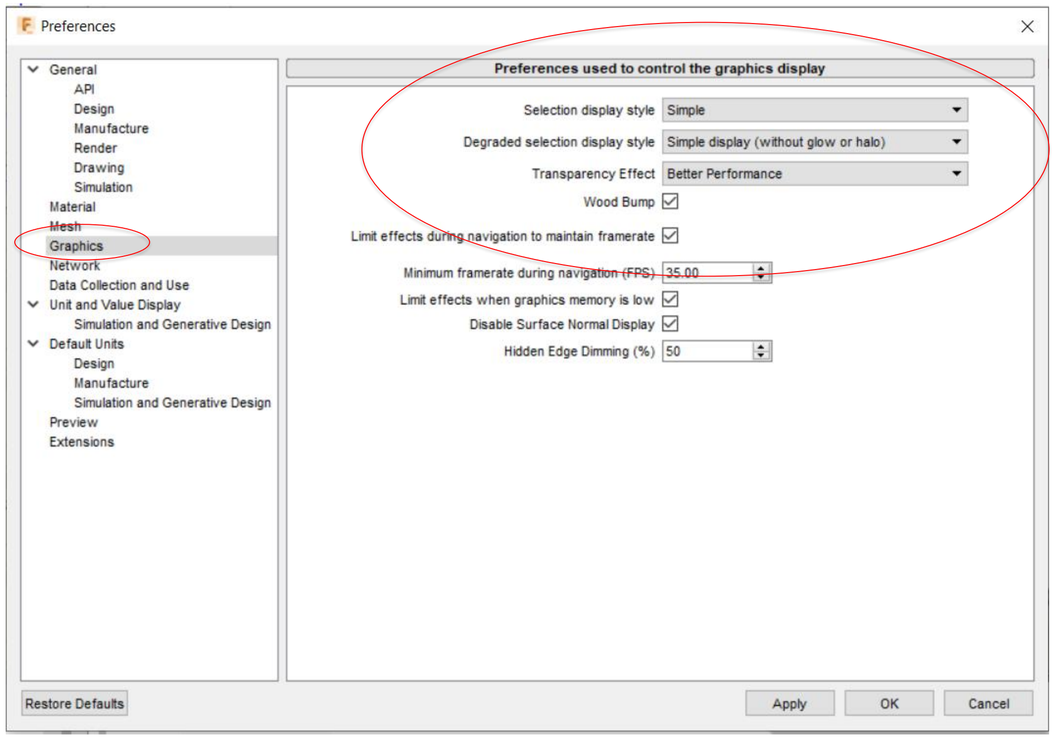
Mirror/pattern geometry and features instead of sketches when possible. SVG files often import as hundreds or thousands of lines/arcs which slows down Fusion.

DIRECT MODELING TOP-LEVEL

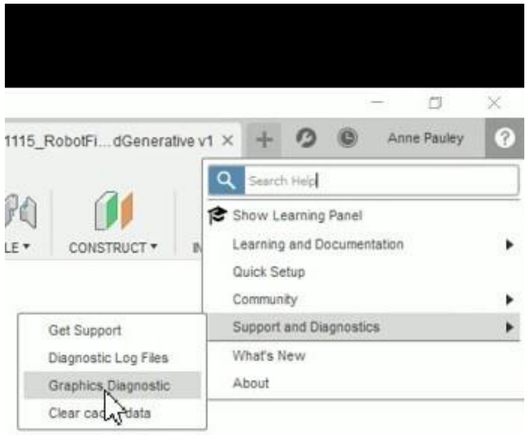
When major subassemblies are segregated into separate design files, the top-level assembly can be timeline-free.

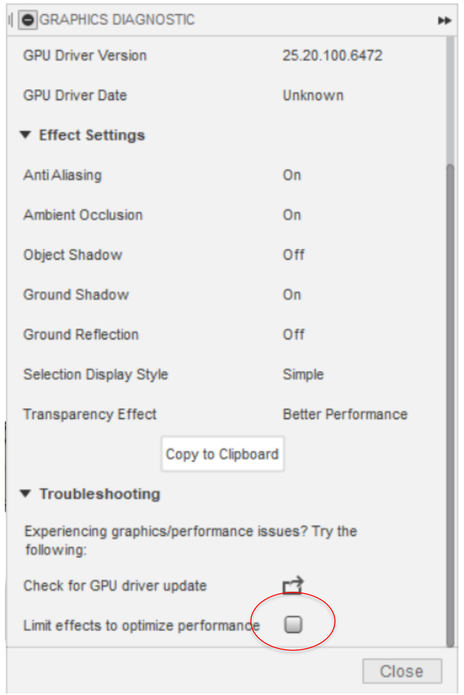
Graphics Settings

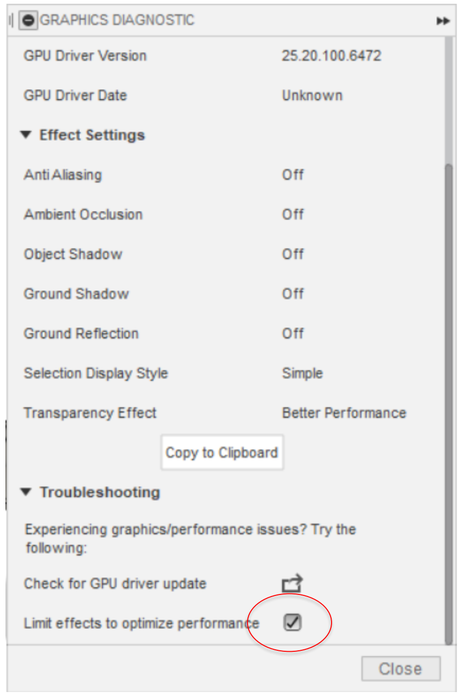
1. Graphics Preferences



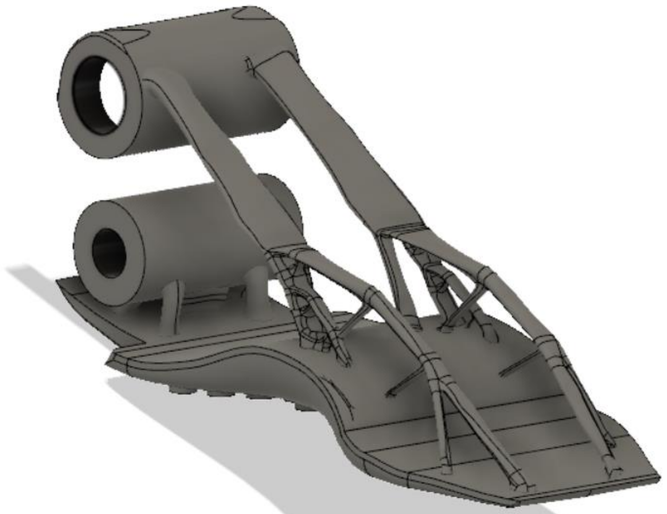
2. Graphics Diagnostic



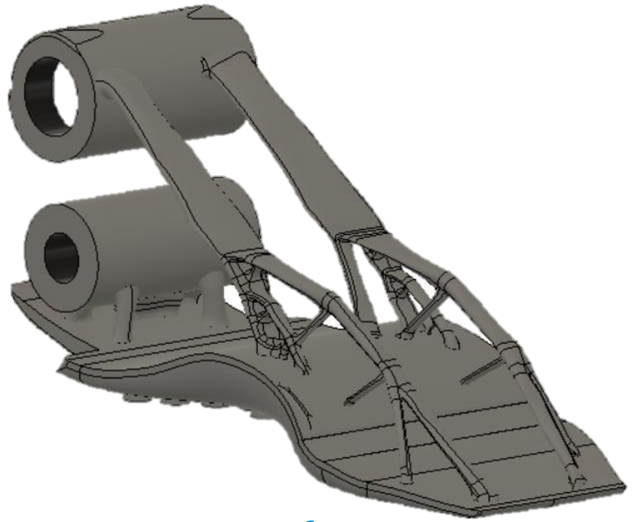




> Help Menu (upper right corner)
> Support and Diagnostics
> Graphics Diagnostic
> "Limit effects to optimize performance"



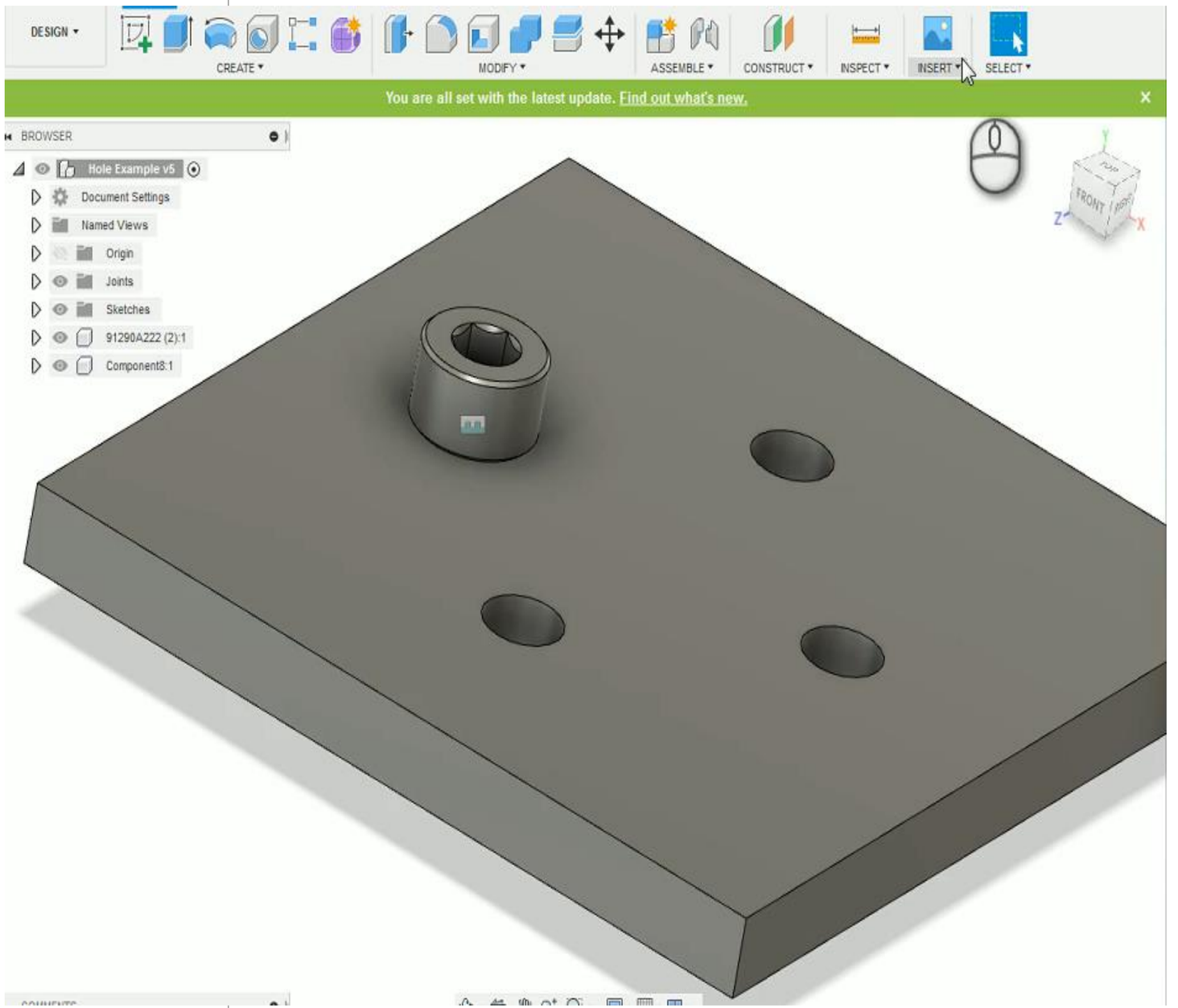
Before



After

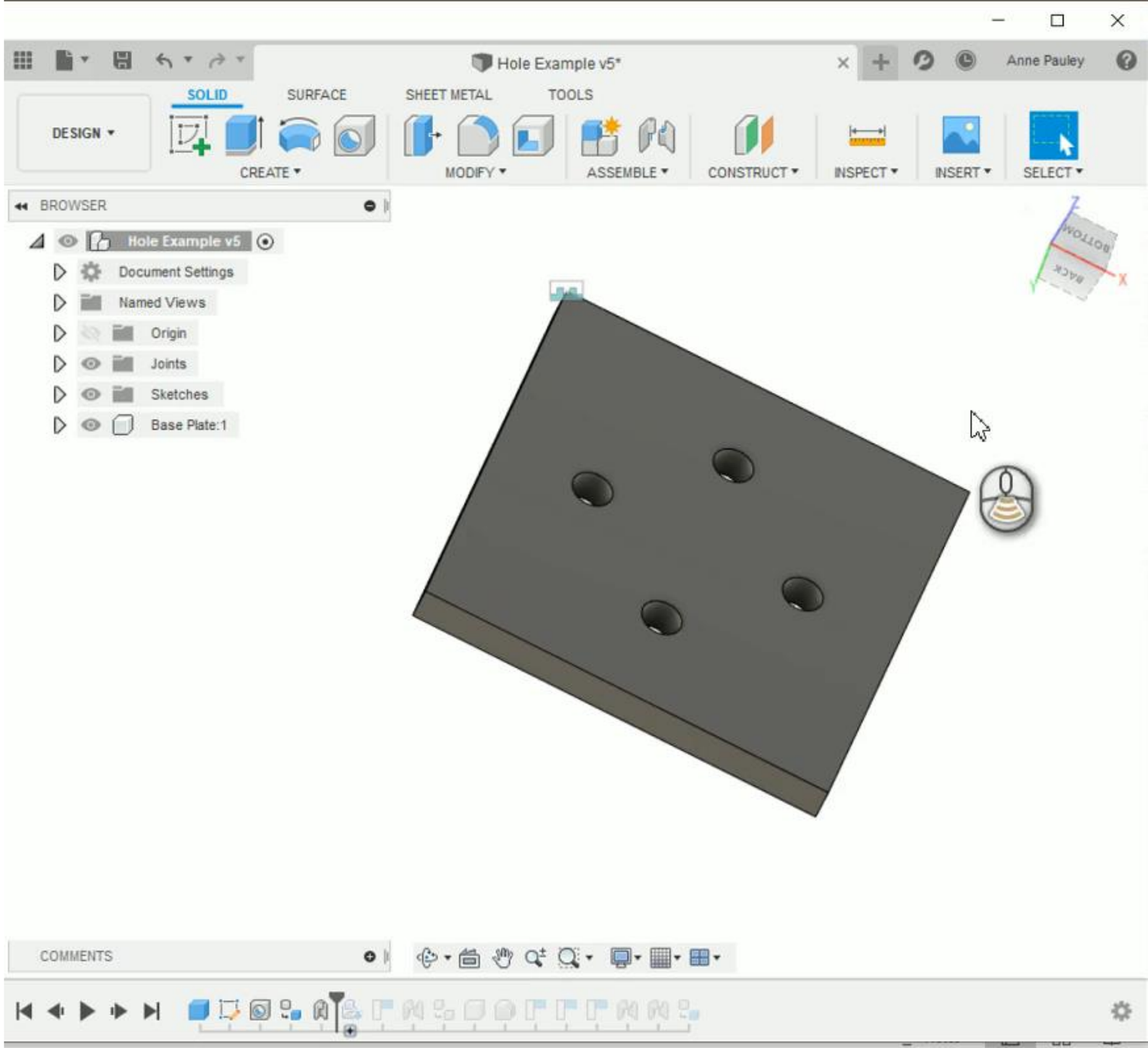
Hardware

- Always include hardware in your model!
  - Collisions
  - Bolt size/length/type
  - Tool clearance
- Use clearance holes for bolts



Hardware

- McMaster integration!
- Setting up descriptions in component properties for your BOM
- Deliberate copy/paste/import decisions



Extras

APPLY JOINTS BETWEEN PARTS, NOT HARDWARE

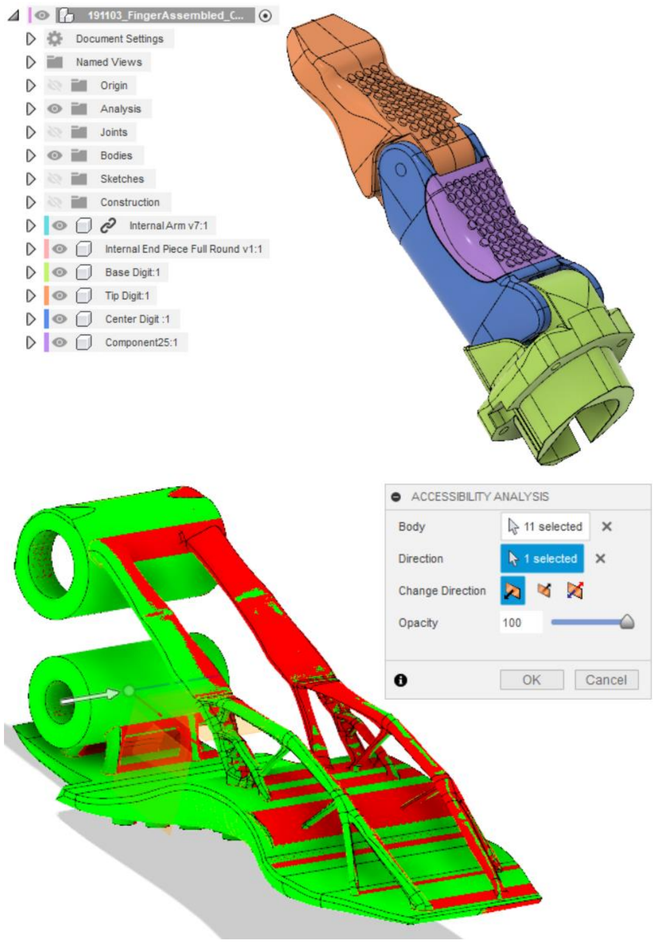
If you delete a bolt, does the assembly still function?

COMPONENT COLOR CYCLING (AKA “SKITTLES MODE”)

Under the “Inspect” menu

“ACCESSIBILITY ANALYSIS”

Check the machinability of your part using “Accessibility Analysis”

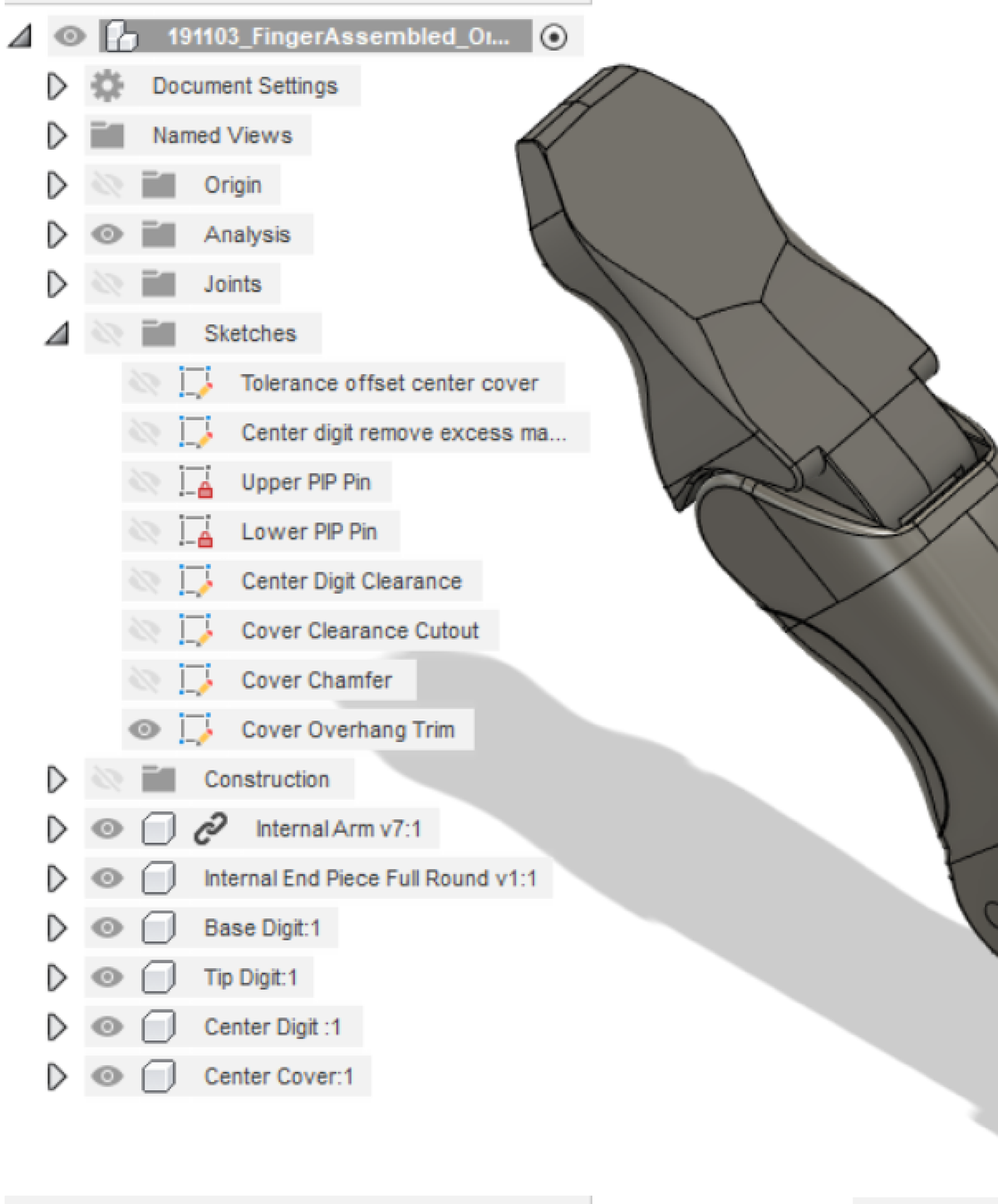


Grounding

- Lots of confusion around “Ground”
  - It does not work the same way as in other programs!
- Alternatives:
  - Lock Joints
    - Right click on joint -> Lock
  - Rigid Joints
  - Rigid Groups (Use to combine Rigid Joints when possible)
  - As-built joint (can join to origin to lock position)

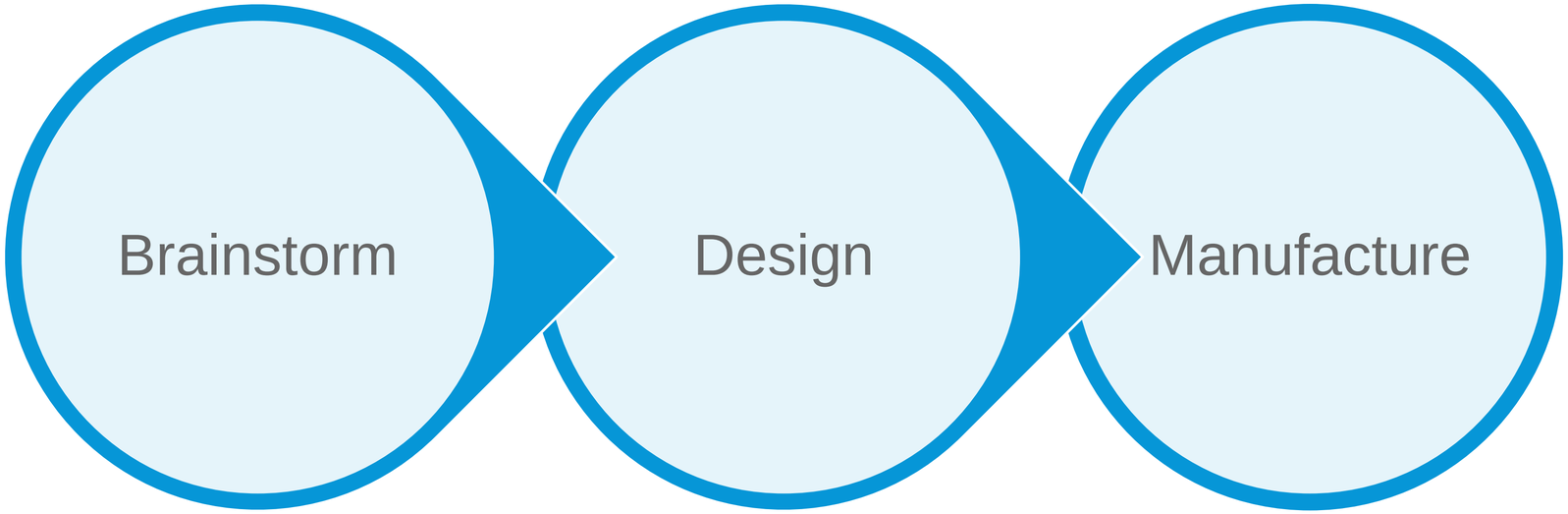
Marie Kondo your Designs

- Label Components
- Label Sketches
- Timeline Groups

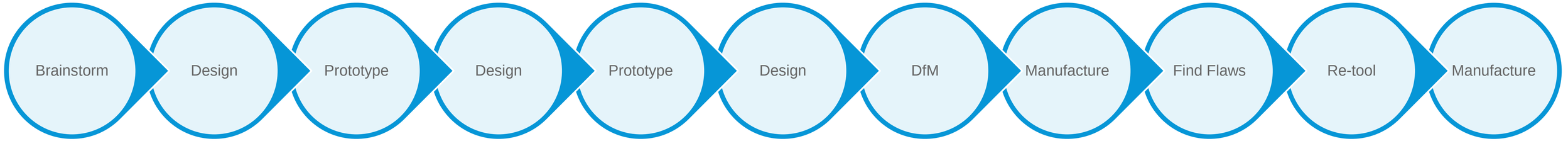


Manufacturing

How your engineering professors tell you it will go



How it actually goes



Prototyping

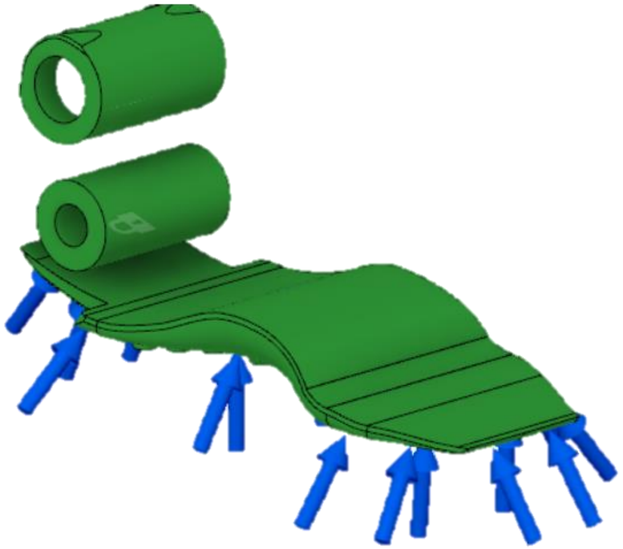
- **Plastics:**
  - 3D Printing
  - Casting
  - Machining
  - Improvising
- **Machined parts:**
  - 3D Printing (limited capability or lifetime)
- **Sheet Metal:**
  - Never underestimate cardboard.
  - Adam Savage: “Cardboard is the gateway drug to making”

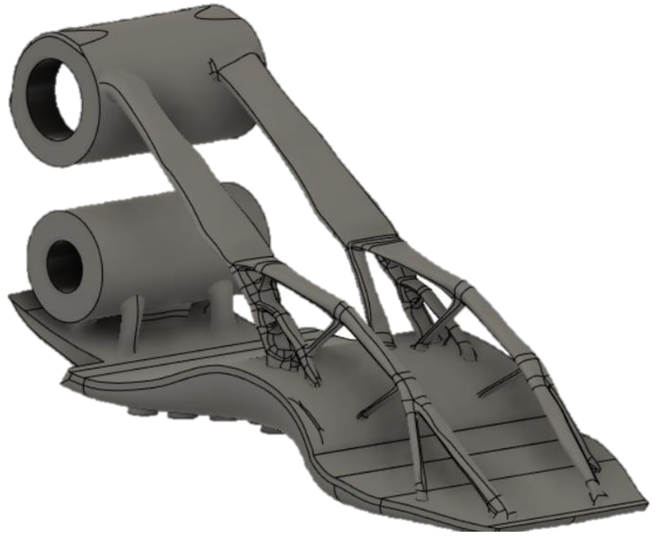
Bridge-To-Production Manufacturing

- The grey area between prototyping and production
- Most useful/effective with technologies that require a lot of tooling (read: injection molding)
  - *For robotics: Shells often require the most iteration, since aesthetics play a huge role*
  - *Speed is often a factor*
- Ways we bridge the gap:
  - *3D Printing (possible post-processing)*
  - *Urethane Casting*
  - *Machining*

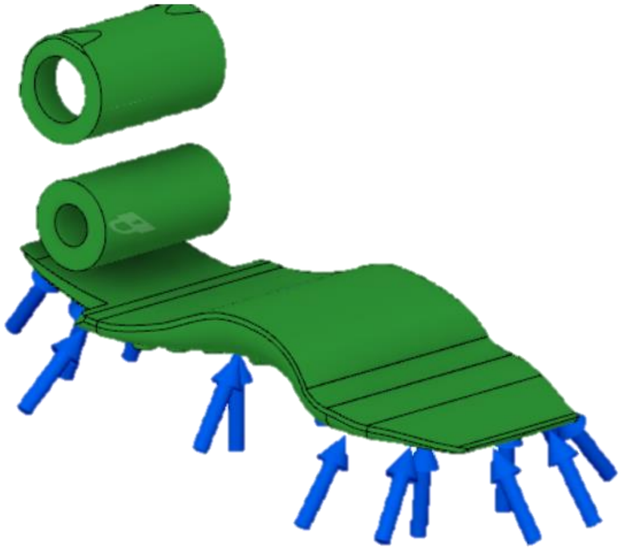
Generative Design and Robotics

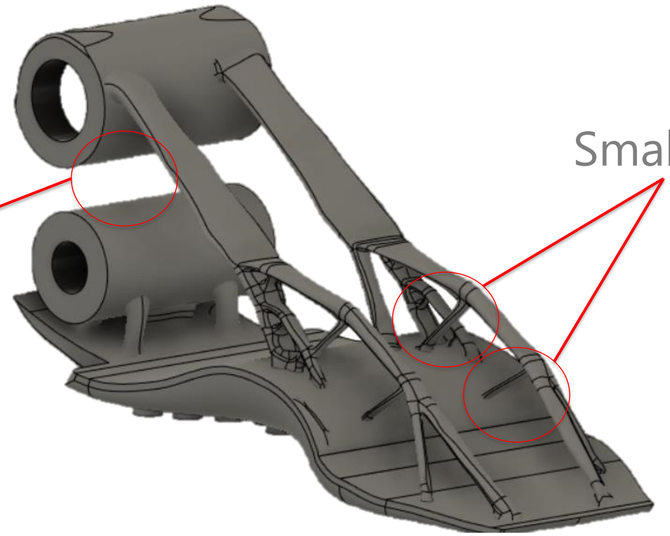
Generative Design and Robotics





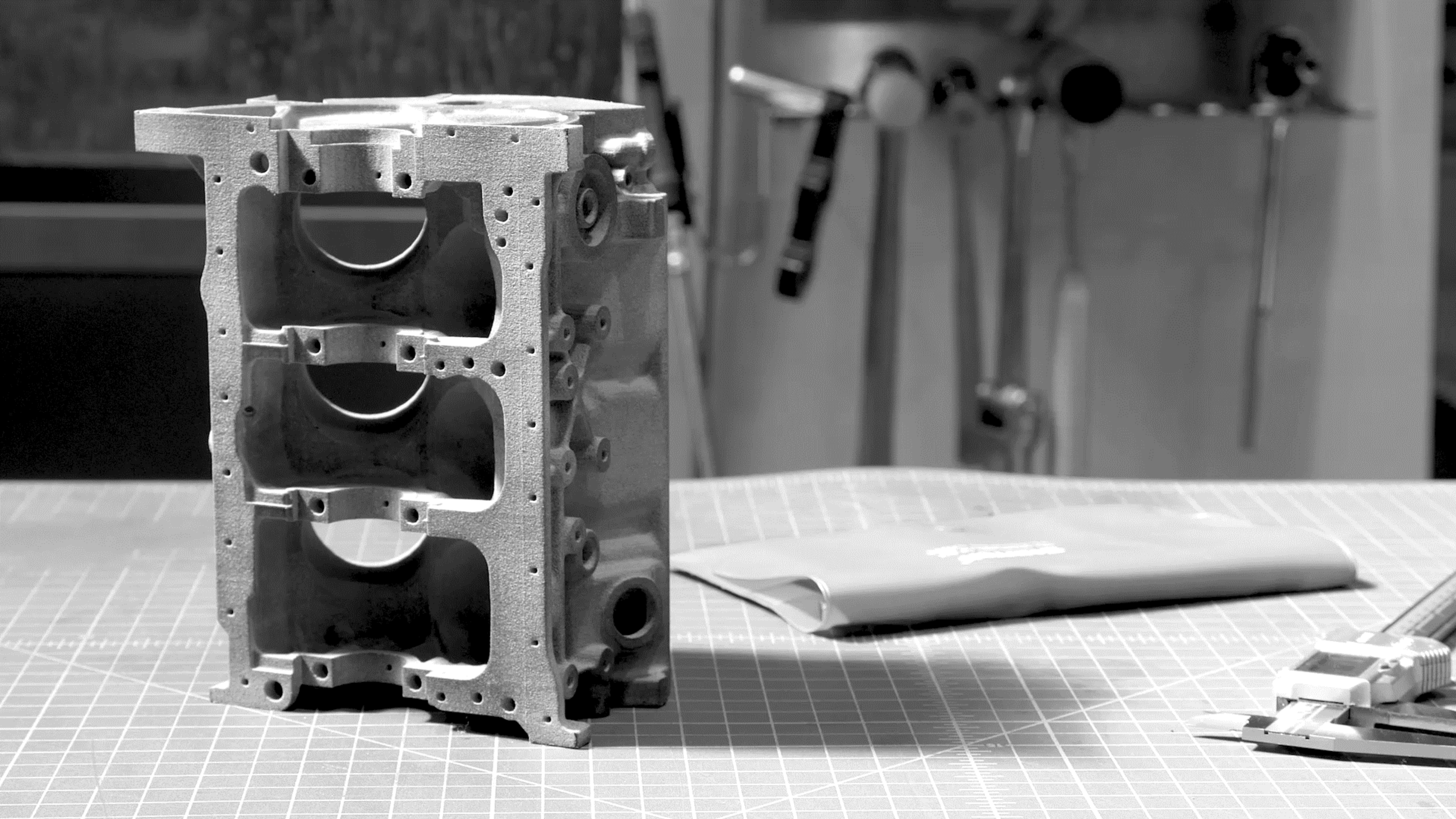
Generative Design and Robotics



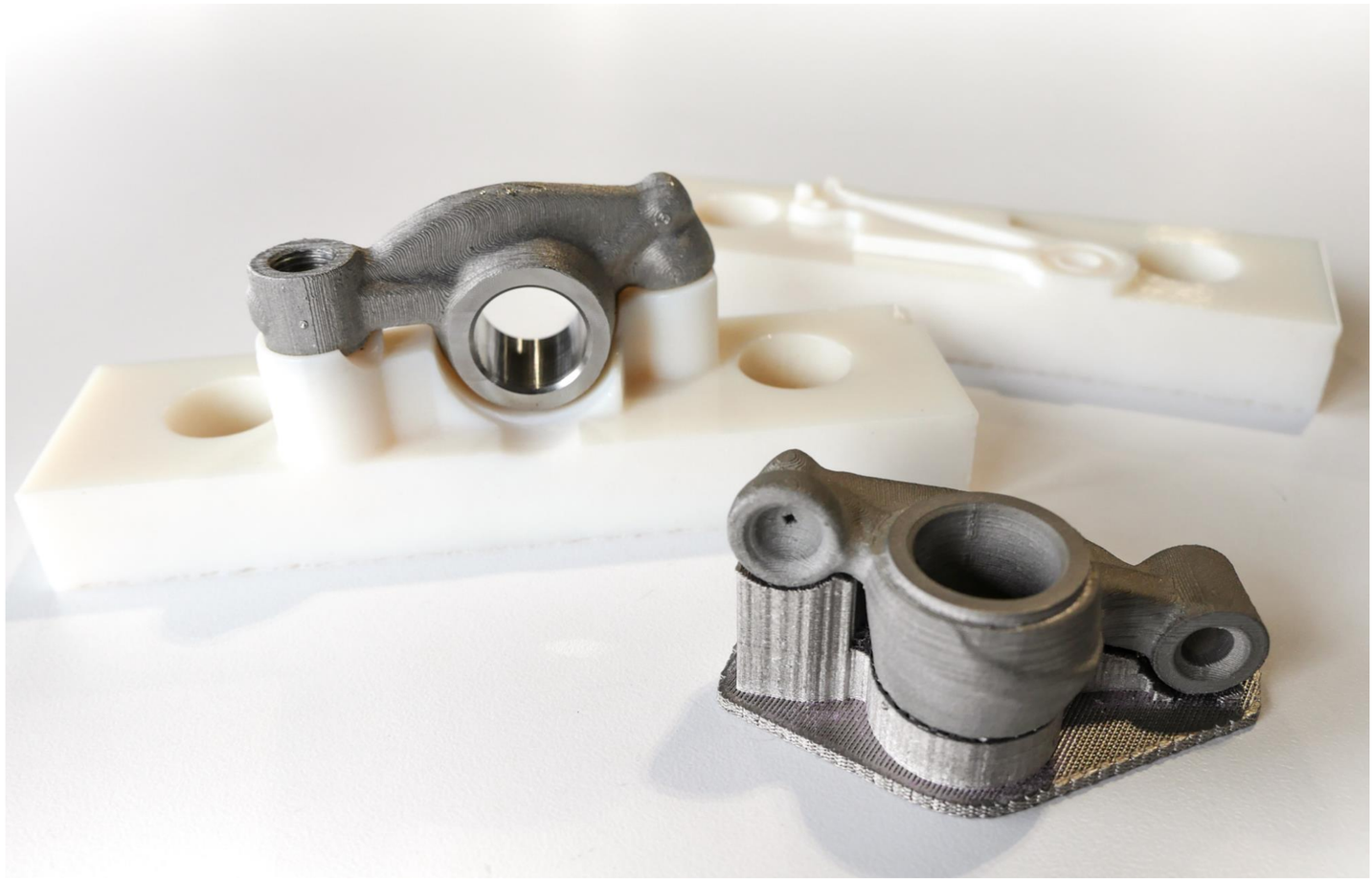


Back to Tolerances…

- Machining optimized geometry is time consuming and can require a higher skill level
  - 2.5D constraints increase the viability of generative + machining
- Additive manufacturing tolerances are MUCH LOOSER than machining
  - Any AM process that uses heat will have some warping/deformation (spoiler: this is most AM technologies)
  - In general, AM parts have a coarser surface finish
  - Casting has similar challenges



Additive & Subtractive

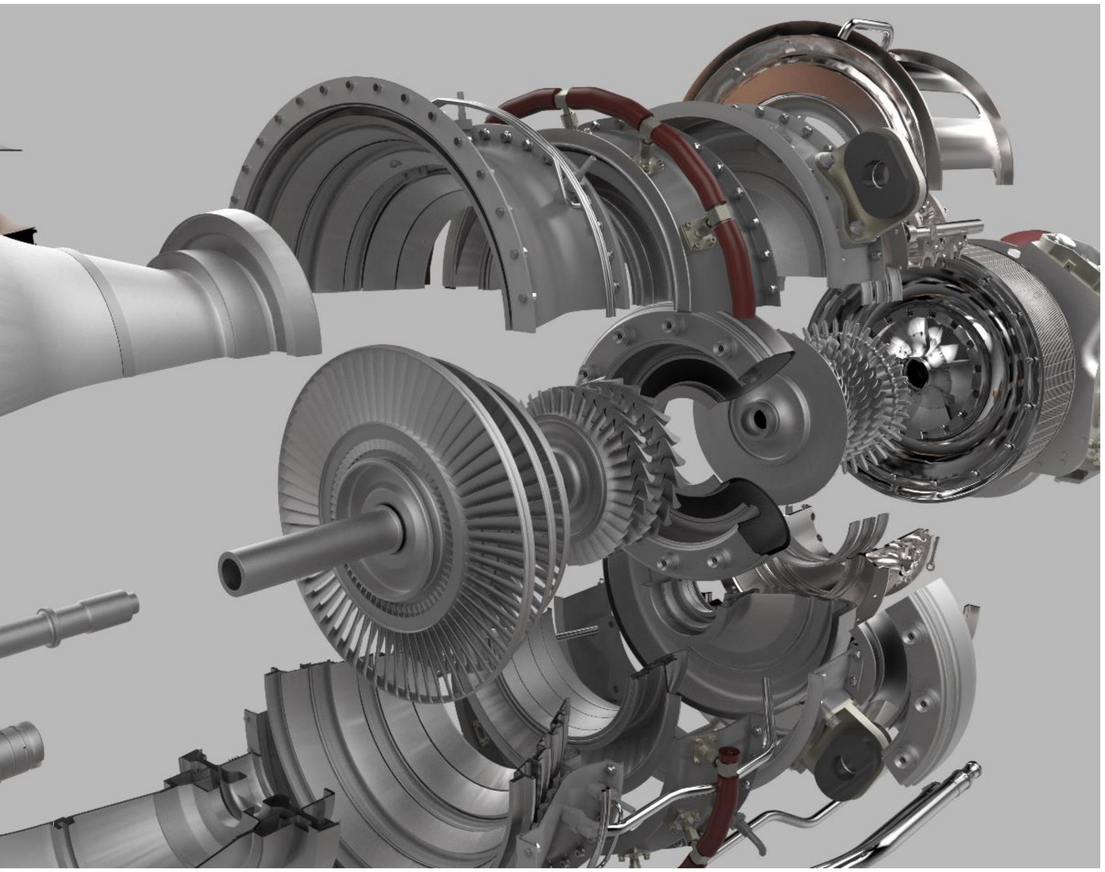


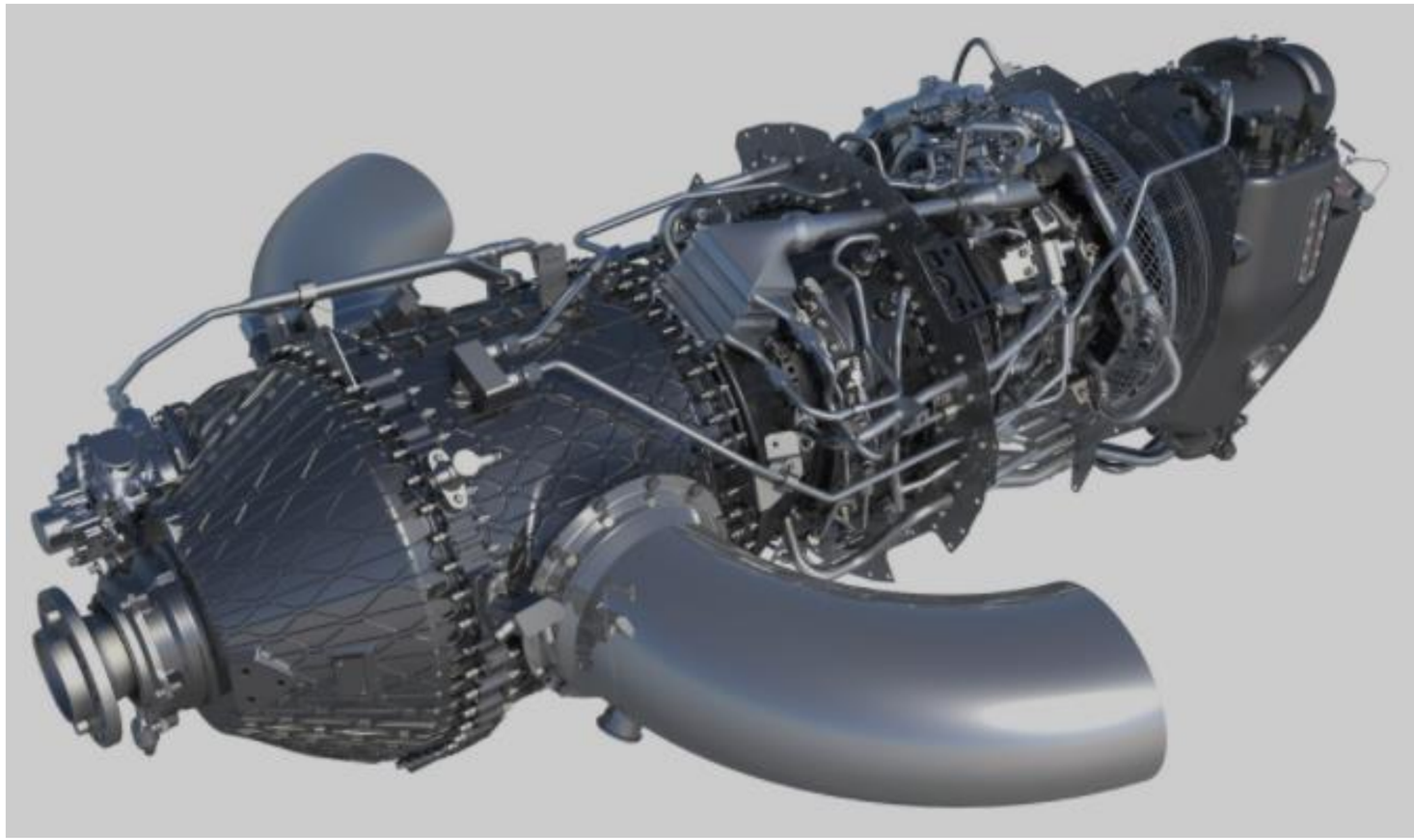
How I plan to use generative for robotics

- Lightweighting
  - Benefits increase as you stack DOFs
- Obstacle avoidance
  - Common problem for assemblies
  - Model all potential collision points as obstacle bodies
  - On this note: Don’t forget to model all neighboring mechanisms as obstacles!

Where can we innovate using additive manufacturing?

Part Consolidation





855-Part Engine Assembly Down To 12 Components

CREDIT // GE Aviation

Integrated vacuum lines

Integrated vacuum lines to reduce assembly and protect vacuum lines

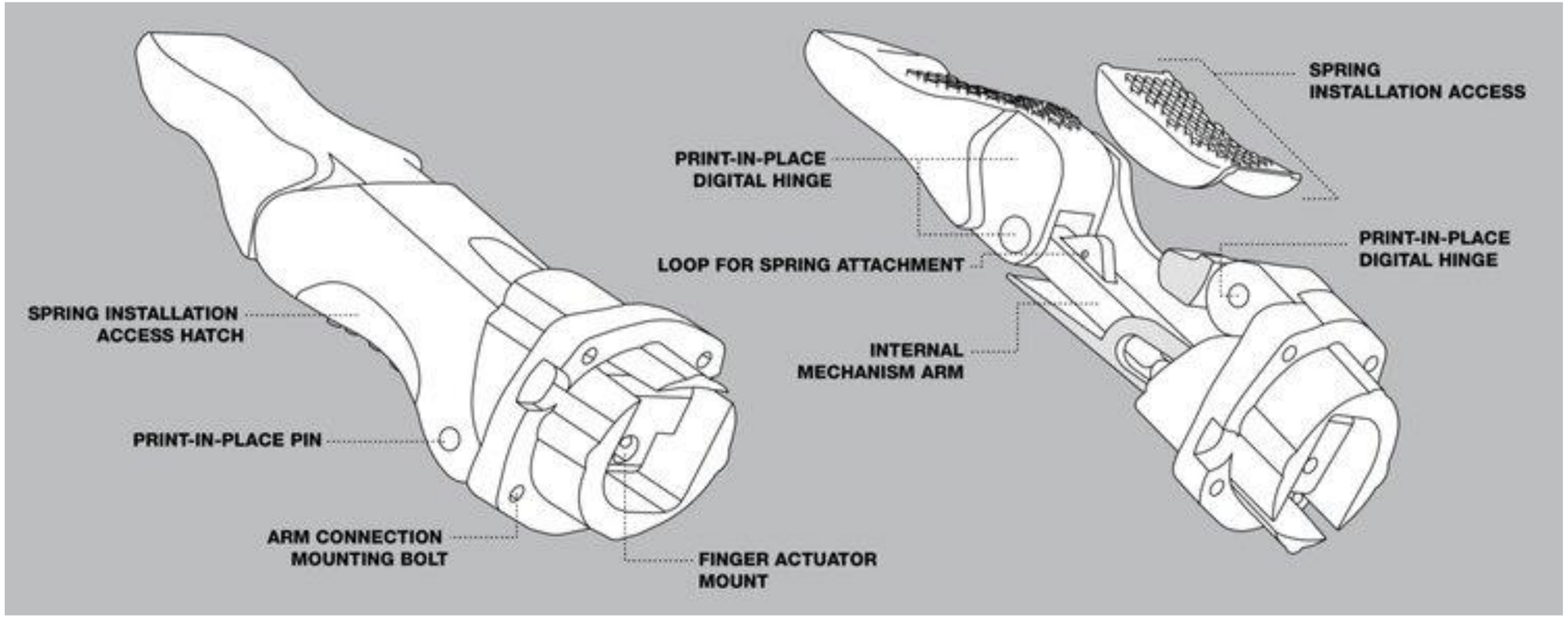
CREDIT // HP, IAM 3D HUB

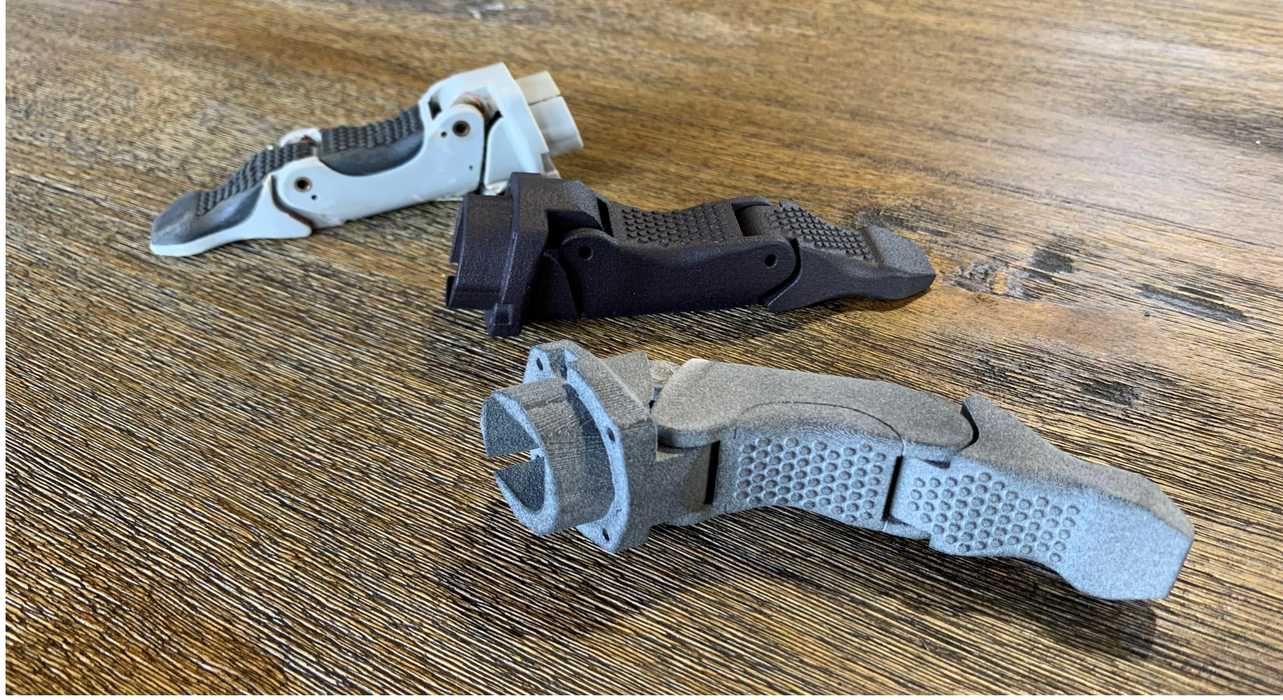
EOATs

Lightweight and optimized for stiffness

CREDIT // Anubis 3D

Print-in-Place Assemblies





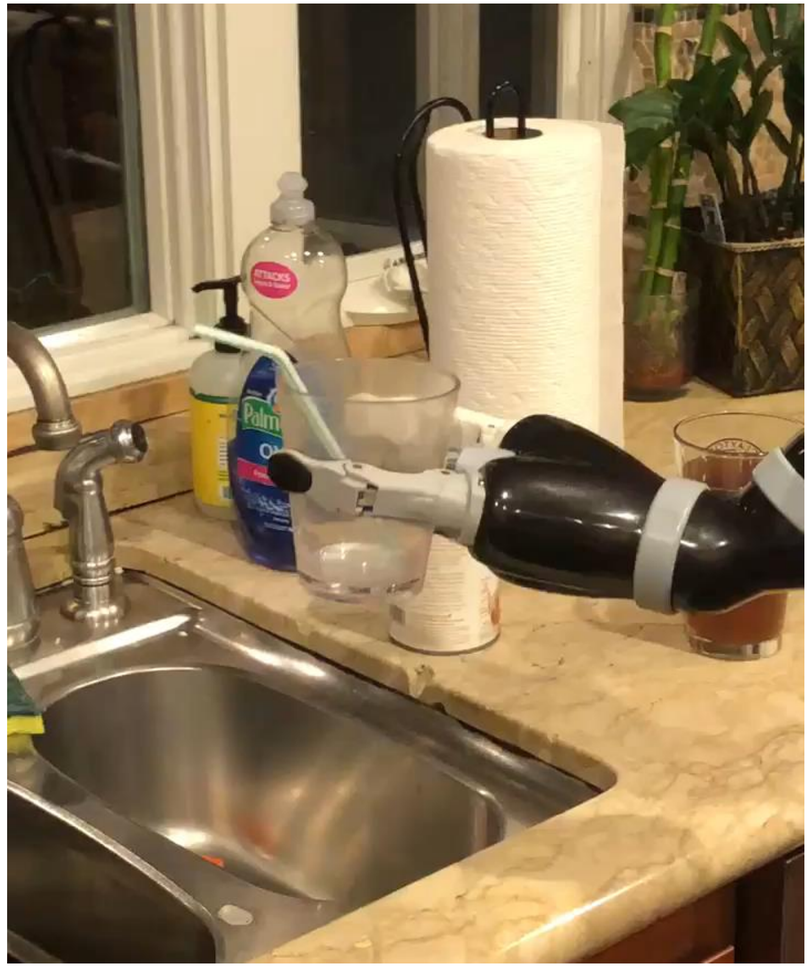
Print-in-place mechanisms

Replacing inserted pins with printed-in-place hinges reduced part count from 12 to 3.

Reduced assembly time

Assembly significantly reduced

Only the steel spring needs to be inserted followed by the cover plate.



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