Prototype Machining for Product Designers with Autodesk Fusion 360®

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Tormach Inc.

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Class summary

Affordable tools from Autodesk and Tormach are helping product designers use CNC milling technology to improve designs, test market products, and reduce lead times.

- Case studies of successful CNC milling in product design
- Discussion of important CNC milling concepts for designers
- Demo of Autodesk Fusion 360® and Tormach PCNC 440 milling machine

Key learning objectives

At the end of this class, you will be able to:

- List advantages of CNC machining for prototyping
- Describe CAD/CAM workflow for designing and machining parts
- Understand essential CNC milling concepts
- Design simple tool path strategies using Autodesk Fusion 360®

Introduction

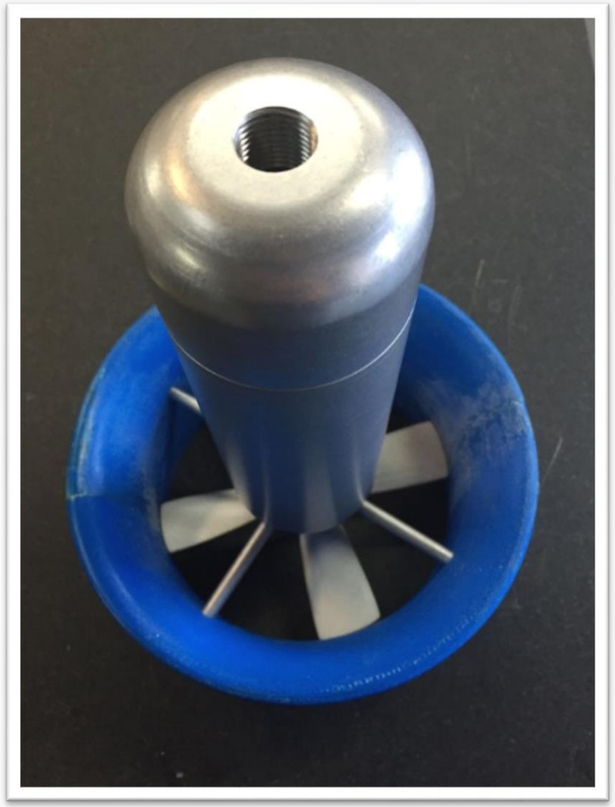
CNC for Product Design

- Affordable
- Accessible
- Easy-to-Use
- Makes Real Parts

Advantages of In-House CNC Machining for Prototyping and Product Design

Functional Prototypes

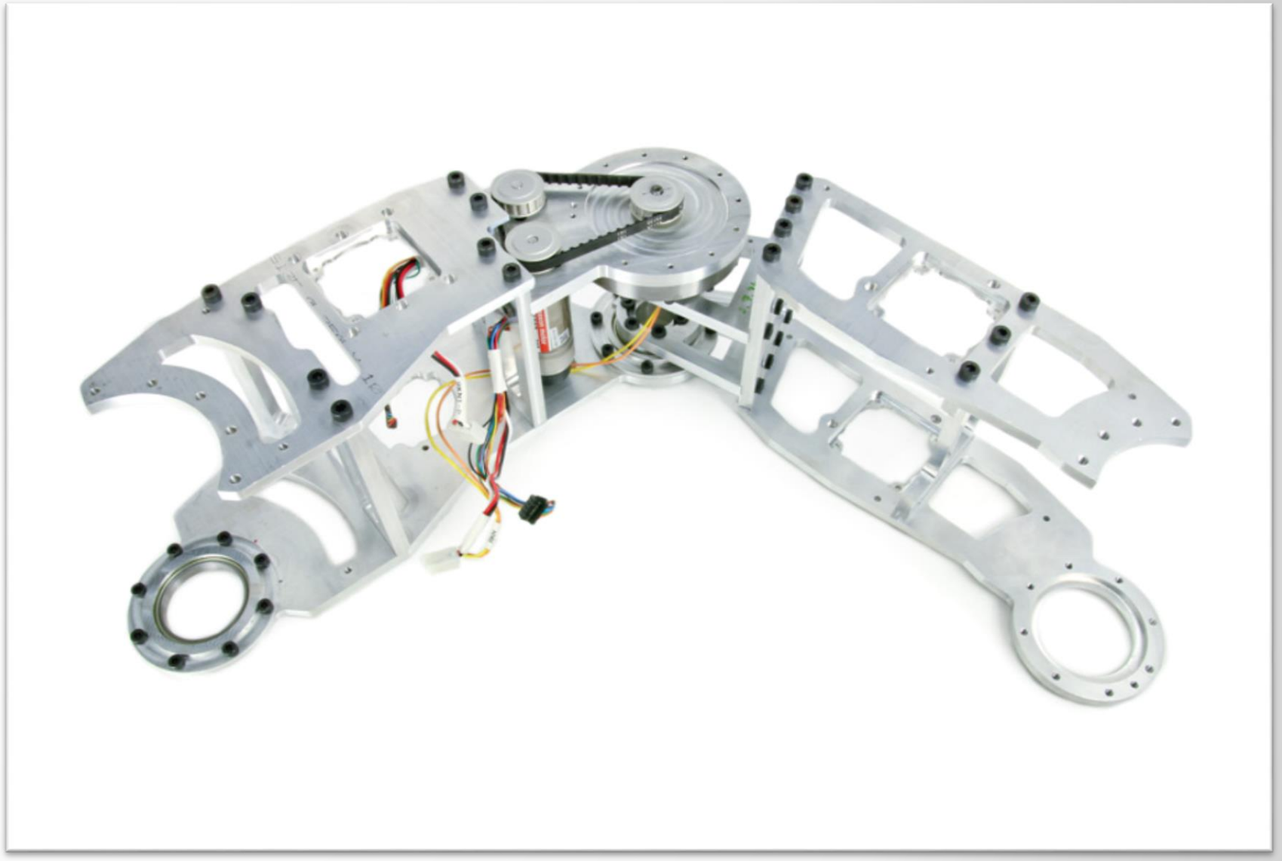
- Function vs. Form
- Real Materials
  - Steel
  - Aluminum
  - Stainless Steel
  - Titanium
  - Engineering Plastics
  - Fiber and Layered Composites
  - Wood



UNDERWATER AUTONOMOUS VEHICLE PROPULSION UNIT. CNC MACHINED PROPELLER AND MOTOR HOUSING MADE WITH TORMACH PCNC 1100® MILL AND 15L SLANT-PRO™ CNC LATHE. 3D PRINTED FAN COWLING.

Functional Prototypes

- Mechanical Assemblies
  - Frames and Structural Components
  - Gears / Cogs / Pulleys
  - Thread connections
  - Shafts / Rotors
  - Bearing Blocks
  - Motor Mounts
  - Heat sinks
  - Valve Bodies



HUBO+ HUMANOID LEG ASSEMBLY BY DREXEL AUTONOMOUS SYSTEMS LABORATORY (DASL). MADE WITH TORMACH PCNC 1100®.

Functional Prototypes

- Additive materials do not have well established design standards.
- Mechanical, heat transfer, optical, etc., properties can be different from bulk material
  - Layer thickness
  - Layer orientation
  - Filament or powder characteristics
  - Machine specific manufacturing methods

MICROFLUIDIC DEVICE MACHINED FROM ACRYLIC PLASTIC ON TORMACH PCNC 770®. PHOTO CREDIT: EDMOND YOUNG, UNIVERSITY OF TORONTO

Test Marketing

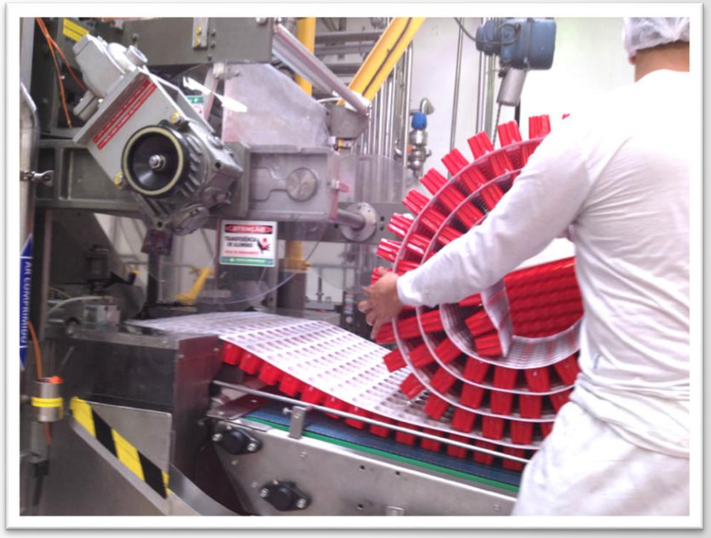
- Create “Product Quality” prototypes
- Test market before committing to expensive production tooling
- Scale up from prototype to short run production – “Bootstrap Manufacturing”

MARSHMALLOW BLASTER PROTOTYPE MADE FOR TEST MARKETING AT NY TOY FAIR. RIGID PLASTIC PARTS AND SHORT RUN ALUMINUM INJECTION MOLDS MADE ON TORMACH PCNC 1100.

Test Marketing

- Rapid Iteration
- Design Refinement
- Compress Design Cycle
- Reduce prototype costs

STEEL DIES FOR YOGURT CUP PROTOTYPED ON TORMACH PCNC 1100 BEFORE COMMITTING TO PRODUCTION TOOLING



Customization and Personalization

- One size does not fit all
- Parametric CAD/CAM in Autodesk Fusion 360 can adjust tool paths in parallel with design modifications
  - Serial numbers
  - Different sizes

PERSONALIZED SUNGLASSES BY INDIVIDJUAL EYEWARE MADE ON TORMACH PCNC 770.

Product Variants and On-Demand Manufacturing

- Autodesk Fusion 360 can easily adapt to product variants
- Reduce overhead and inventory
- Fulfill on demand

TITANIUM SCREWS AND PLASTIC SPACERS FOR SPINAL IMPLANT SURGERY MADE BY EISERTECH ON TORMACH PCNC 770.

CAD/CAM Workflow and Machining Process Design

Design for Machining

"Think like a Machinist"

- Minimize setups
- Minimize tools
- Don't design things that can't be machined
- Sequence of Operations

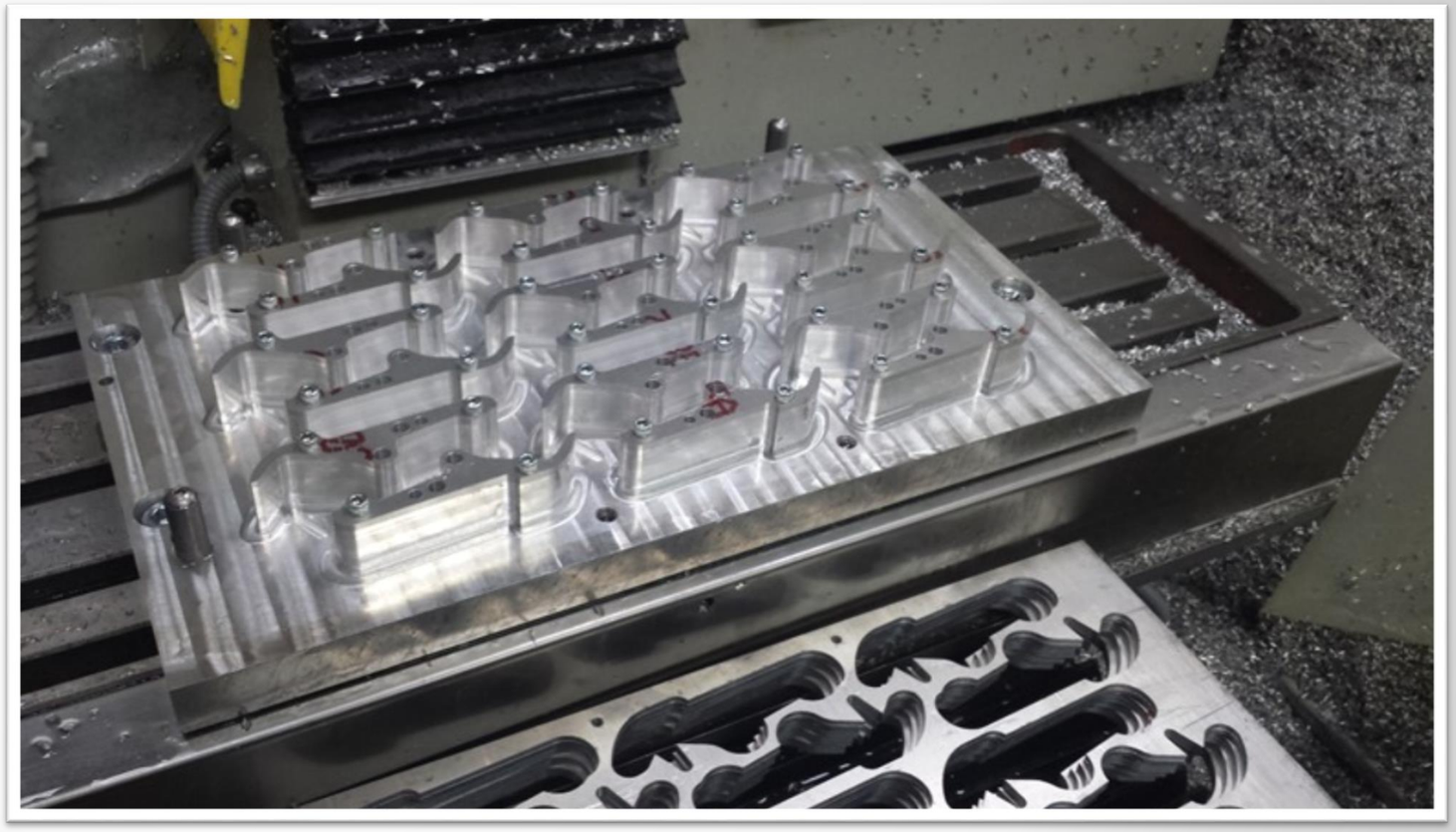
It all starts with
<u>WORKHOLDING</u>

Workholding: Flip and Deck

- Naturally adapts to vise work
- Machine majority of part from one side, then flip to deck the part

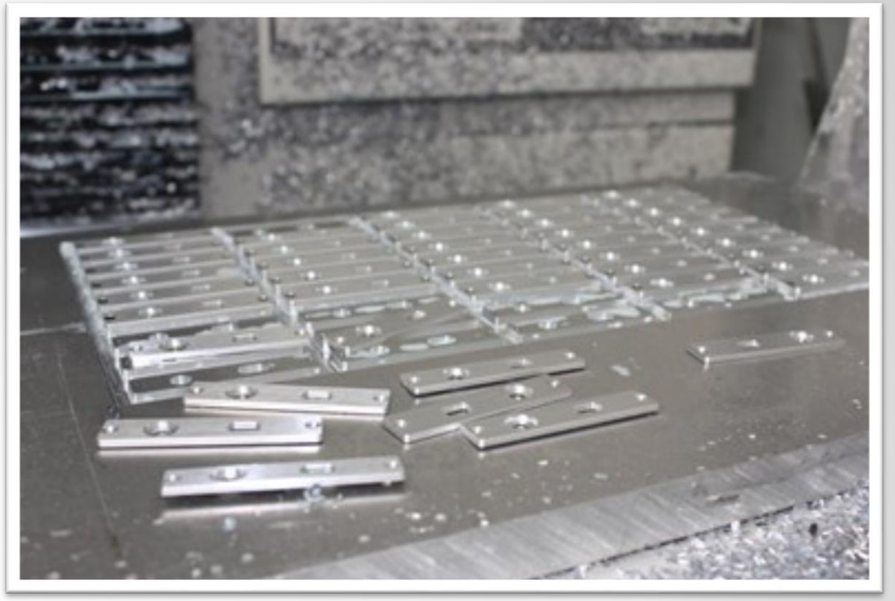
Workholding: Picture Frame

- Effective for complicated shapes
- Needs a secondary finishing operation to remove tabs



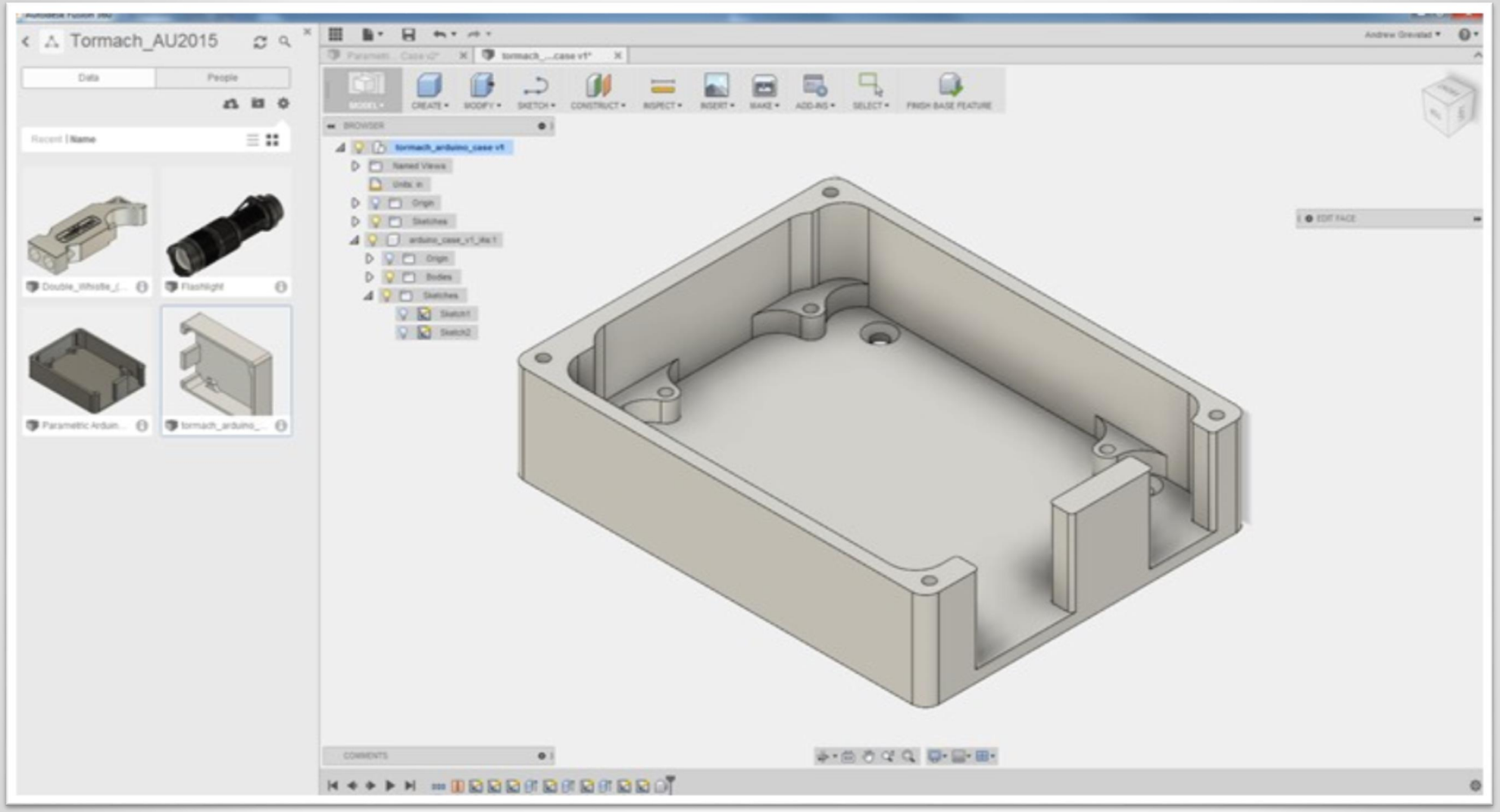
Workholding: Fixture Plates

- Large Parts and Thin Parts
- Can you use Existing Holes?
  - If not, where can you add holes without interfering with part function?
- Clamps must be repositioned?



Workholding: Collet Fixtures

- Round, hex and square parts
- End work
- V-blocks, V-Jaws, and Table Chucks can also be used in a similar way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Parametric Arduin...
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BROWSER
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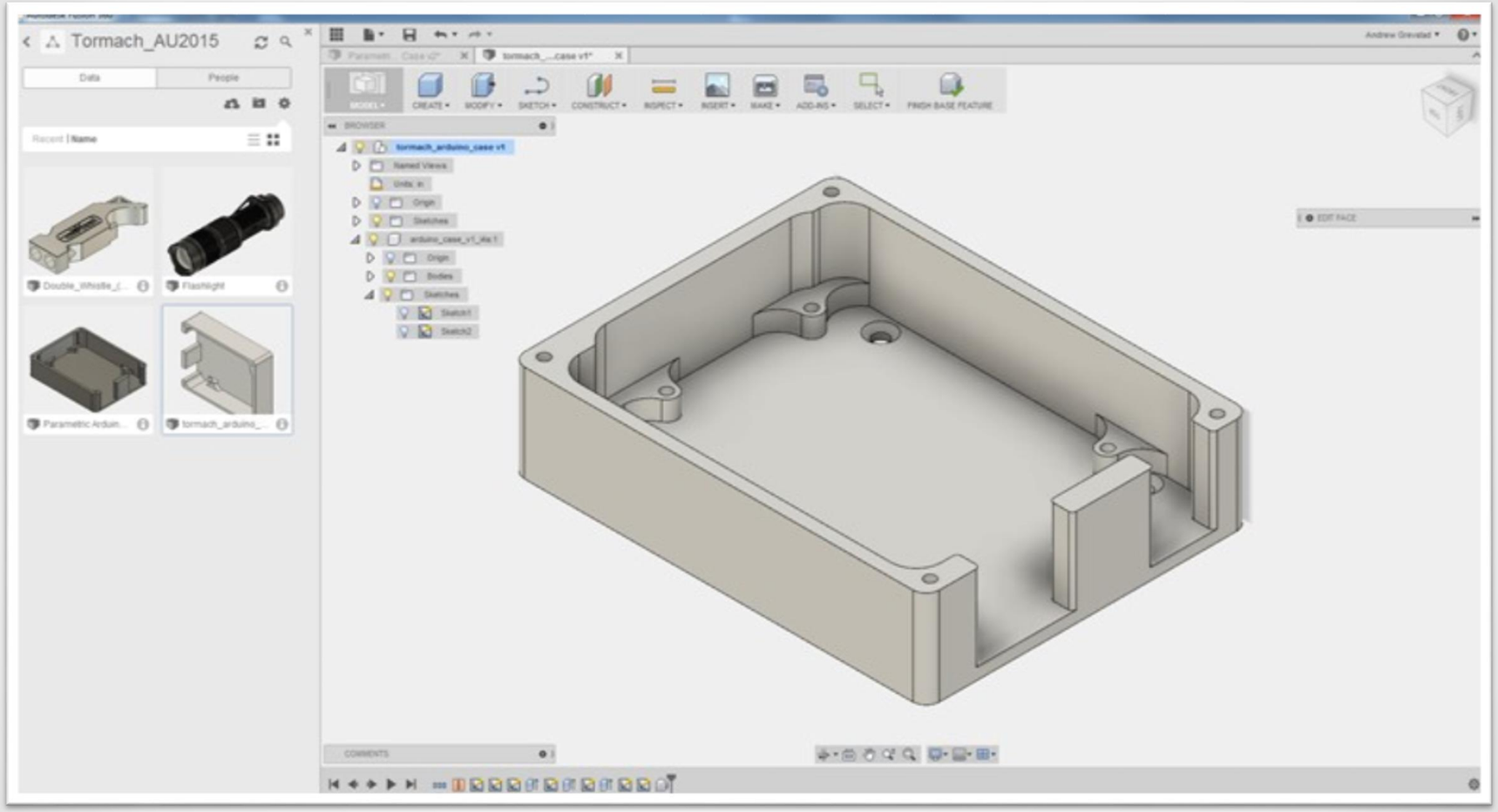
Named Views
Origin
Sketches
Origin
Bodies
Sketches
Sketch1
Sketch2
COMMENTS

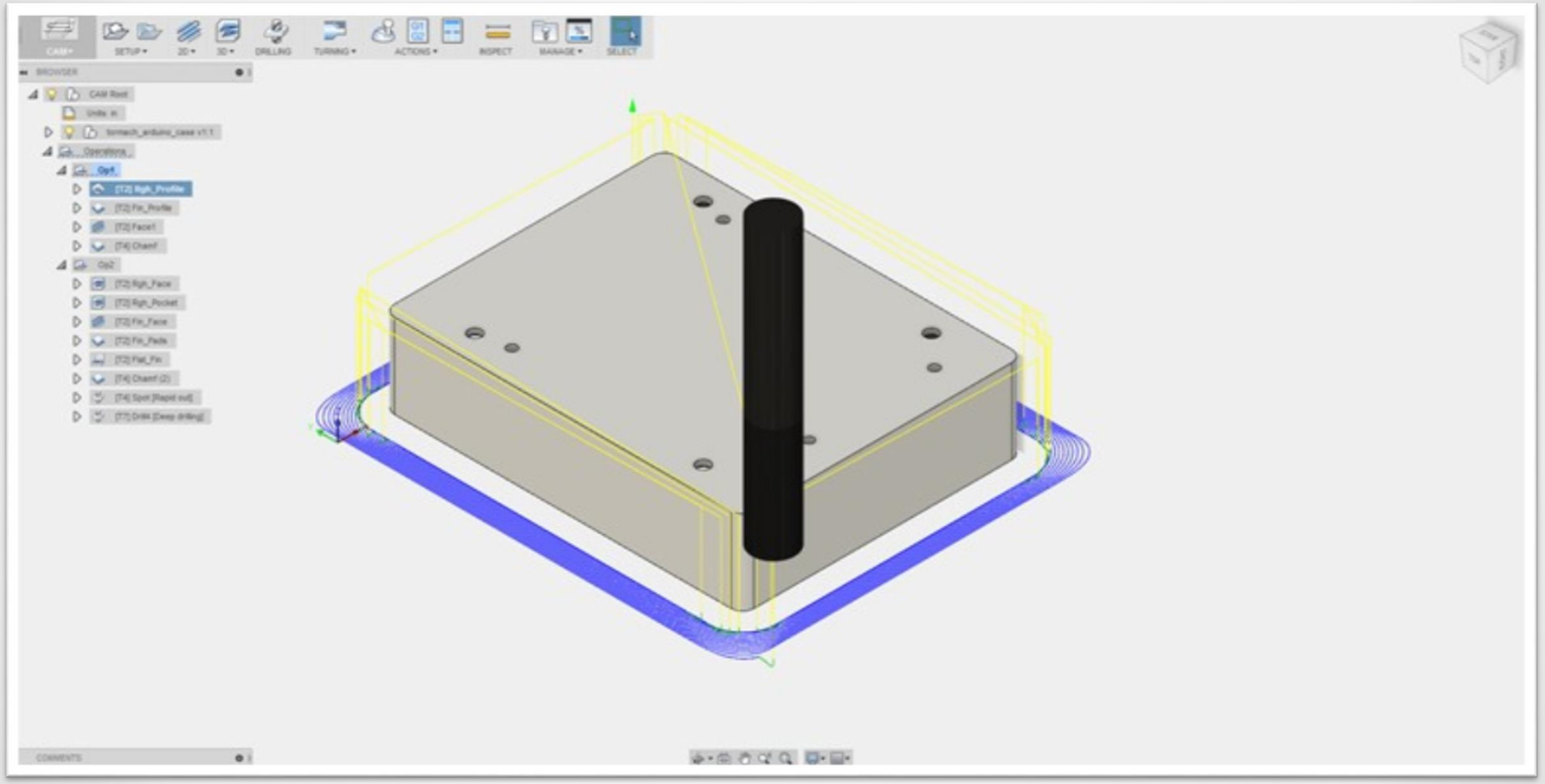
CNC Workflow Cheat Sheet

- Evaluate design for machining (DFM)
  - Which tools to use?
  - Workholding!
- Figure out the sequence
  - How many operations?
  - How many strategies?
- Setup the project in CAM
  - Orientation
  - Work Offset
  - How much modeling is needed? Vise, Machine, Toolholders, Fixtures?
- Design tool paths
  - Get the geometry right first
  - Then fill in the details (Feeds, Speeds, Depth of Cut, Width of Cut)
- Simulate

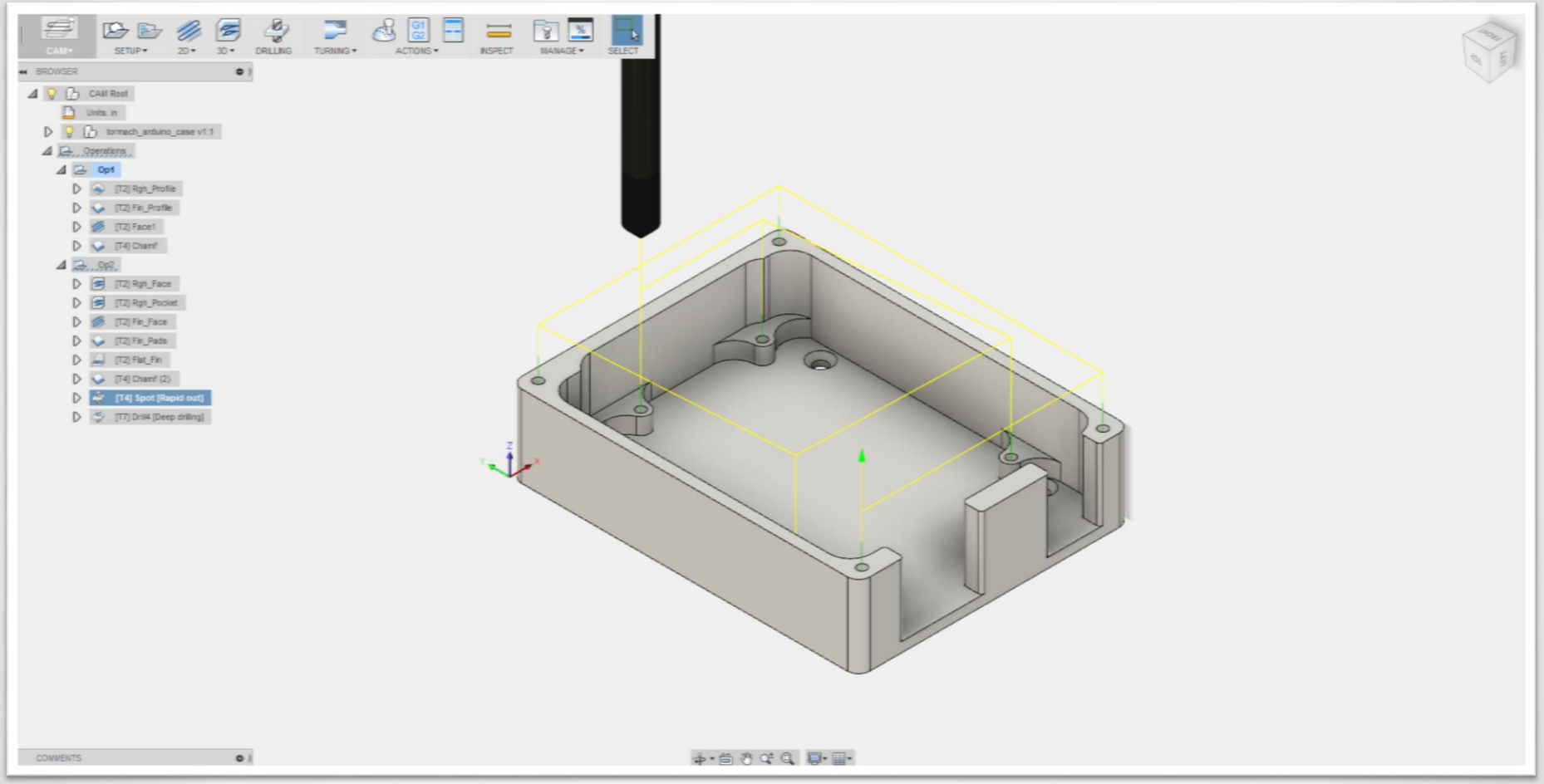
Orient and Locate in CAM



Design Tool Paths



Simulate


CAM
SETUP
2D
3D
DRILLING
TURNING
ACTIONS
INSPECT
MANAGE
SELECT
BROWSER
CAM Root
Units: in
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Operations
Op1
[T2] Rgh_Profile
[T2] Fin_Profile
[T2] Face1
[T4] Chamf
Op2
[T2] Rgh_Face
[T2] Rgh_Pocket
[T2] Fin_Face
[T2] Fin_Pads
[T2] Flat_Fin
[T4] Chamf (2)
[T4] Spot [Rapid out]
[T7] Drill4 [Deep drilling]
COMMENTS

Technique in Action

Connect with Tormach

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