

Opportunities and Challenges with Additive and Subtractive Manufacturing



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Composites Manufacturing*

GLOBAL PRODUCT DATA INTEROPERABILITY **S U M M I T** 2017



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Senior Product Manager
Additive, Cutting & Composites
Manufacturing Software



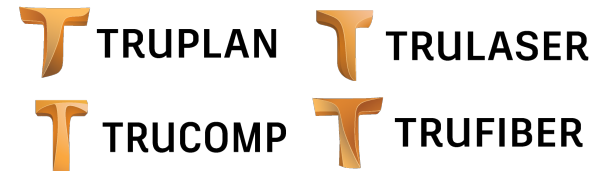
Previously at:



Shapeways

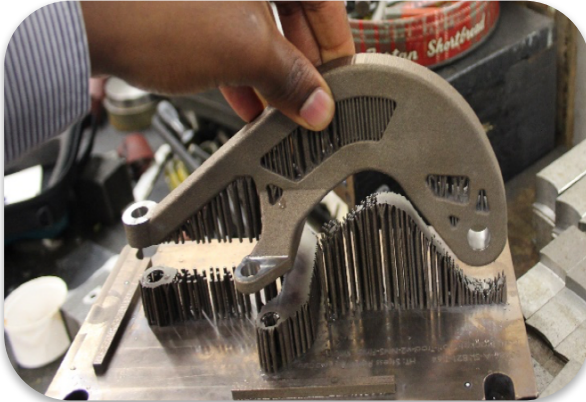


Microsoft

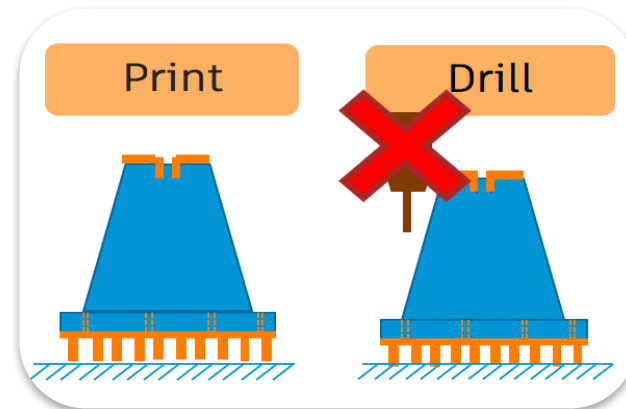


Agenda

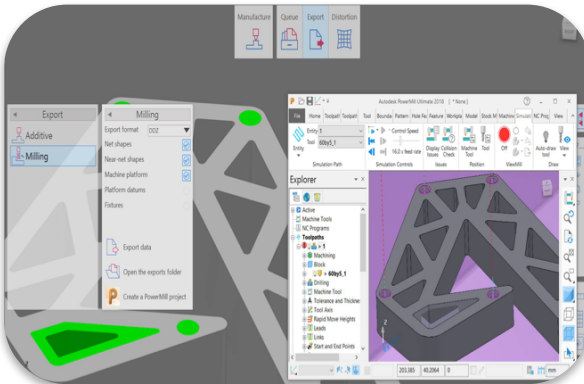
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Why Additive + Subtractive



Challenges



Opportunities with Better Planning & Data Management

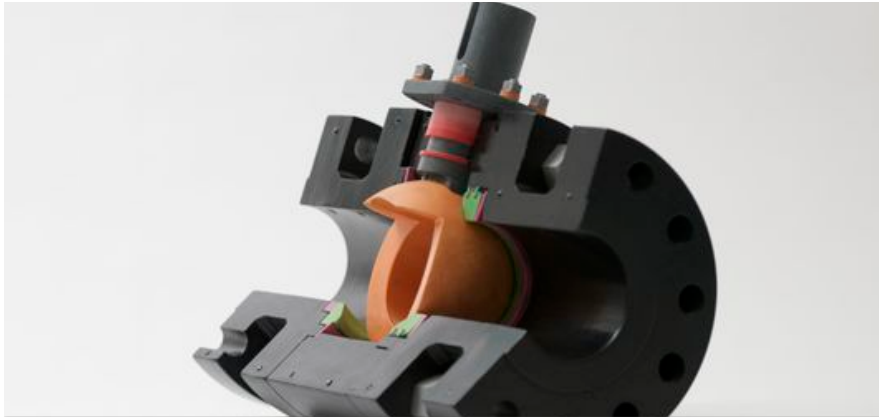


Image courtesy of Under Armour

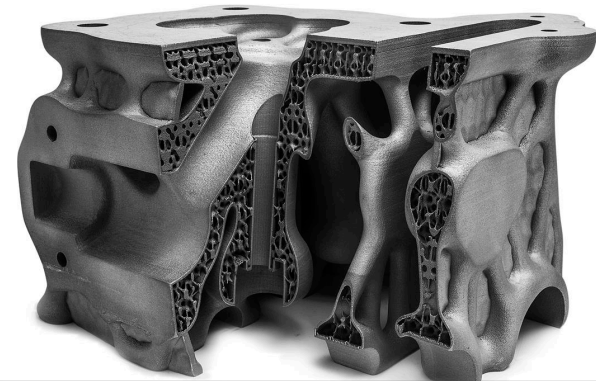
Future Automation Implications

Why Additive Manufacturing?

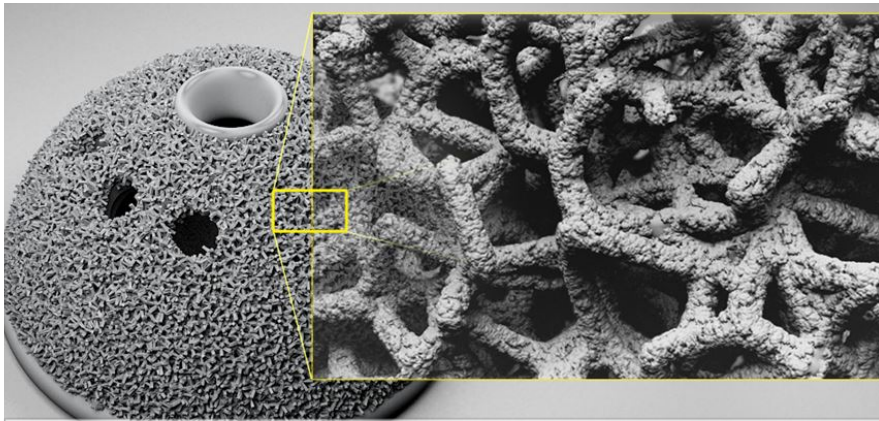
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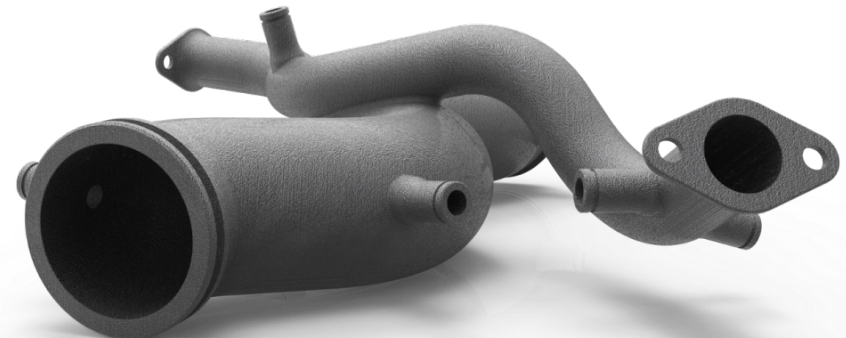
Prototyping & visual aids



Impossible geometries



Custom medical implants



Part consolidation

Types of Additive Manufacturing

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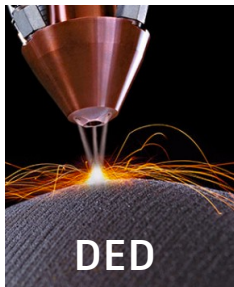


Image courtesy of Stanley Black & Decker



Image courtesy of Under Armour

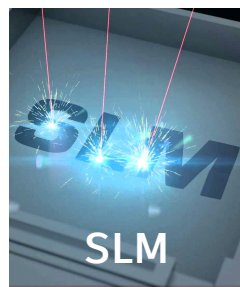
Metal



DED



DMLS

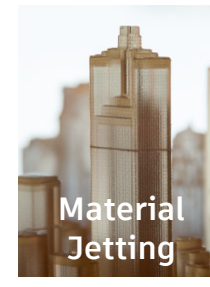


SLM

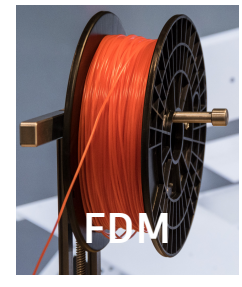
Polymers



DLP



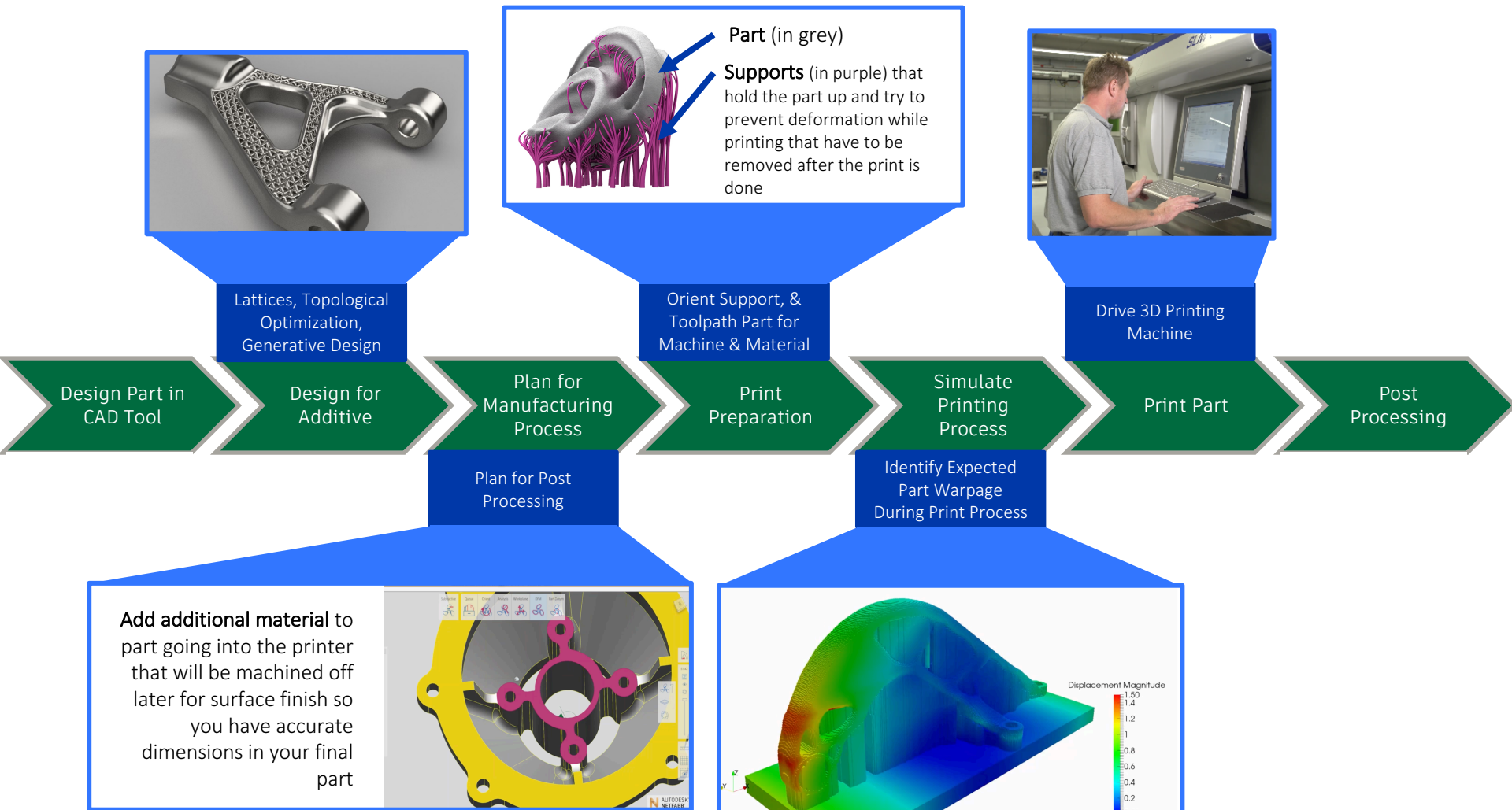
Material
Jetting



FDM

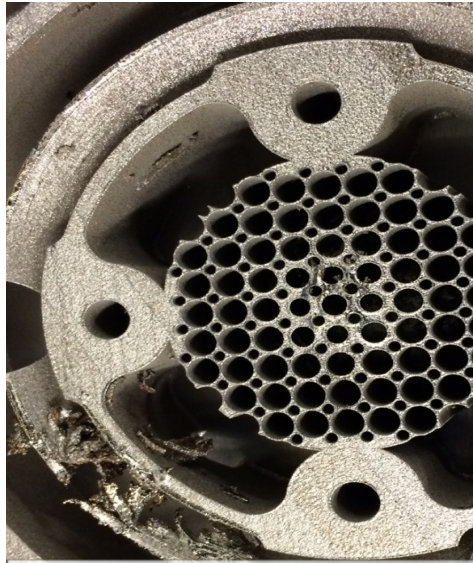
Additive Manufacturing Workflow

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Challenges with Additive Manufacturing

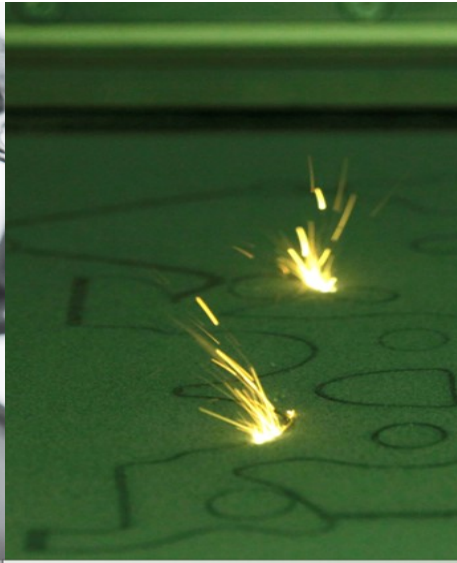
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**PART DISTORTION AND
PRINT FAILURES**



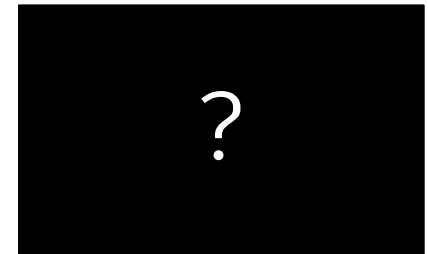
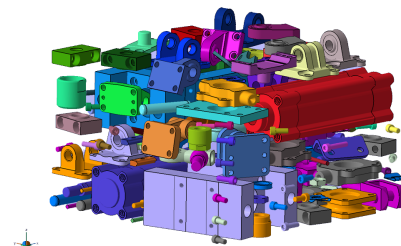
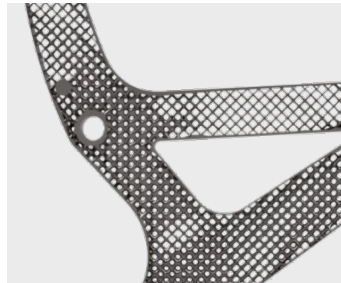
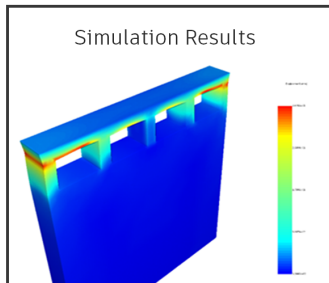
**CREATING COMPLEX,
ORGANIC FORMS**



**MACHINE UTILIZATION
& THROUGHPUT**

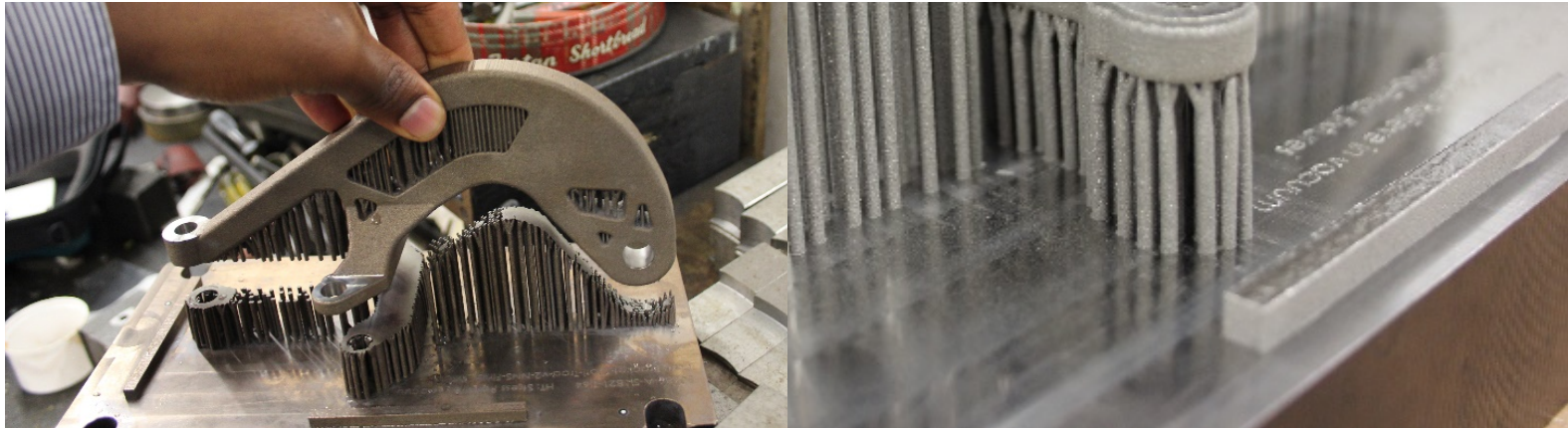


**PLANNING CNC FINISHING
OPERATIONS**

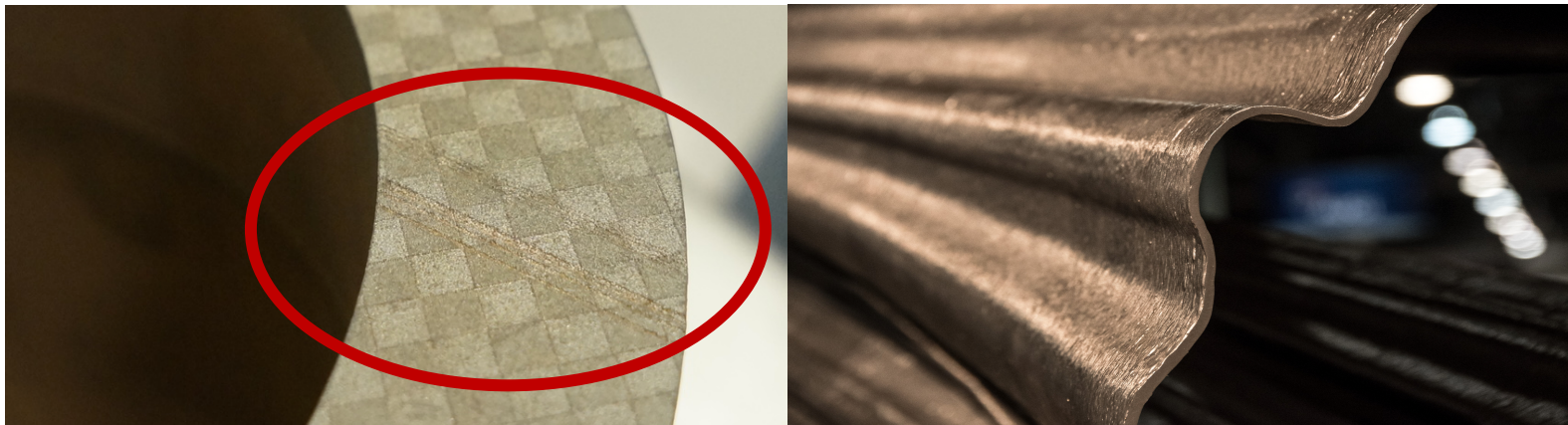


Why CNC? Why Post Processing?

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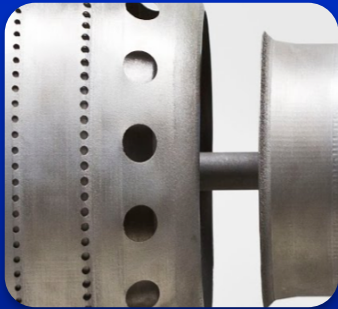
Labor: e.g. Remove Supports From Part and Print Bed – By Hand or Machine



Design Goals: Building to Tolerance, Design Goals

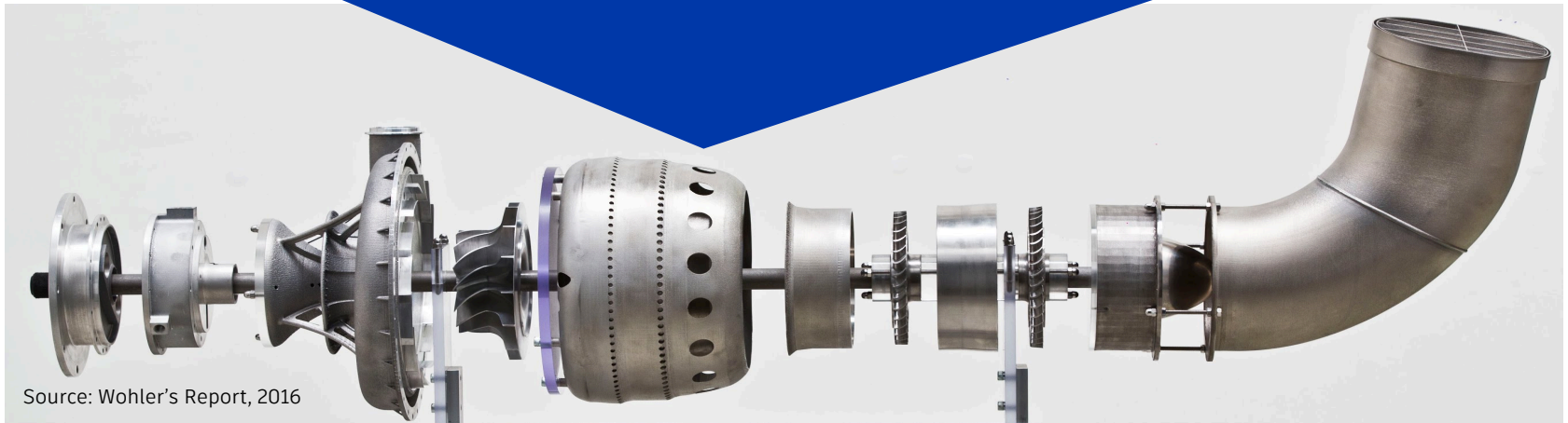
Why CNC? Why Post Processing?

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Accuracy of Critical Surfaces

- Smaller tolerances than AM machine capabilities

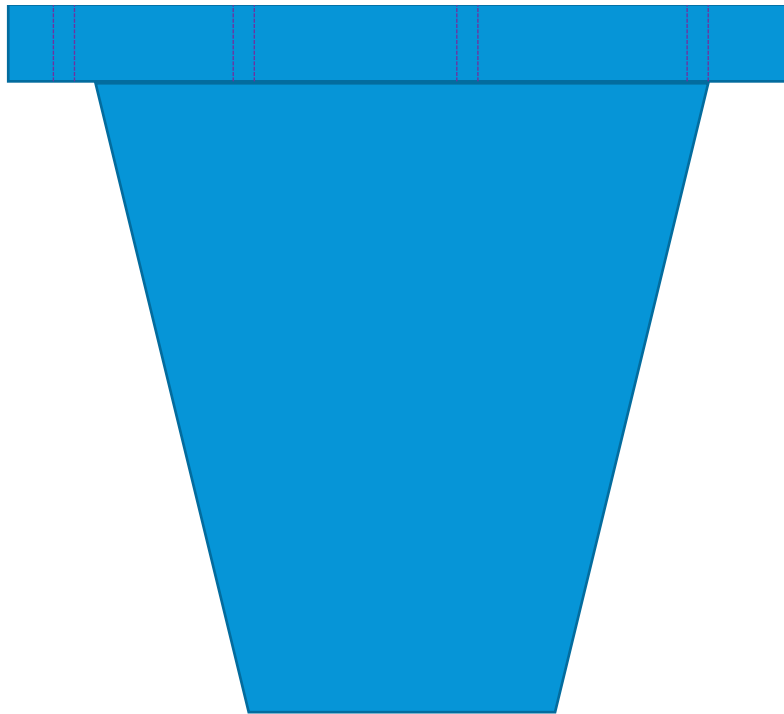


Source: Wohler's Report, 2016

Challenge: Planning for the Manufacturing Process

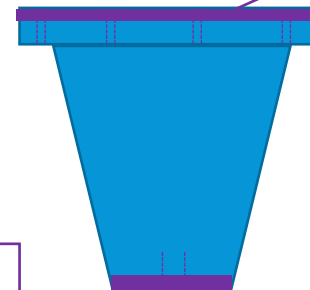
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Goal: End Product Looks Like This



3D Model at End of Design Process

Requirements



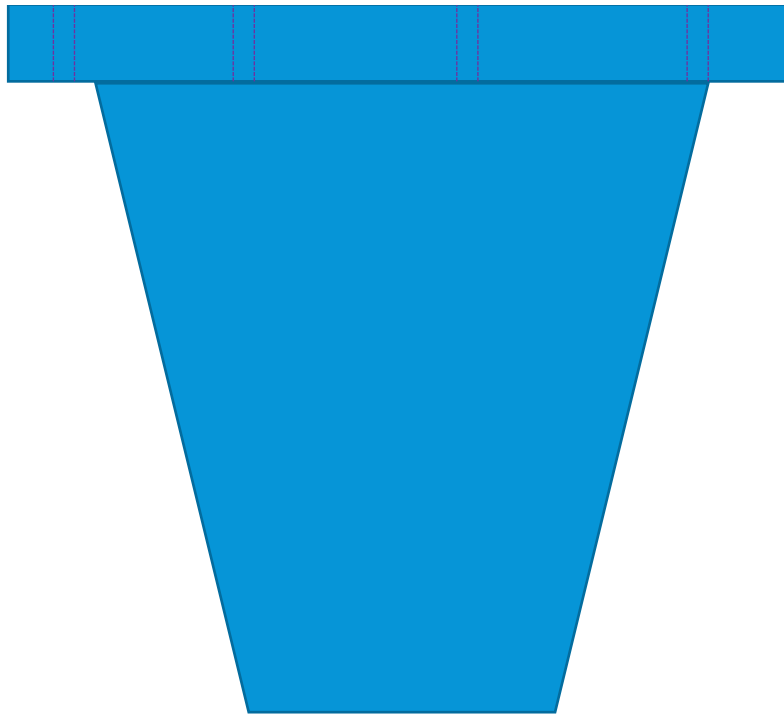
Drill Holes
in Top &
Smooth
Surface
Finish

Smooth
Surface
Finish +
Precise
Tolerances

Challenge: Planning for the Manufacturing Process

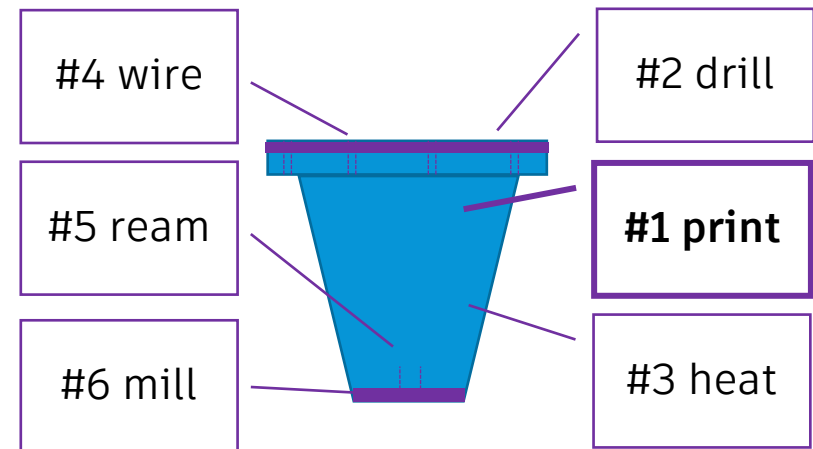
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Goal: End Product Looks Like This



3D Model at End of Design Process

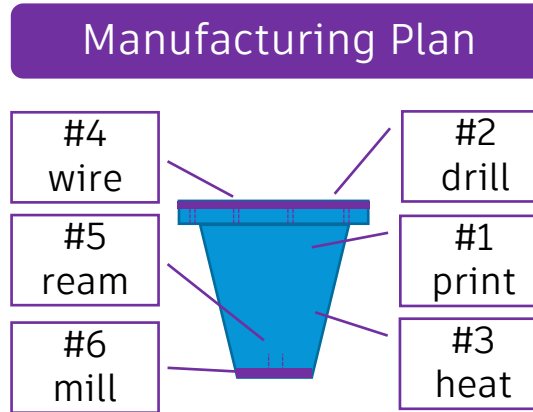
Draft Manufacturing Plan



Add material where subtractive operations will occur
Orient and fixture for print

Challenge: Planning for the Manufacturing Process

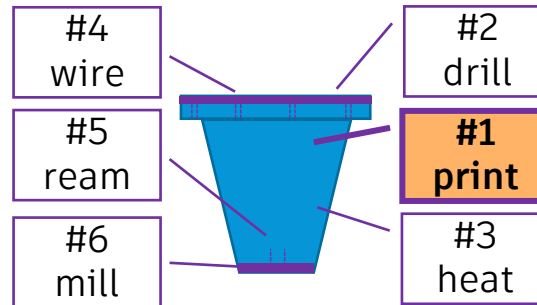
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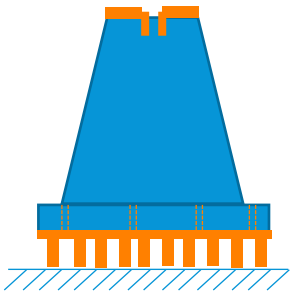
Challenge: Planning for the Manufacturing Process

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Manufacturing Plan

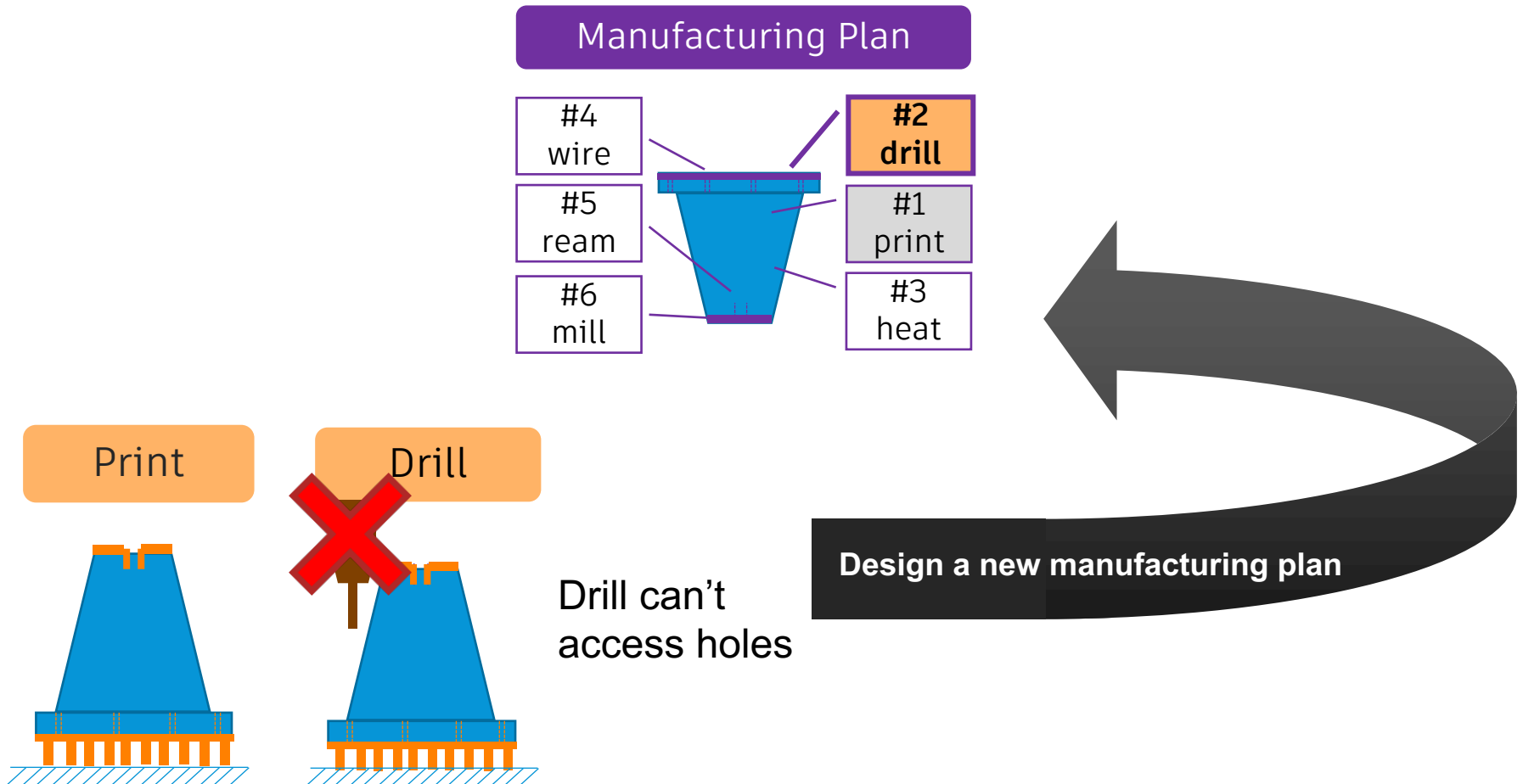


Print



Challenge: Planning for the Manufacturing Process

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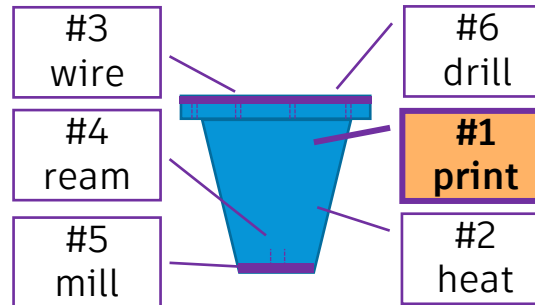


Challenge: Planning for the Manufacturing Process

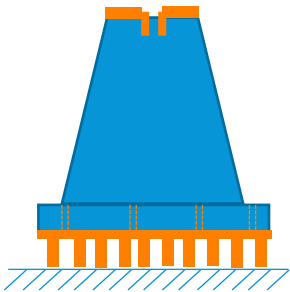
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New Plan

Manufacturing Plan



Print

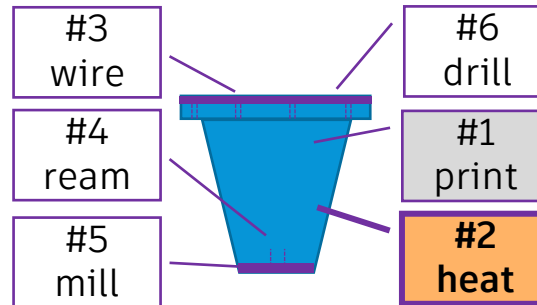


Challenge: Planning for the Manufacturing Process

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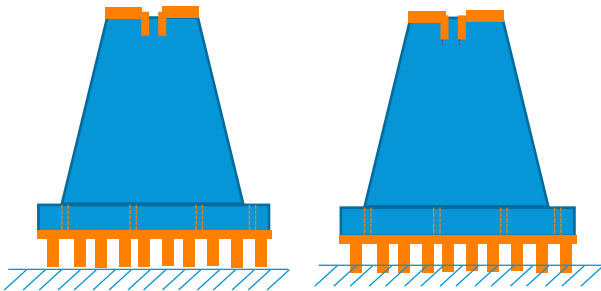
New Plan

Manufacturing Plan



Print

Heat

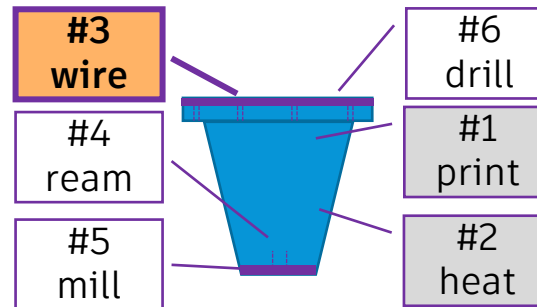


Challenge: Planning for the Manufacturing Process

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New Plan

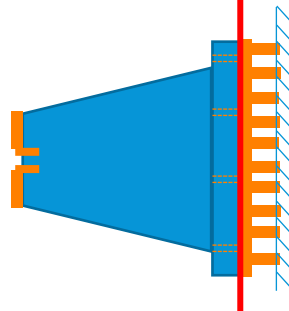
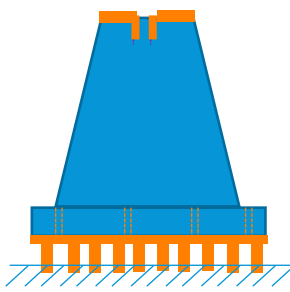
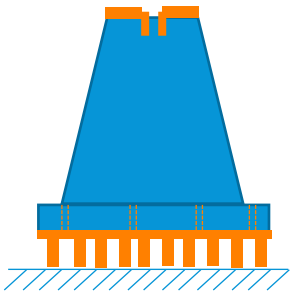
Manufacturing Plan



Print

Heat

Wire EDM

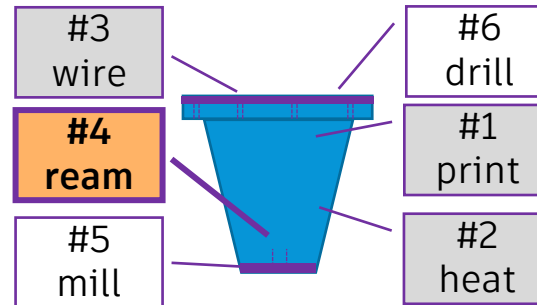


Challenge: Planning for the Manufacturing Process

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New Plan

Manufacturing Plan

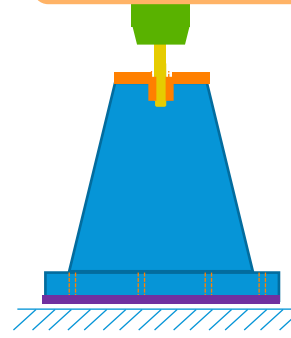
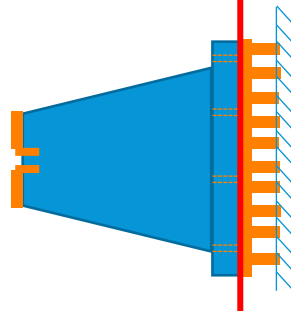
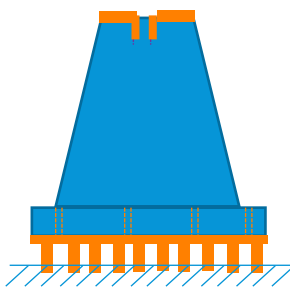
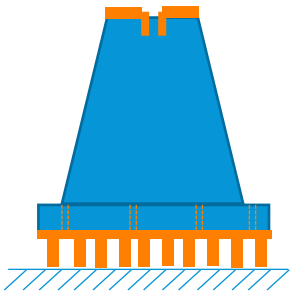


Print

Heat

Wire EDM

Ream

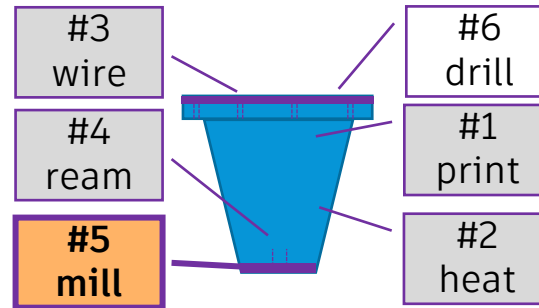


Challenge: Planning for the Manufacturing Process

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New Plan

Manufacturing Plan



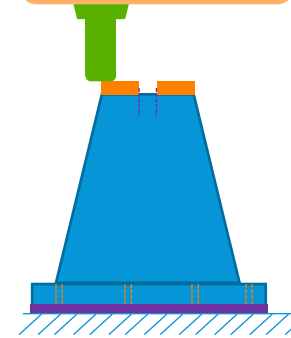
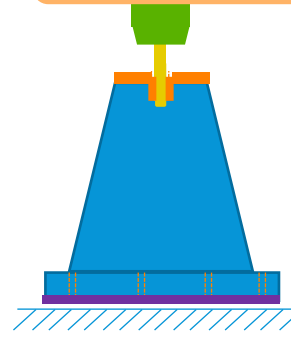
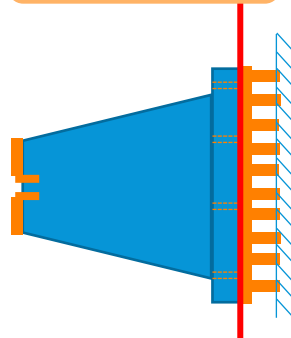
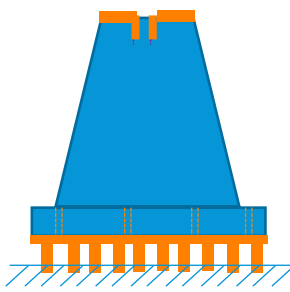
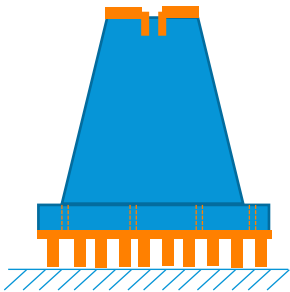
Print

Heat

Wire EDM

Ream

Mill

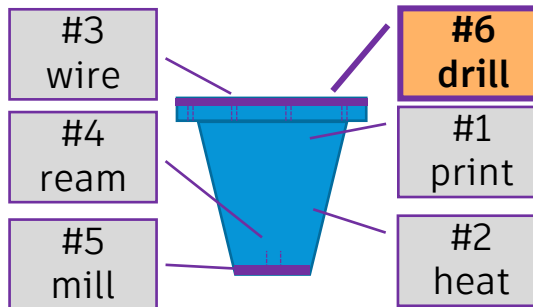


Challenge: Planning for the Manufacturing Process

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New Plan

Manufacturing Plan



Print

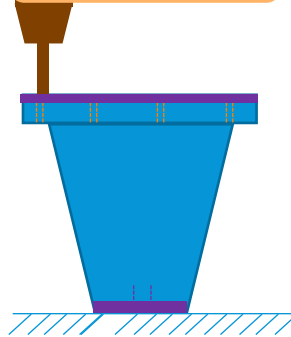
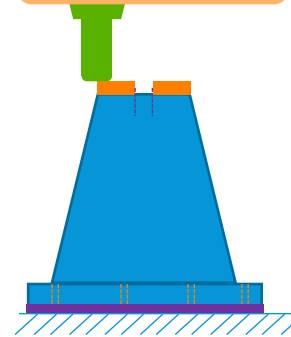
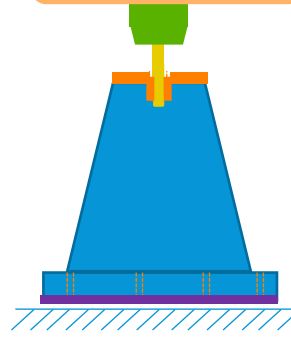
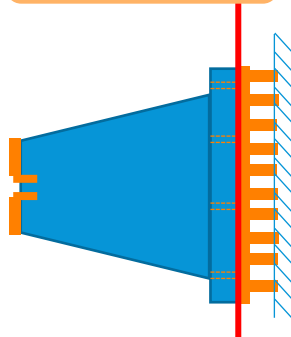
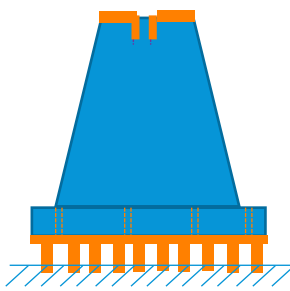
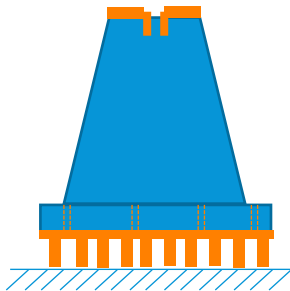
Heat

Wire EDM

Ream

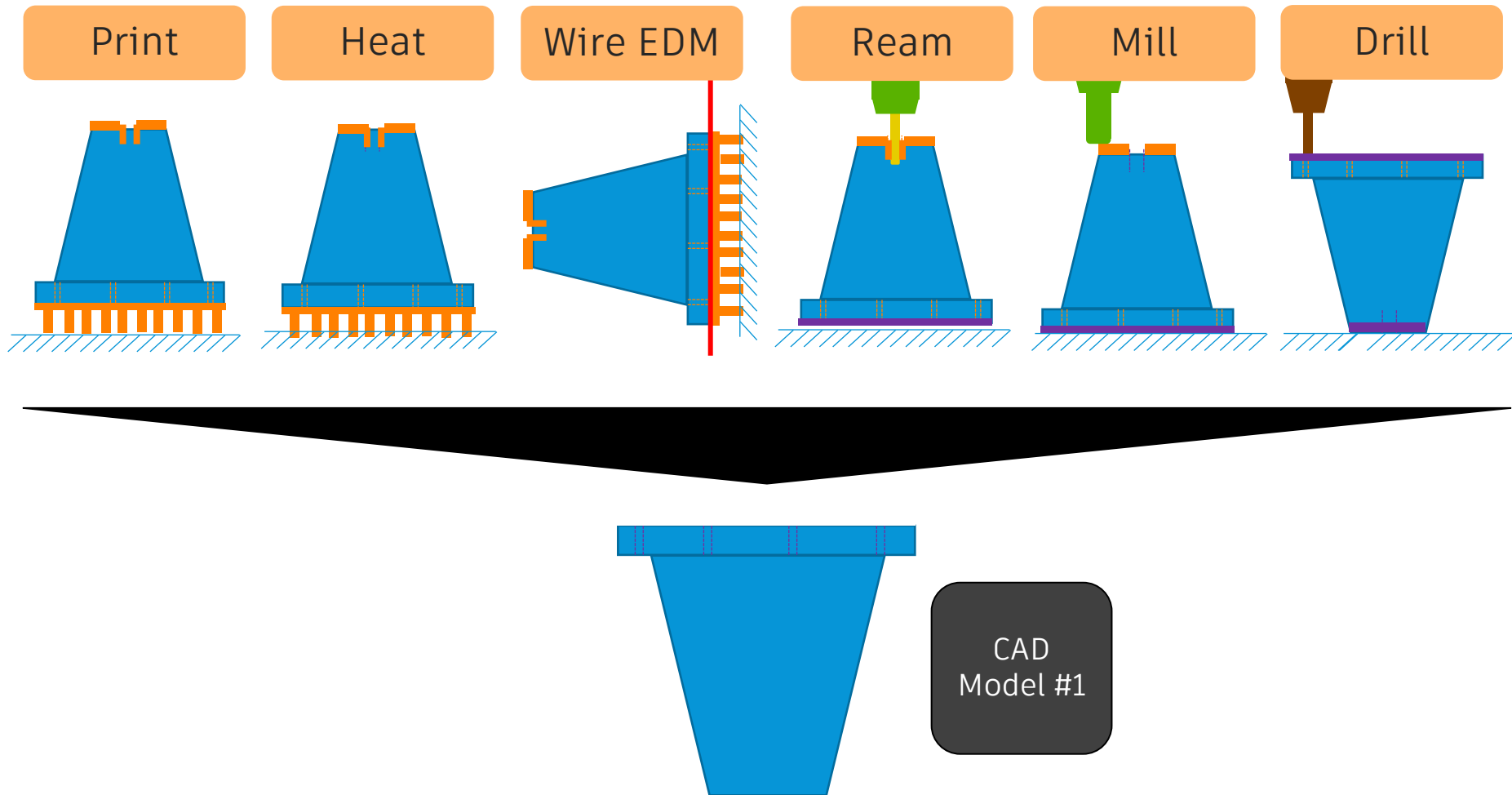
Mill

Drill



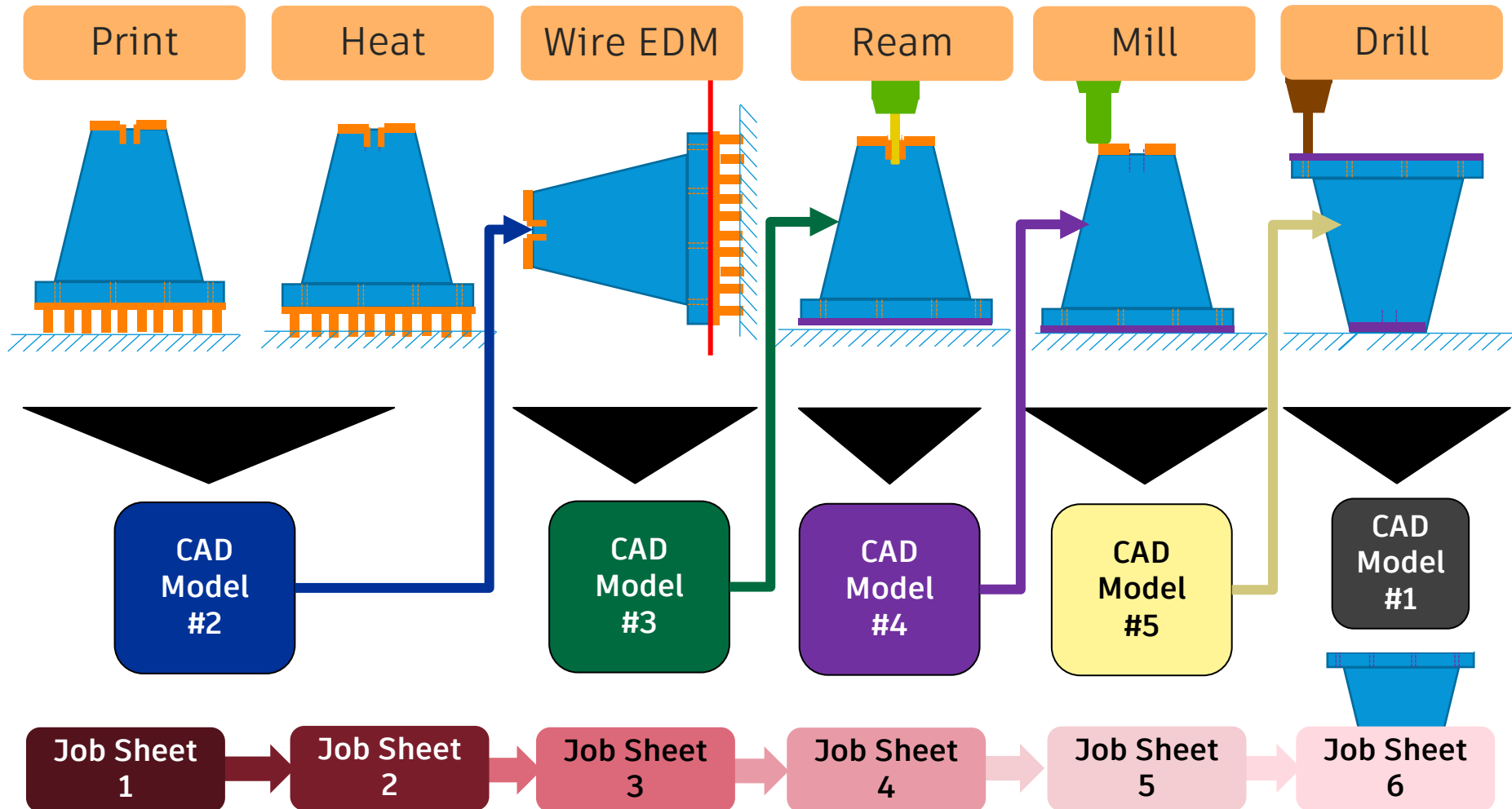
Challenge: Planning for the Manufacturing Process

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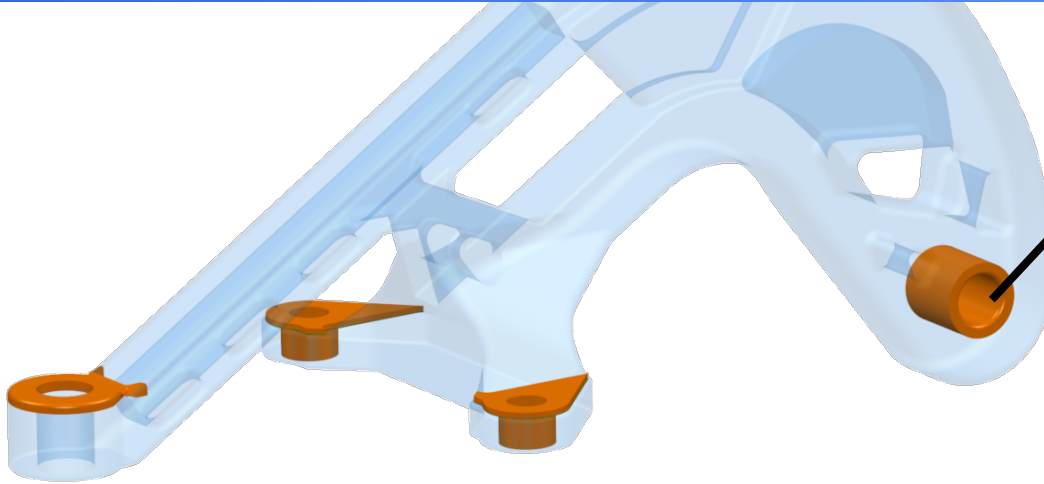
Challenge: Data & Model Management

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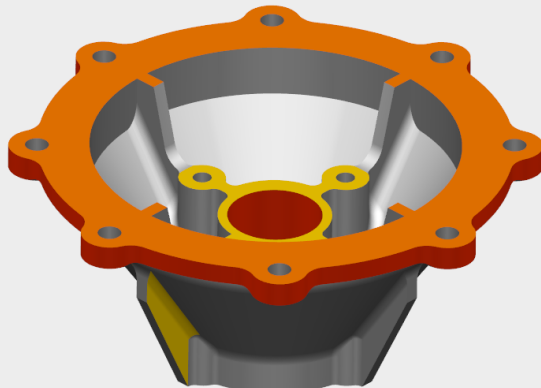
How To Tackle These Challenges: Plan AM + SM Together

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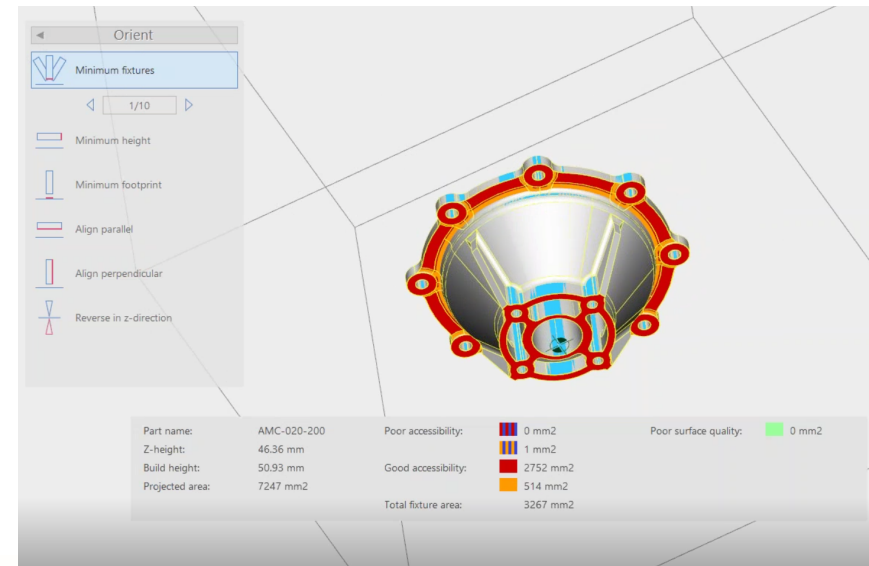


Mark-up – capture minimum requirements for manufacture directly on the CAD parametrically

Add stock to your model that will be machined away

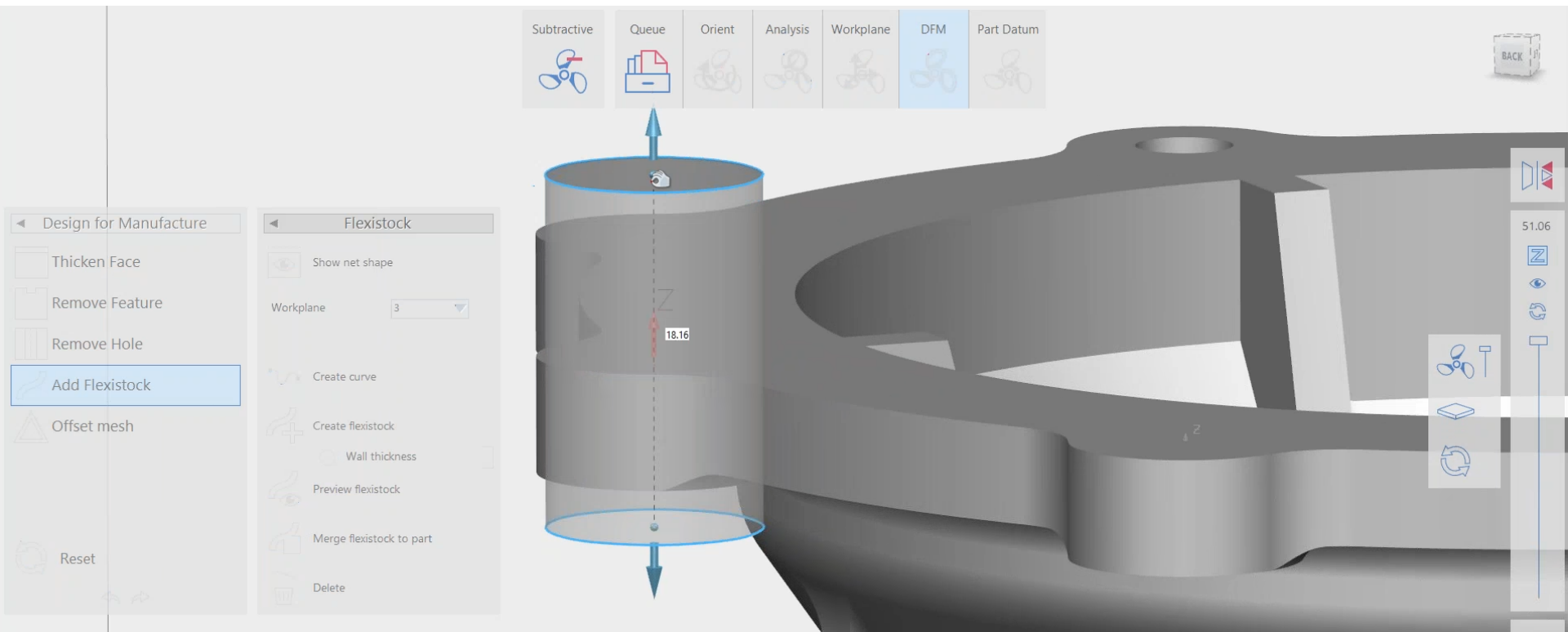


Keep Stock Model Data
Delineated from Core CAD Model



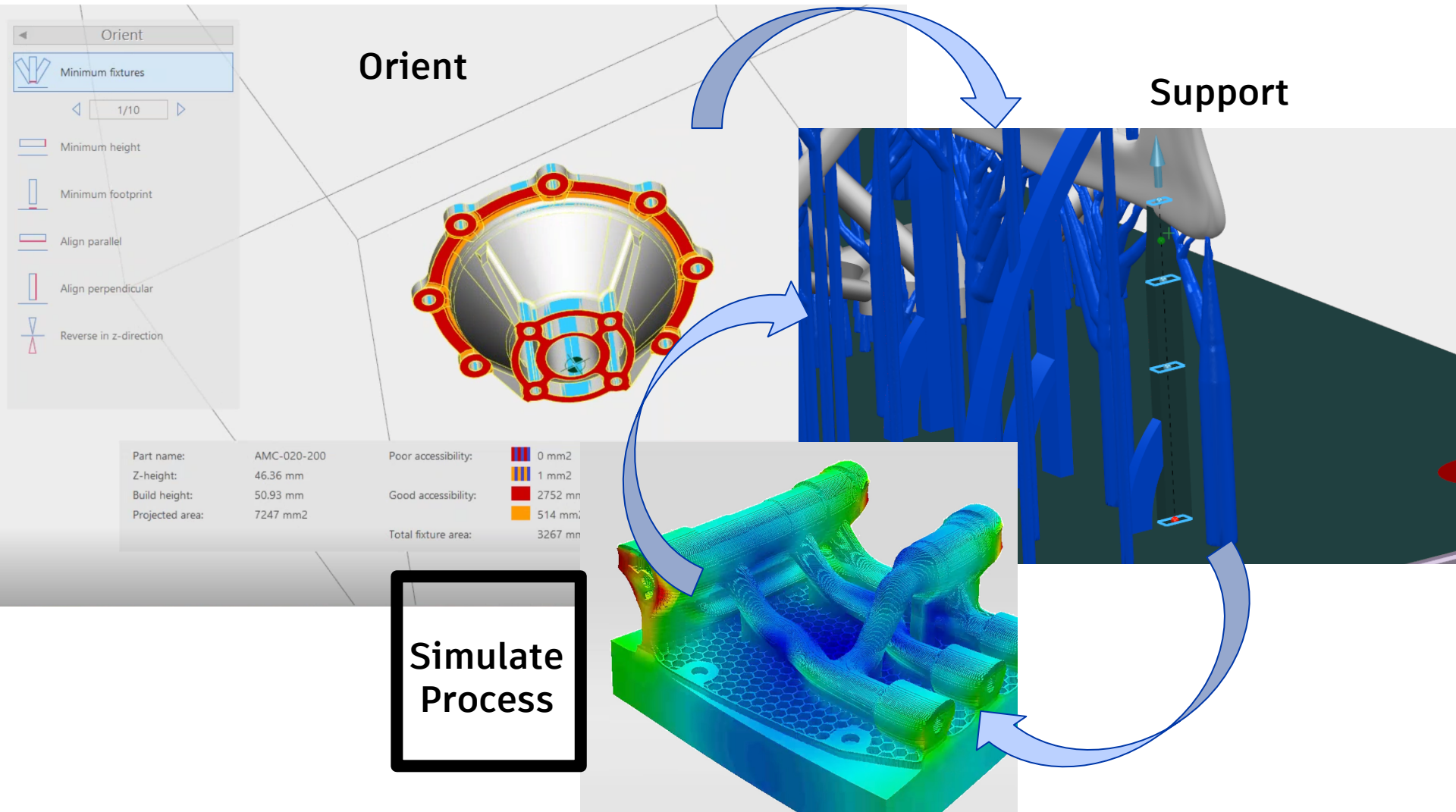
How To Tackle These Challenges: Plan AM + SM Together

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Orient, Support, & Simulate on the Model You Will Print

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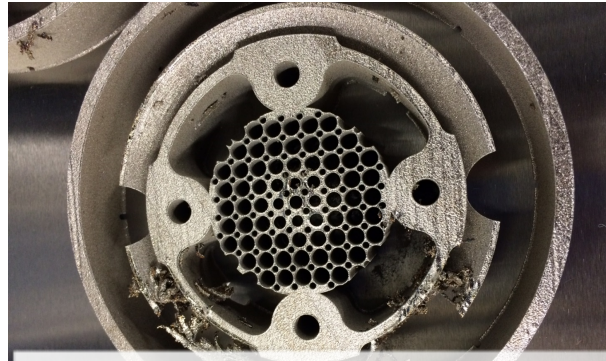


Run Process Simulation on the Model You Will Print

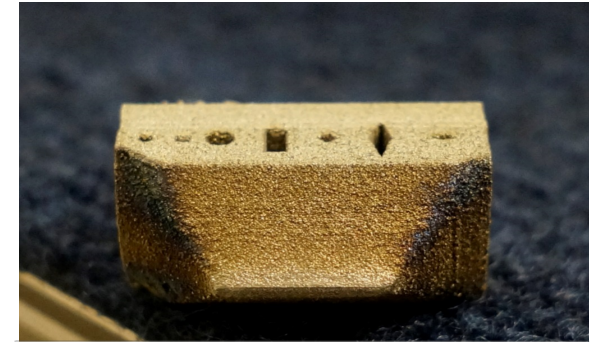
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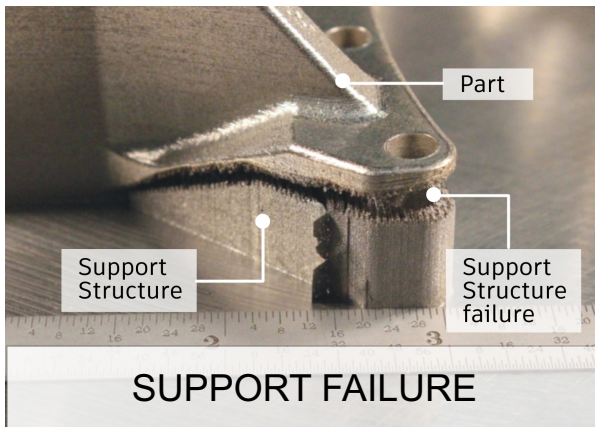
DISTORTION



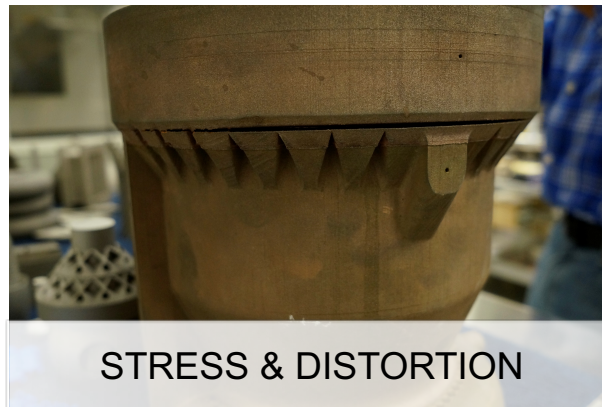
RECOATER INTERFERENCE



LACK OF FUSION



SUPPORT FAILURE



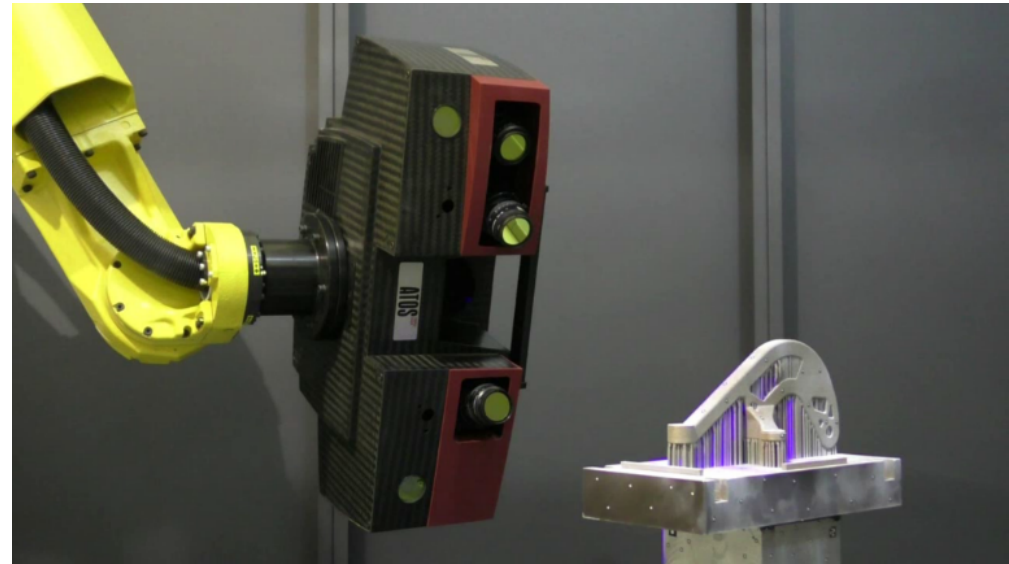
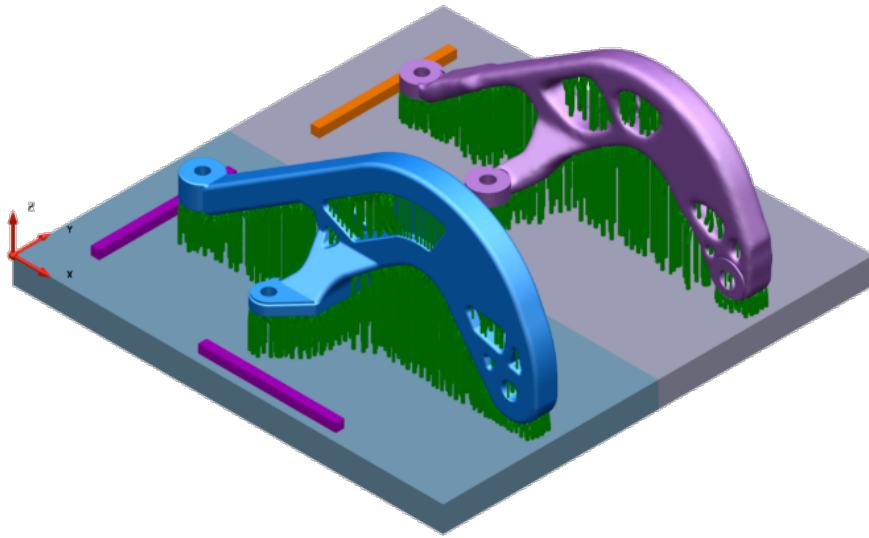
STRESS & DISTORTION



LACK OF FUSION

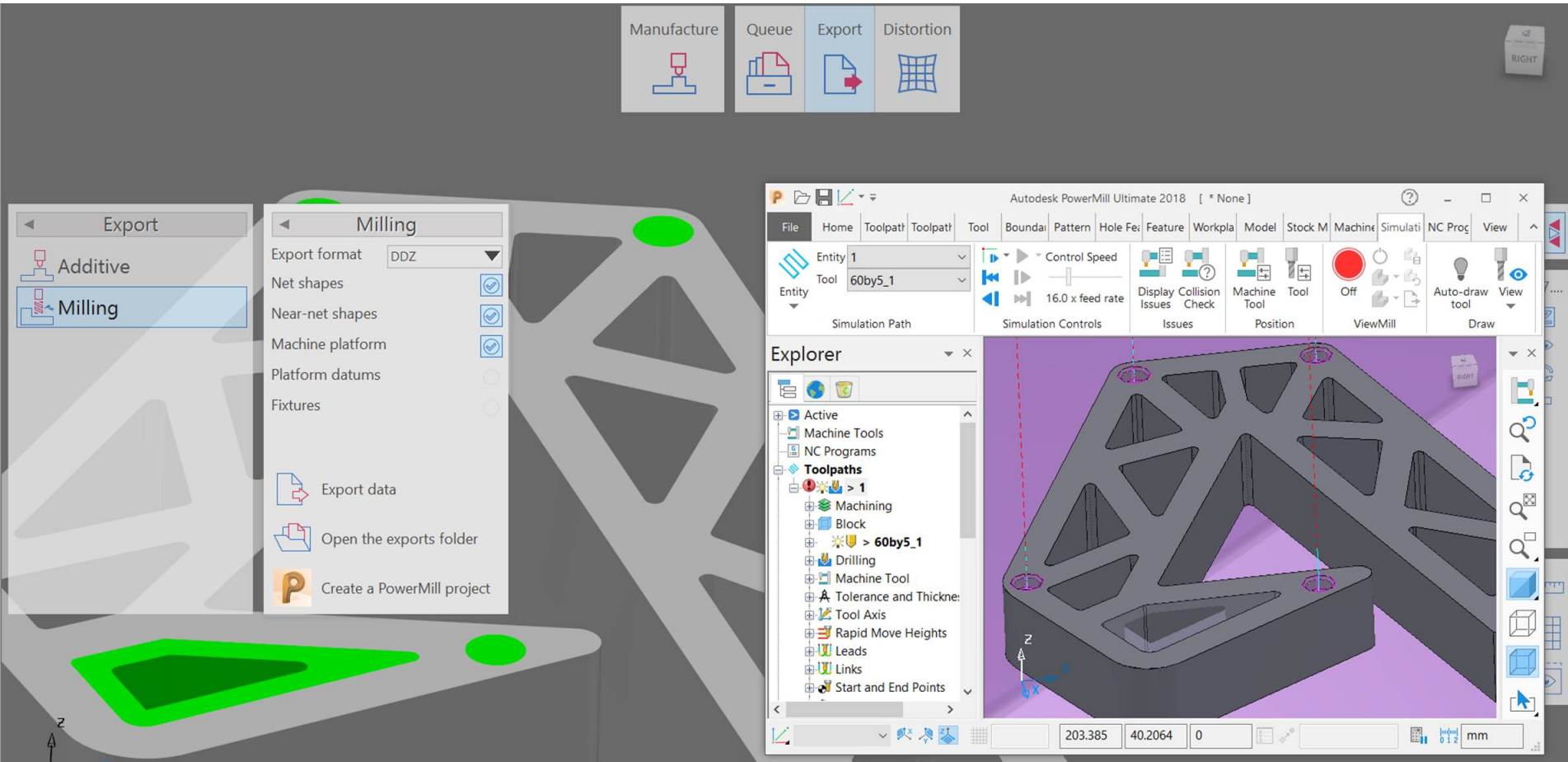
Specify the Reference Datums for Post Processing

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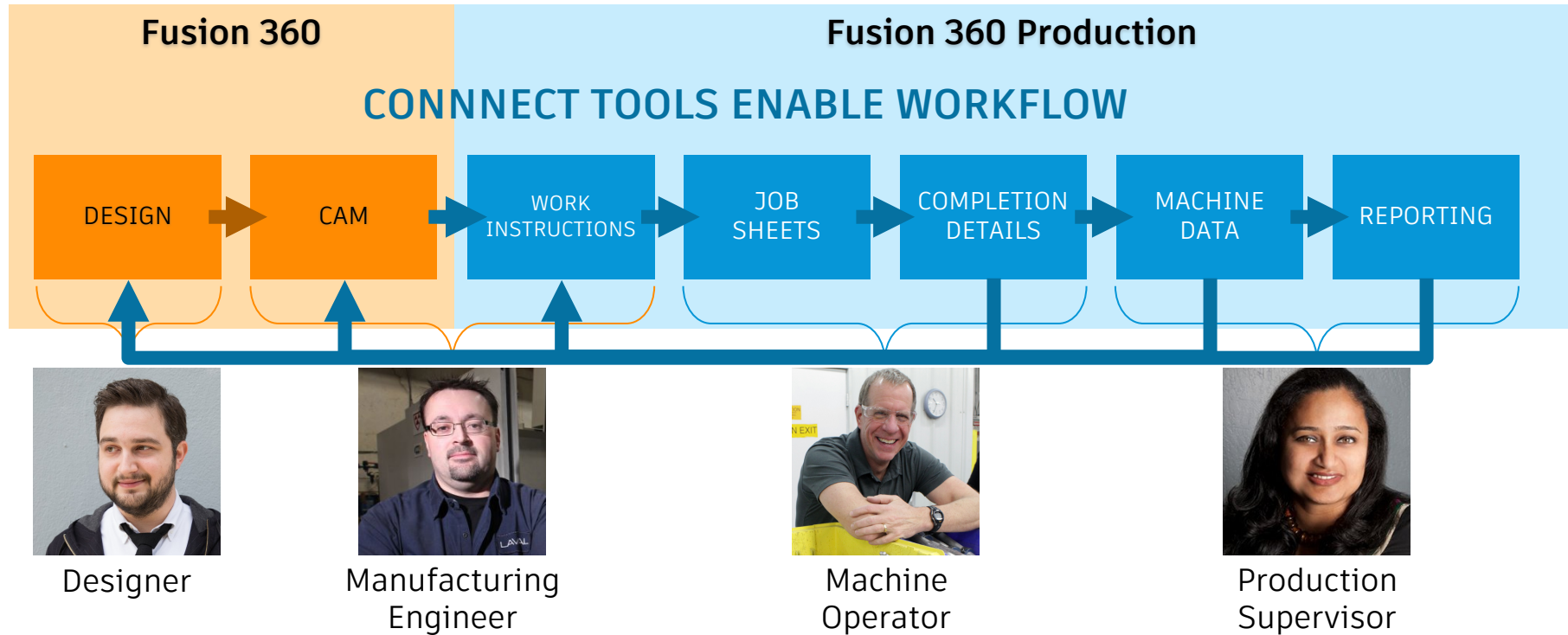
Keep Your Data Connected – Export to AM and SM at Same Time

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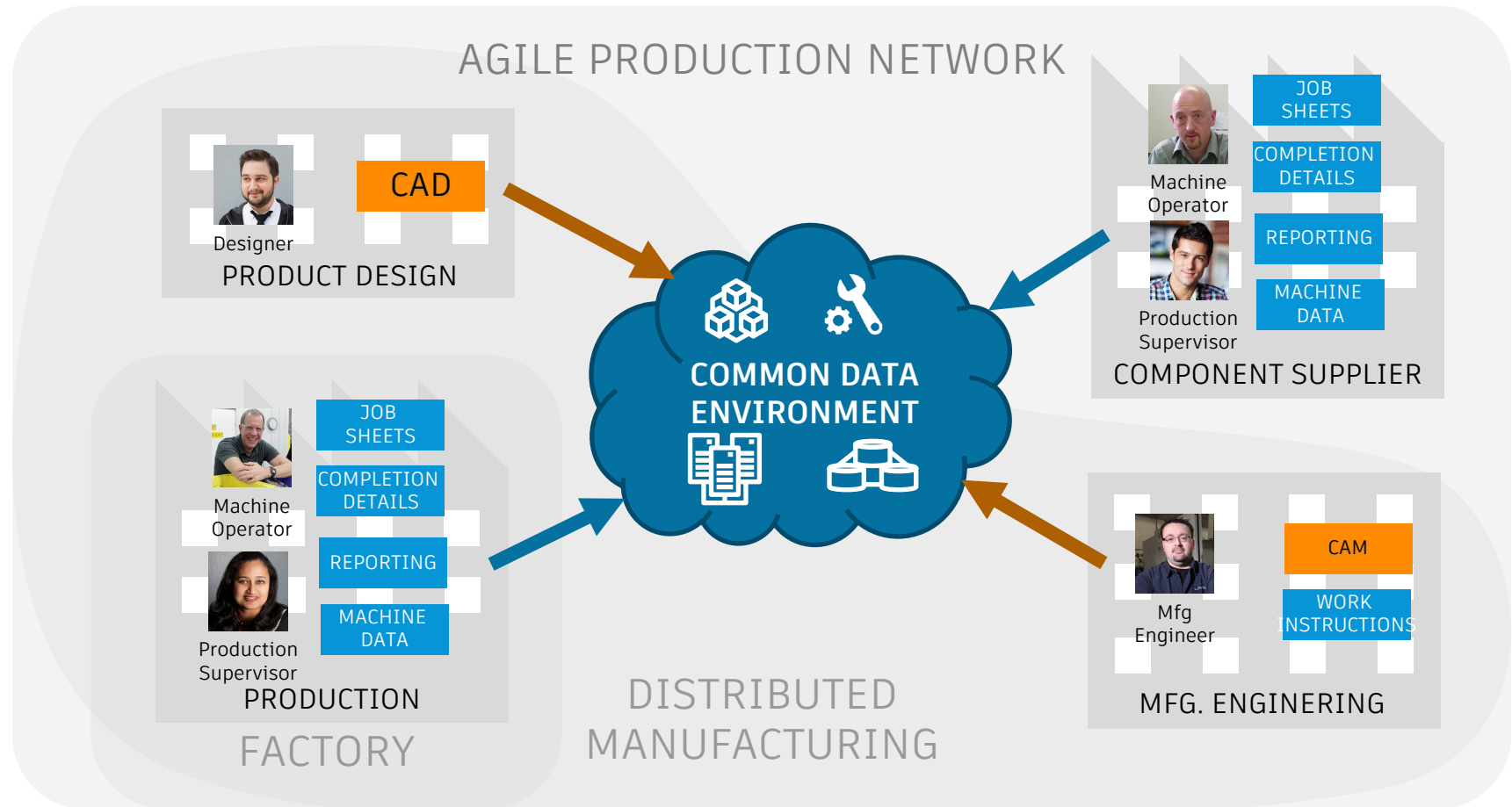
Manage Your Data Across Your Team

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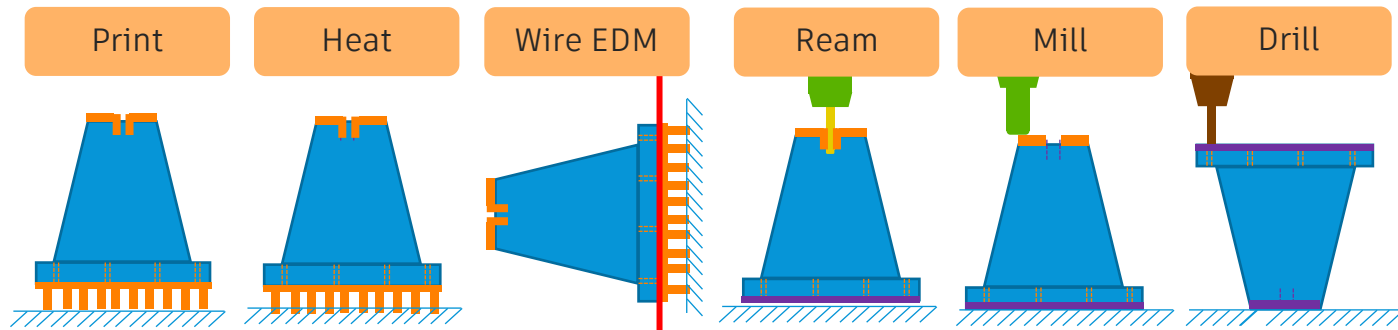
Manage Your Data Across Your Factory Operations

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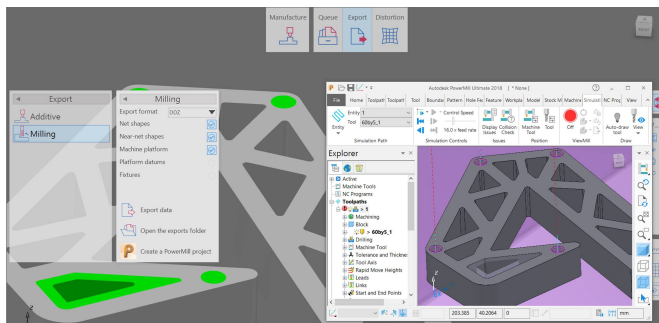


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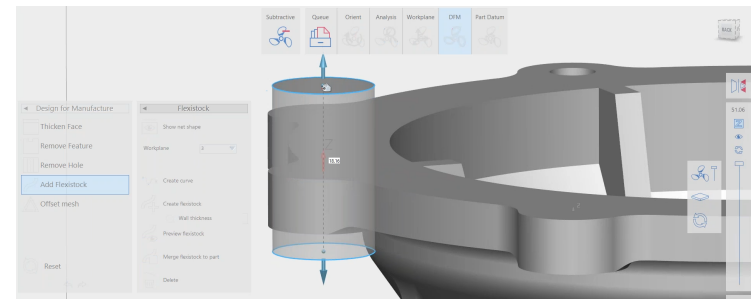
Plan Your Process



Minimize Data Loss



Prep for the Right Model For Each Phase of Manufacturing



Automation: Additive, Post Processing, Assembly

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Image courtesy of Under Armour

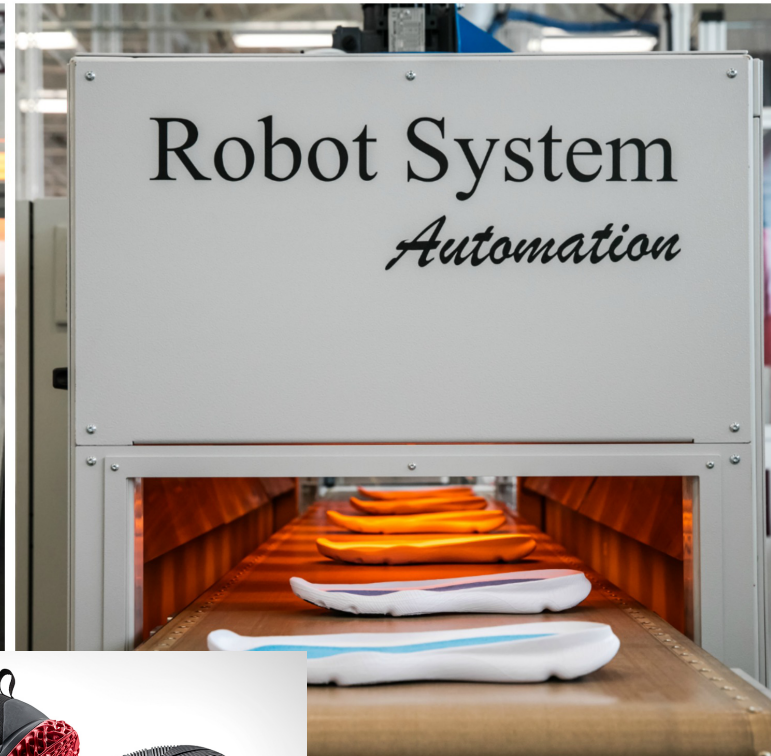


Image courtesy of Under Armour

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Thank you.
Questions?

allessandra.mcginis@
autodesk.com

