AUTODESK. UNIVERSITY

TR463351 – Get Up To Speed With Automotive Manufacturing

Rob Walker

Sr. Technical Marketing Manager

About the speaker

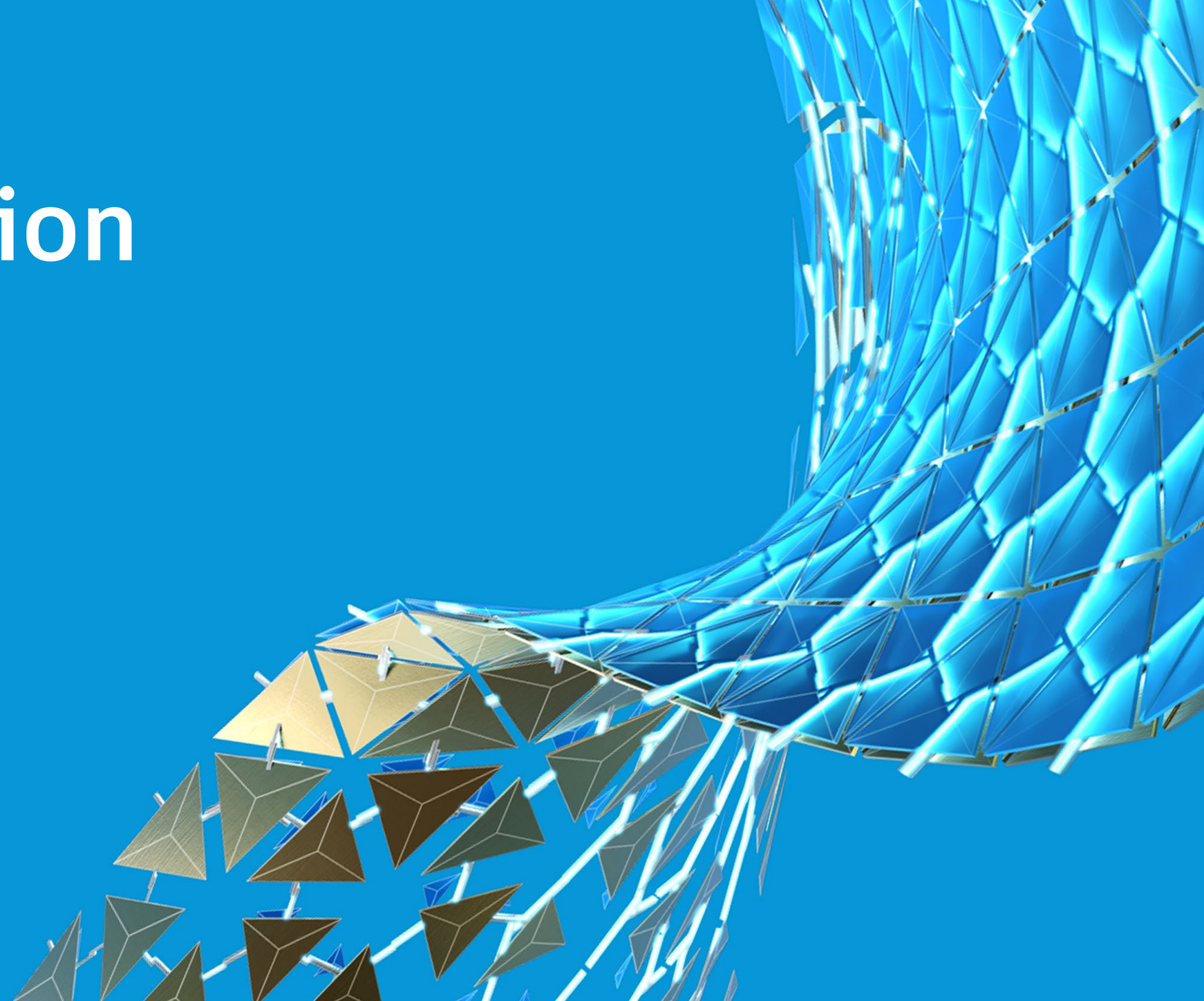
Rob Walker

Rob is a Sr. Technical Marketing Manager at Autodesk, where he and his team are responsible for helping customers understand how they can achieve their manufacturing goals, using the advanced manufacturing solutions that Autodesk offers.

Rob graduated from the University of Liverpool with a Bachelor's degree in Aerospace Engineering and a Masters in Product Design and Management before embarking on a career with Delcam as an Applications Engineer. Initially starting in the UK department, he trained and supported UK customers, before moving into an international role, where he assisted the global network of subsidiaries and resellers in both pre- and post-sales activities. Following the acquisition of Delcam by Autodesk in 2014, he moved to Technical Marketing, and is now in his 17th year of service.

Agenda

Introduction

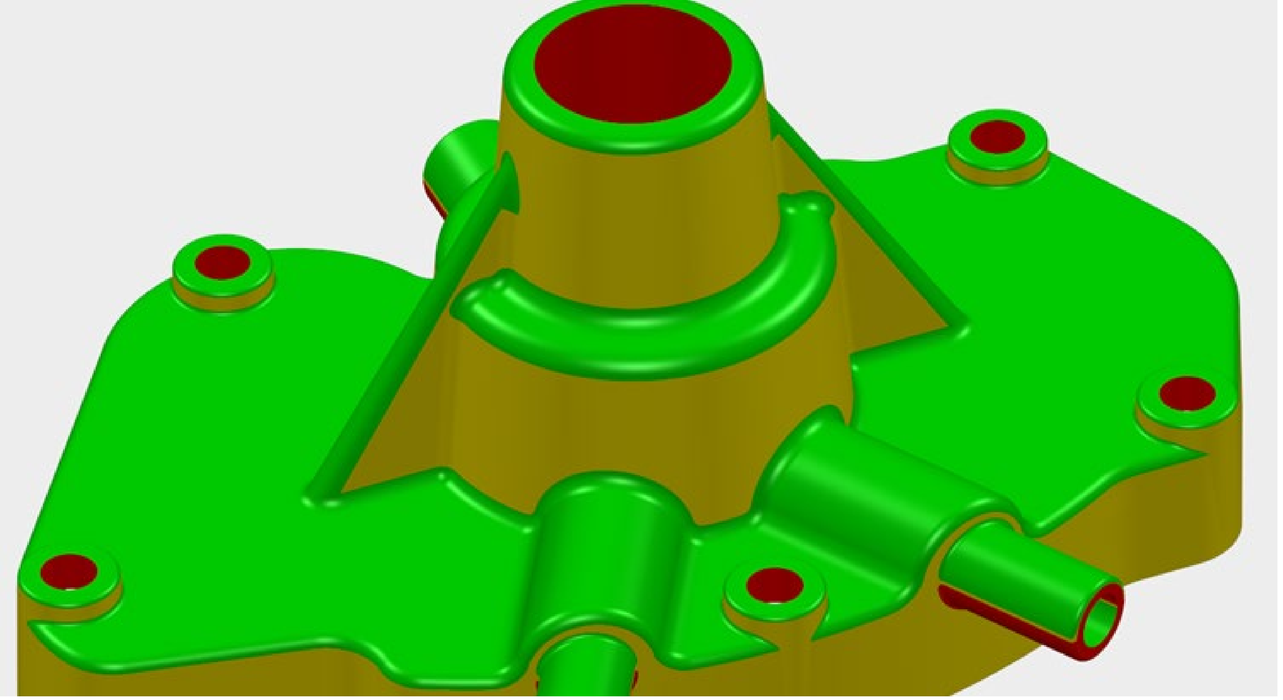


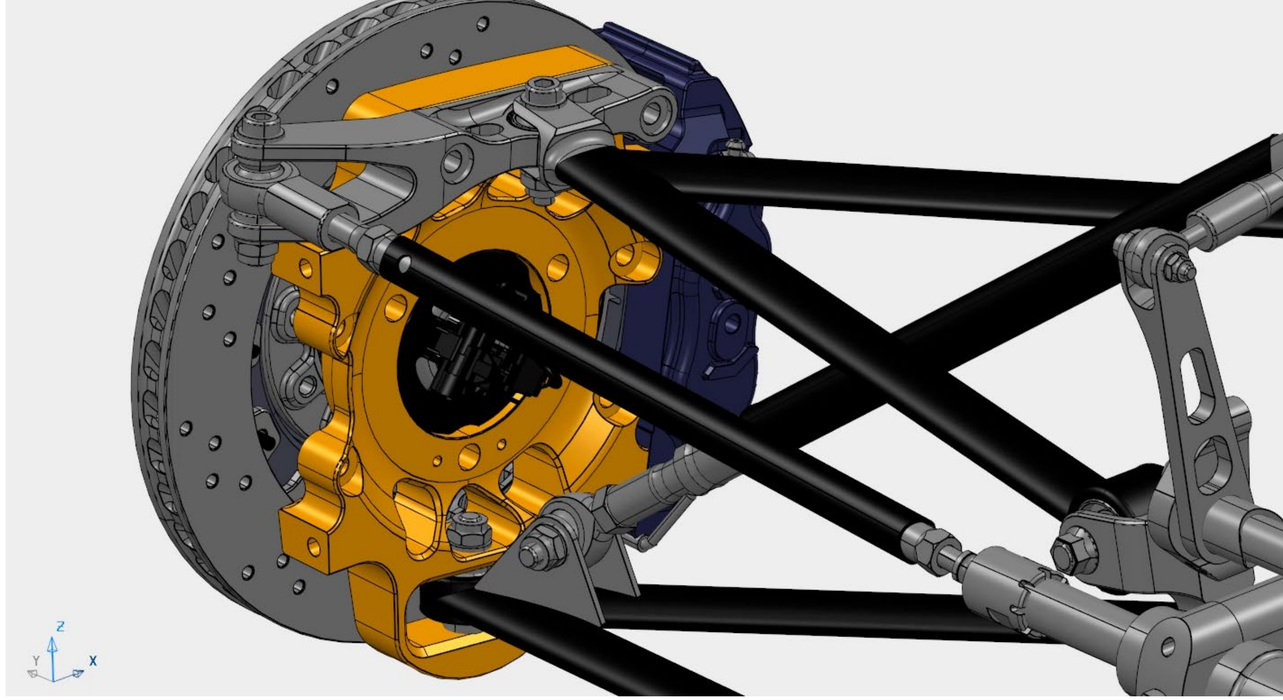
Introduction

- **Many aspects to automotive manufacturing**
- **4 key topics**
  - Mold and Die Manufacturing
  - Factory Planning
  - Automated Manufacturing
  - Emerging Technology

Learning Objectives

1. Explain the technological solutions that can be used to improve the quality of automotive tooling and the parts they produce.
2. Define the challenges that drive change in manufacturing facilities, and explain the use of a unified digital model, to manage projects, equipment and production.
3. Identify where automation can be utilized in manufacturing processes to improve production consistency.
4. Describe generative design, additive and hybrid manufacturing processes, and explain how they can be used to improve component performance and efficiency.





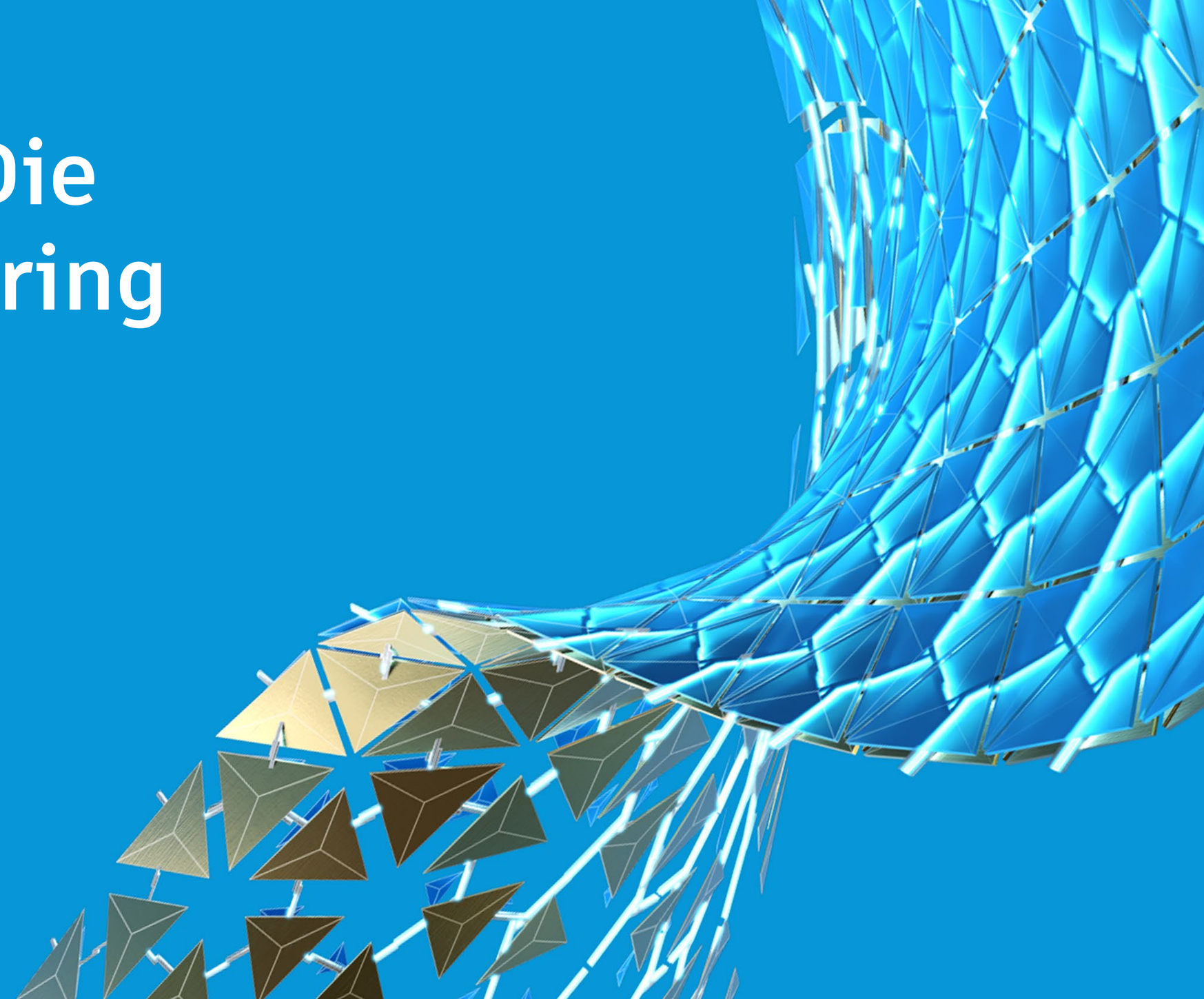
Mass-Produced Component

- **Water pump cover**
- **Plastic injection molded**

Low-Volume Component

- **Performance car upright**
- **Billet machined**

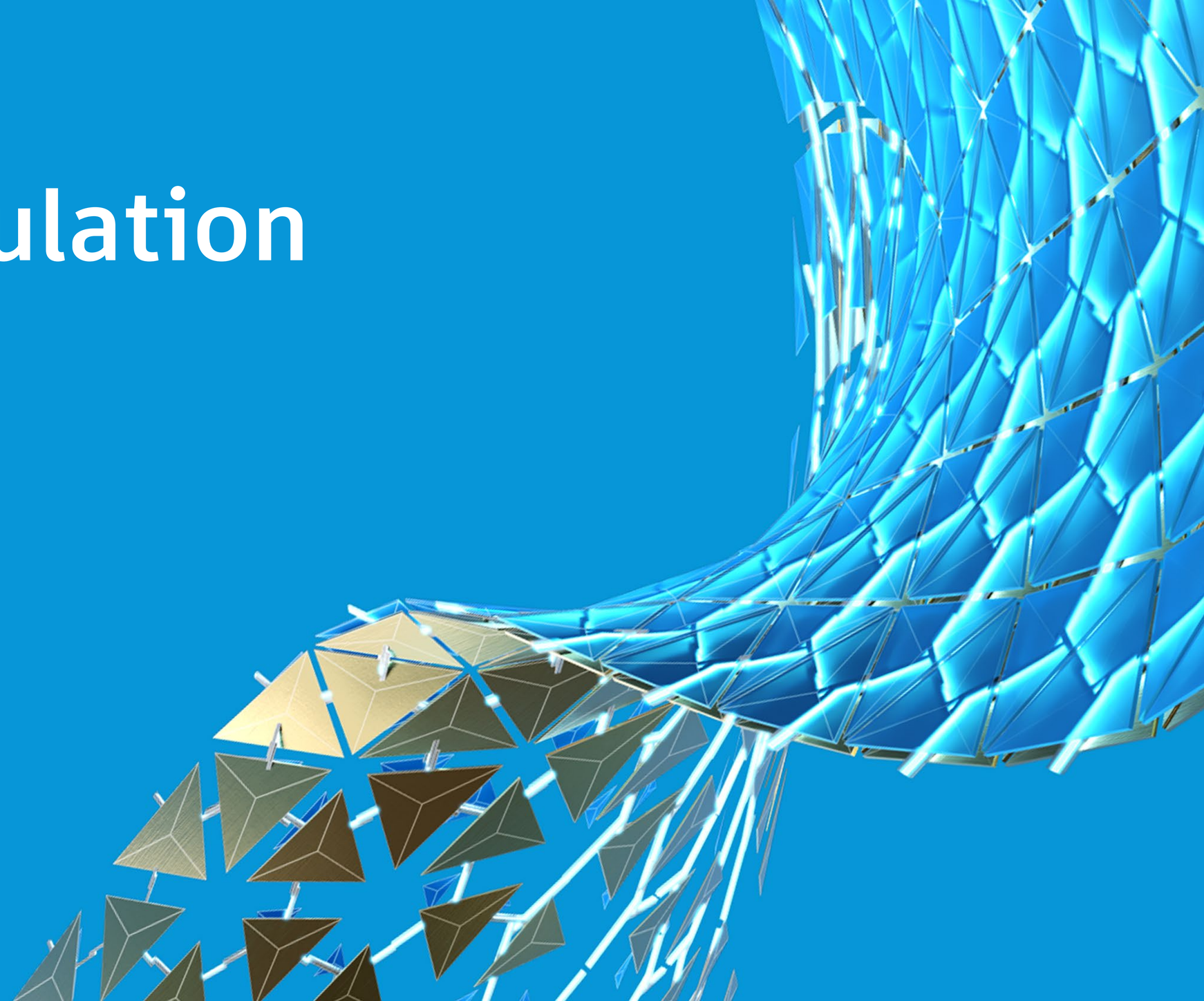
Mold and Die Manufacturing



Introduction

- **A highly competitive industry**
- **Constant challenges**
  - Quality
  - On-Time
  - On-Budget
  - Profitably
- **Use new technology and increase machine utilization**

Mold Simulation

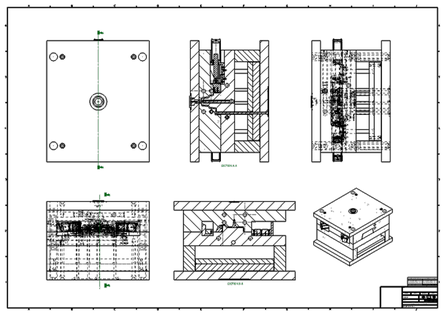


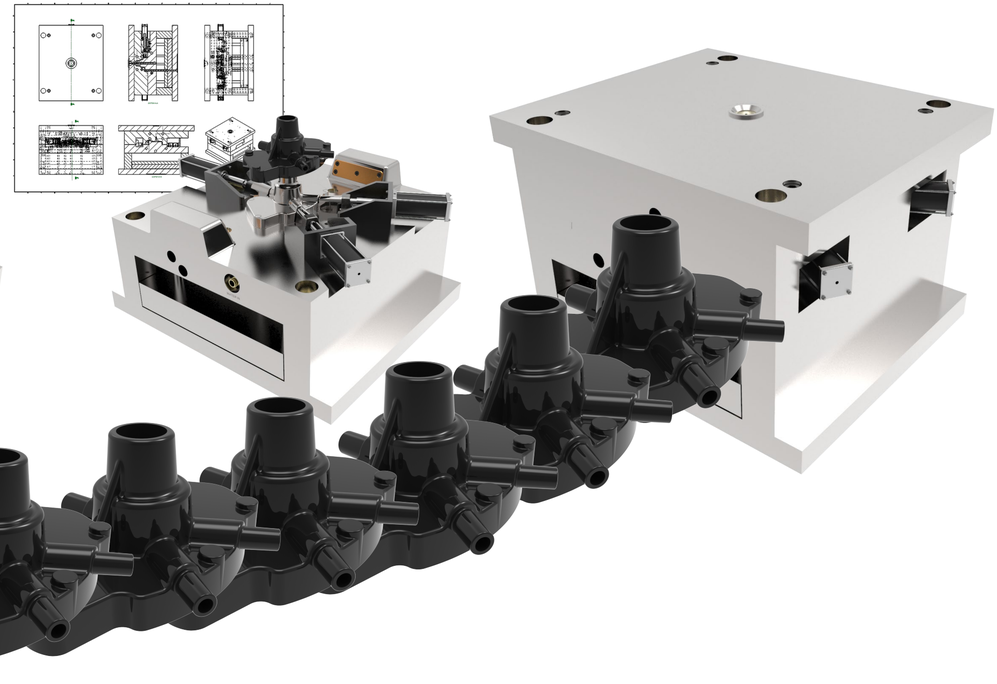
What Could Possibly Go Wrong?

- Warpage & Shrinkage
- Solidification failure
- Weld marks
- Sink marks
- Air traps
- Short shots
- Core Shifts

Traditional Mold Design Workflow

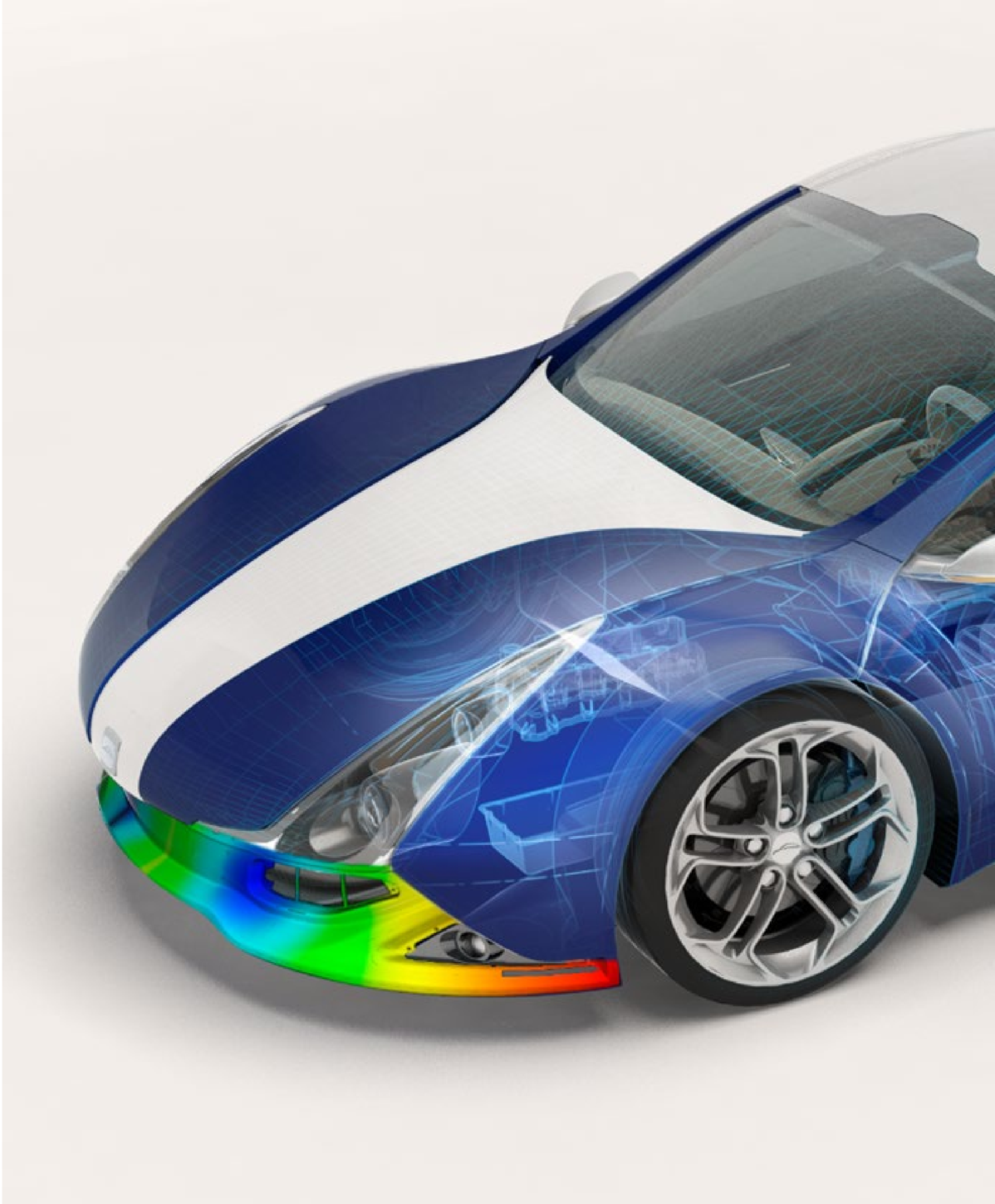
Full Design → Manufacture → Try-out → Re-design & Re-build → Use

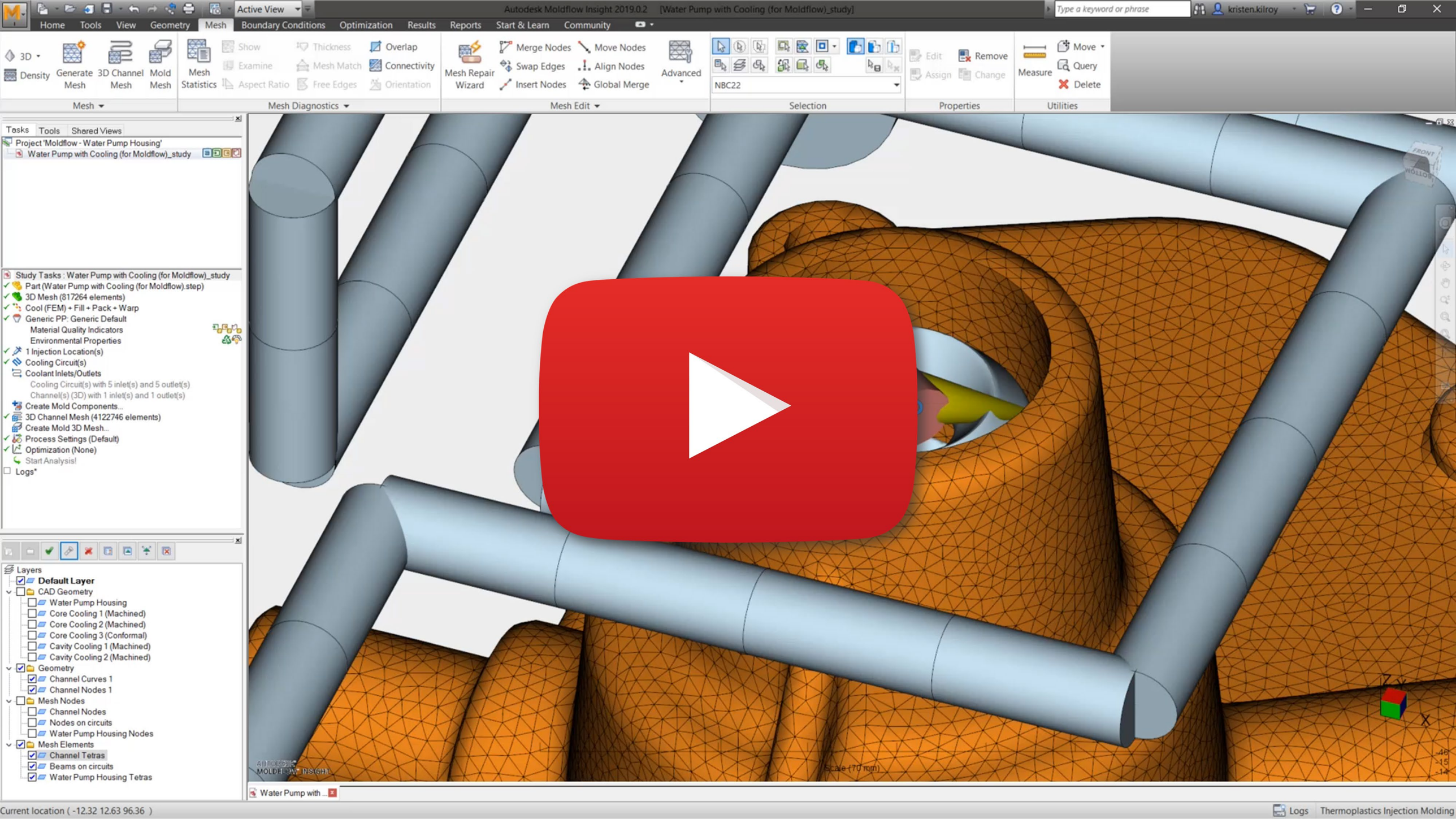




What Can We Do?

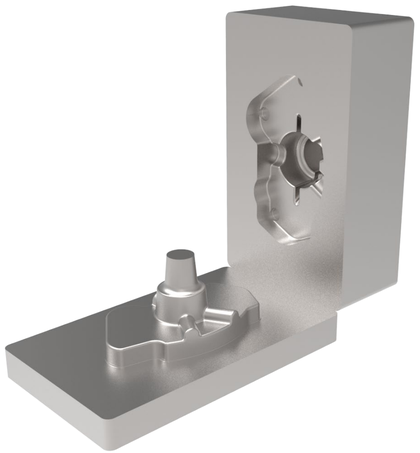
- Use simulation
- Review wall thicknesses, gating locations, undercuts, draft angles
- Identify part quality
- Provide costing and design advice
- Analyse advanced tooling options
- Test part and mold material types
- Export results
- Optimize for quality and cycle time
- Reduce defects and get to market faster

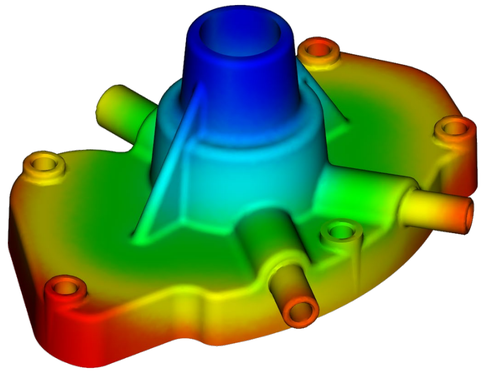


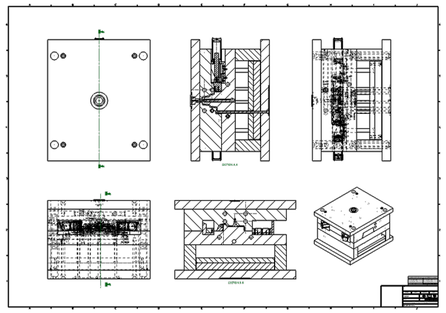

Active View
Autodesk Moldflow Insight 2019.0.2 [Water Pump with Cooling (for Moldflow)_study]
Type a keyword or phrase
kristen.kilroy
Home Tools View Geometry Mesh Boundary Conditions Optimization Results Reports Start & Learn Community
3D Density Generate Mesh 3D Channel Mesh Mold Mesh
Mesh Statistics Show Examine Aspect Ratio Thickness Mesh Match Free Edges Overlap Connectivity Orientation
Mesh Repair Wizard Merge Nodes Swap Edges Insert Nodes Move Nodes Align Nodes Global Merge Advanced
NBC22
Edit Assign Remove Change
Measure Move Query Delete
Mesh
Mesh Diagnostics
Mesh Edit
Selection
Properties
Utilities
Tasks Tools Shared Views
Project 'Moldflow - Water Pump Housing'
Water Pump with Cooling (for Moldflow)_study
Study Tasks : Water Pump with Cooling (for Moldflow)_study
Part (Water Pump with Cooling (for Moldflow).step)
3D Mesh (817264 elements)
Cool (FEM) + Fill + Pack + Warp
Generic PP: Generic Default
Material Quality Indicators
Environmental Properties
1 Injection Location(s)
Cooling Circuit(s)
Coolant Inlets/Outlets
Cooling Circuit(s) with 5 inlet(s) and 5 outlet(s)
Channel(s) (3D) with 1 inlet(s) and 1 outlet(s)
Create Mold Components...
3D Channel Mesh (4122746 elements)
Create Mold 3D Mesh...
Process Settings (Default)
Optimization (None)
Start Analysis!
Logs*
Layers
Default Layer
CAD Geometry
Water Pump Housing
Core Cooling 1 (Machined)
Core Cooling 2 (Machined)
Core Cooling 3 (Conformal)
Cavity Cooling 1 (Machined)
Cavity Cooling 2 (Machined)
Geometry
Channel Curves 1
Channel Nodes 1
Mesh Nodes
Channel Nodes
Nodes on circuits
Water Pump Housing Nodes
Mesh Elements
Channel Tetras
Beams on circuits
Water Pump Housing Tetras
Water Pump with ...
Current location (-12.32 12.63 96.36)
Logs
Thermoplastics Injection Molding

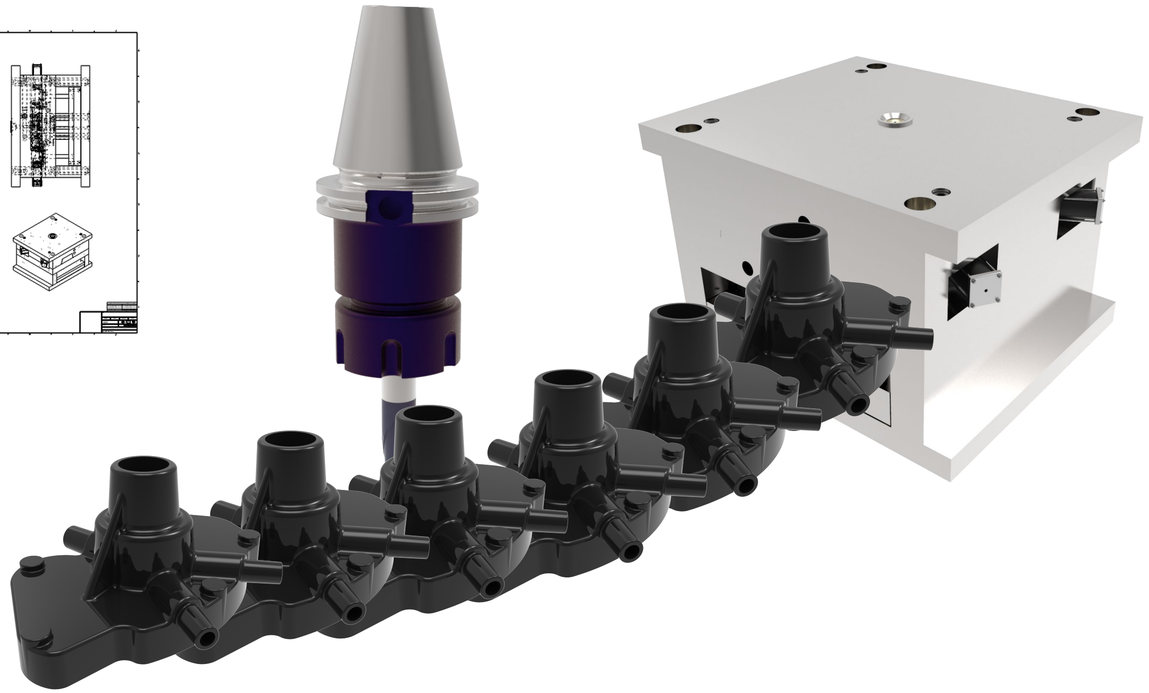
Mold Design Workflow With Simulation

Design cavity/core → Simulate → Detail → Manufacture → Use

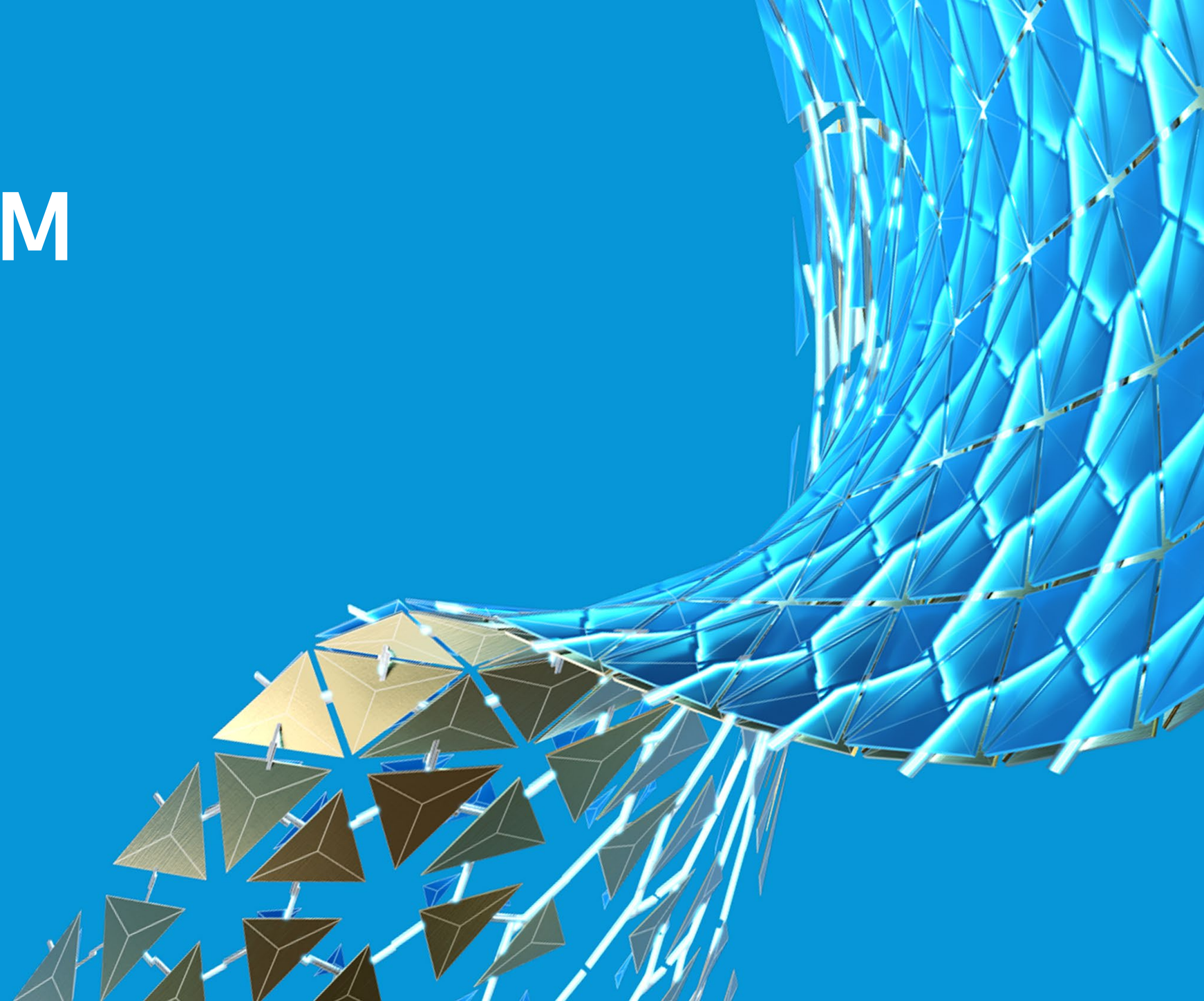






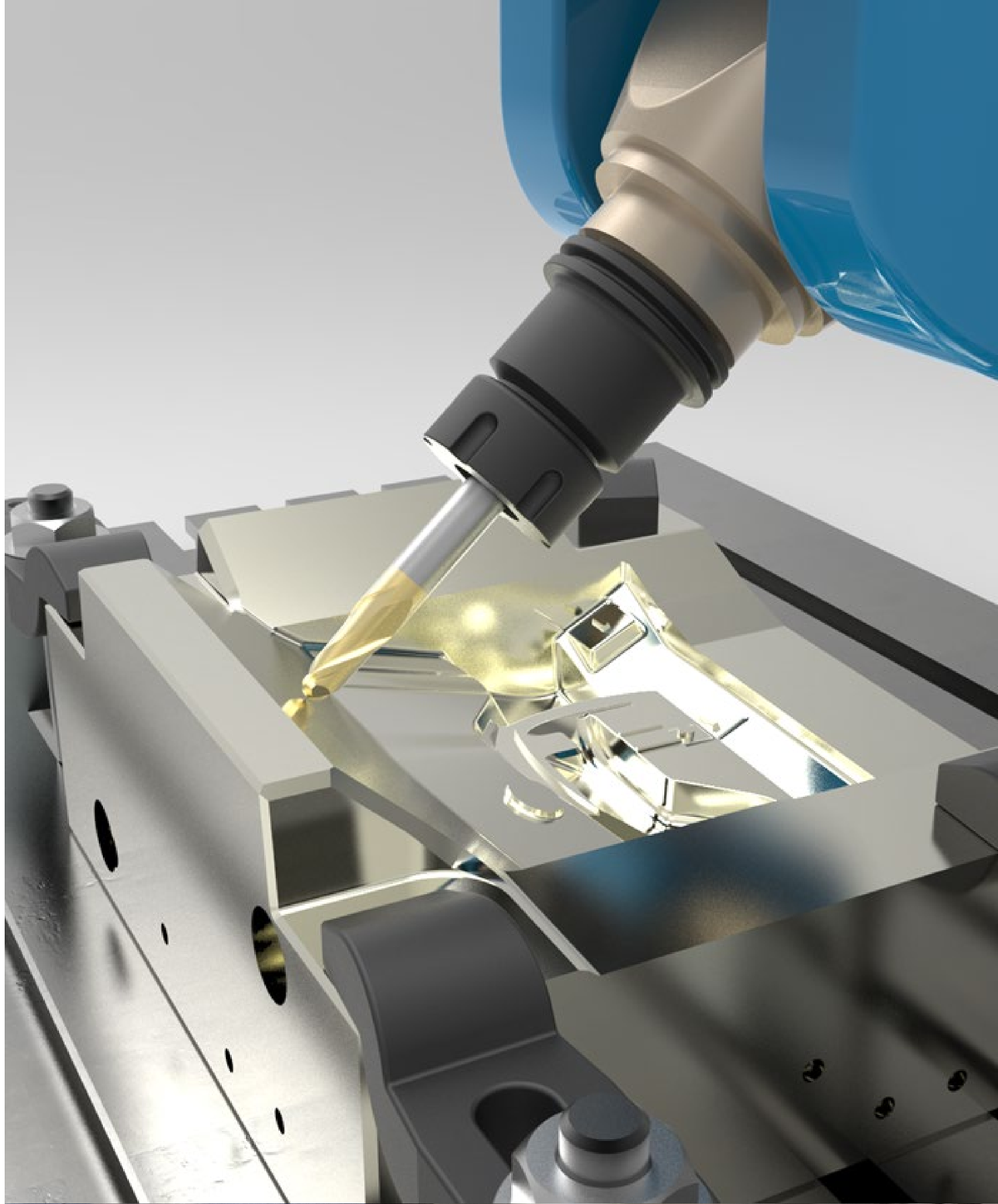


Expert CAM



Mold Machining

- **Traditional 3-axis machining**
- **More profitable molds, are often more complex**
- **Use 5-axis to address mold complexity**
  - Fewer setups, reduce time and increase accuracy
  - Better access
  - Shorter tools have improved rigidity and increase accuracy further
- **Minimizes hand finishing**

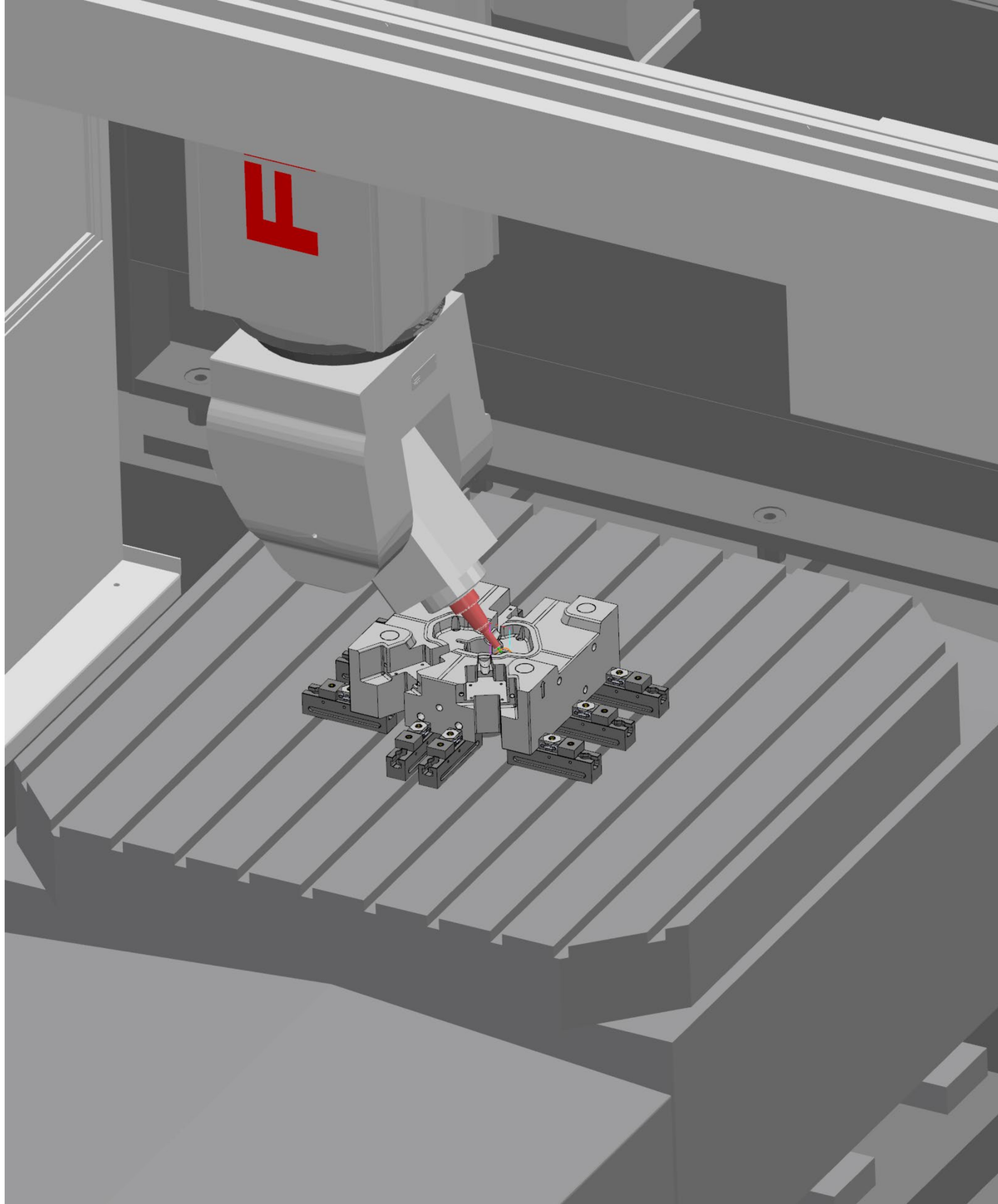


Expert CAM Software

- **High-speed machining capabilities**
  - Reduce load
  - Minimize wear
  - More aggressive, optimized feedrates
- **Advanced finishing strategies**
- **Tool and Toolpath Control**
  - Toolpath editing without recalculation
  - Dynamic axis manipulation
  - Improved surface finish, tool life and time savings

Expert CAM Software

- Accurate simulation and verification
- Better machine utilization
- Optimized setup for each machine
- Collision detection and avoidance
- Inspire confidence, maximize existing capacity and increase productivity
- Save time and money



63% Autodesk PowerMill Ultimate 2019 [Editable Project * Water Pump Housing Mold]

File | Home | Toolpath | Toolpath Edit | Tool | Boundary | Pattern | Hole Feature Set | Feature Group | Workplane | Model | Stock Model | Machine Tool | Simulation | NC Program | View

Entity | Entity: Clean Face - Calculated | Tool: FaceMill 53mm (TR3.0)
Simulation Path

Increment | Go to Beginning | Step Back | Pause | Step Forward | Run to End | Control Speed | 6.0 x feed rate
Simulation Controls

Display Issues | Collision Check
Issues

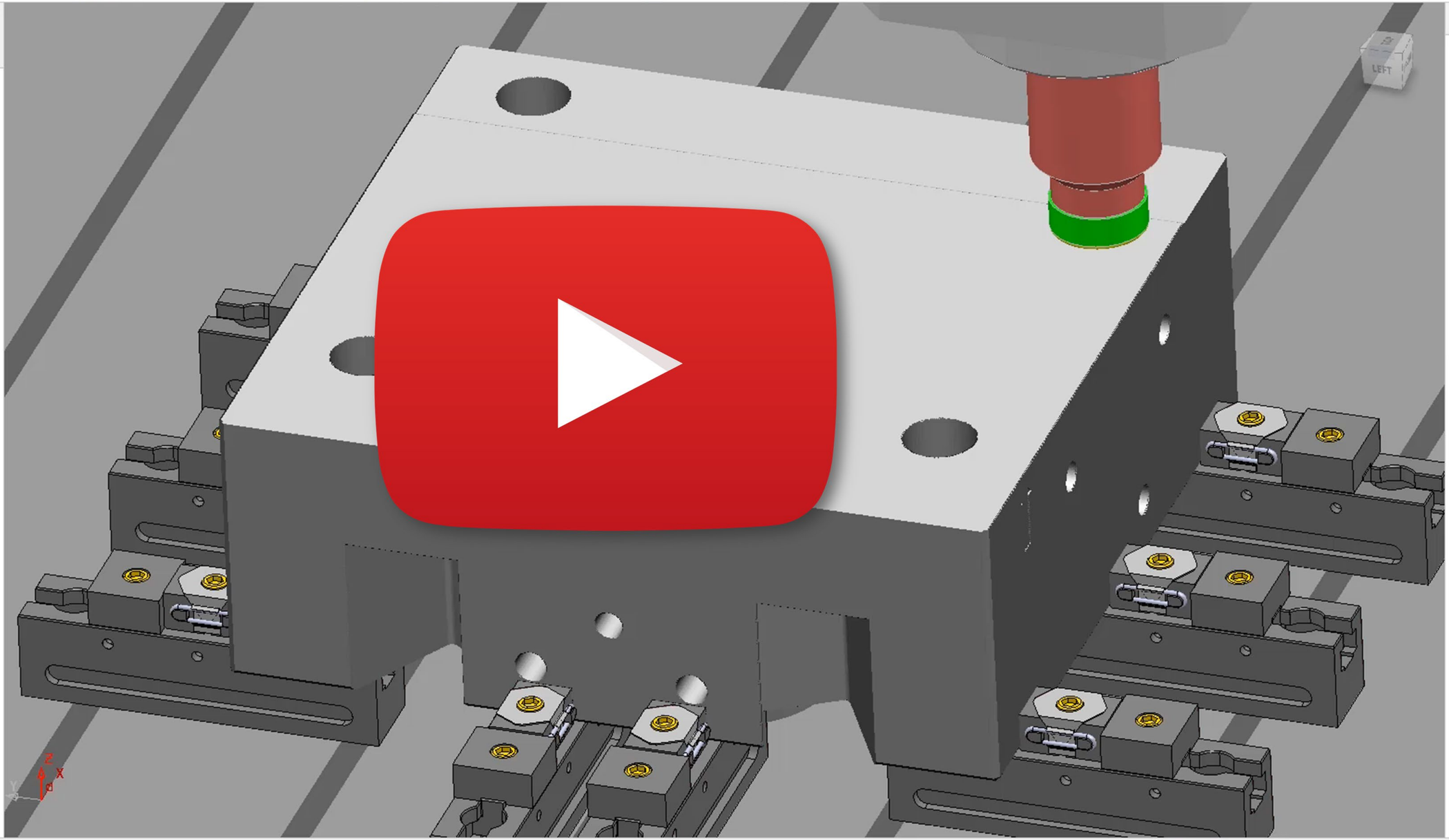
Machine Tool | Tool
Position

On | Exit ViewMill | Mode | Shading | Store | Restore | Export | Remaining Material
ViewMill

Auto-draw tool | View
Draw

Explorer

- Active
- Machine Tools
- NC Programs
- Setups
  - > Setup1 - G54
- Toolpaths
- Tools
- Boundaries
- Patterns
- Feature Groups
- Hole Feature Sets
- Workplanes
- Levels and Sets
- Models
- Stock Models
- Groups
- Macros



Simulated 63%

Factory Planning for the Automotive Supply Chain

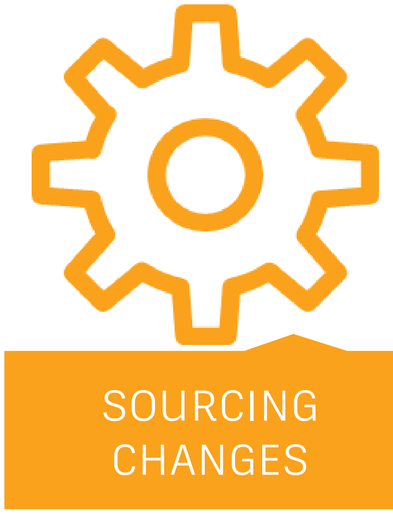
Manufacturing is Constantly Changing

NEW PRODUCT INTRODUCTION

DEMAND CHANGES

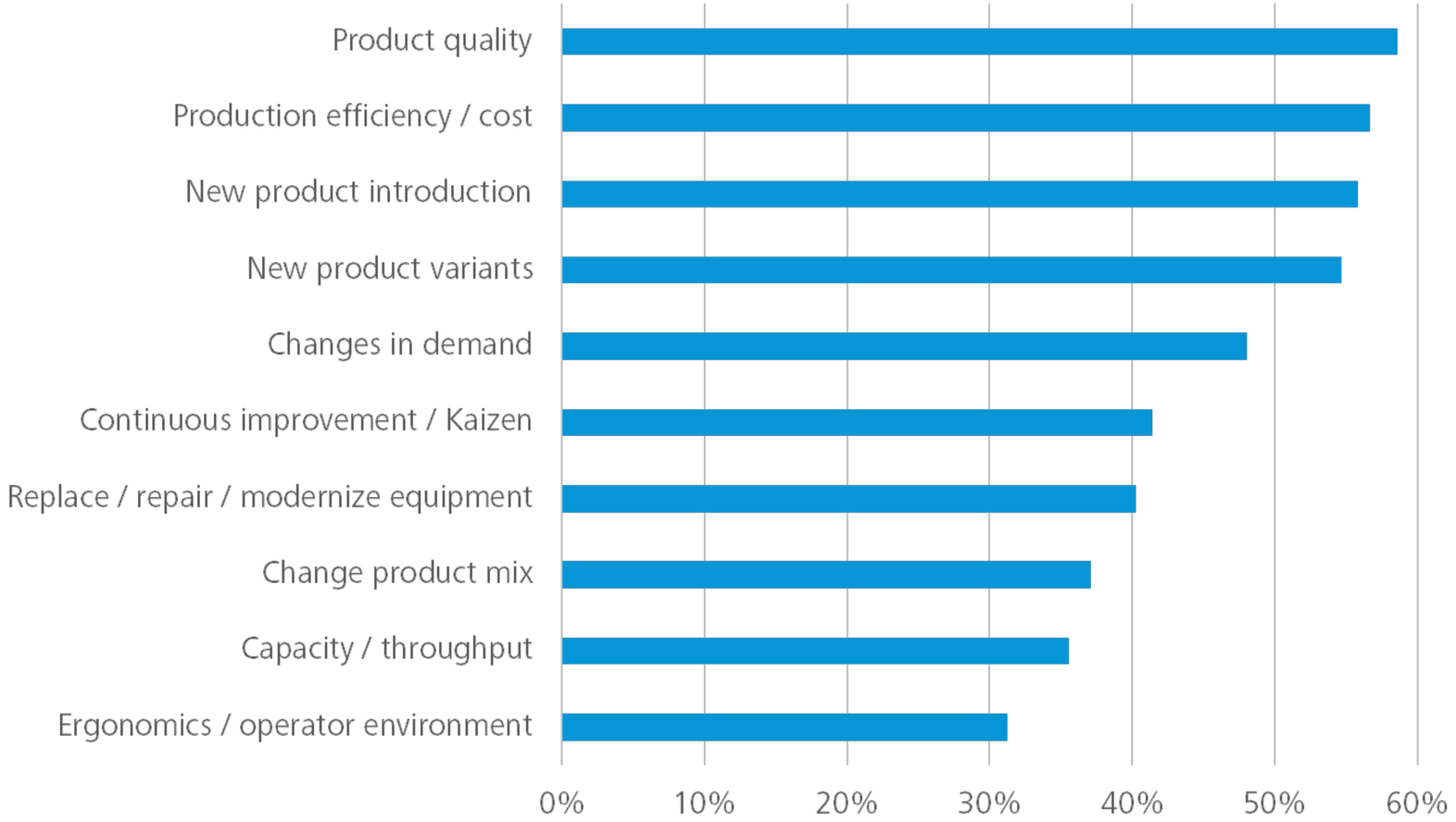
COST CUTTING INITIATIVES

QUALITY INITIATIVES



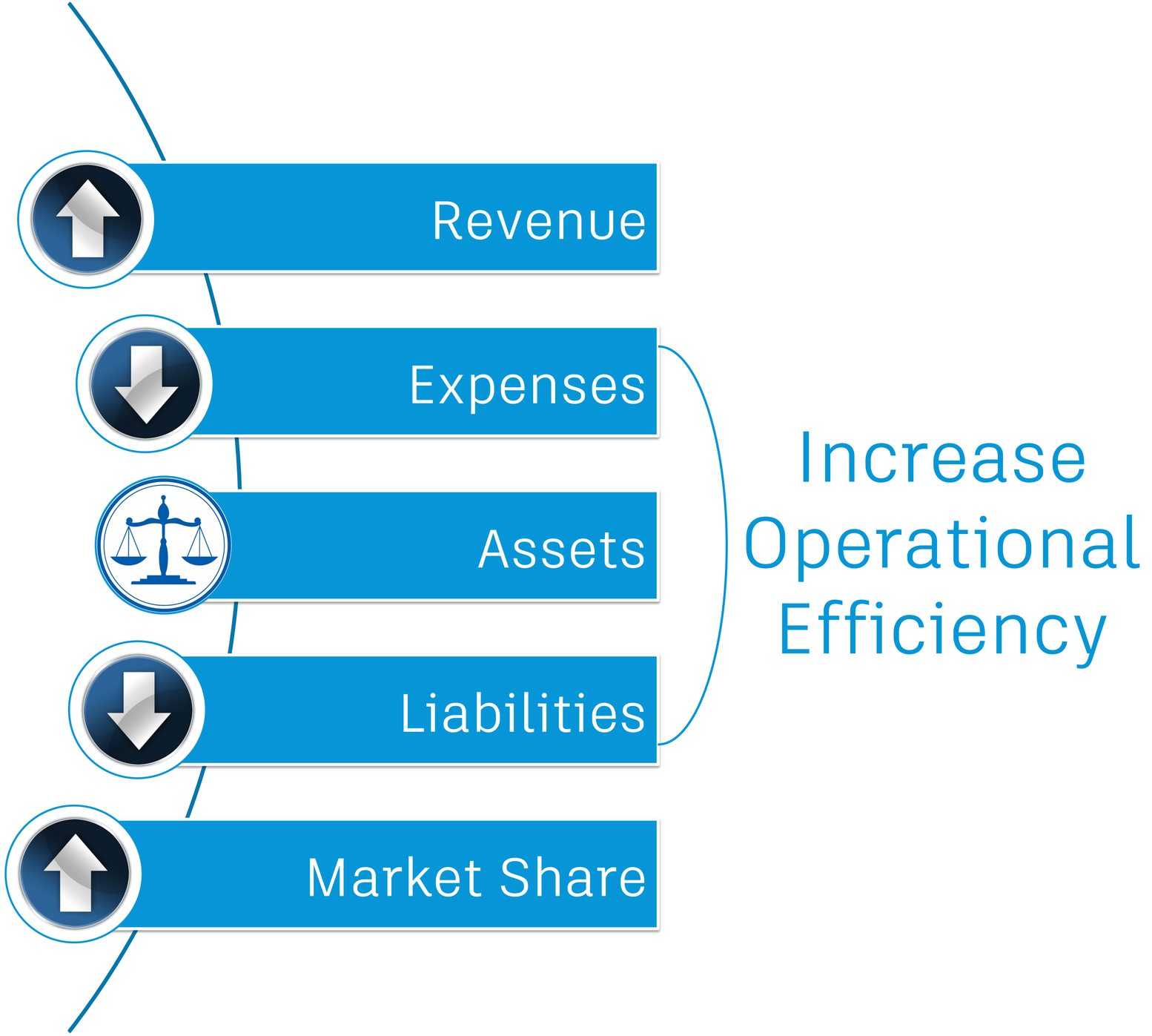
SOURCING CHANGES

Top 10 Drivers of Change in the Factory

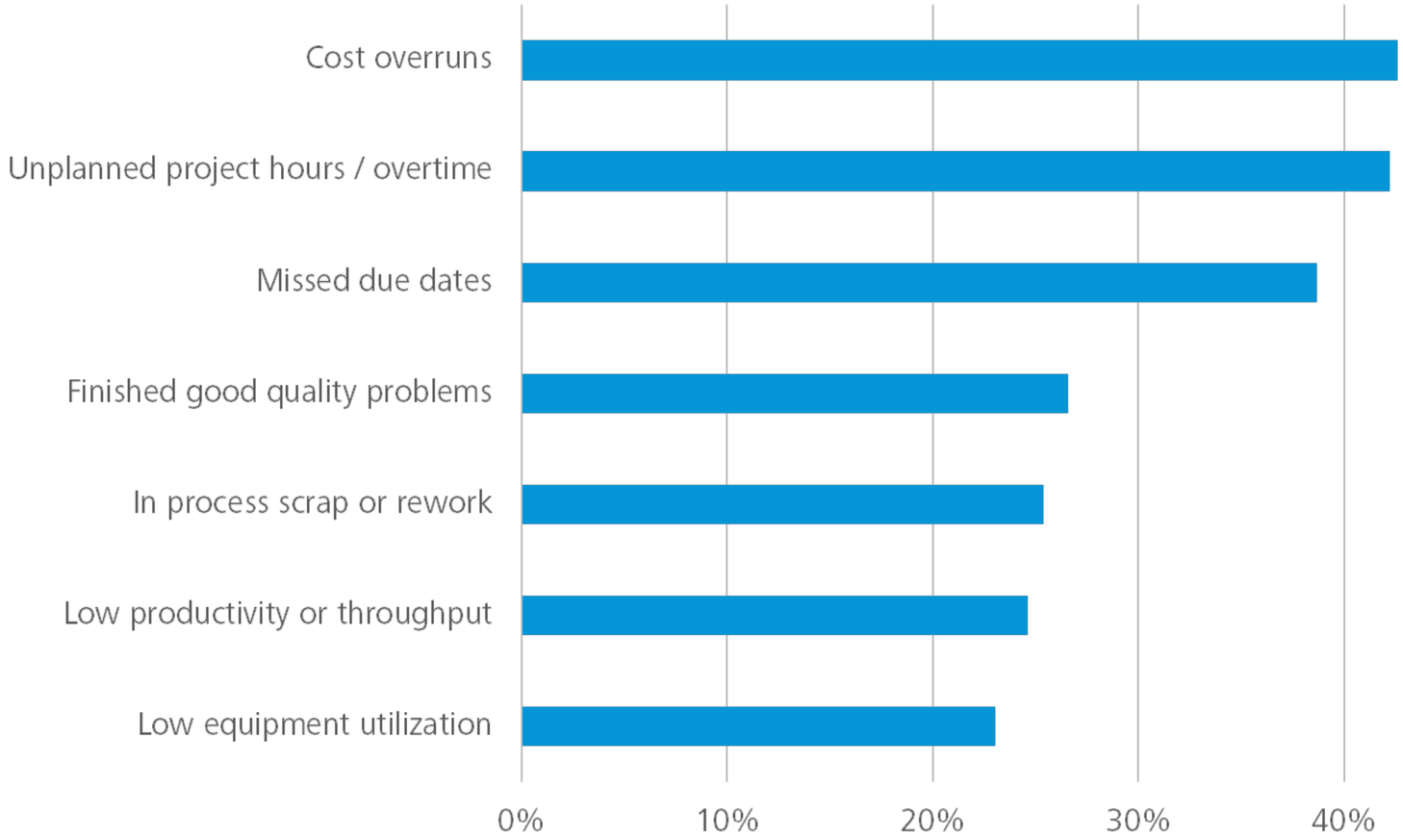


Source: "Best Practices for Managing Change in the Factory," Tech-Clarity

In manufacturing
the ability to adapt quickly
to change is *critical* for
long-term business growth

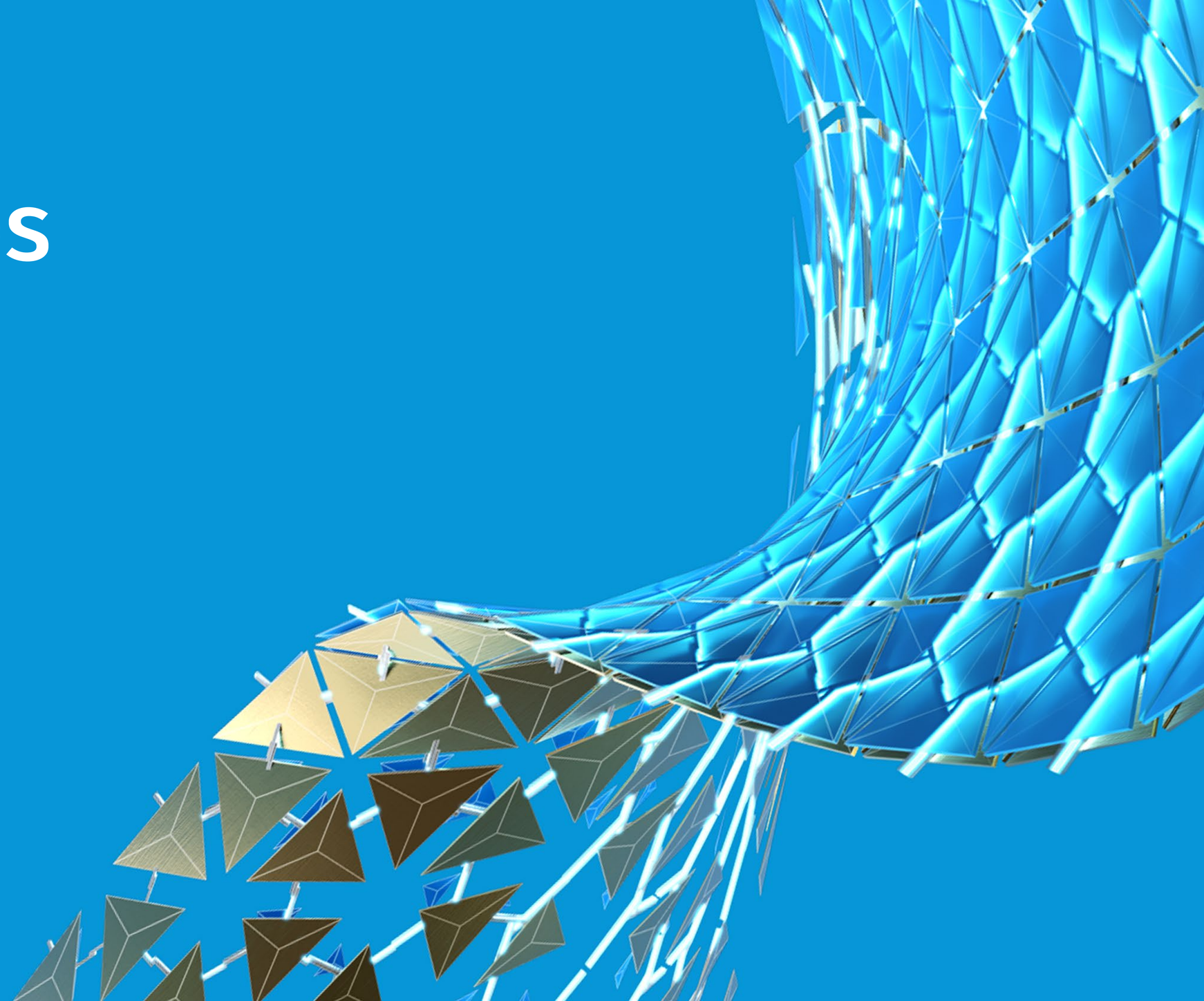

Revenue
Expenses
Assets
Liabilities
Market Share
Increase
Operational
Efficiency

Common Outcomes of Factory Change



Source: "Best Practices for Managing Change in the Factory," Tech-Clarity

Challenges



Challenges

Due to poor integration between process planning, production layout, facilities design, installation, and operation, projects often struggle to stay on schedule and on budget.

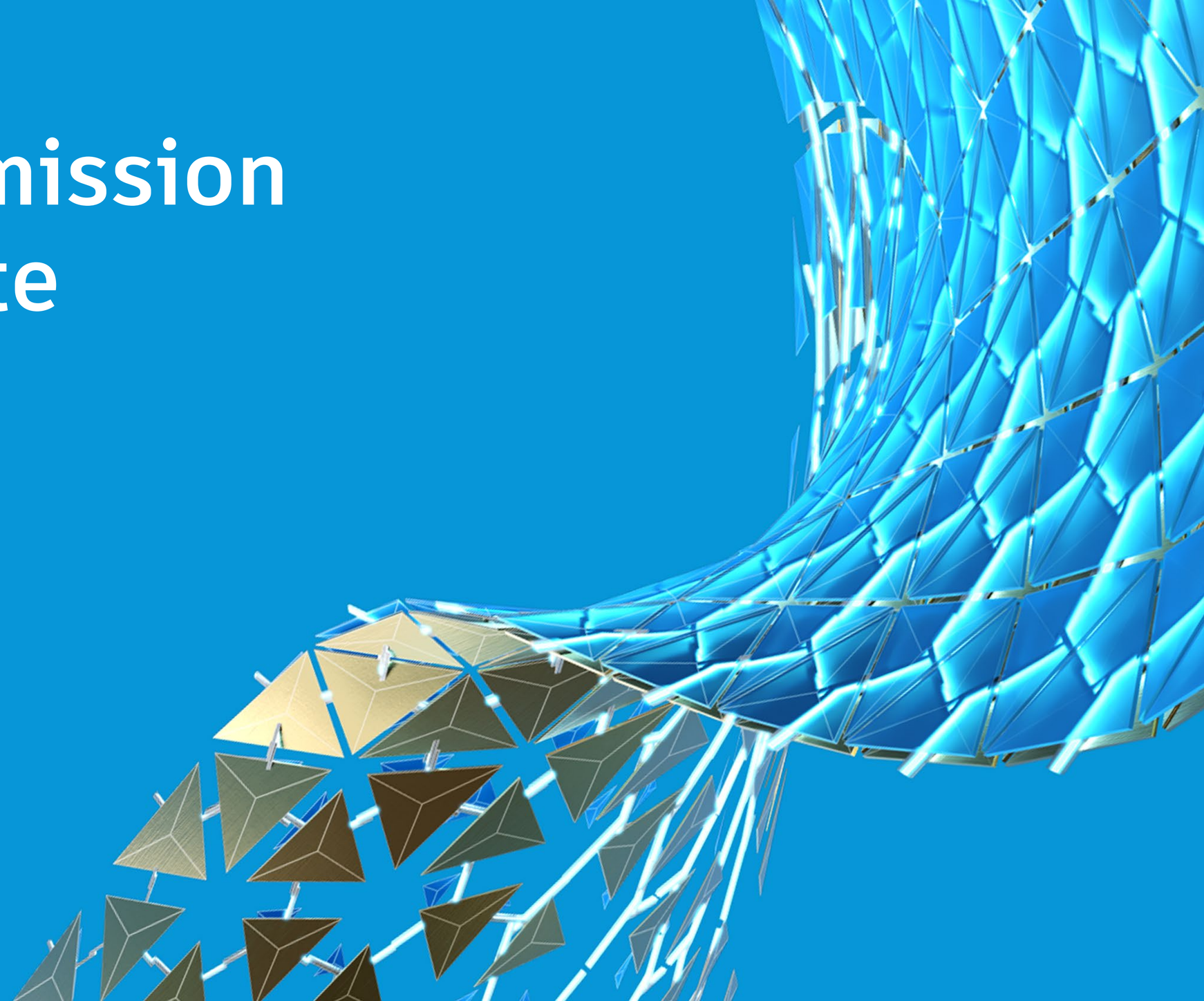
Production lines might not even perform at optimal efficiency

And many times, the cost and impact of changes are unclear

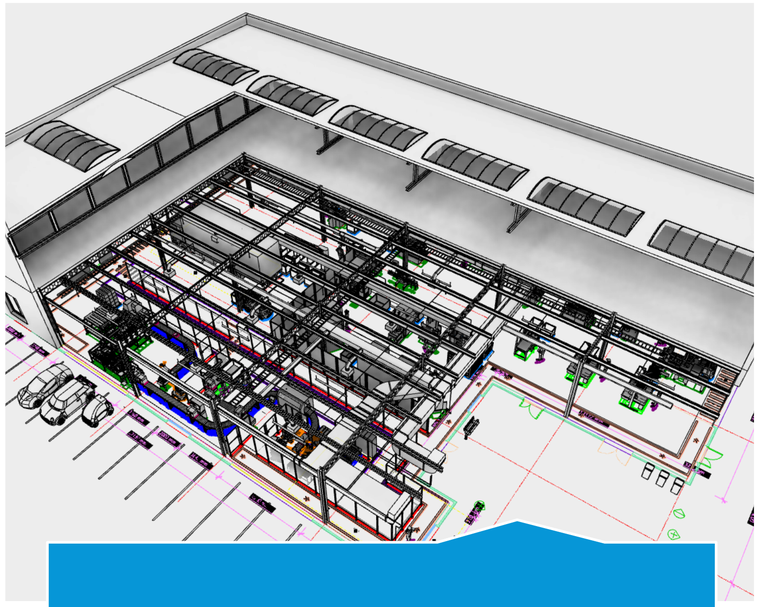
Example: Impact of Cost & Schedule Overruns

Item	Description
Project delay $100,000/day	Opportunity cost of project taking longer than planned
Field check $10,000/incident	Time required to measure factory environment
Field change order $20,000/incident	Fix issues found during build out
Major interference $100,000+ /incident	Collision between machine and environment

Plan, Commission and Operate



3 Key Areas - Plan, Commission and Operate

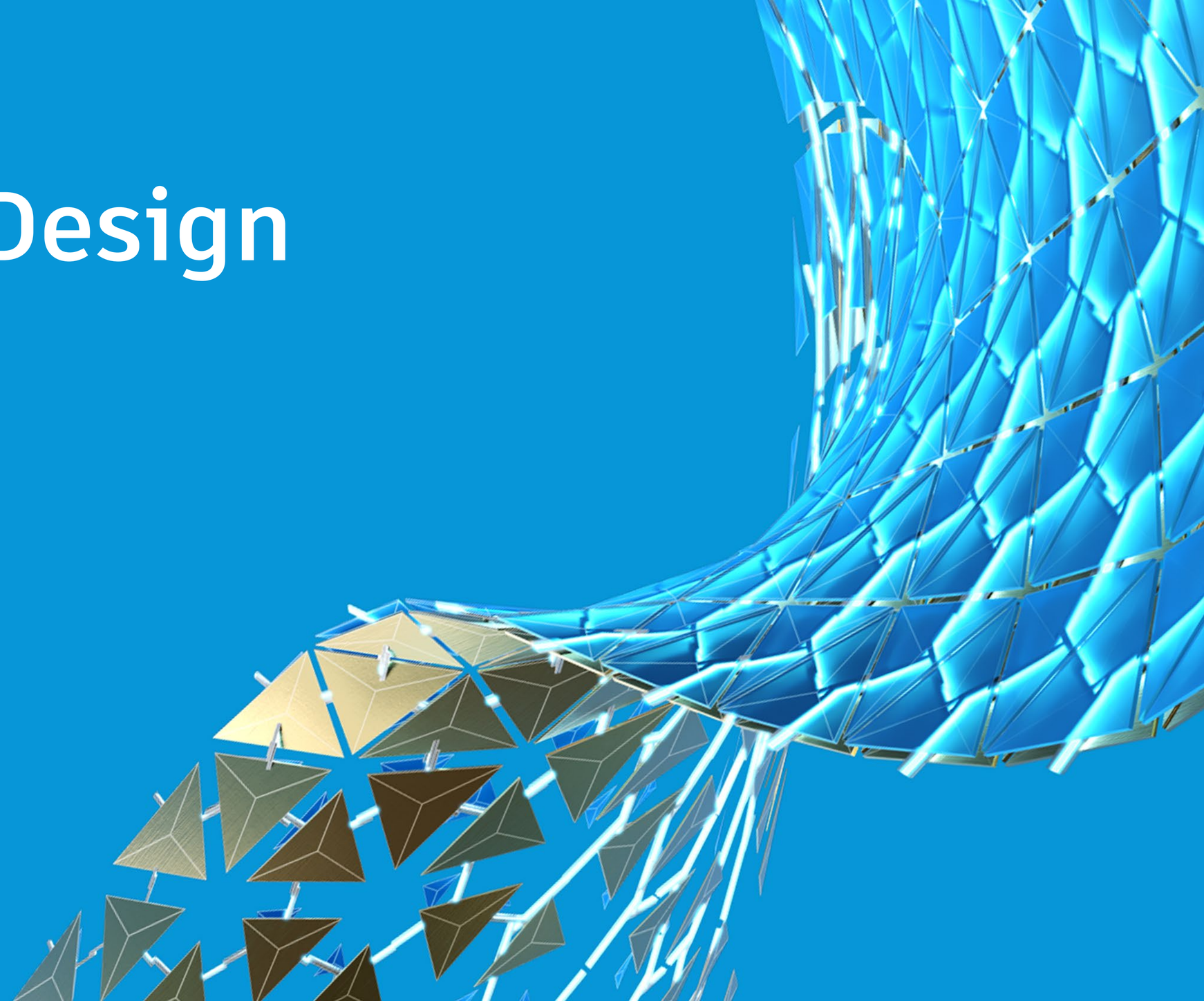


Plan and Design

Construct and Commission

Operating Factory Efficiently

Plan and Design



Plan

Ensure factory changes are for the better

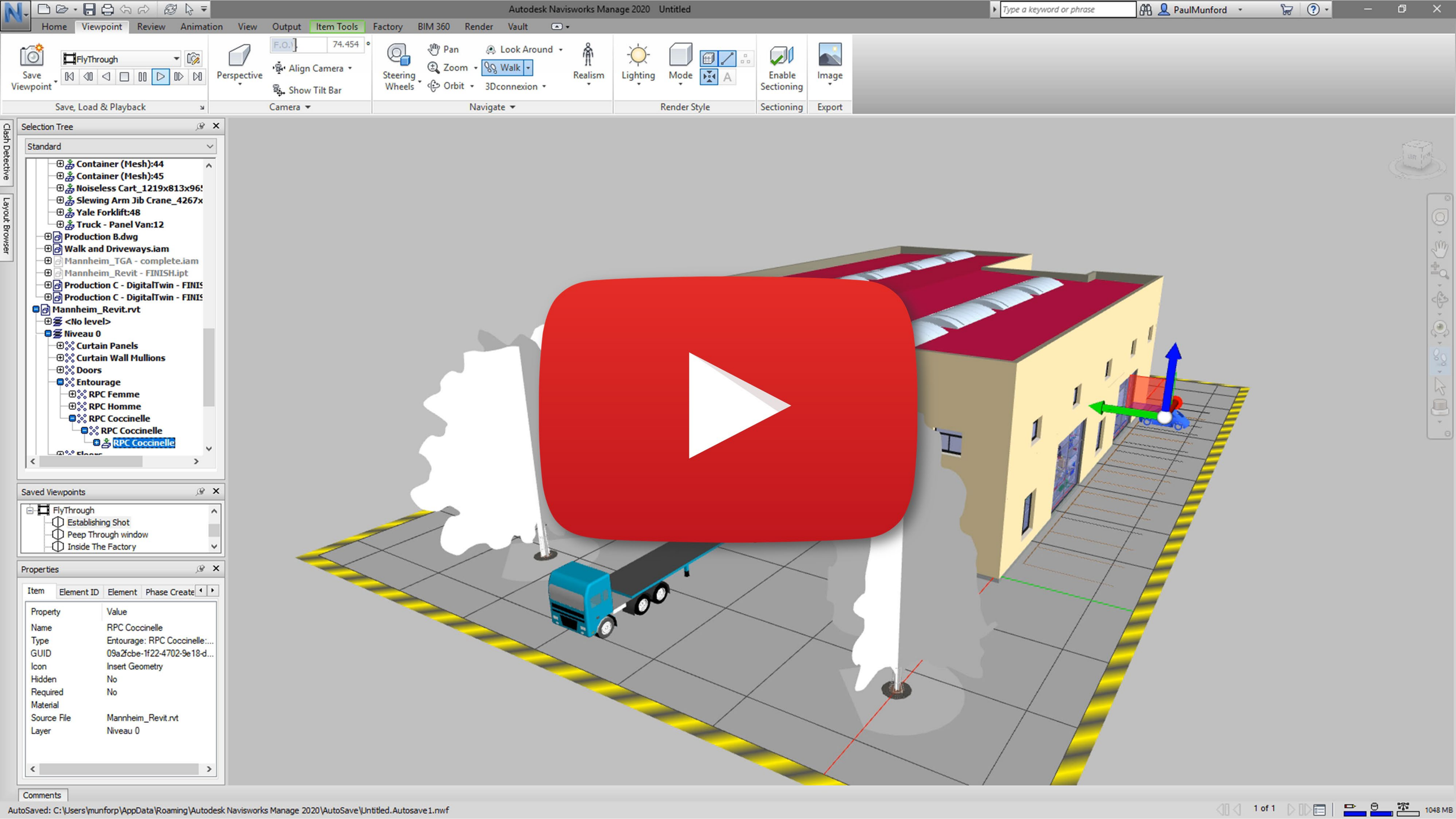
Bring together your manufacturing and building operation teams to **collaborate** on an integrated factory model and help deliver a fully optimized production at lower risk—and often lower cost

Plan and Design a More Efficient Factory

Improve design efficiency during process, production, and site planning and identify opportunities to improve overall factory efficiency

Create one integrated model that includes 3D equipment lines with the building systems such as BIM models for structural, architectural and MEP components

3D virtual walkthroughs help stakeholders (including operations, facilities, and industrial and manufacturing engineering) easily understand design intent so they can provide feedback and identify potential issues early in the design process


Autodesk Navisworks Manage 2020 Untitled
Home
Viewpoint
Review
Animation
View
Output
Item Tools
Factory
BIM 360
Render
Vault
Save Viewpoint
FlyThrough
Perspective
Align Camera
Show Tilt Bar
Steering Wheels
Pan
Zoom
Orbit
Look Around
Walk
3Dconnexion
Realism
Lighting
Mode
Enable Sectioning
Image
Save, Load & Playback
Camera
Navigate
Render Style
Sectioning
Export
Selection Tree
Standard
Container (Mesh):44
Container (Mesh):45
Noiseless Cart_1219x813x96!
Slewing Arm Jib Crane_4267x
Yale Forklift:48
Truck - Panel Van:12
Production B.dwg
Walk and Driveways.iam
Mannheim_TGA - complete.iam
Mannheim_Revit - FINISH.ipt
Production C - DigitalTwin - FINIS
Production C - DigitalTwin - FINIS
Mannheim_Revit.rvt
<No level>
Niveau 0
Curtain Panels
Curtain Wall Mullions
Doors
Entourage
RPC Femme
RPC Homme
RPC Coccinelle
RPC Coccinelle
RPC Coccinelle
Saved Viewpoints
FlyThrough
Establishing Shot
Peep Through window
Inside The Factory
Properties
Item
Element ID
Element
Phase Create
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Comments
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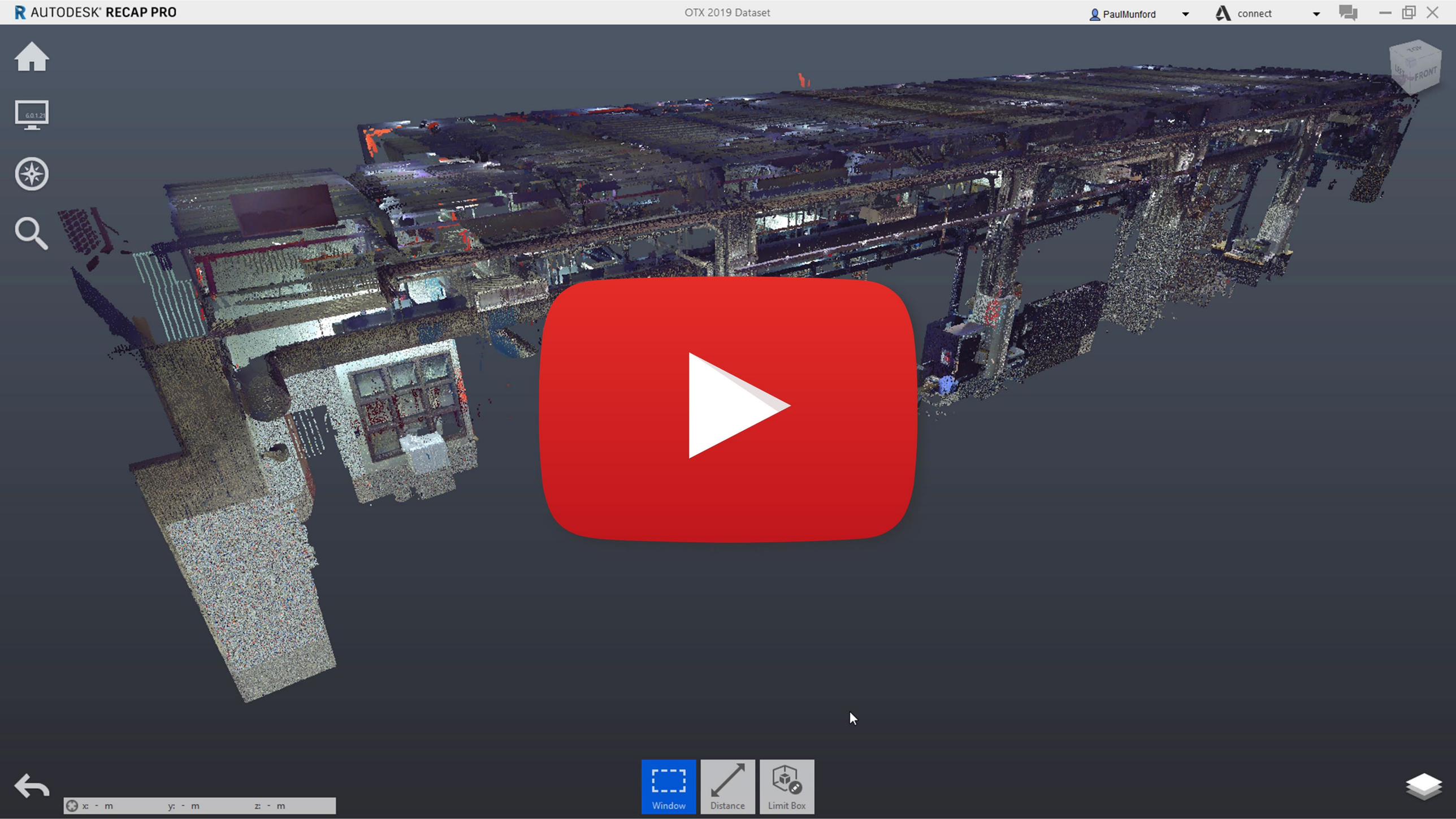
1 of 1
1048 MB

Plan and Design a More Efficient Factory

Improve design efficiency during process, production, and site planning and identify opportunities to improve overall factory efficiency

	Create one integrated model that includes 3D equipment lines with the building systems such as BIM models for structural, architectural and MEP components
✓	**3D virtual walkthroughs** help stakeholders (including operations, facilities, and industrial and manufacturing engineering) easily understand design intent so they can provide feedback and identify potential issues early in the design process
	Laser scanning accurately documents the as-is state of your facility to build 3D models, providing high-resolution representations of the space. This is less expensive, less time consuming, and more accurate than manual field checking


AUTODESK RECAP PRO
OTX 2019 Dataset
PaulMunford
connect
FRONT
Window
Distance
Limit Box

Plan and Design a More Efficient Factory

Improve design efficiency during process, production, and site planning and identify opportunities to improve overall factory efficiency

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✓	**3D virtual walkthroughs** help stakeholders (including operations, facilities, and industrial and manufacturing engineering) easily understand design intent so they can provide feedback and identify potential issues early in the design process
✓	**Laser scanning** accurately documents the as-is state of your facility to build 3D models, providing high-resolution representations of the space. This is less expensive, less time consuming, and more accurate than manual field checking
	Analyze and Visualize the sequence of operations in your manufacturing process, identify bottlenecks, and stations exceeding Takt time, optimize work distribution across stations, and improve workflows

Autodesk Process Analysis

AUTODESK PROCESS ANALYSIS > Designs > Mannheim_Process_Finish

Save

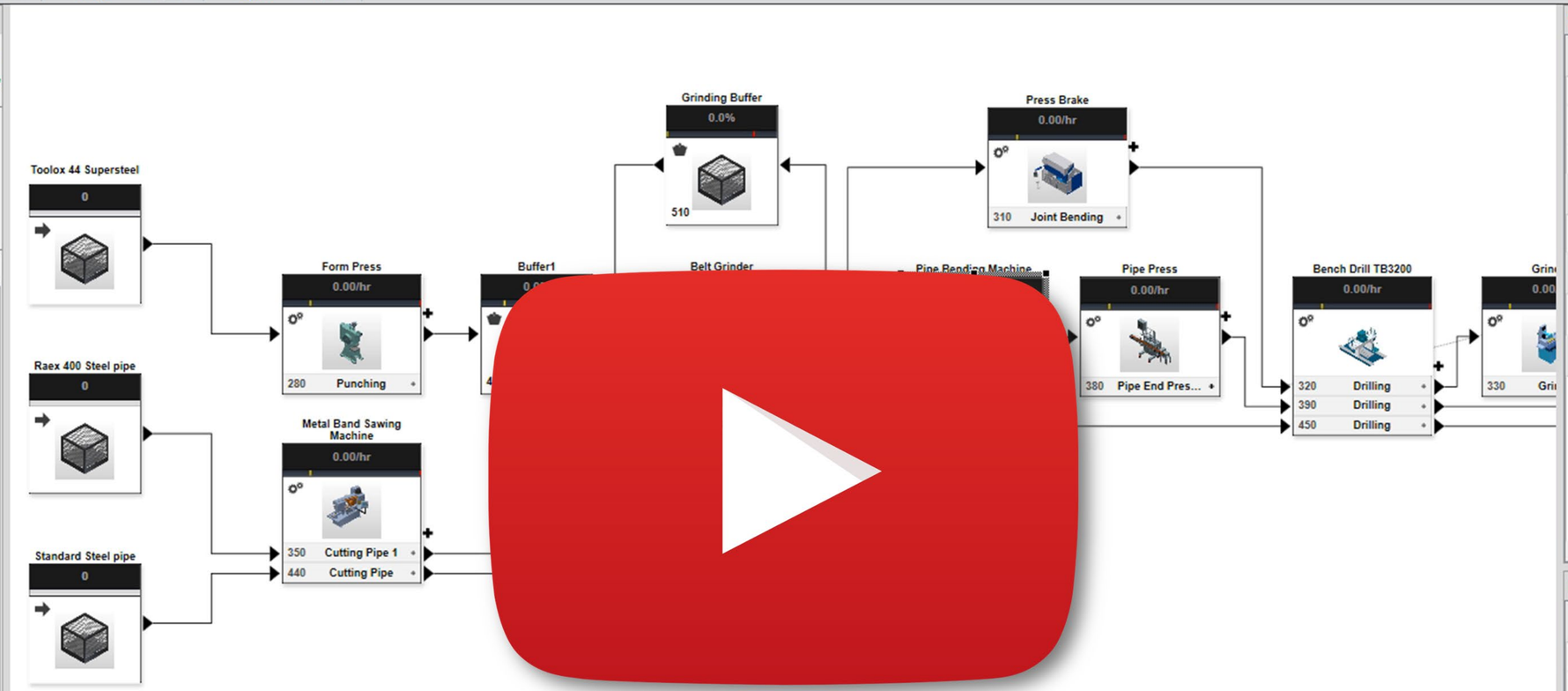
Undo | Redo | Cut | Copy | Paste | Group | Ungroup | Export | Reports | User Interface

Asset Browser

Source
Processor
Buffer
Product
Operator

System Assets

Architectural | Automotive | Building Utili...
Conveyor | General | Material Han...
Placeholders | Point Cloud | Process Equi...
Retail | Robot | Safety Equip...



Settings

Simulation Settings
Simulation Mode: Push
Duration: Target Quantity
Enable Animations

Distribution Settings
Distribution Type: Normal

Takt Time Settings
Takt Time: 10 min

Notes
Input notes here.

Process

Processor Settings
Name: Pipe Bending Machine
MTBF: 4400 hr; 0 Variability(%)
MTTR: 60 min; 0 Variability(%)
Utilization Alarms: 20 Min(%); 100 Max(%)
Operation Sequencing: Sequential

Pipe Bending
Op Sequence #: 370
0 min

Stations/Connections: 32/40 | Zoom: 83.46%

00:00:00

Plan and Design a More Efficient Factory

Improve design efficiency during process, production, and site planning and identify opportunities to improve overall factory efficiency

Create one integrated model that includes 3D equipment lines with the building systems such as BIM models for structural, architectural and MEP components

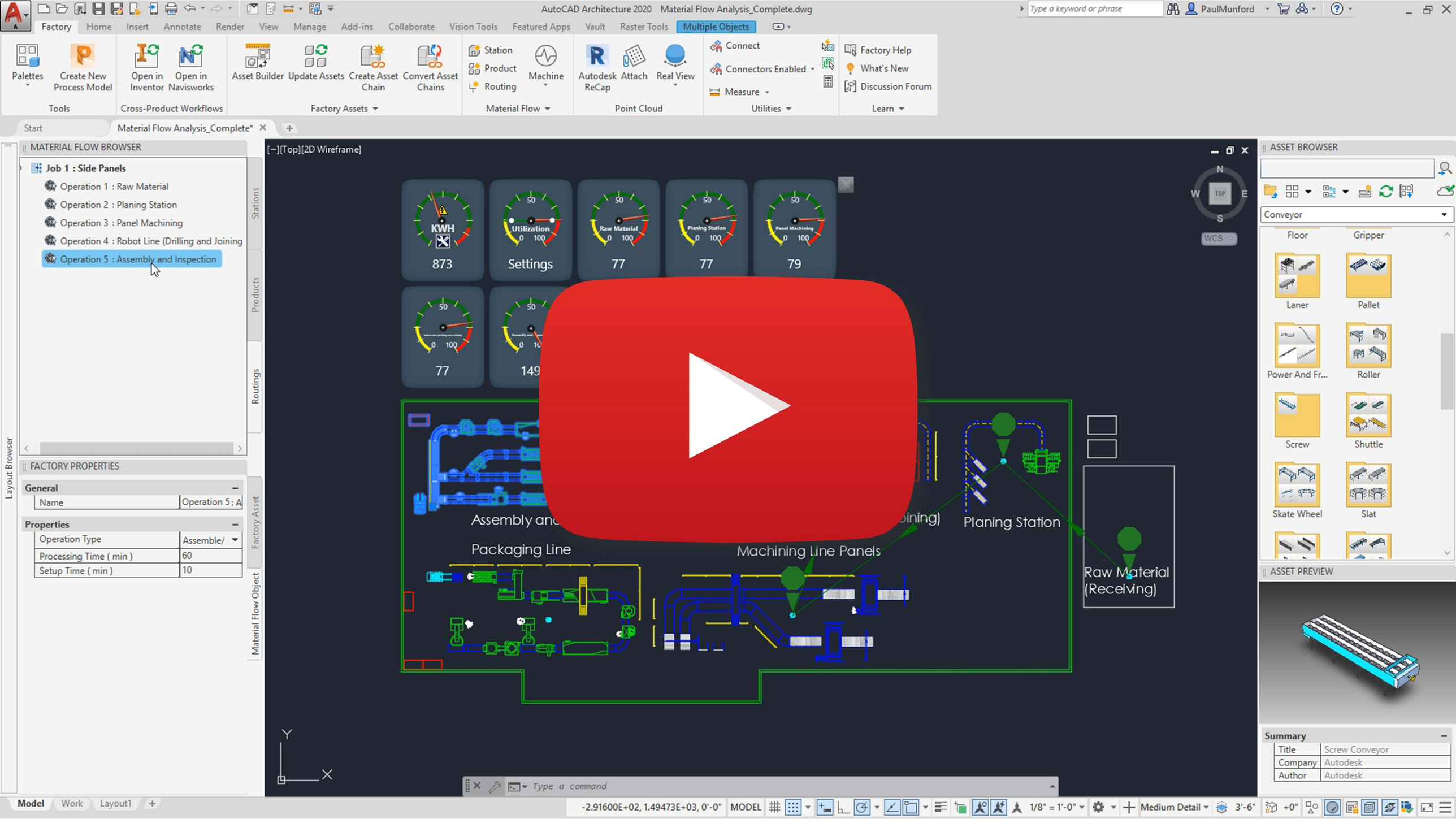
✓ **3D virtual walkthroughs** help stakeholders (including operations, facilities, and industrial and manufacturing engineering) easily understand design intent so they can provide feedback and identify potential issues early in the design process

✓ **Laser scanning** accurately documents the as-is state of your facility to build 3D models, providing high-resolution representations of the space. This is less expensive, less time consuming, and more accurate than manual field checking

✓ **Analyze and Visualize** the sequence of operations in your manufacturing process, identify bottlenecks, and stations exceeding Takt time, optimize work distribution across stations, and improve workflows

Digital simulation analyzes material and facility flow so you can fully optimize equipment placement

Provide the most efficient work environment for designers to layout production lines in 2D while using an asset library to create 3D factory models. Integrate production lines into your BIM model of the facility


AutoCAD Architecture 2020 Material Flow Analysis_Complete.dwg
Factory
Home
Insert
Annotate
Render
View
Manage
Add-ins
Collaborate
Vision Tools
Featured Apps
Vault
Raster Tools
Multiple Objects
Palettes
Create New Process Model
Open in Inventor
Open in Navisworks
Asset Builder
Update Assets
Create Asset Chain
Convert Asset Chains
Station
Product
Routing
Machine
Autodesk ReCap
Attach
Real View
Connect
Connectors Enabled
Measure
Factory Help
What's New
Discussion Forum
Tools
Cross-Product Workflows
Factory Assets
Material Flow
Point Cloud
Utilities
Learn
Start
Material Flow Analysis_Complete*
MATERIAL FLOW BROWSER
Job 1 : Side Panels
Operation 1 : Raw Material
Operation 2 : Planing Station
Operation 3 : Panel Machining
Operation 4 : Robot Line (Drilling and Joining
Operation 5 : Assembly and Inspection
Stations
Products
Routings
FACTORY PROPERTIES
General
Name
Operation 5 : A
Properties
Operation Type
Assemble/
Processing Time (min)
60
Setup Time (min)
10
Factory Asset
Material Flow Object
Layout Browser
[−][Top][2D Wireframe]
KWH
873
Utilization
Settings
Raw Material
77
Planing Station
77
Panel Machining
79
77
149
Assembly and
Packaging Line
Machining Line Panels
Planing Station
Raw Material (Receiving)
ASSET BROWSER
Conveyor
Floor
Gripper
Laner
Pallet
Power And Fr...
Roller
Screw
Shuttle
Skate Wheel
Slat
ASSET PREVIEW
Summary
Title
Screw Conveyor
Company
Autodesk
Author
Autodesk
Type a command
Model
Work
Layout1
-2.91600E+02, 1.49473E+03, 0'-0"
MODEL
1/8" = 1'-0"
Medium Detail
3'-6"

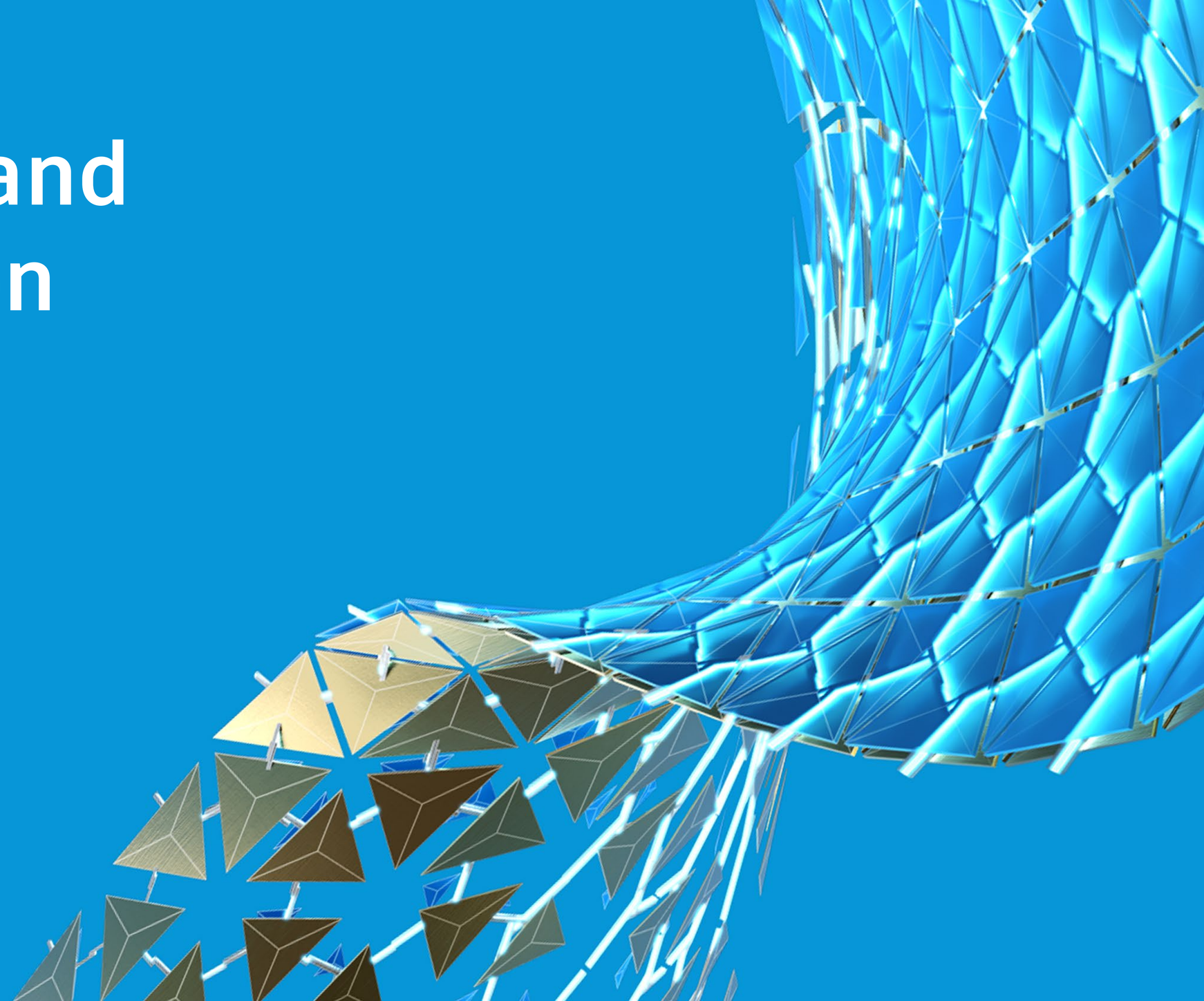
Plan and Design a More Efficient Factory

Improve design efficiency during process, production, and site planning and identify opportunities to improve overall factory efficiency

Create one integrated model that includes 3D equipment lines with the building systems such as BIM models for structural, architectural and MEP components

- ✓ **3D virtual walkthroughs** help stakeholders (including operations, facilities, and industrial and manufacturing engineering) easily understand design intent so they can provide feedback and identify potential issues early in the design process
- ✓ **Laser scanning** accurately documents the as-is state of your facility to build 3D models, providing high-resolution representations of the space. This is less expensive, less time consuming, and more accurate than manual field checking
- ✓ **Analyze and Visualize** the sequence of operations in your manufacturing process, identify bottlenecks, and stations exceeding Takt time, optimize work distribution across stations, and improve workflows
- ✓ **Digital simulation analyzes material and facility flow** so you can fully optimize equipment placement
- ✓ **Provide the most efficient work environment** for designers to layout production lines in 2D while using an asset library to create 3D factory models. Integrate production lines into your BIM model of the facility

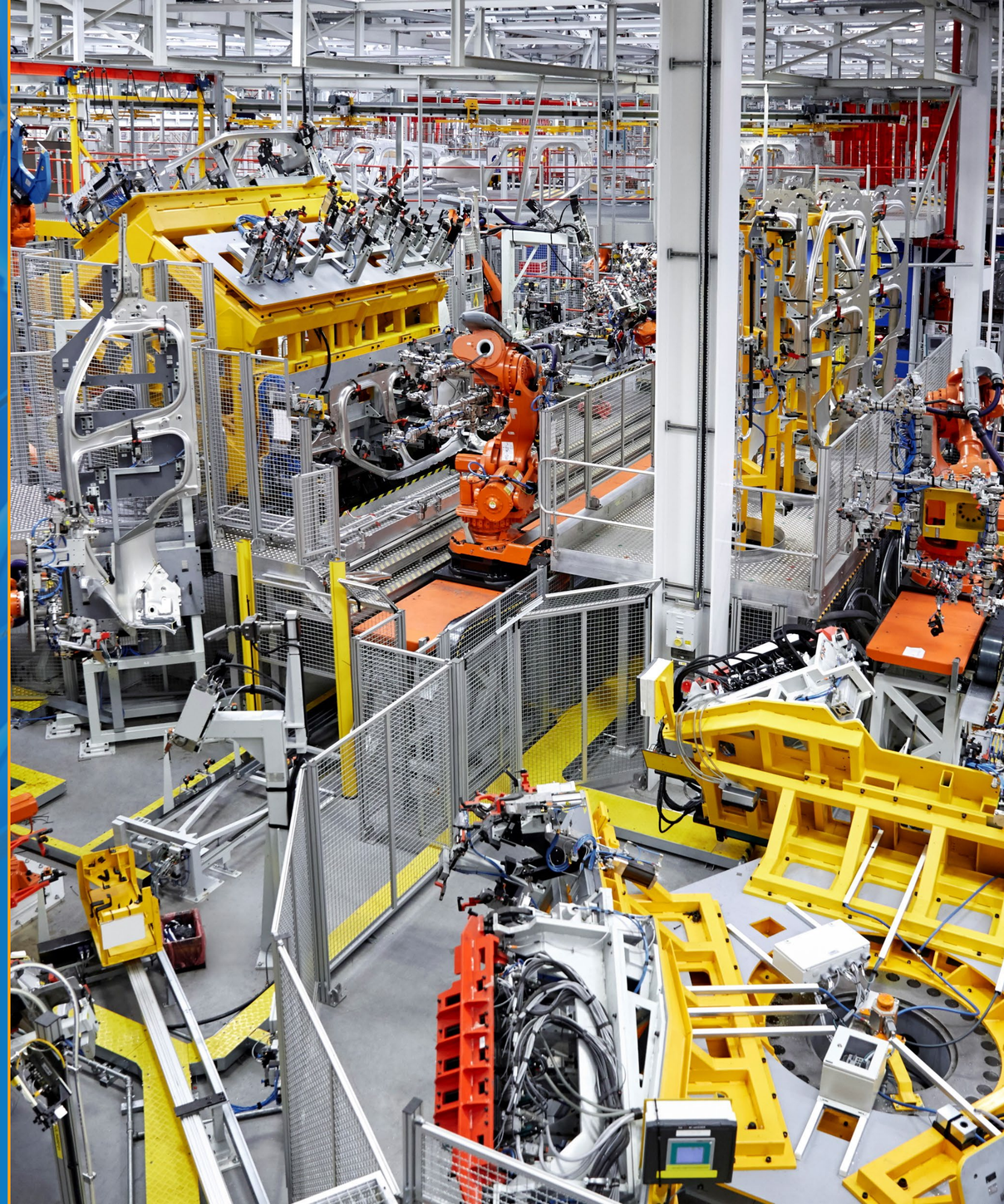
Construct and Commission



Commission

Ensure factory changes are communicated effectively

Communicate design decisions across the entire project team using a single digital model that integrates equipment, production line layouts, building designs, and reality capture data as a single database of project information



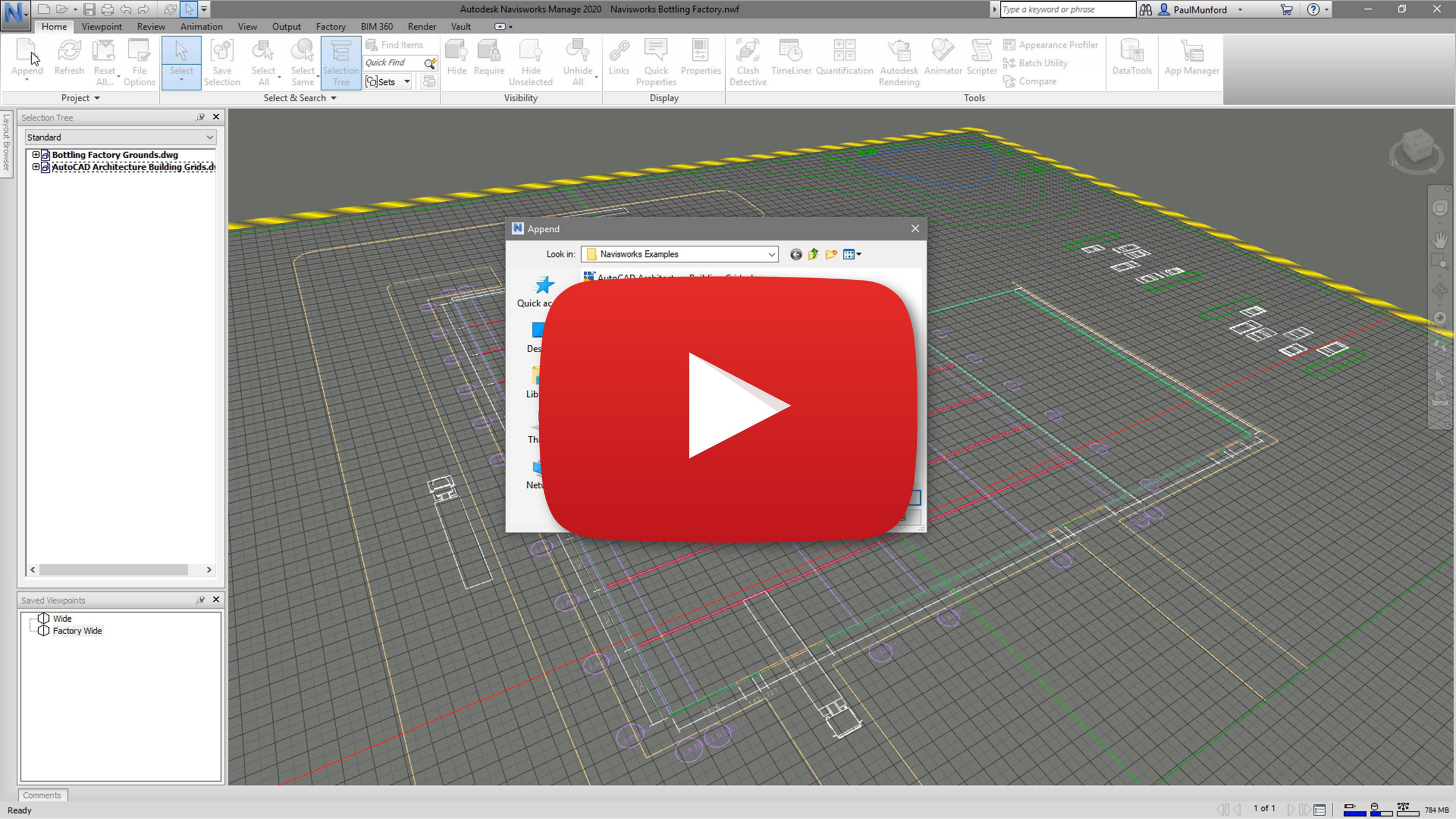
Make Better Decisions During Construction and Installation

Stay on schedule and on budget during factory change projects by integrating building planning and production line design

Integrated factory model of the existing/new facility and production systems, allows the project coordinator to identify issues prior to installation, when on-site changes become costly and time consuming

Detect clashes and collisions before project starts, identify areas with potential clearance issues that can be addressed and tracked prior to installation

Pre-construction planning and sequencing provides project teams with insights into any potential scheduling issues that could delay production kick off


Autodesk Navisworks Manage 2020 Navisworks Bottling Factory.nwf
Type a keyword or phrase
PaulMunford
Home Viewpoint Review Animation View Output Factory BIM 360 Render Vault
Append Refresh Reset All... File Options
Select Save Selection Select All Select Same Selection Tree
Find Items Quick Find Sets
Hide Require Hide Unselected Unhide All
Links Quick Properties Properties
Clash Detective TimeLiner Quantification Autodesk Rendering Animator Scripter
Appearance Profiler Batch Utility Compare
DataTools App Manager
Project Select & Search Visibility Display Tools
Selection Tree
Standard
Bottling Factory Grounds.dwg
AutoCAD Architecture Building Grids.d
Saved Viewpoints
Wide
Factory Wide
Append
Look in: Navisworks Examples
Comments
Ready
1 of 1
784 MB

Make Better Decisions During Construction and Installation

Stay on schedule and on budget during factory change projects by integrating building planning and production line design

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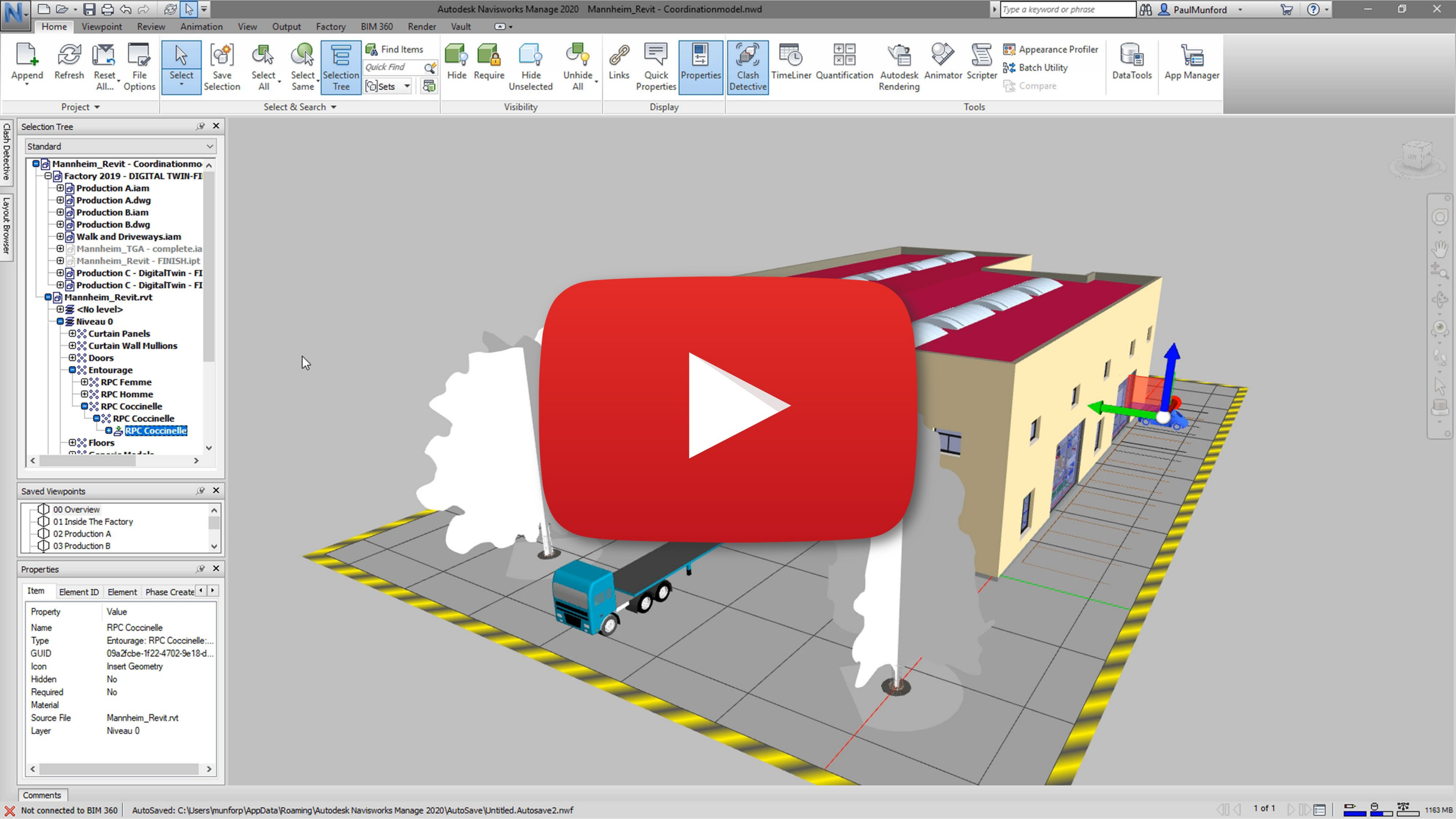
- ✓ **Pre-construction planning and sequencing** provides project teams with insights into any potential scheduling issues that could delay production kick off
- **Seamless exchange of data between factory equipment and the BIM model** allows manufacturing engineers to design in context of the facility and building designers to accurately place structural and MEP features to support the production line
- **Leverage your integrated factory model, to extract required views and relevant documentation for installation**, easily generated from 3D representations, reducing manual effort and showing production equipment in the context of the building systems


Autodesk Navisworks Manage 2020 Mannheim_Revit - Coordinationmodel.nwd
Type a keyword or phrase
PaulMunford
Home Viewpoint Review Animation View Output Factory BIM 360 Render Vault
Append Refresh Reset All... File Options
Select Save Selection Select All Select Same Selection Tree
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Appearance Profiler Batch Utility Compare
DataTools App Manager
Project Select & Search Visibility Display Tools
Selection Tree
Standard
Mannheim_Revit - Coordinationmo
Factory 2019 - DIGITAL TWIN-FI
Production A.iam
Production A.dwg
Production B.iam
Production B.dwg
Walk and Driveways.iam
Mannheim_TGA - complete.ia
Mannheim_Revit - FINISH.ipt
Production C - DigitalTwin - FI
Production C - DigitalTwin - FI
Mannheim_Revit.rvt
<No level>
Niveau 0
Curtain Panels
Curtain Wall Mullions
Doors
Entourage
RPC Femme
RPC Homme
RPC Coccinelle
RPC Coccinelle
RPC Coccinelle
Floors
Saved Viewpoints
00 Overview
01 Inside The Factory
02 Production A
03 Production B
Properties
Item Element ID Element Phase Create
Property Value
Name RPC Coccinelle
Type Entourage: RPC Coccinelle:...
GUID 09a2fcbe-1f22-4702-9e18-d...
Icon Insert Geometry
Hidden No
Required No
Material
Source File Mannheim_Revit.rvt
Layer Niveau 0
Clash Detective
Layout Browser
Comments
Not connected to BIM 360
AutoSaved: C:\Users\munforp\AppData\Roaming\Autodesk Navisworks Manage 2020\AutoSave\Untitled.Autosave2.nwf
1 of 1
1163 MB

Make Better Decisions During Construction and Installation

Stay on schedule and on budget during factory change projects by integrating building planning and production line design

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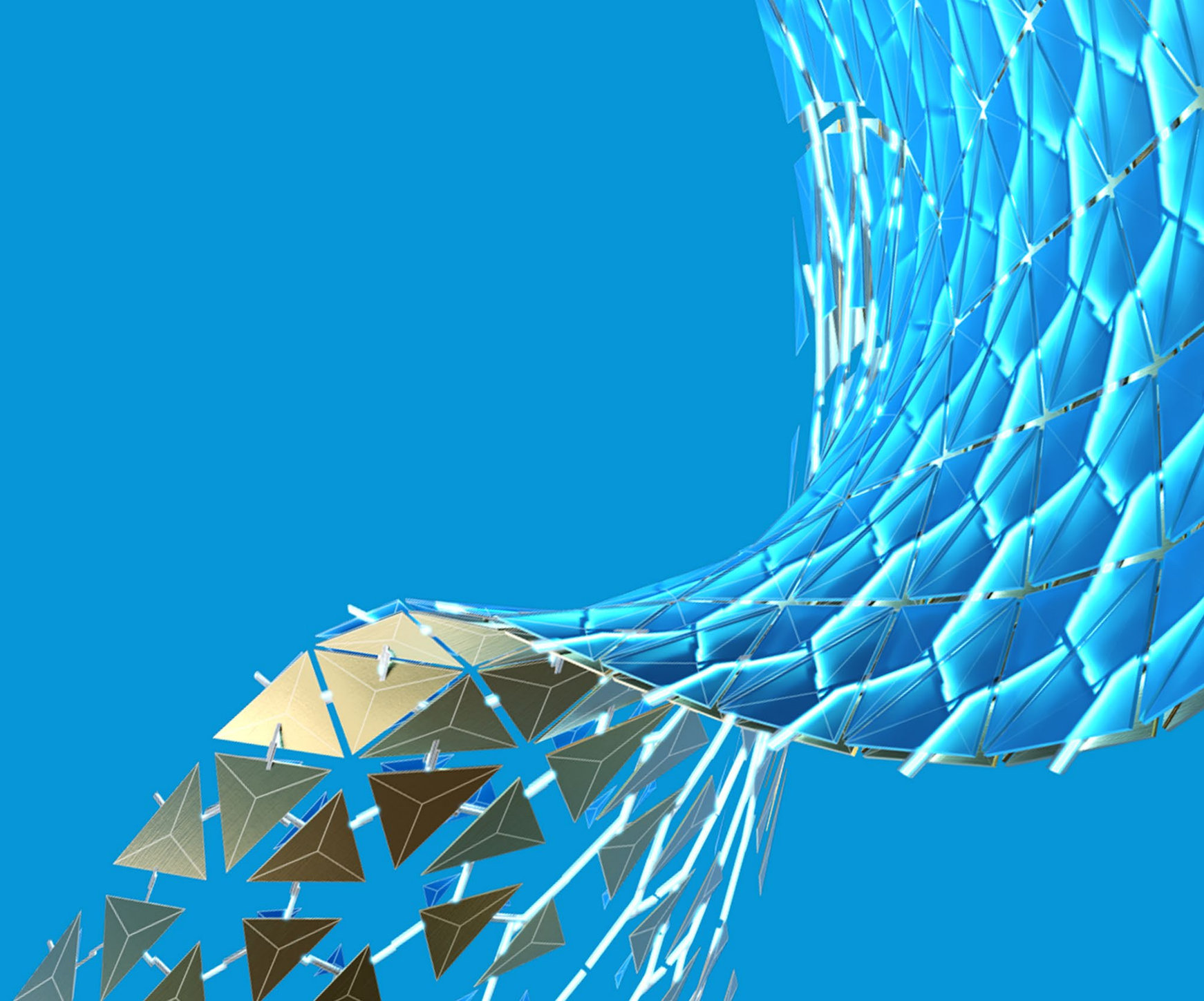
Operate



Operate

Continuously improve factory operations

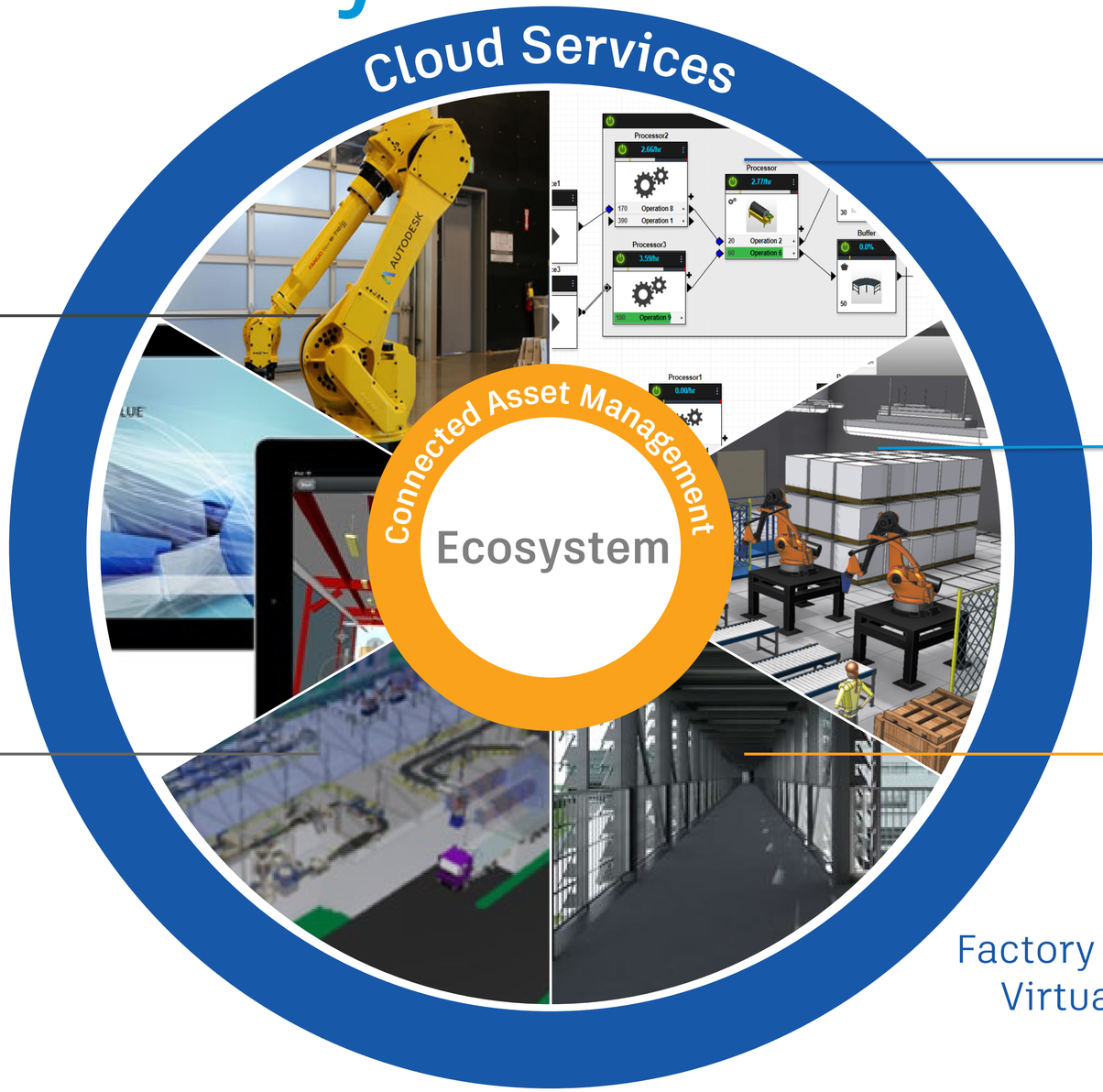
Make the most of your integrated factory model to manage equipment, production changes, and product quality.

Operate Efficiently While Managing Changes and Risk

Determine the cost and impact of factory change projects, coordinate engineering and manufacturing, and improve documentation of changes

- ✓ **Centralized data management** allows everyone to access the right information at the right time
- ✓ **Manage change process** and multiple workflows saving time during production
- ✓ **More quickly plan and implement adjustments to production line** by leveraging existing 3D representations of both the building and production line
- ✓ **Deliver accurate work instructions and quality procedures** to each task in the production process plan, so they are automatically updated as changes are made and delivered to the production floor

Phases of a Factory Lifecycle



Plan
Process Concept
Rough Layout
Site Knowledge

Design
2D & 3D Design
As built scanning
Optimization
Supplier Integration

Validate
Design Review
Clash Management
Factory Sustainability Simulation
Virtual Manufacture/ Assembly

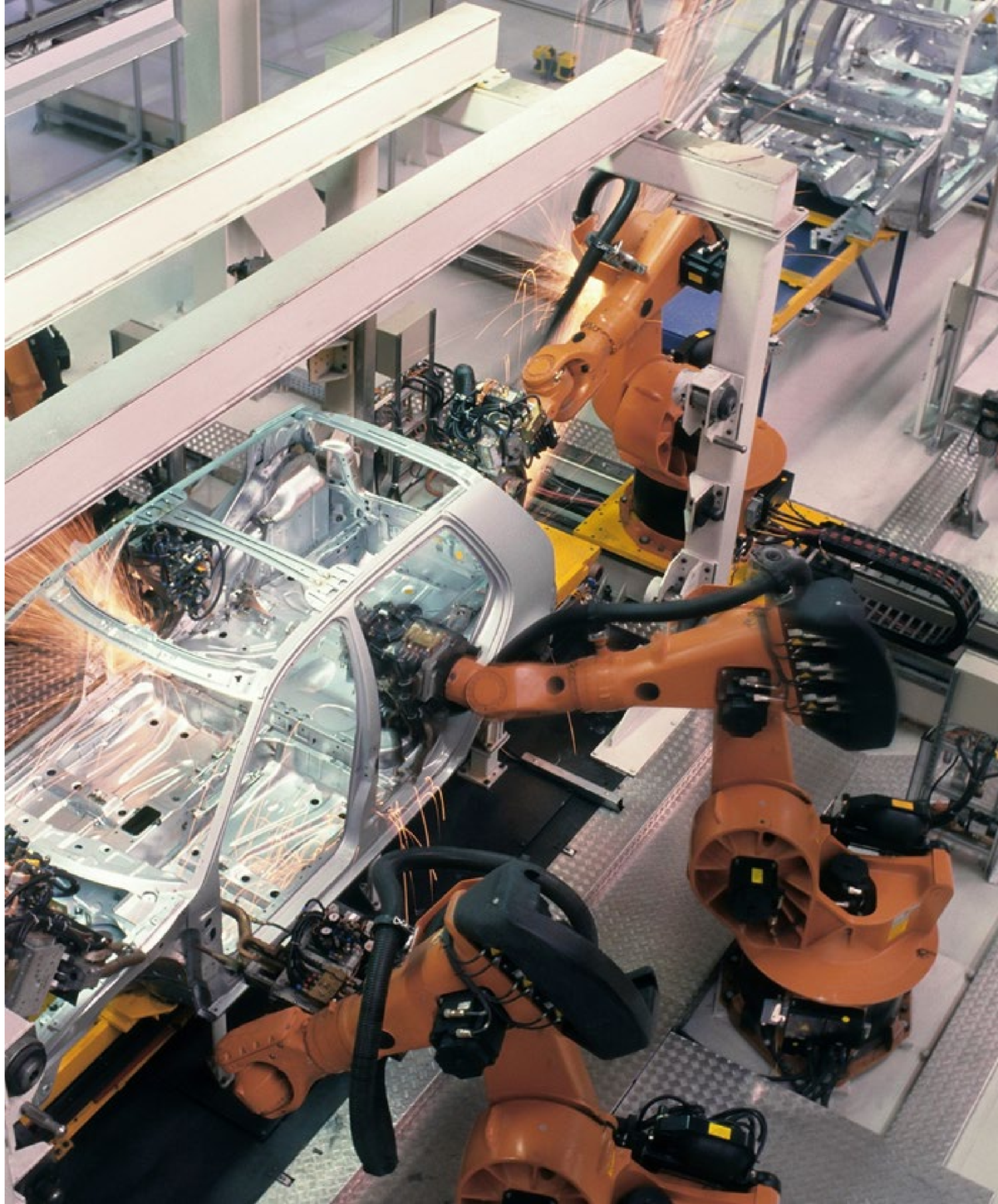
Build
4D & 5D Planning
Virtual Commissioning
Asset Sign Off
Site Management

Operate
Connected Assets
Predictive Maintenance
Manufacturing Change Management
Local Update

Automated Manufacturing

Automated Manufacturing

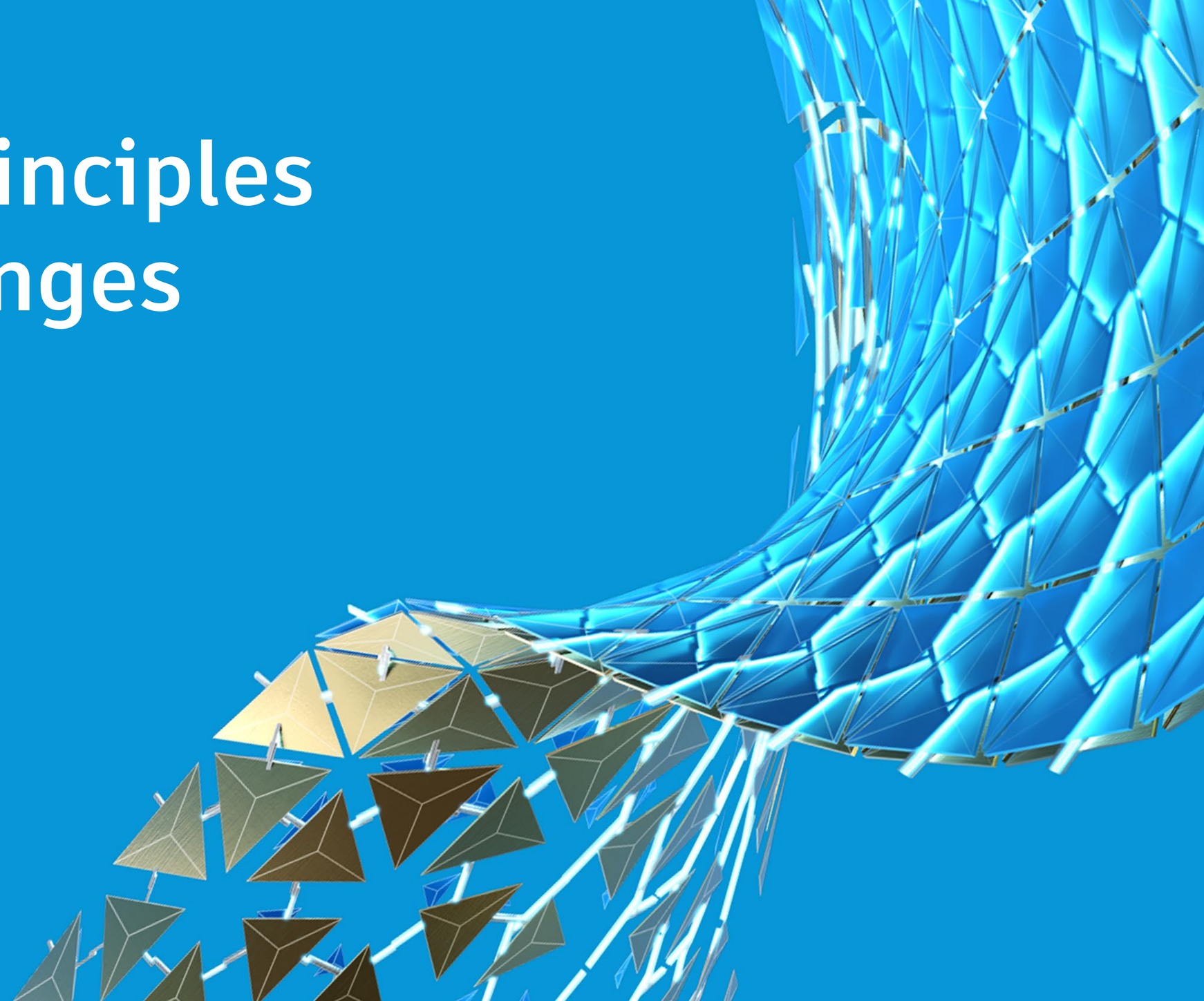
- Reliability and time to market are critical to success
- Utilize Automation
- Deliver repeatability and consistency
- Improve quality and reliability



Automated Manufacturing

- **What do we mean by “Automated”?**
- **Many types of automation**
  - Assembly lines, industrial robots, automated guided vehicles (AGV), etc.
- **Focus on automation within design and manufacturing software**

Guiding Principles and Challenges



Lean Manufacturing

- **Originating in Japan**
  - Minimize waste
  - Maintain productivity
  - Focus on what adds value
- **Improves quality**
- **Reduces production time and cost**
- **Same principles can be used across many manufacturing process**

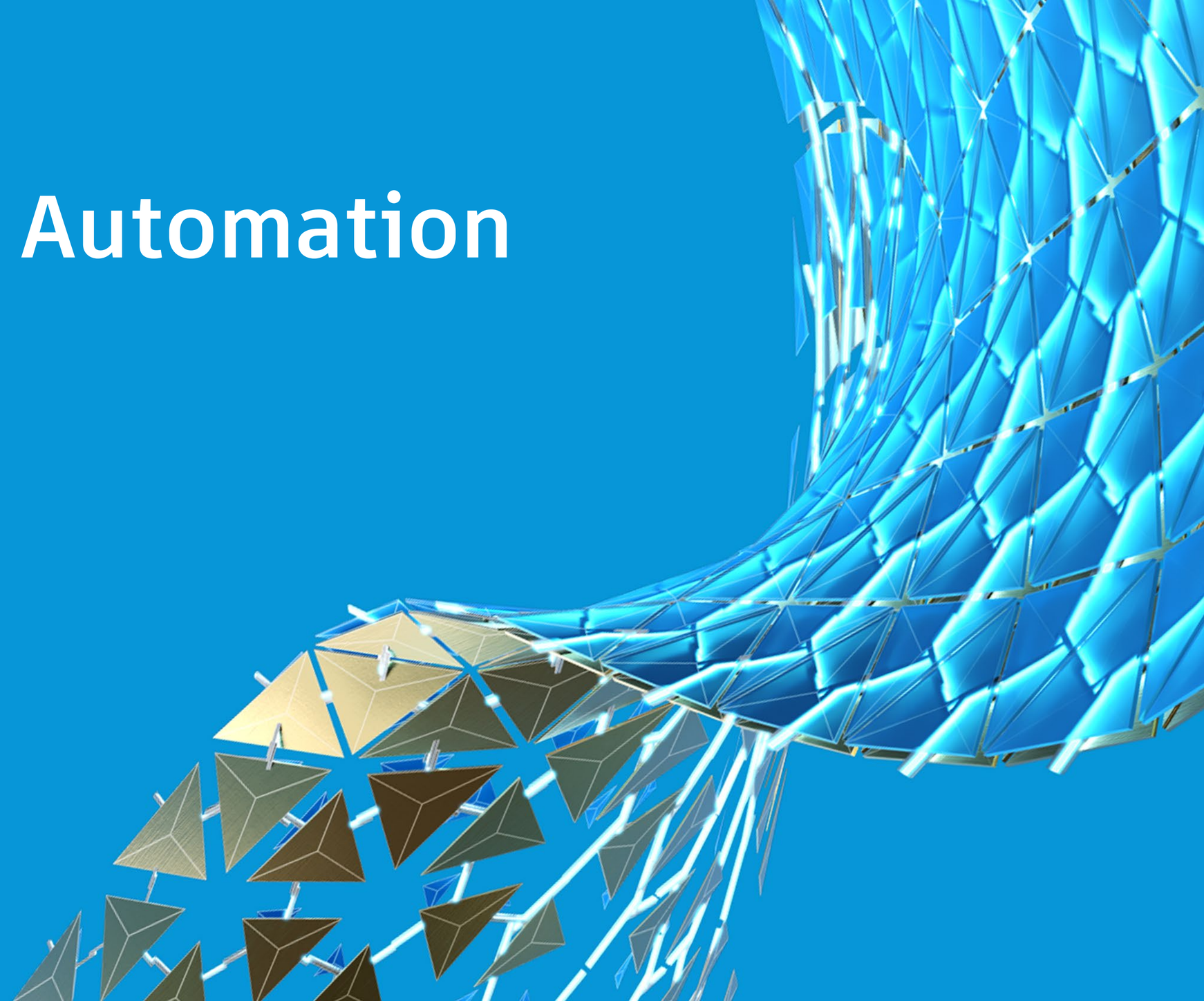
Challenges

- **Skills Gap**
  - Gap between skilled jobs and the skilled workforce available
- **Skilled but aging workforce**
  - Capturing knowledge is vital
- **Use software which can capture this knowledge**
  - Train others to follow the best practices
  - Refine over time

Manufacturing Shift

- **Embrace advanced technologies and automation**
  - Changes required skills
- **Software with reduced learning curve**
  - Become productive sooner

Intelligent Automation

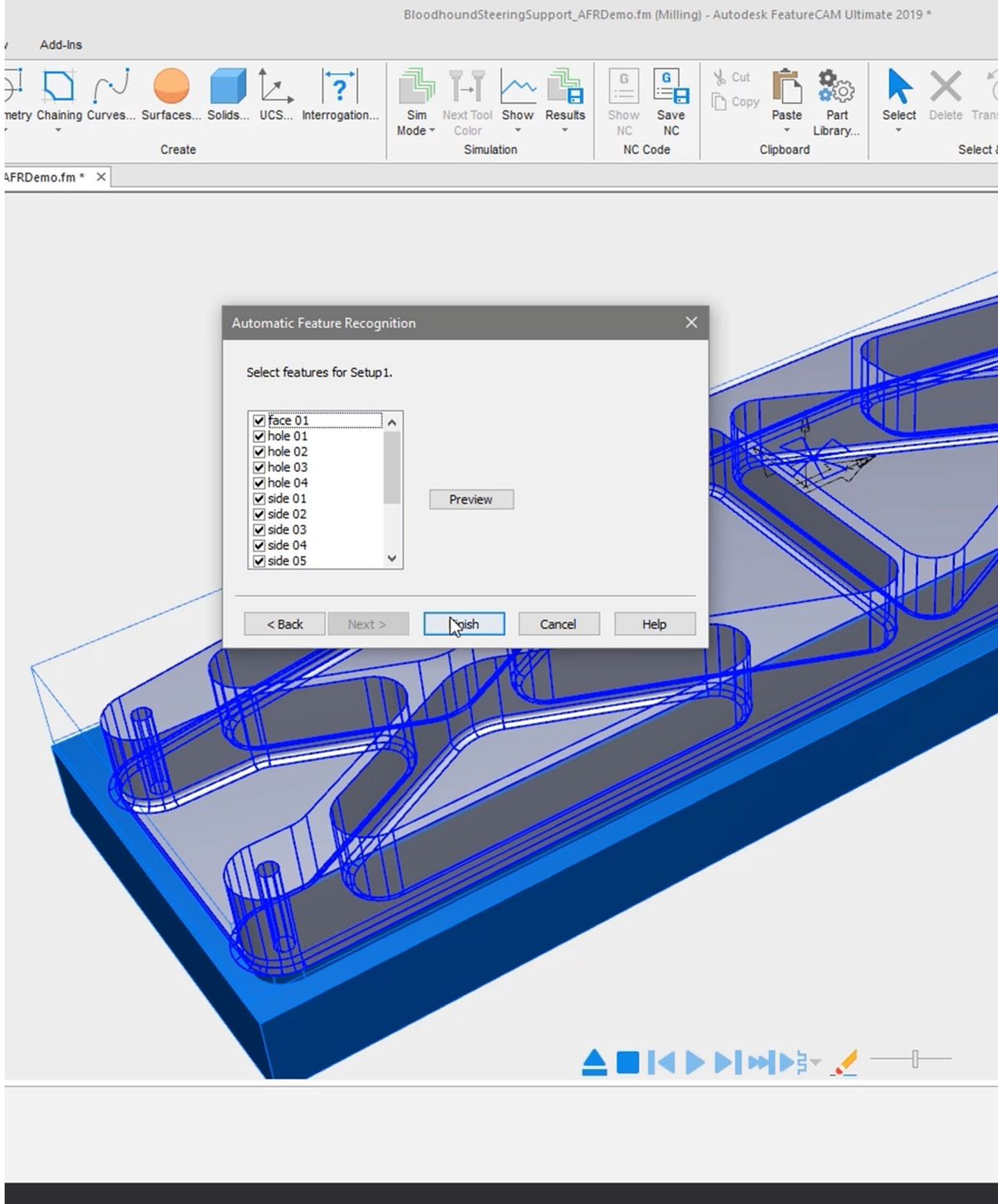


Intelligent Automation

- Many manual decisions required
- Repetitive decision making wastes valuable time
- Intelligent automation can automate repetitive tasks to speed up part programming
- Programmer can add more value to the process

Intelligent Automation

- **Program parts entirely**
- **Automated part programming technologies**
  - Can identify machinable part features
  - Use same automated decision tools
- **Fine-tune results if needed**
- **Consistent and repeatable**



BloodhoundSteeringSupport_AFRDemo.fm (Milling) - Autodesk FeatureCAM Ultimate 2019 *

File | Home | Construct | Features/Manufacturing | View | Add-Ins

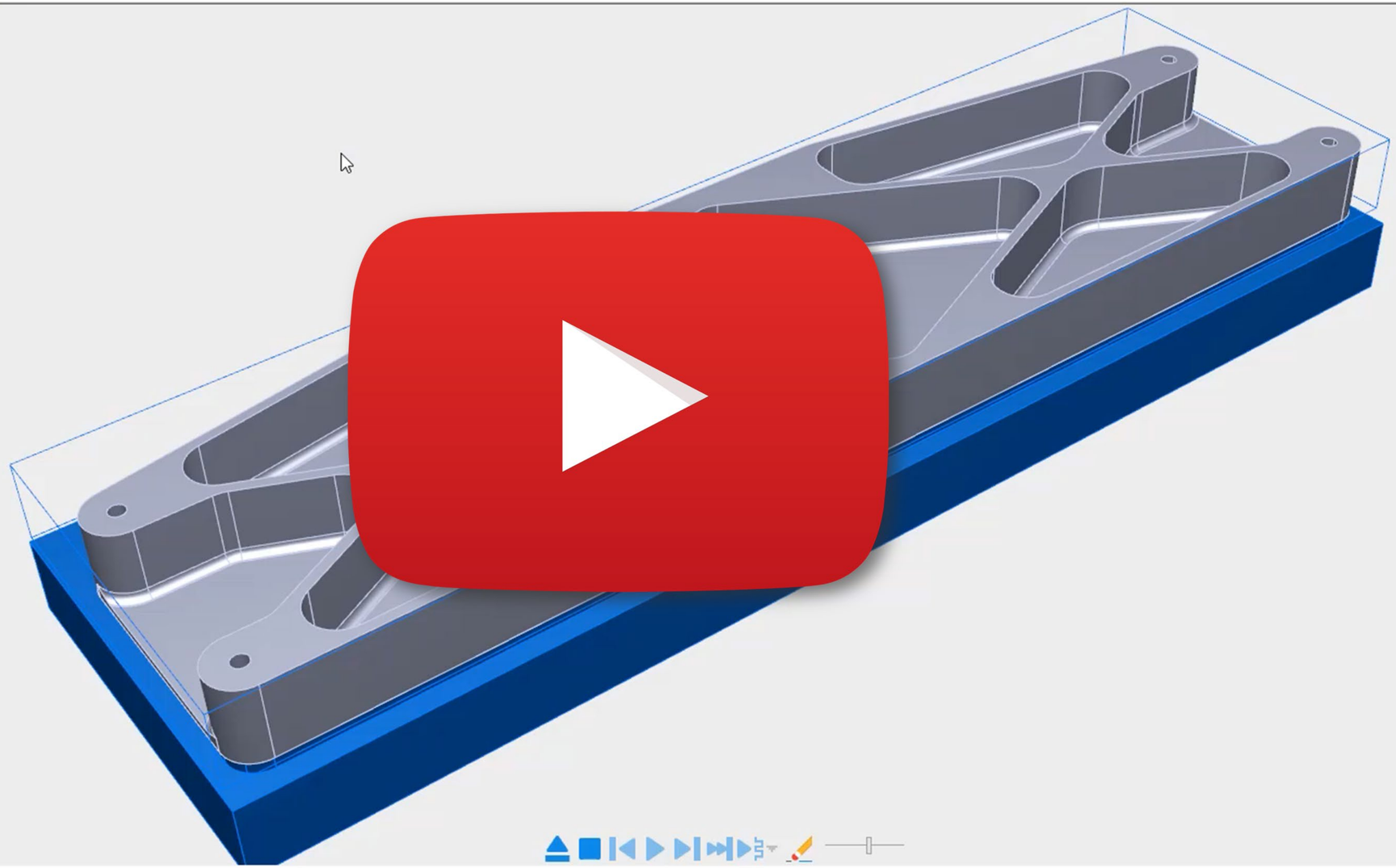
Show | Hide | Shade Surfaces — Display
Stock... | Setups... | Features... | AFR... — Part Program
Geometry | Chaining | Curves... | Surfaces... | Solids... | UCS... | Interrogation... — Create
Sim Mode | Next Tool Color | Show | Results — Simulation
Show NC | Save NC — NC Code
Cut | Copy | Paste | Part Library... — Clipboard
Select | Delete | Transform... | Properties... — Select & Edit
Edit | Save Now | Reload — Options
Shared Views — Collaborate

Part View
Steps
1. Stock
2. Geometry
3. Curves
4. Surfaces
5. Solids
6. AFR
7. Features
8. Toolpaths
9. NC Code
Customize Mfg.
Browser

BloodhoundSteeringSupport_AFRDemo.fm *

TOOLBOX

RESULTS

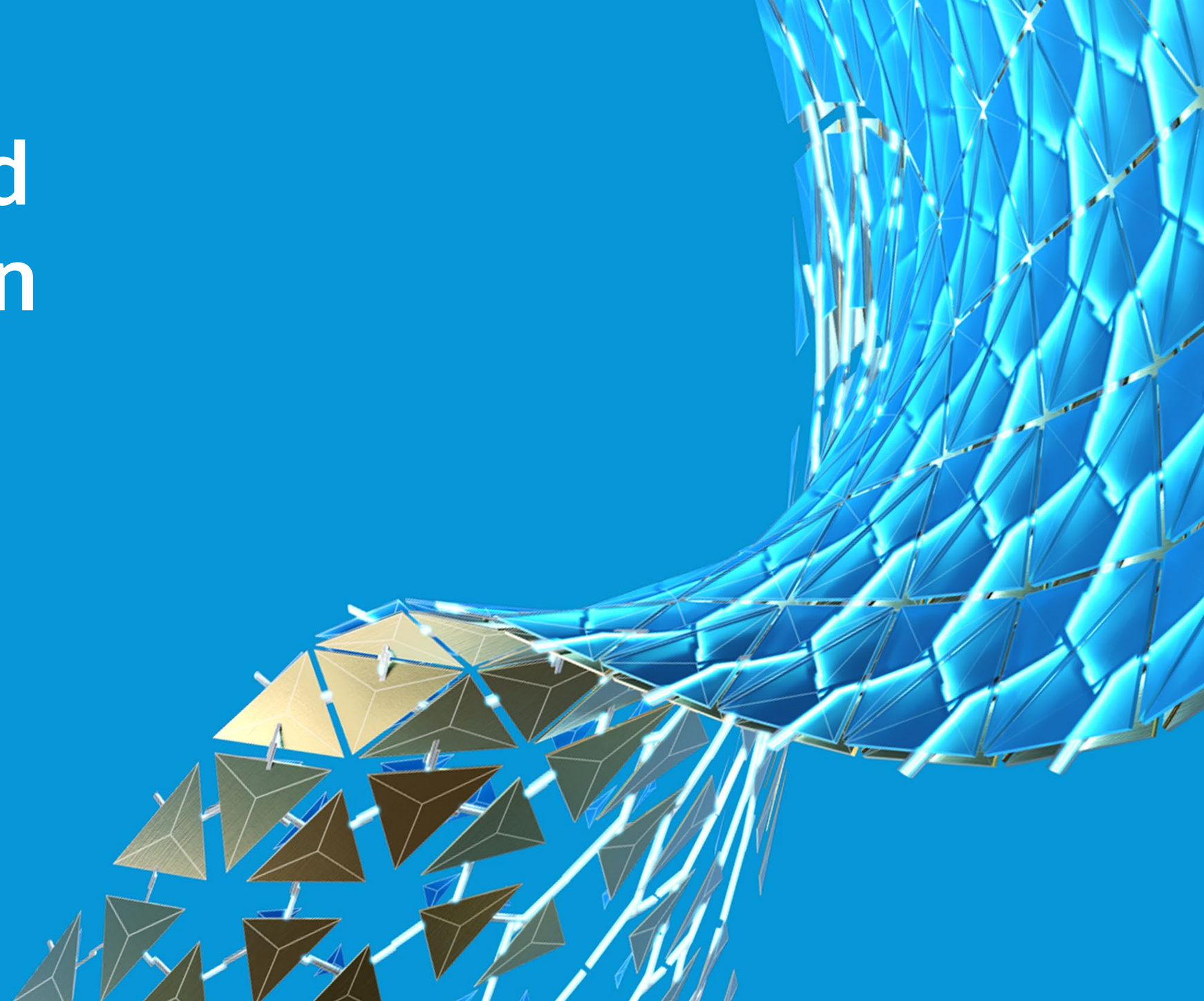


Select something, or click-and-drag a box selection

Properties

[163.376, -168.201, -80.4687] XZ Millimeter Steering Column Mount UCS_Setup1 Setup1 HAAS VF 4x.cnc FC_M_Haas_VF_8_4A_.md tools 4 cores

Customized Automation



Customized Automation

- **Decision Settings can be customized**
  - Modifying default values
  - Saving process templates
- **“Best practice” knowledge is captured**
  - Helps less experienced users
  - Improves programming consistency, repeatability and quality
- **Can be referred to by intelligent automation processes**

Autodesk PowerMill Ultimate 2019 [Editable Project - SD57-Performance-Turbo-Impeller] MULTIAXIS ENABLED

File | Home | Setup | Toolpath | Toolpath Edit | Tool | Boundary | Pattern | Hole Feature Set | Feature Group | Workplane | Model | Stock Model | Machine Tool | Simulation | NC Program | View

Entity: Hub Fin
Tool: VC2MB_3mmBN_TH_Sh
Simulation Path

Increment | Go to Beginning | Step Back | Play | Step Forward | Run to End | Control Speed | 5.0 x feed rate
Simulation Controls

Display Issues | Collision Check
Issues

Machine Tool | Tool
Position

Off | Exit ViewMill | Mode | Shading | Store | Restore | Export | Remaining Material
ViewMill

Auto-draw tool | View
Draw

Explorer

- Active
- Machine Tools
  - > SAUER_US20
- NC Programs
- Setups
  - > G54
  - Calculated Toolpaths
    - Area Clear
      - Area Clearance
    - Hub
      - > Hub Fin
    - Blade
      - Blade fin
- Toolpaths
- Tools
  - > VC2MB_3mmBN_TH_Shank_LongCut
  - VC2MB_6mmBN_TH_Shank_LongCut
- Boundaries
- Patterns
- Feature Groups
- Hole Feature Sets
- Workplanes
- Levels, Sets and Clamps
  - Shroud
  - Start
  - Stop
  - Hub
  - Splitter
  - ExtraSurfaces
  - Fixture
  - Vise Base
  - Lower Hard Jaws
  - Upper Hard Jaws
- Models
  - F2 ORIGINAL
  - splitter
  - ExtraSurfs
  - Fixture
  - 6-Inch-Round-Chuck-Vise
- Stock Models
- Groups
- Macros

491.343 | 4338.69 | 0 | mm | 0.1 | 0.0 | 3.0 | 1.5

Consumer Customization

- Consumer customization can be aided by automation
- Automation can be used reprogram parts
- Features and processes can be saved to databases and recalled later
- Minimal programmer input required

PartLibrary.fm (Milling) - Autodesk FeatureCAM Ultimate 2019

File | Home | Construct | Features/Manufacturing | View | Add-Ins

Show | Hide | Shade Surfaces | Stock... | Setups... | Features... | AFR... — Display / Part Program

Geometry | Chaining | Curves... | Surfaces... | Solids... | UCS... | Interrogation... — Create

Sim Mode | Next Tool Color | Show | Results — Simulation

Show NC | Save NC — NC Code

Cut | Copy | Paste | Part Library... — Clipboard

Select | Delete | Transform... | Properties... — Select & Edit

Edit | Save Now | Reload — Options

Shared Views — Collaborate

Part View

- Global Settings
  - Tool Manager...
  - Spindles and Tool Holders...
  - Feeds Speeds Tables...
  - Part Library...
  - Post Process...
  - Machining Configurations...
- PartLibrary.fm
  - Machining Attributes...
  - stock1
  - Setup1
    - outer-profile-boss
    - inner-pocket
    - pattern1
      - hole1
    - left-dial-aperture
    - right-dial-aperture
  - Stock Models
  - Curves
  - Surfaces
  - Solids
  - Layers
    - Stock models
    - Reference Axis
    - UCS Axis
    - STOCK Axis
    - Setup Axis
    - Stock
    - Part 1
    - Part 2
    - Vise
  - User Views

Steps

Browser

Press eject or stop button to erase the screen.

Properties

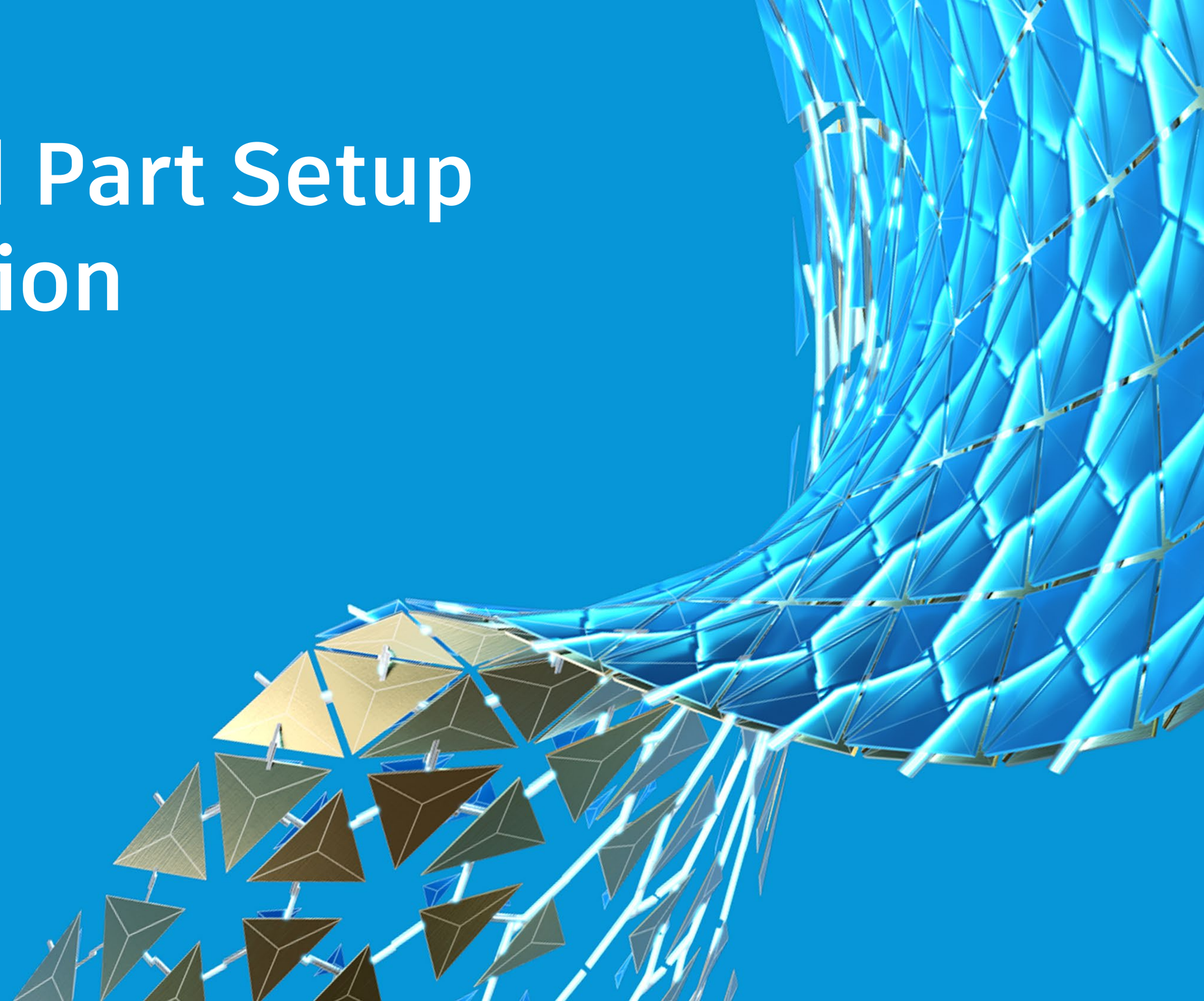
PartLibrary.fm

TOOLBOX

RESULTS

TOP FRONT RIGHT

Automated Part Setup & Verification

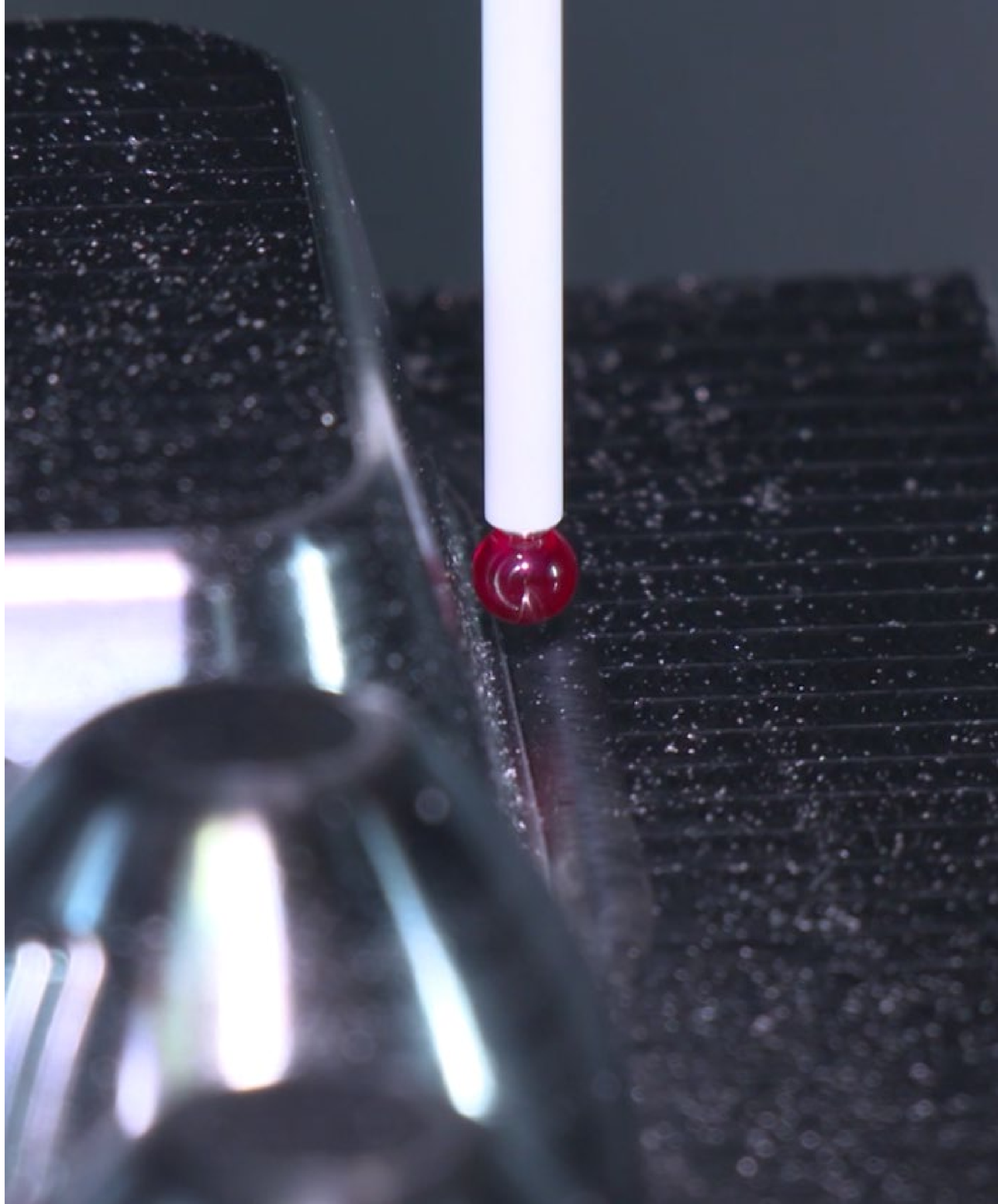


Manual Setup

- **Need to locate stock or mold tool**
  - Difficult to locate accurately
  - Time-consuming
- **Machine is under-utilized**
- **Taking the mold off the machine?**
  - Problems repositioning mold tool
  - Poor repeatability
- **Part accuracy suffers**

Automated Setup & Verification

- **Use machine tool probe**
  - Combine with software to create measurement sequence
  - Allows automated setups and verification
  - Measure complex free-form and prismatic parts, including multi-axis
- **Setup time significantly reduced**
  - Accurate and repeatable
  - Machine tool capacity is utilized for production
- **Verification of part accuracy**
  - Maximizes machine productivity
  - Reduces potential expensive rework
- **Mold and final part accuracy increased**




00:00:04:25
00:00:00:25

Autodesk PowerInspect Ultimate OMV 2019 - [Water Pump Housing Mold.pwi (MM)*]

File | Home | Geometry | Alignments & Datums | Form | Point-Cloud | Probe Path | Measure | Report | Tools | View | Addin Tab

Create: Geometric Group, Geometry, Form, Alignment
Probe Path: Probe & Parameters, Orient, Link, Visibility, Verify, Auto-Avoid
Execute: Play, Simulate, E-Stop
Report: CAD View Image, Note, Interactive Dimensions, Dimensions
Mouse Context: Wireframe Checker, Dynamic Points Editor, Move Probe, Surface Selector, Edit Geometry
Edit: Reset, Delete, Paste, Cut, Copy, Copy as Points
Collaborate: New Shared View

Sequence Tree | Run | CAD | Machine | Shared Views

Simulate Program | NC Program

- Orientation Point 1
- Orientation Point 2
- Intermediate Path 1
- Orientation Point 3
- CAD View Image 8
- Inspection Group 3
- CAD View Image 9
- Intermediate Path 2
- Orientation Point 4
- Intermediate Path 3
- Orientation Point 5
- CAD View Image 10
- Inspection Group 4

Program status: Inactive

0/62

Simulate Program

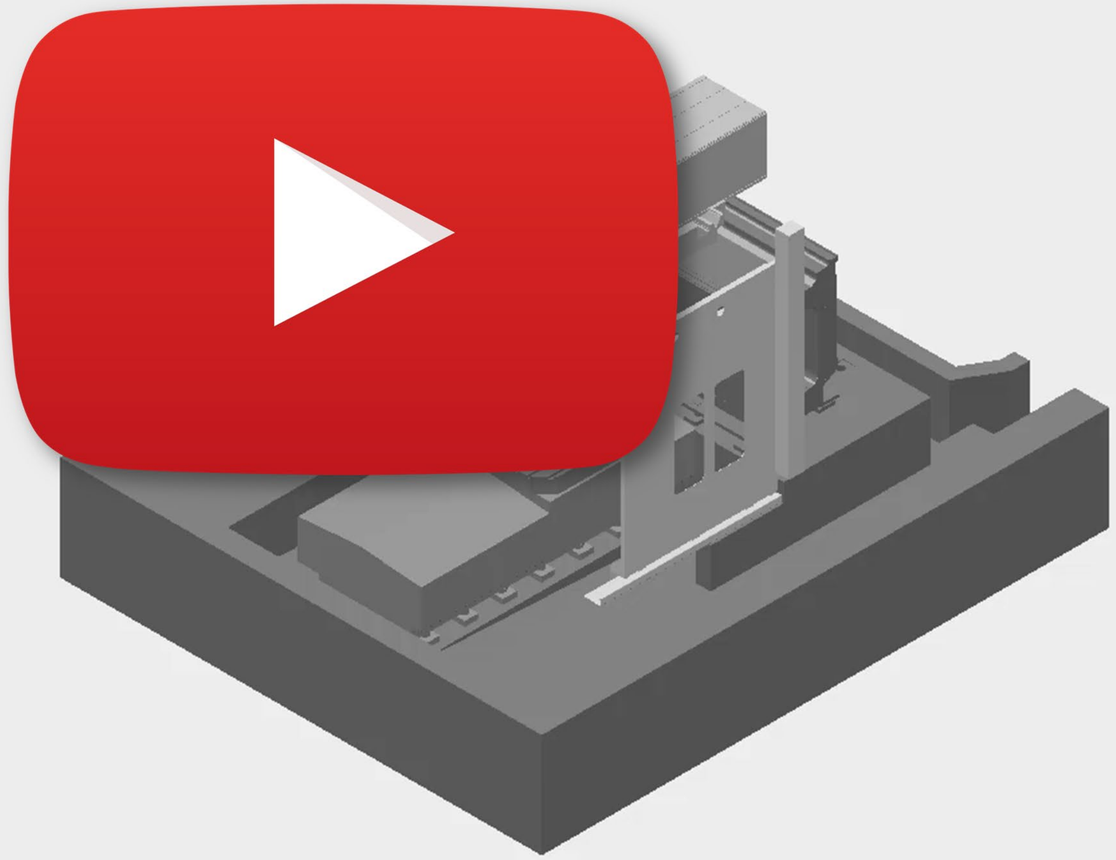
Control

Loop program

Error Handling

Stop on error | Configure...

CNC Error	#	Sequence Item



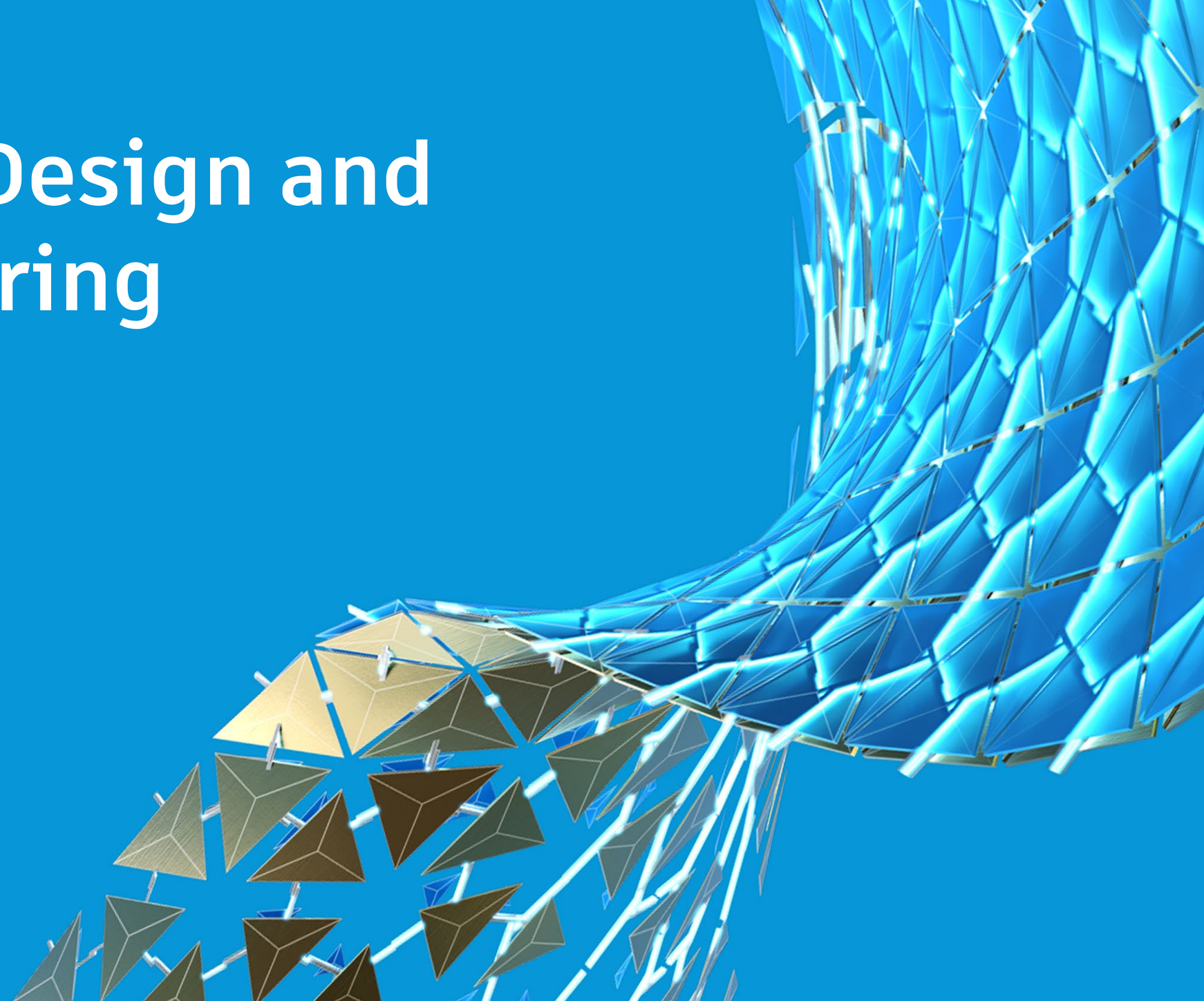
5000

CAD View | Info | Report | Dynamic Points

This box allows you to change the current active group in the sequence tree

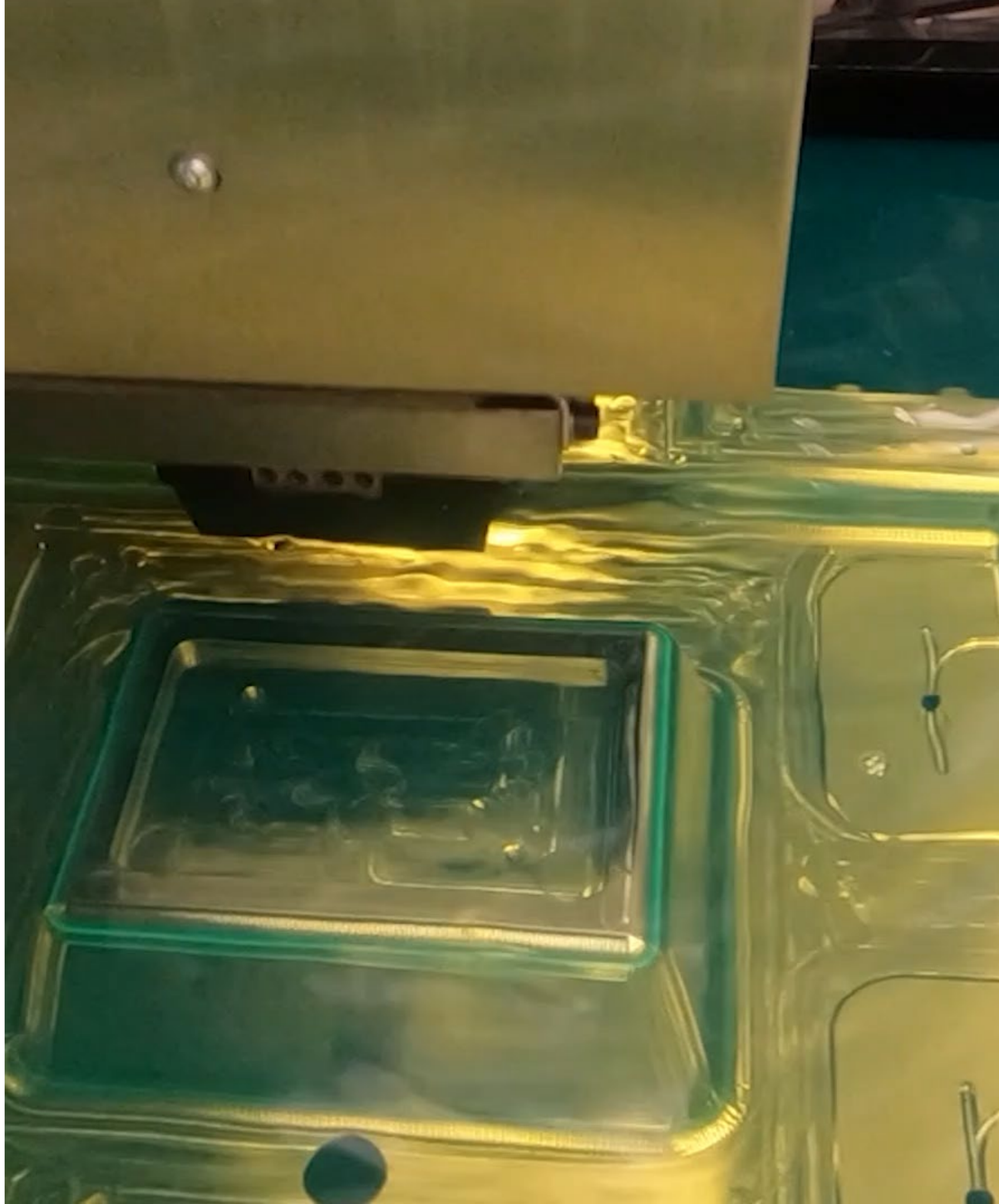
Geometric PLP Alignment 1 <simulated measure> OMP400_100x6_CE - M4_100x6_CE [D 6.0000 mm] PCS 5186.015 -6827.092 1166.543

Electrode Design and Manufacturing



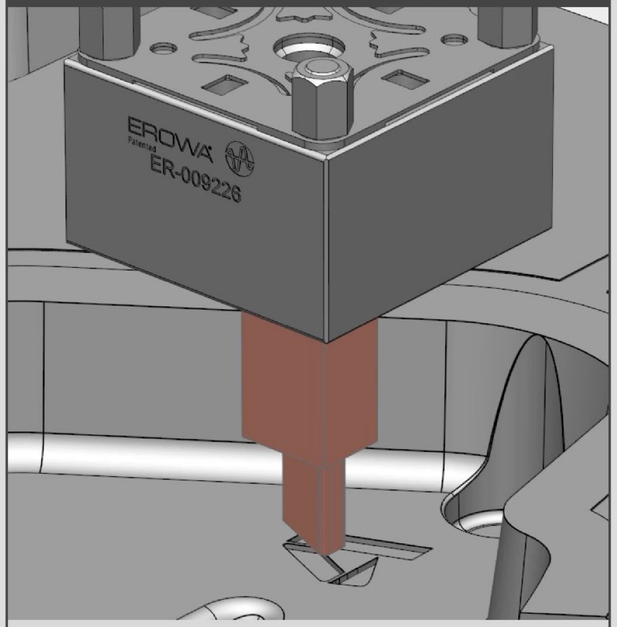
Electrical Discharge Machining (EDM)

- **Machining process using sparks**
- **Used to add detail to mold tools**
- **Necessary where conventional machining cannot be used**
- **Challenges**
  - Electrode accuracy
  - Human error with data entry



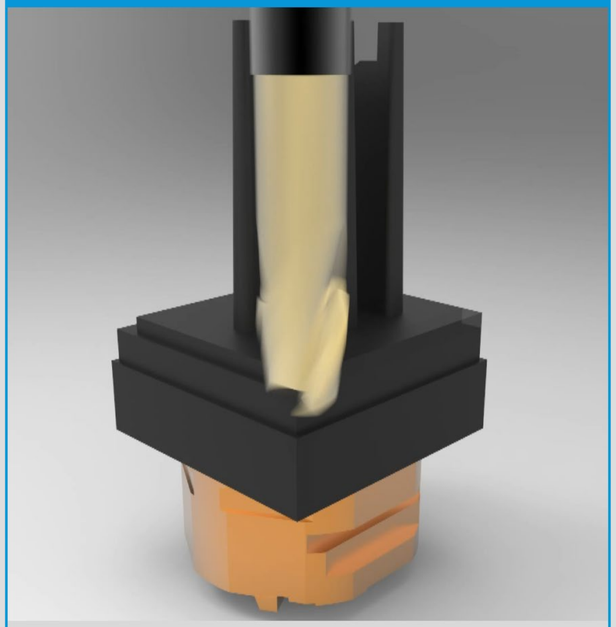
Design and Manufacturing Processes

DESIGN
EXTRACT FROM CAD



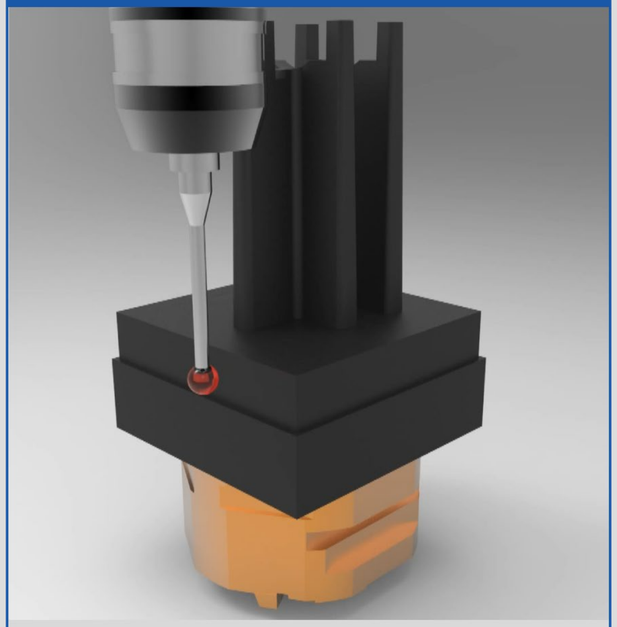
STAGE 1

CAM
CNC MACHINING



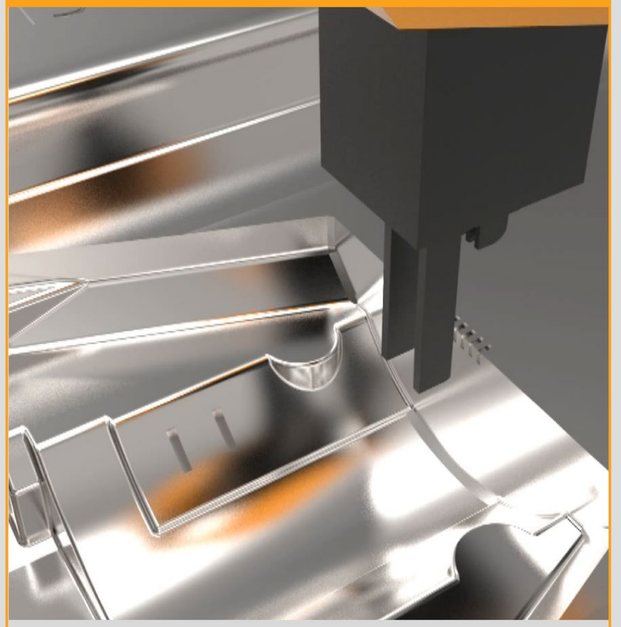
STAGE 2

INSPECT
CMM OR ON-MACHINE



STAGE 3

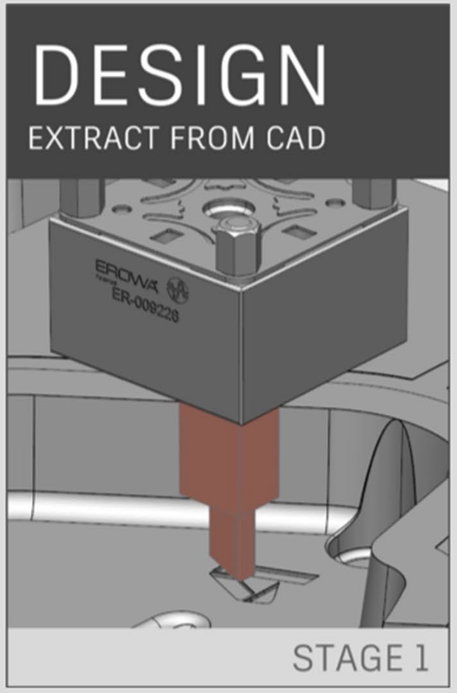
EDM
ELECTRODE POSITIONING

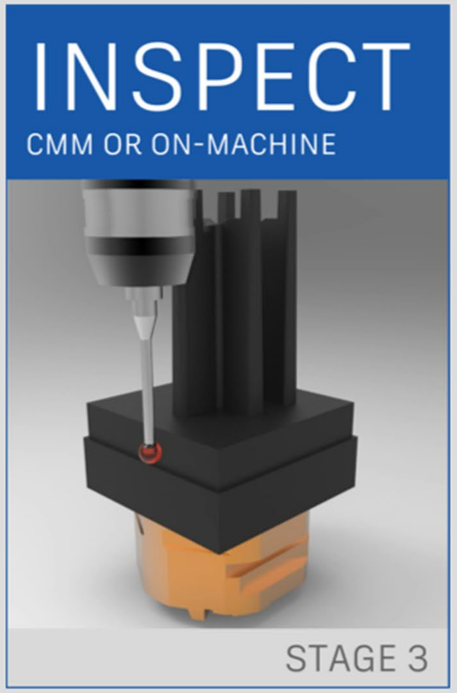


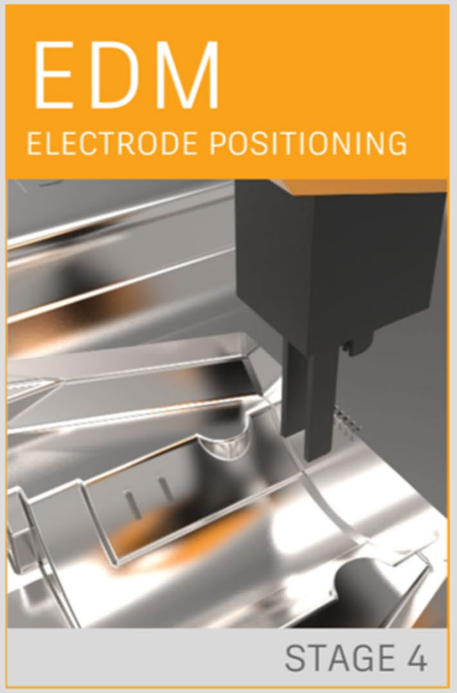
STAGE 4

How Does Software Help?

- **Design**
  - Conventional, direct and assembly modelling
  - Measurement and EDM use information
  - Single file
- **CAM**
  - Automated electrode programming
- **INSPECT**
  - Measure electrode and update EDM usage
- **EDM**
  - Customisable data entered automatically
  - Easily transferred to the EDM machine
- **Closed-loop workflow**





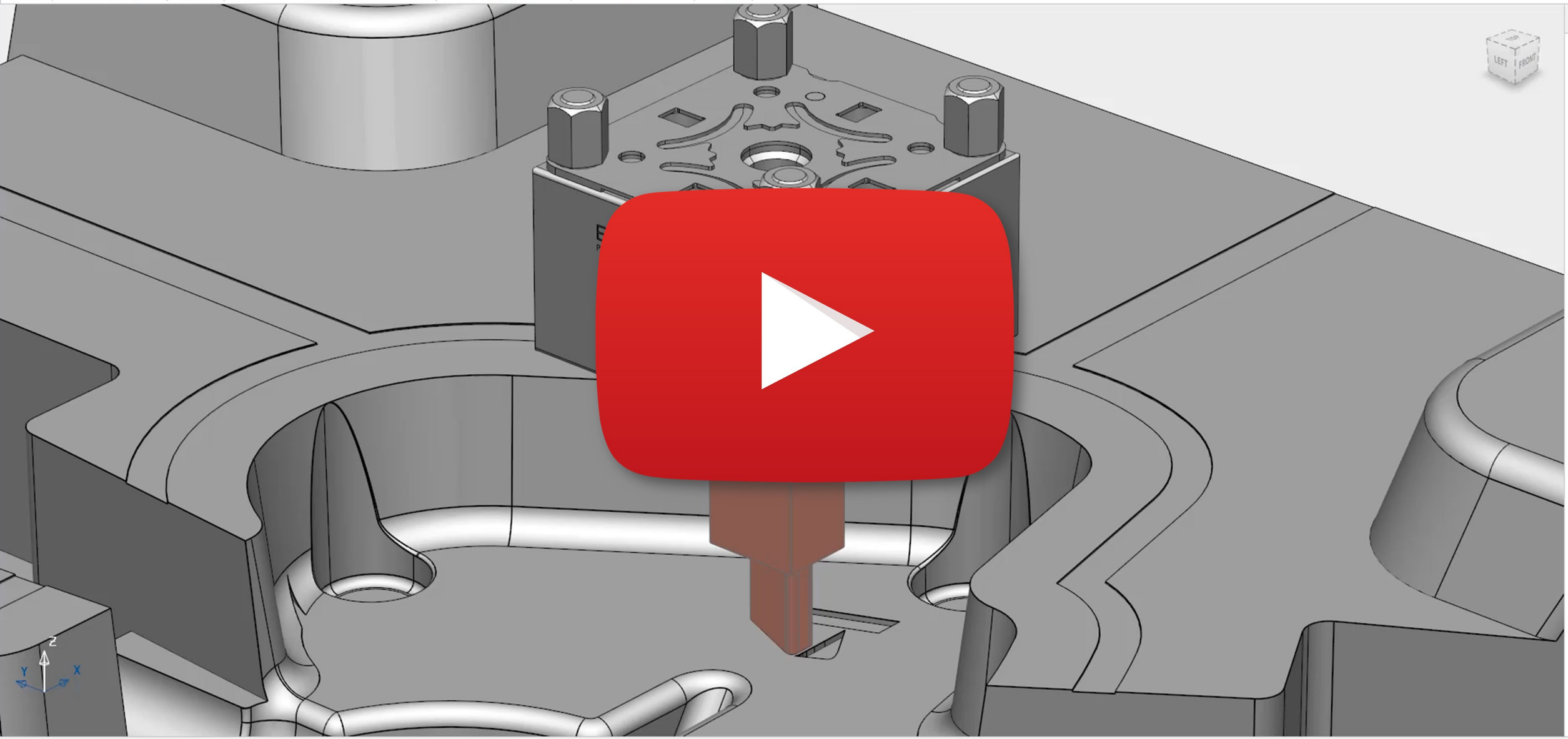


Autodesk PowerShape Ultimate 2019 - [Water Pump Housing Mold]

File | Home | Workplane | Wireframe | Solid | Surface | Assembly | Edit | Wizard | Visualisation | Annotation | Draft | View

Create | Separate Surfaces | Separate Solids | Die | Toolmaker On/Off | Cavity/Core | Moldbase | Mold Lock | Slide Core | Slide | Cooling | Component | Power Feature Trimming | Simulation | Scanner/Probe | Artec | Primitives from Points | Sole | Heel | EVA

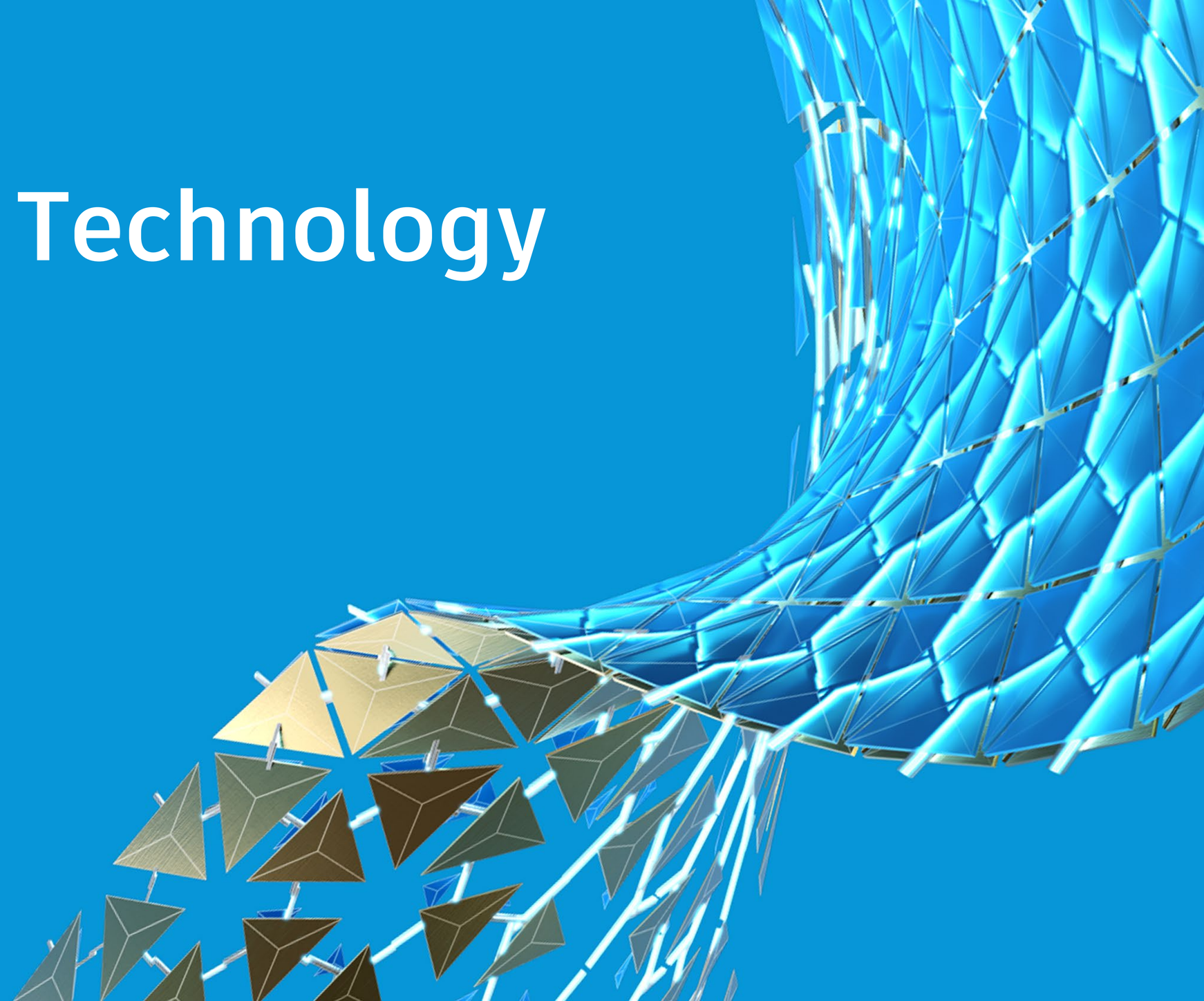
Electrode | Part Splitting | Mode | Create Molds | Modify Molds | Devices | Grading



Mo Coo Con 0 1 2 3 4 5 6 7 10 11 20 100

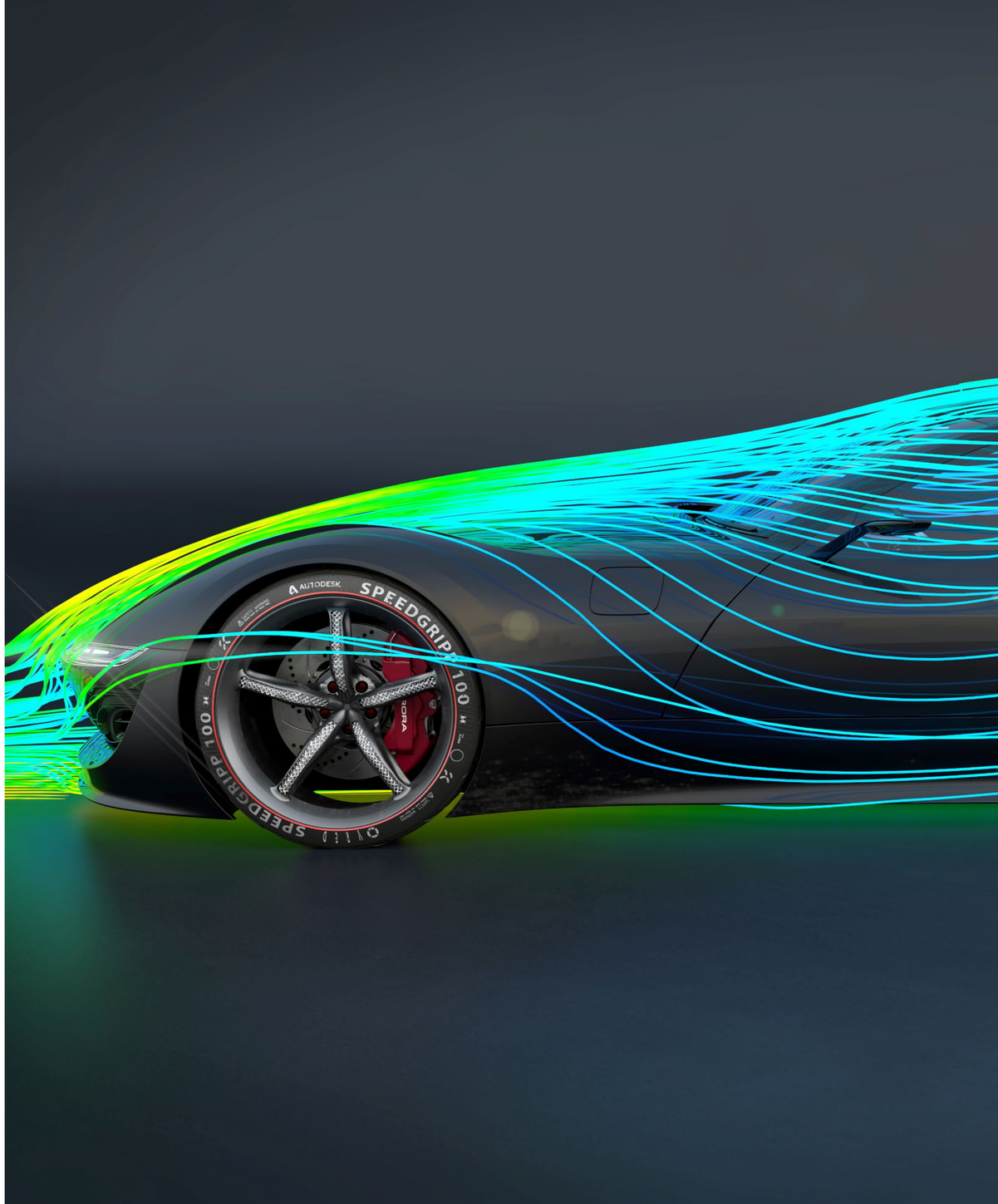
0 : General | 65.586 | -150.96 | 0 | Tol 0.01 | Type Command

Emerging Technology

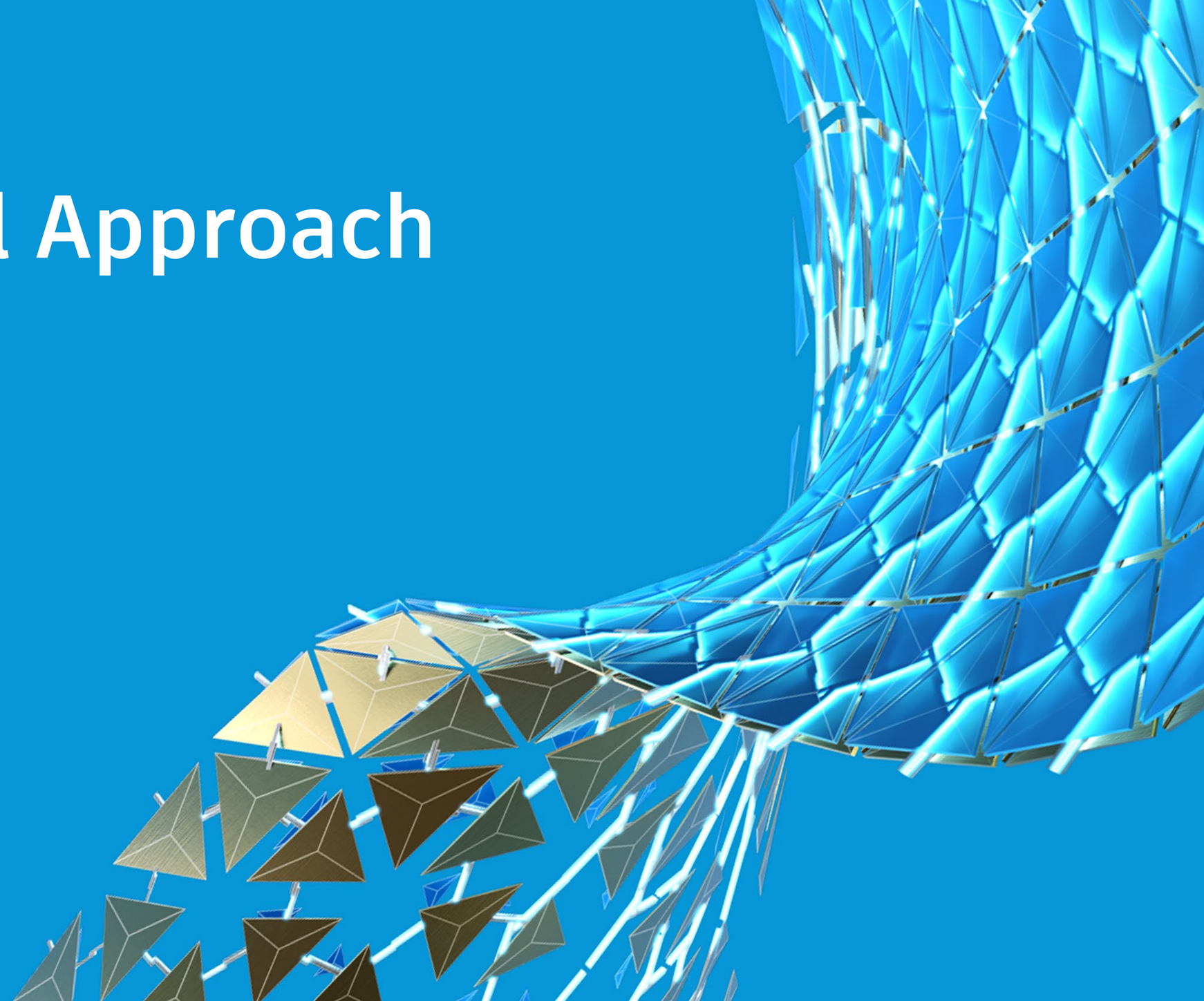


Emerging Technology

- **Constant pressures**
  - Performance
  - Efficiency
  - Sustainability
  - Regulations
- **Look to new design and manufacturing technology to address these pressures**

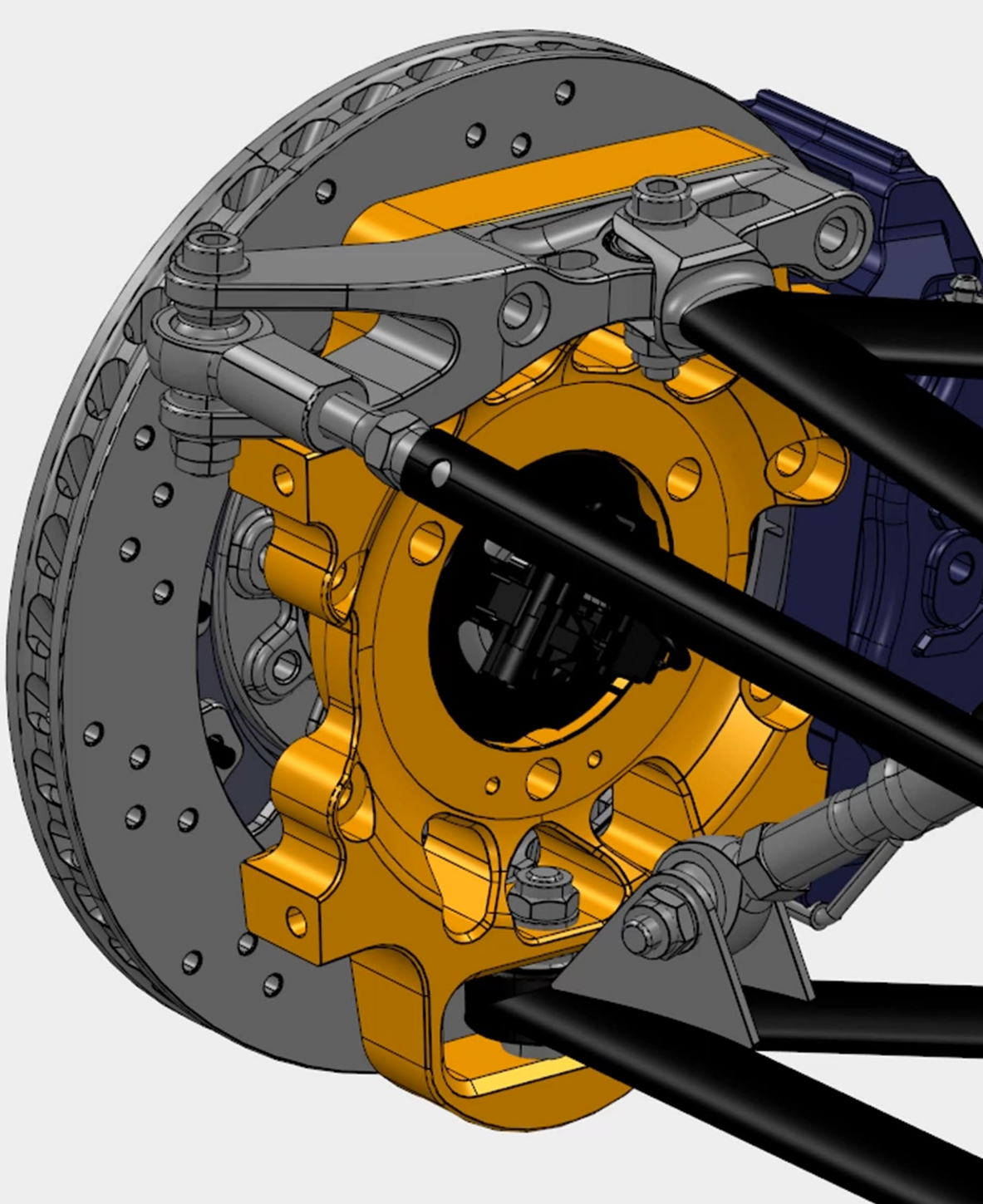


Traditional Approach



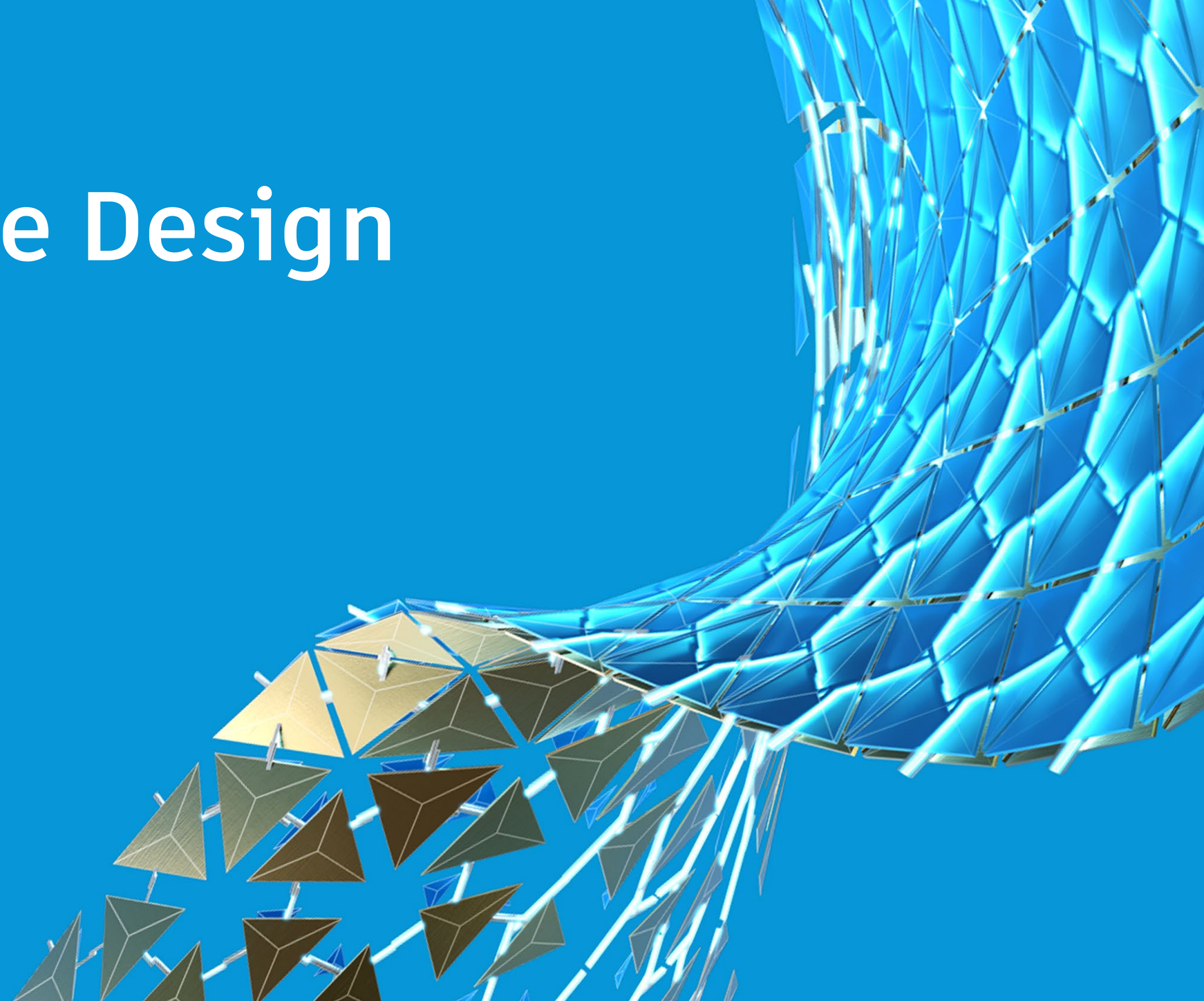
Traditional Approach

- **How might we manufacture serviceable components?**
  - Molding, Casting, Forging, etc.?
- **Performance car suspension upright**
  - How might we manufacture this part?
- **Considerations**
  - High accuracy method
  - Material to withstand loads
  - Smaller production volume
  - Avoid the costs of tooling




Autodesk PowerShape Ultimate 2019 - [Mono]
File
Home
Workplane
Wireframe
Solid
Surface
Assembly
Edit
Wizard
Visualisation
Annotation
Draft
View
From
ISO
User
Angle
Last
Refresh
Views
Resize to Fit
Zoom
Rotate & Pan
Navigate
Shade
Wireframe
Mesh
Appearance
Blanking
Unblank
Visibility
Cross Hair
Cursor
User Interface
New
Arrange & Switch
Window
Z
Y
X
World
-135.08
0
246.283
Tol 0.01
Type Command

Generative Design



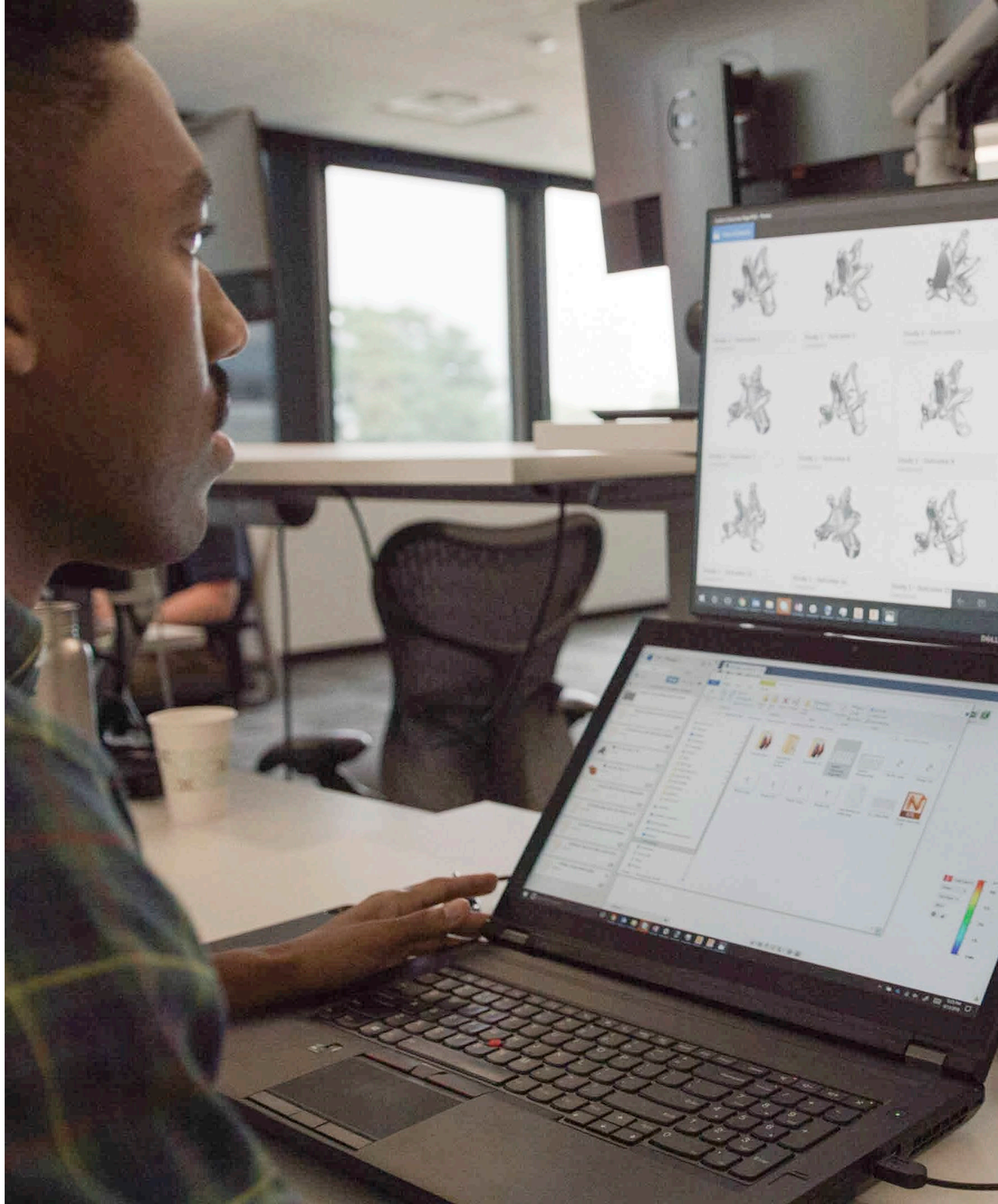
Challenges

When designing automotive parts…

- **Limited time to conceptualize**
- **Increasing demand for engineering expertise**
- **Design and manufacturing disconnect**
- **Late-stage changes are cost prohibitive**

Autodesk Generative Design Technology

- 1 Designer
- Hours vs Days/Weeks
- Fraction of the Cost
- A design exploration and manufacturing solutions technology
- Multiple CAD-ready solutions
- Real-world manufacturing constraints & performance requirements

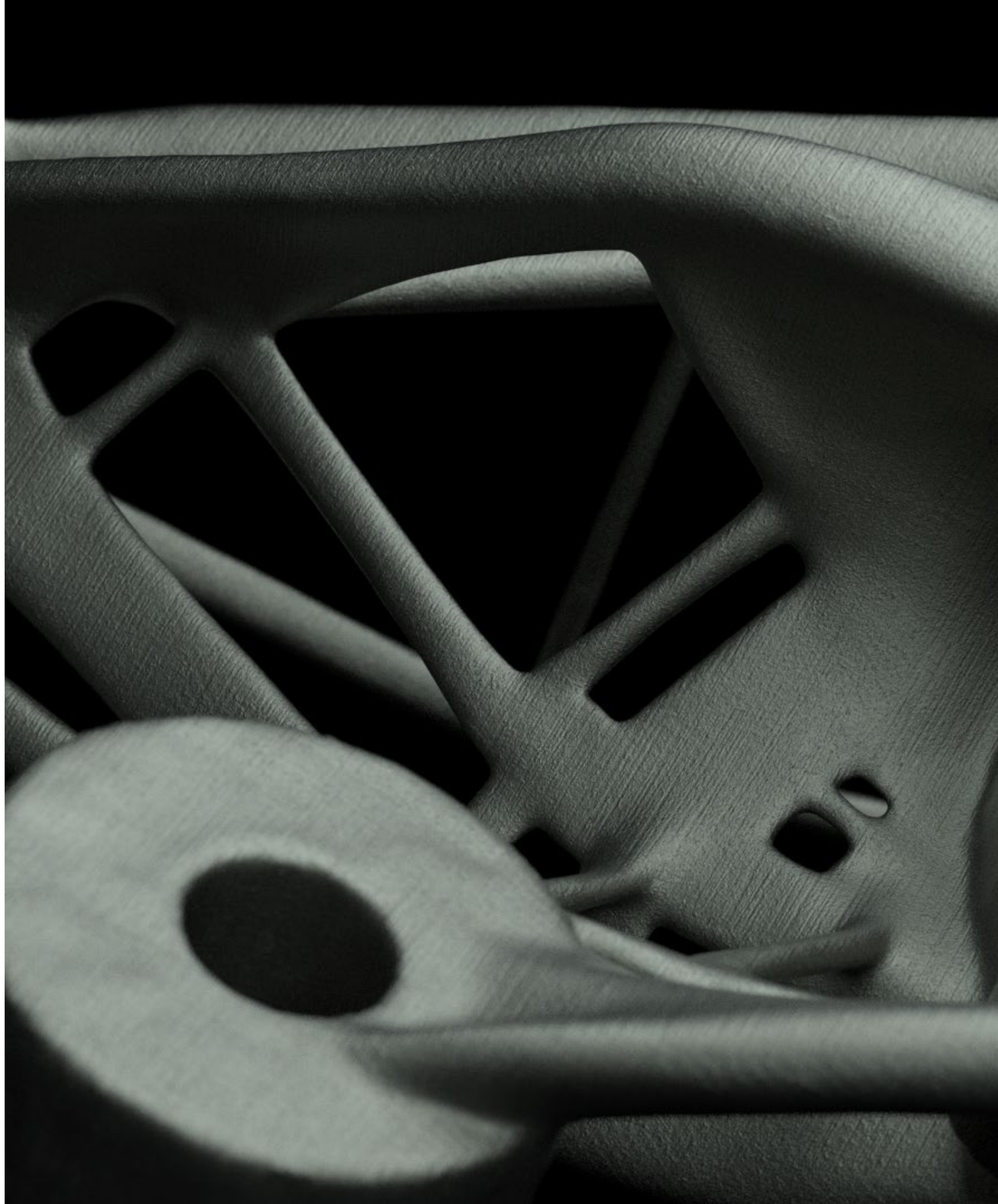


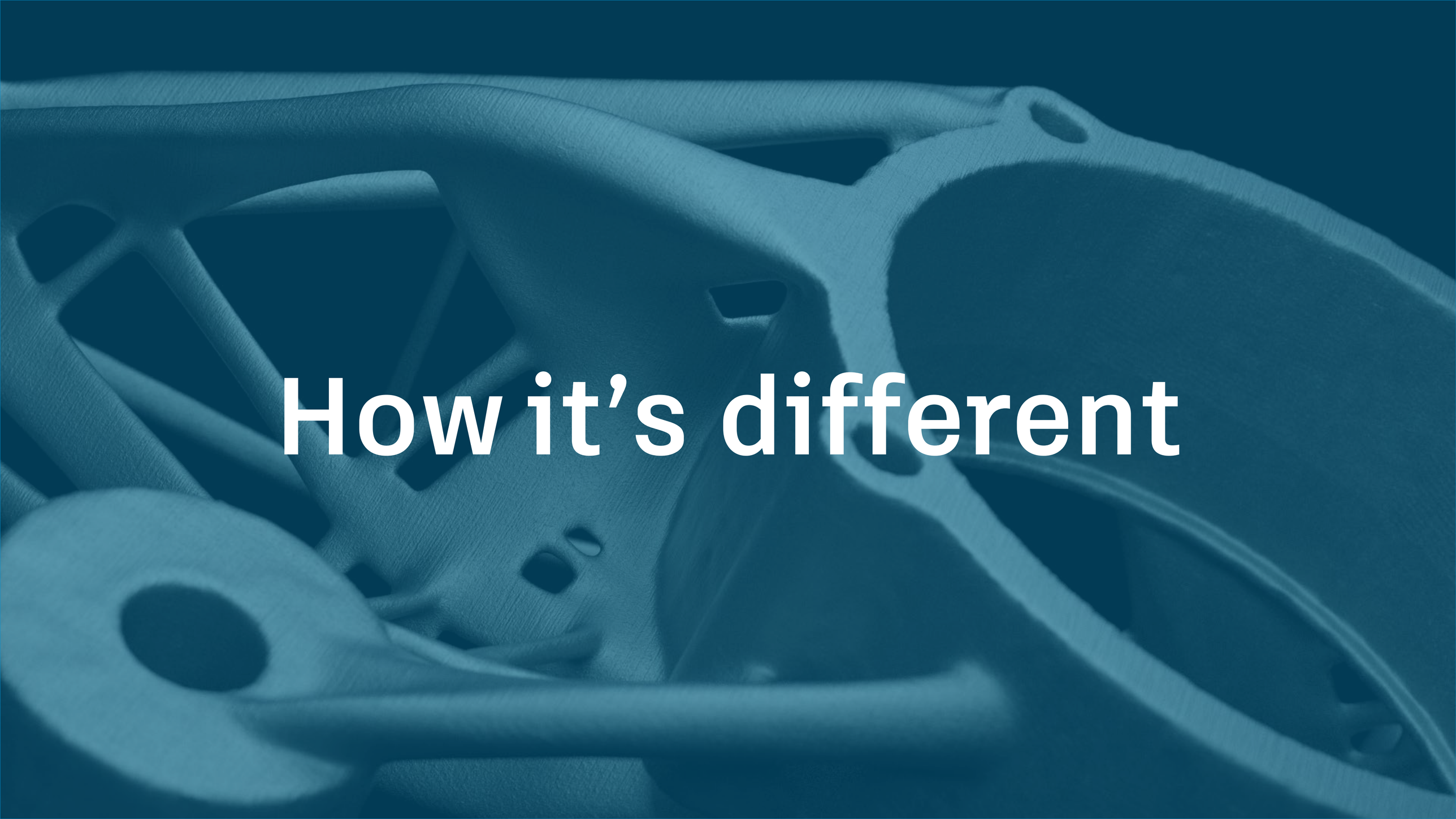
Relatable Process

- **Solving problems the way we were trained:**
  - What is my performance criteria?
  - What constraints need to be considered?
  - What are my fabrication options?

Project Objectives

- Innovation
- Performance
- Process Improvement
- Cost Improvements





How it’s different

Multiple Outcomes

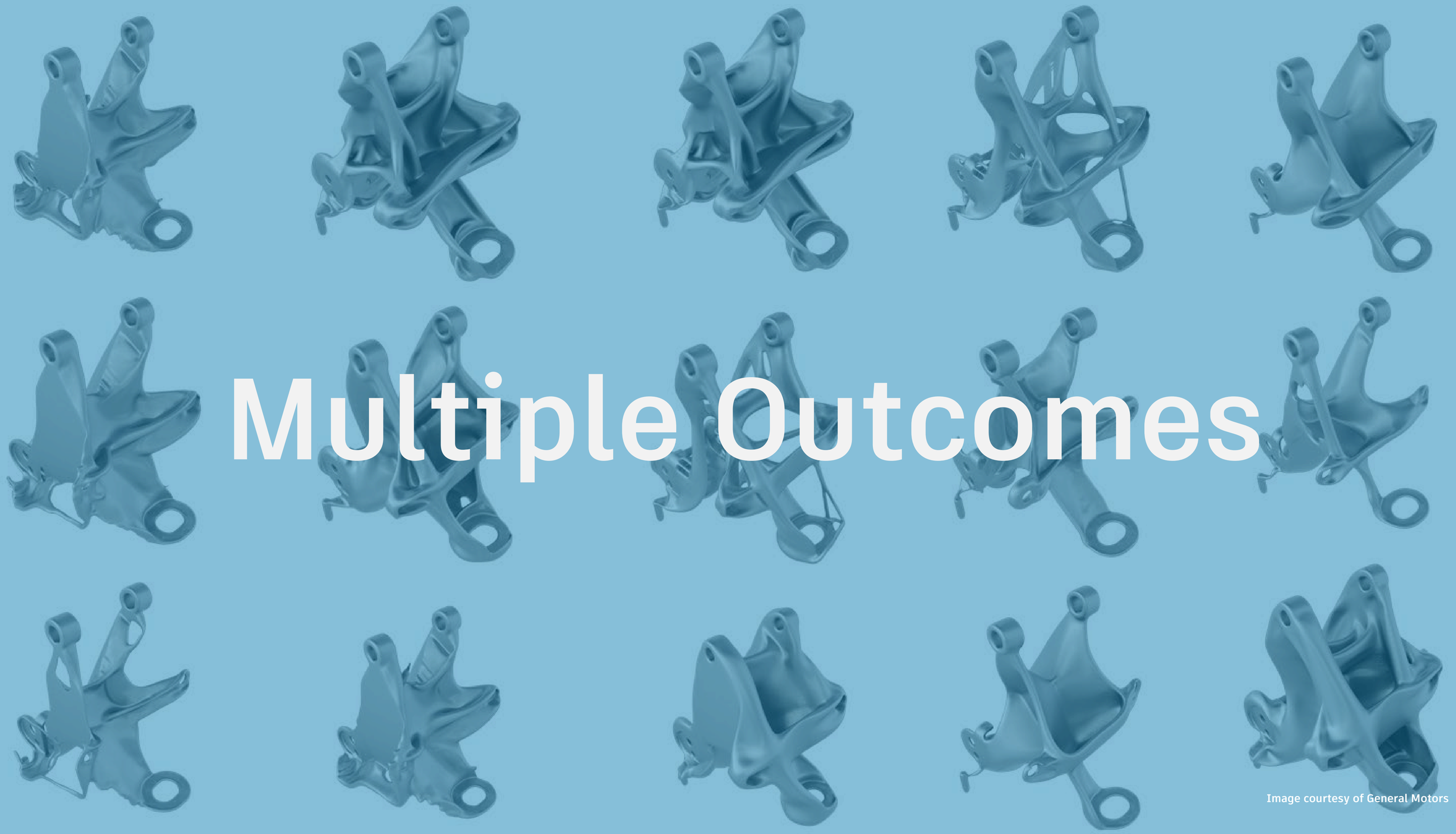
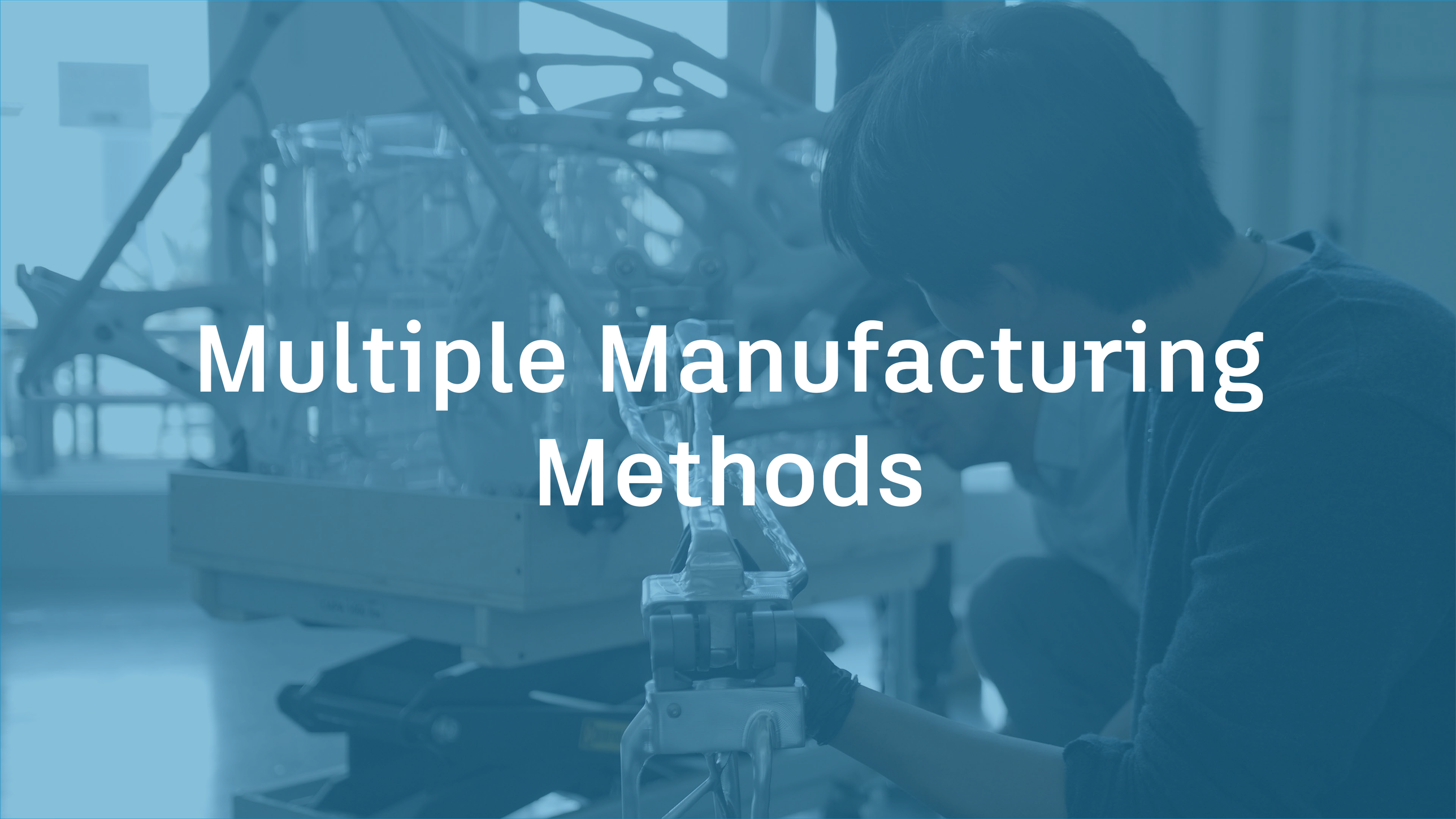


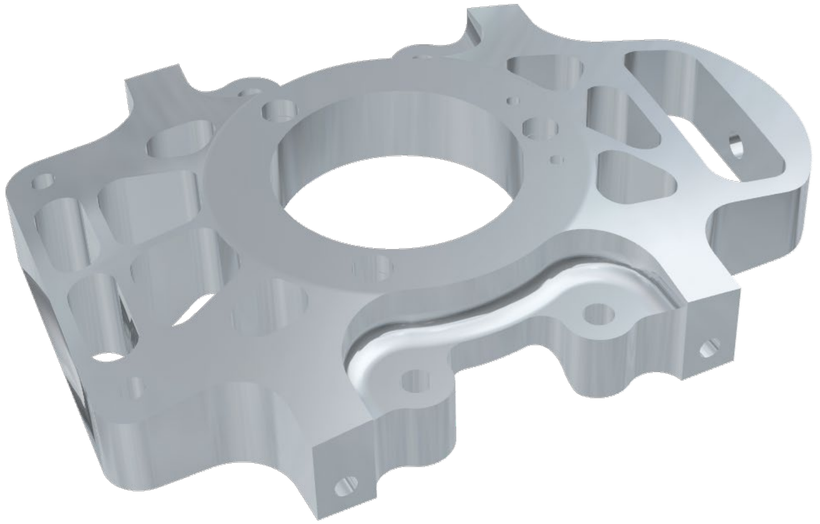
Image courtesy of General Motors

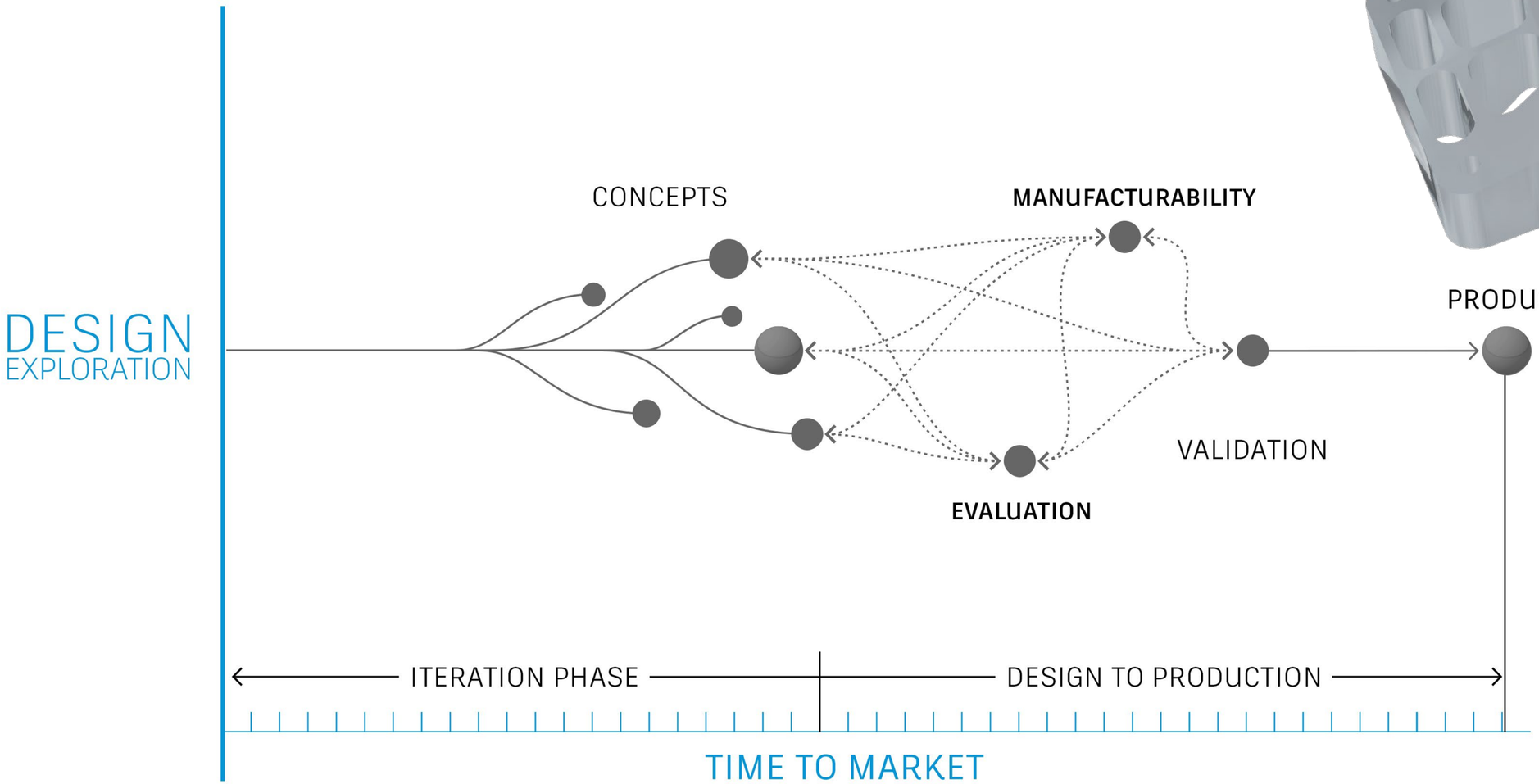


Multiple Manufacturing Methods

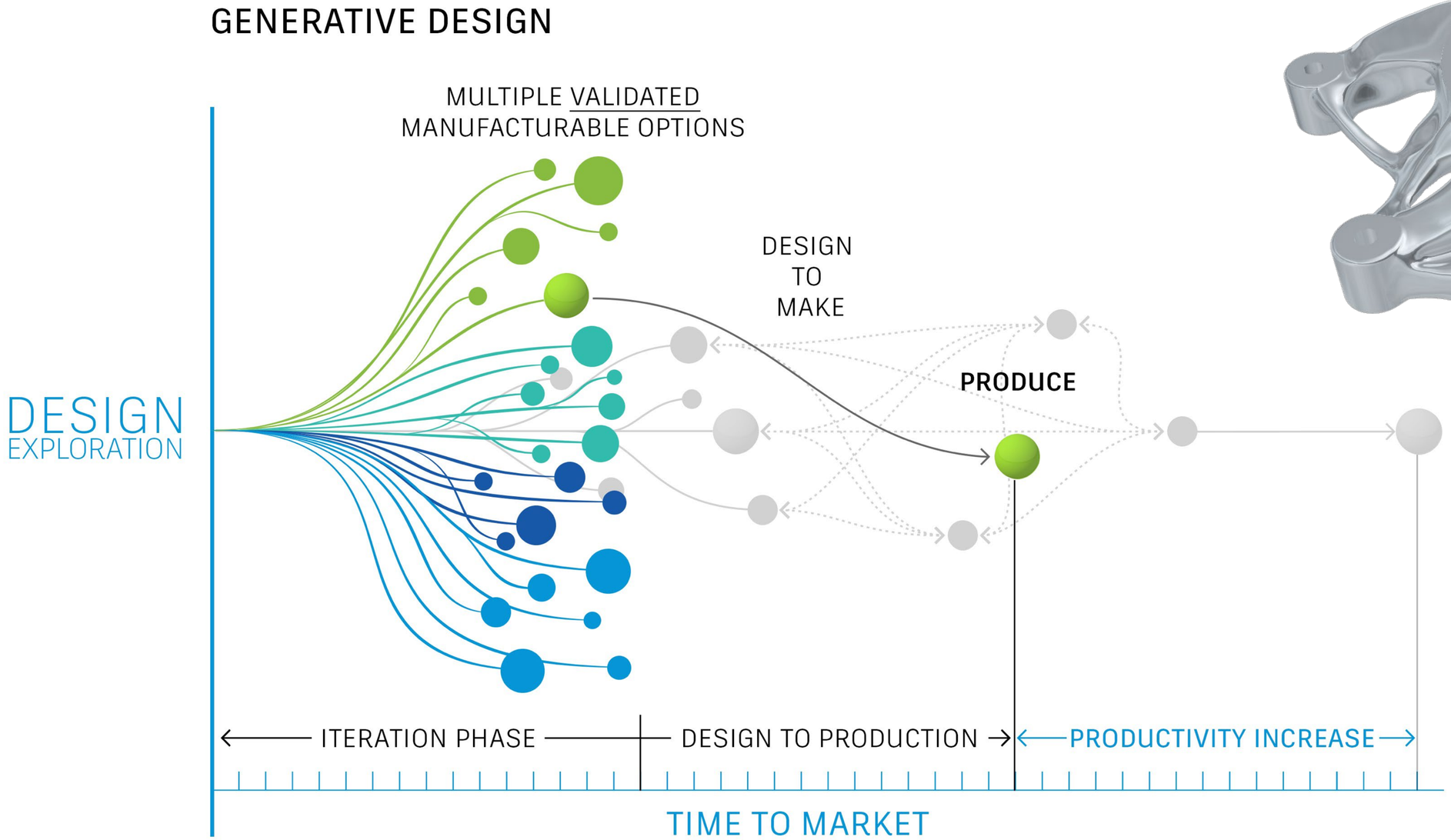
The Traditional Product Development Process

TRADITIONAL





Autodesk Generative Design: Improved Productivity



Autodesk Fusion 360

BAC Mon..._CC v2*

Curtis Chan

DESIGN

SOLID SURFACE FORM MESH TOOLS

CREATE MODIFY ASSEMBLE CONSTRUCT INSPECT INSERT SELECT

BROWSER

- BAC Mono Front Left Assem...
  - Document Settings
  - Named Views
  - Selection Sets
  - Origin
  - Analysis
  - Joints
  - Sketches
  - M-CH-1175-001 v28:1
  - M-FS-1004:1
  - M-FS-1004 (1):1
  - Generative Geometry:1
  - M-FS-1005 v1:1
  - EDITED Study14-Outcome4-36:1
  - CAM Setup 1 Workholding:1
  - CAM Setup 2 Workholding:1
  - CAM Setup 3 Workholding:1

COMMENTS

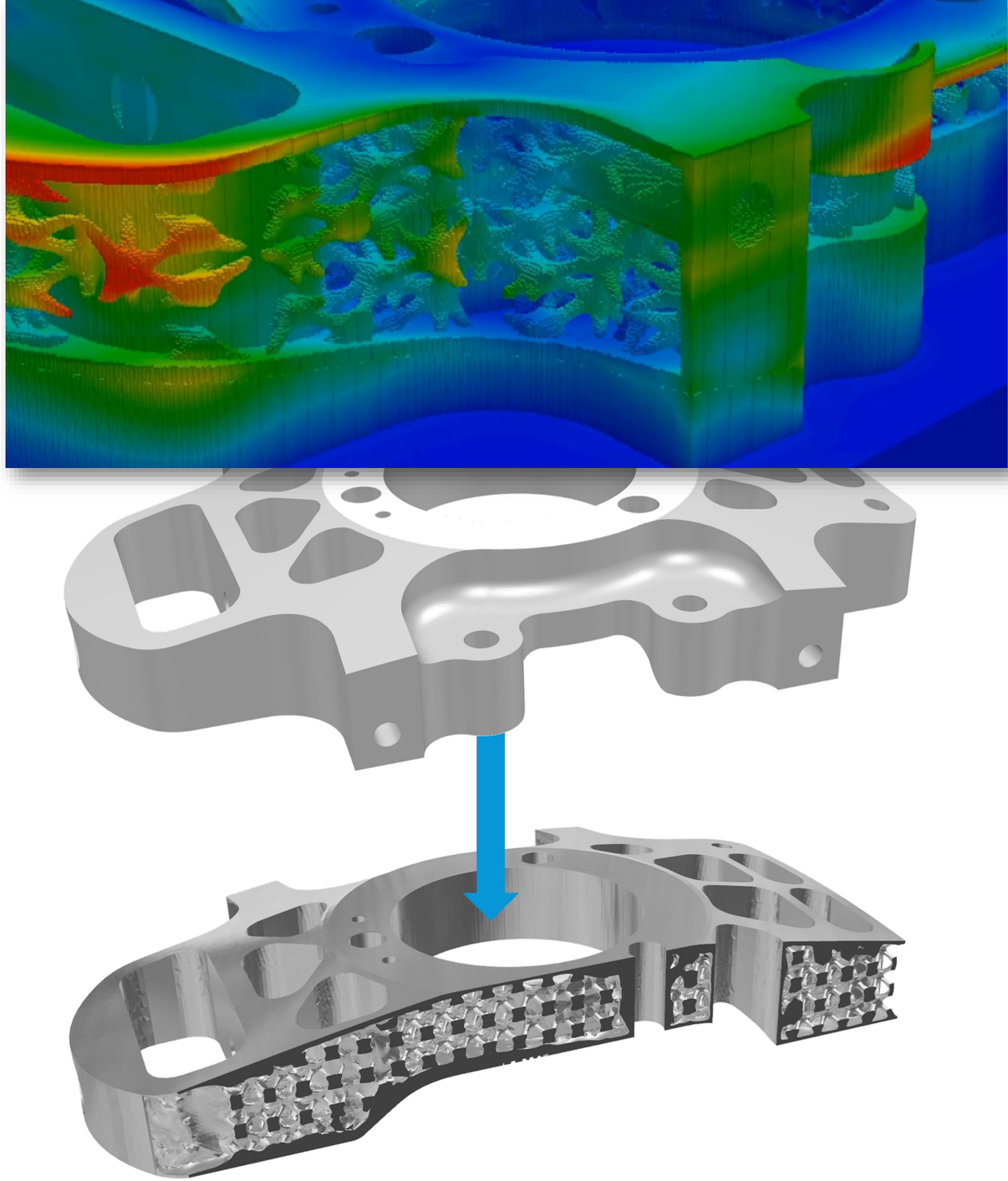
Additive Manufacturing

Challenges

- Improve part performance
- Need to address more complex parts
- Shorter lead times
- Minimizing tooling costs
- Reduction in labor costs from assembly

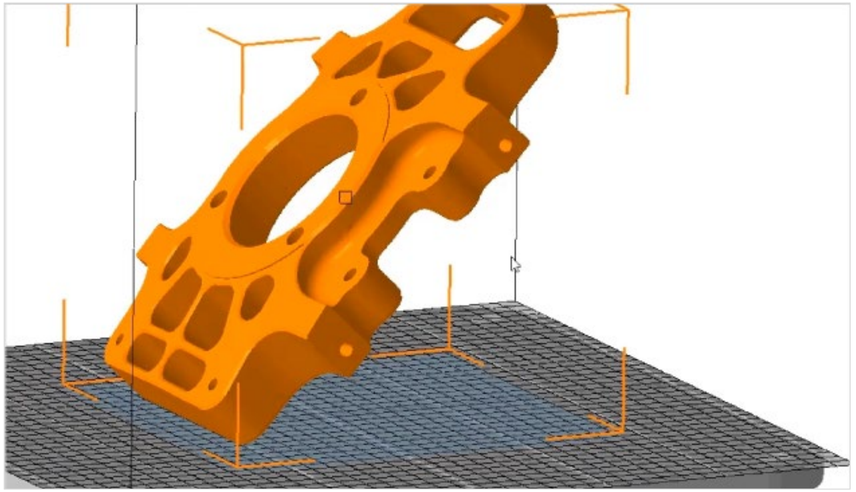
How Can Additive Manufacturing Help?

- **Builds parts layer by layer**
- **Can exploit Lattice Optimization**
  - Maximize stiffness
  - Minimize mass
- **Part consolidation**
- **Part built directly from CAD design**
  - Minimize lead time
  - Reduced costs associated with tooling

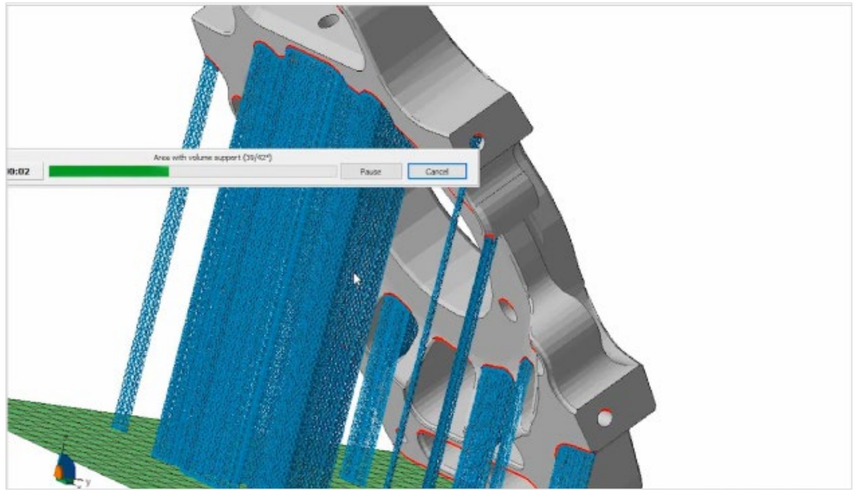


Additive Manufacturing - What do we need to be successful?

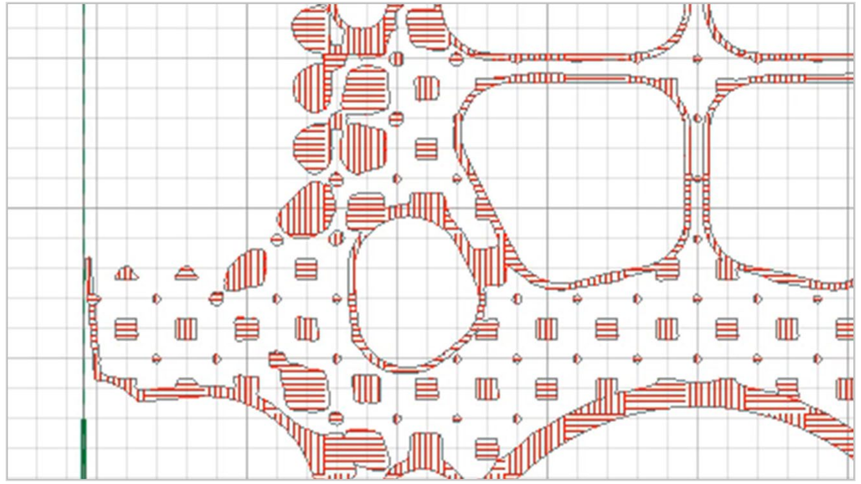
Orientation & Nesting



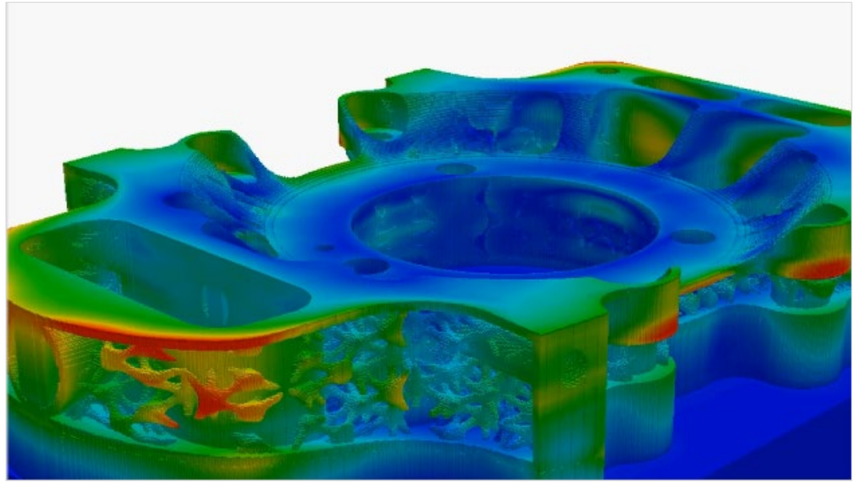
Part Support



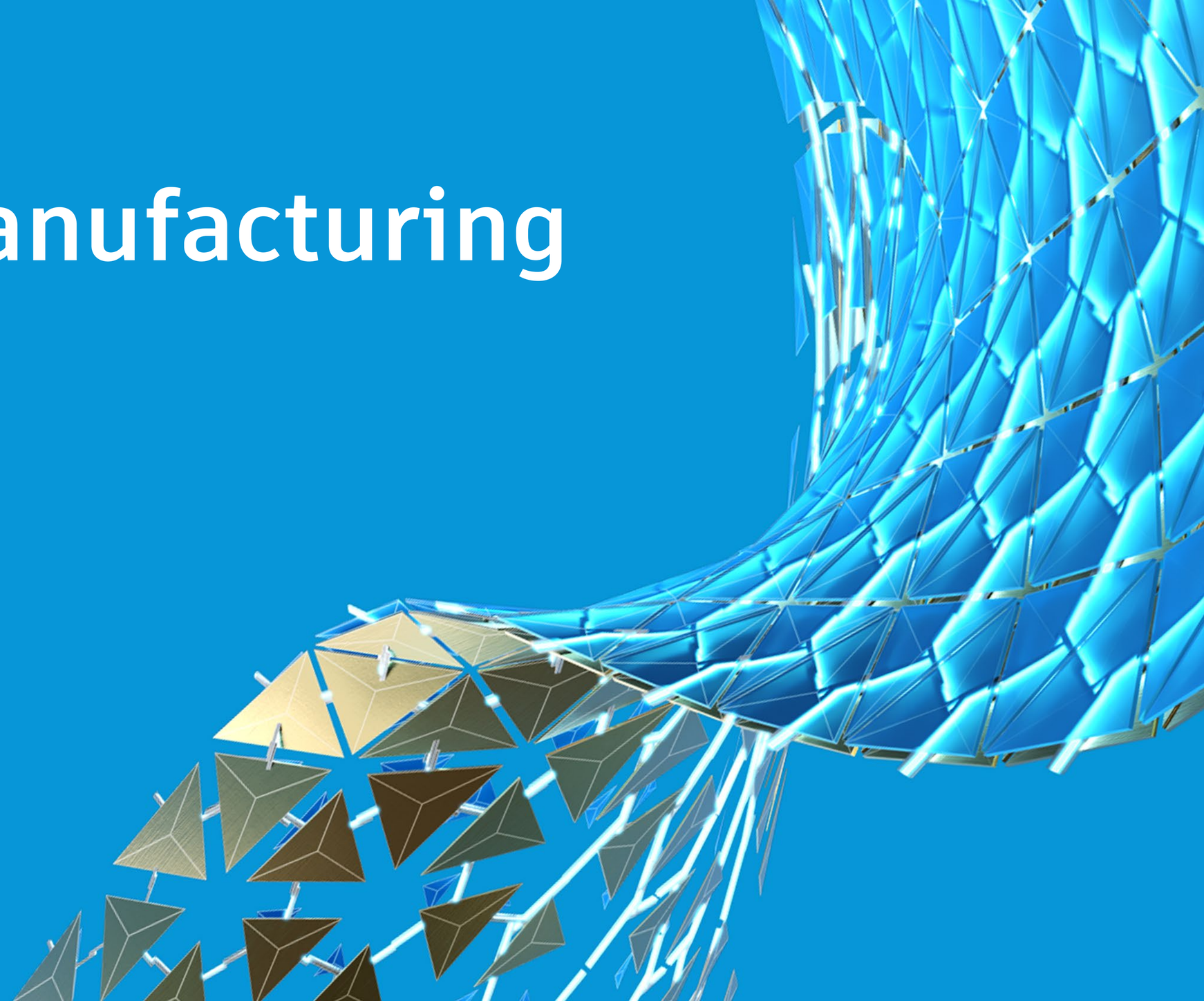
Toolpath Creation



Build Simulation



Hybrid Manufacturing



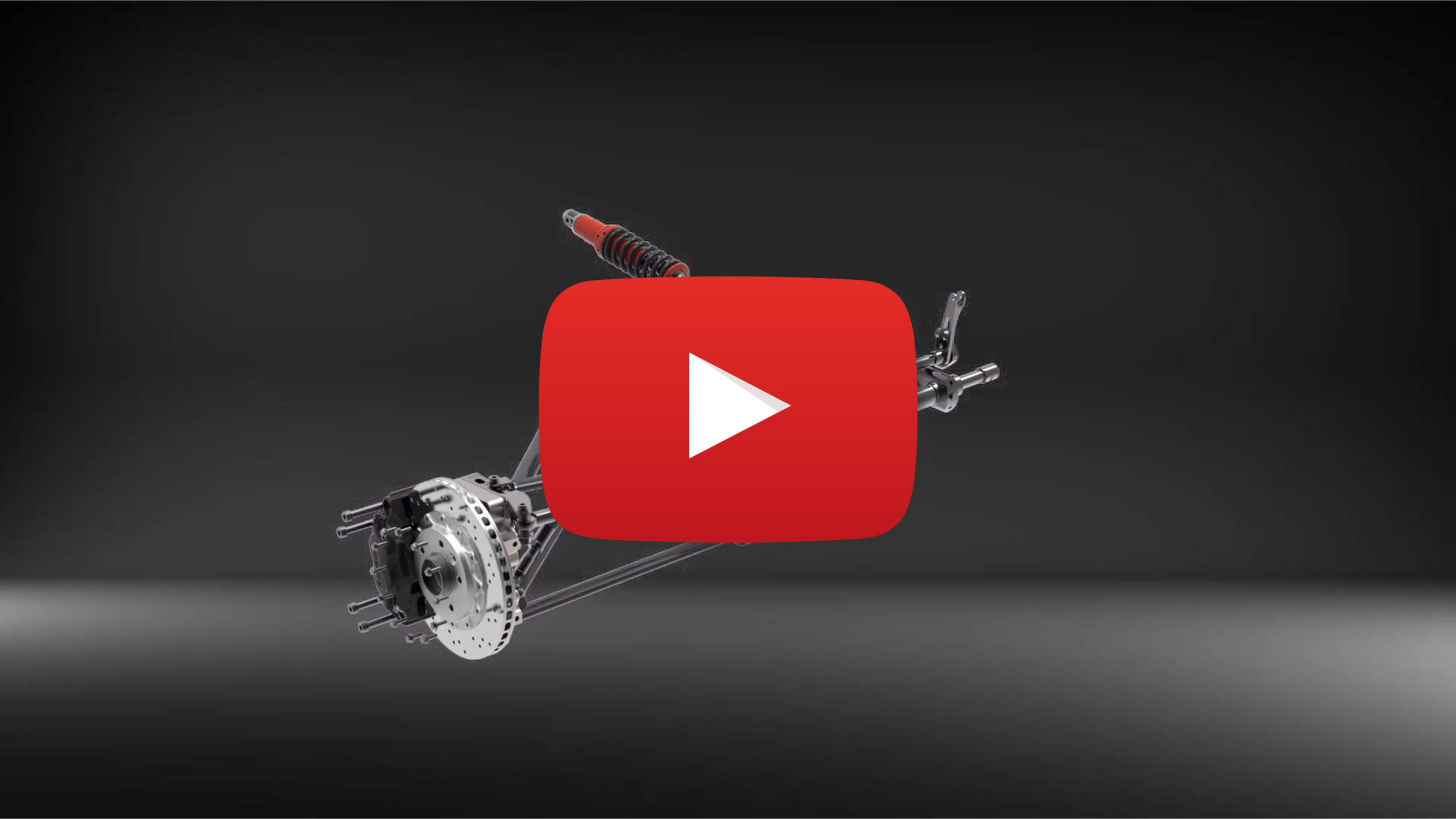
Challenges

- **Adequate part accuracy**
  - Mating faces
  - Sealing faces
  - Tapped holes
- **Stock allowances**
- **Factory floor space**

Hybrid Manufacturing

- What do we mean by Hybrid Manufacturing?

- Combination of Additive and Subtractive manufacturing



Automotive Upright Results - How do the parts compare?

Original Design
Subtractively Machined
From Solid Billet

1693 grams

Generative Design
Subtractively Machined
From Solid Billet

1365 grams
(19% Lighter)

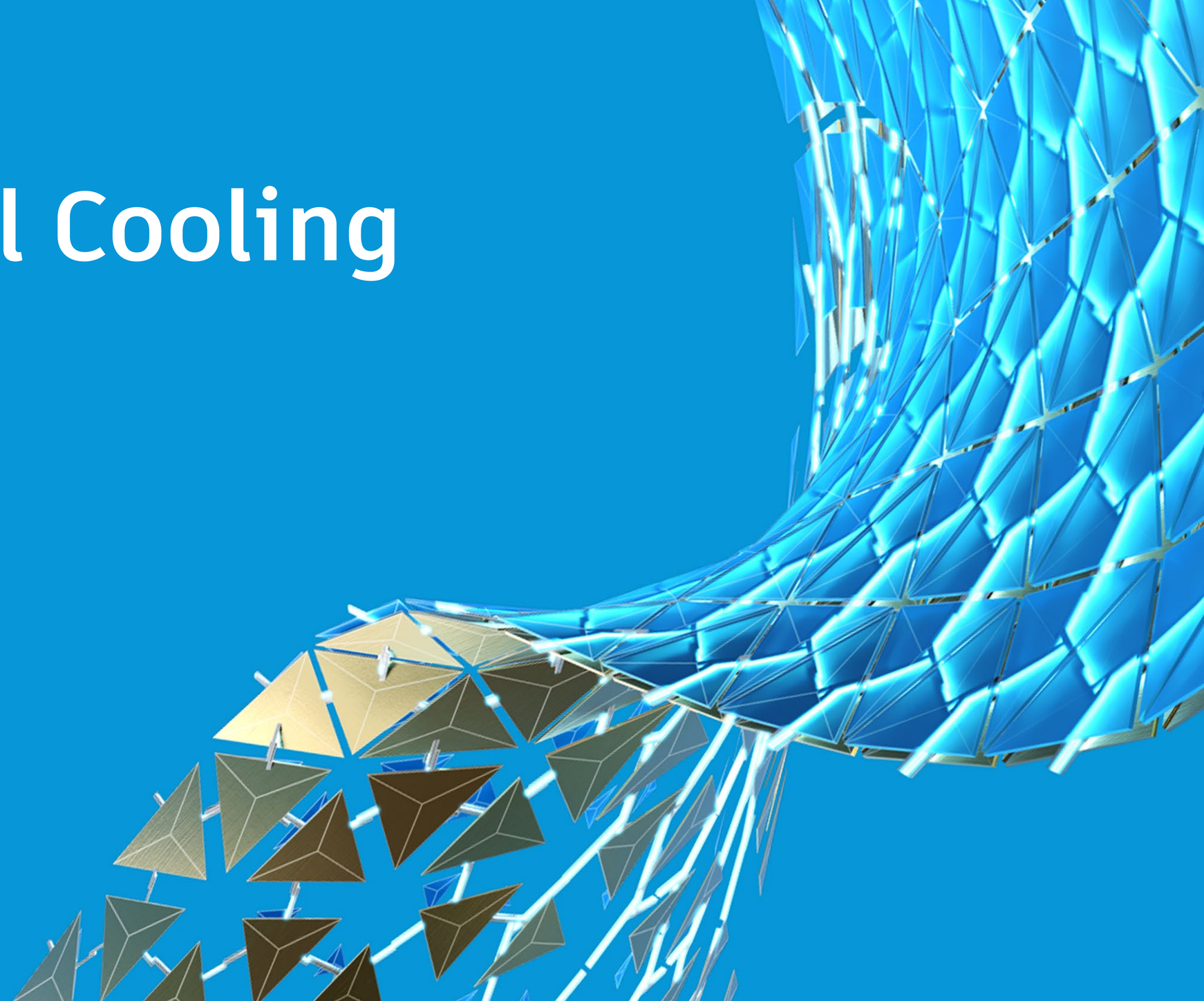
Latticed Prismatic
Additive/Subtractive (Hybrid)
Manufacture

924 grams
(45% Lighter)

Generative Design Latticed
Additive Manufacture

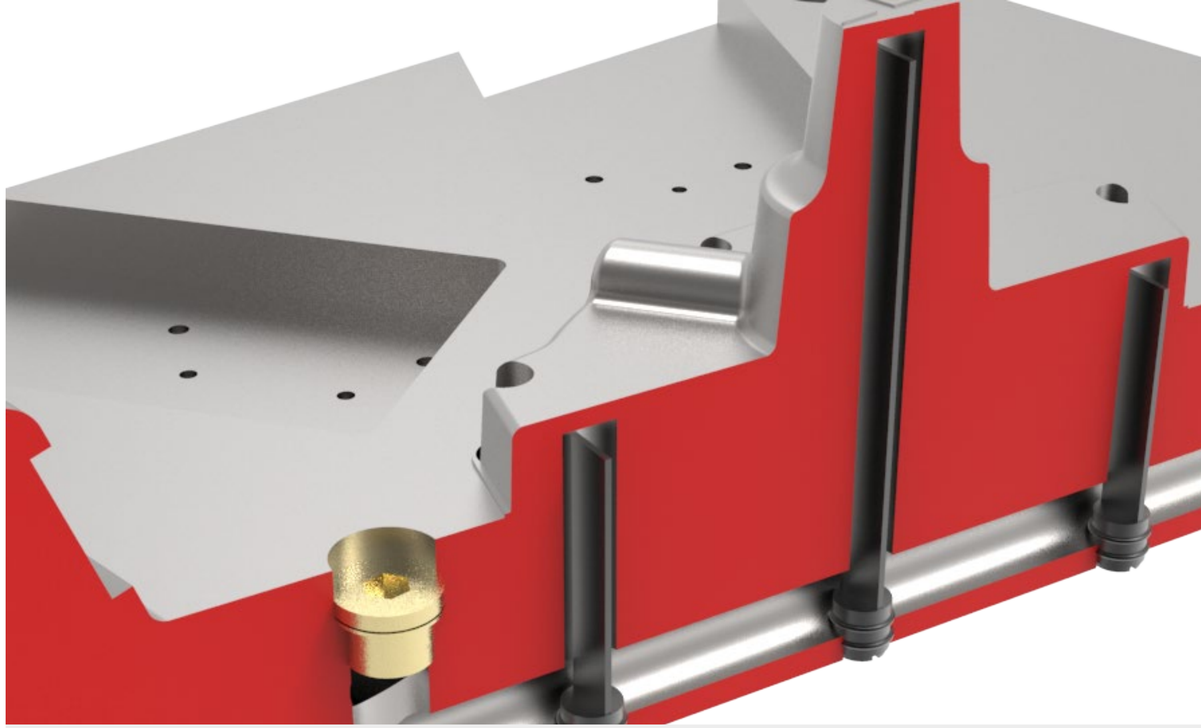
692 grams
(59% Lighter)

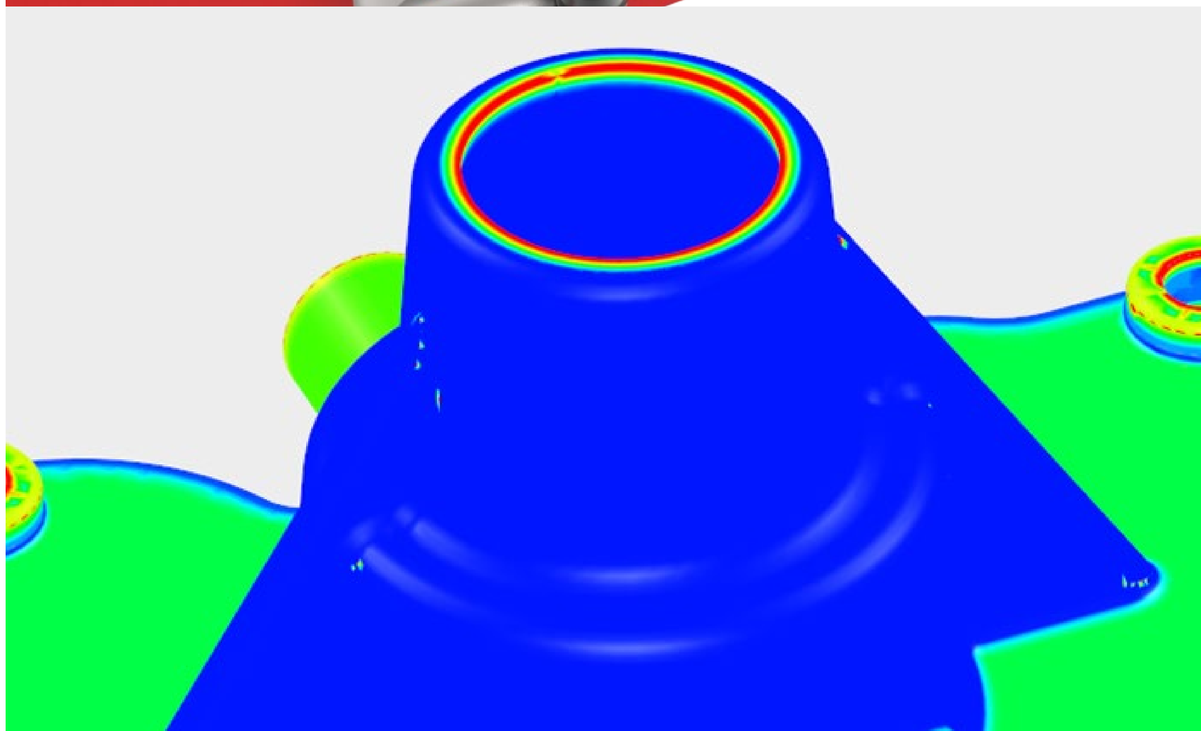
Conformal Cooling



Considerations

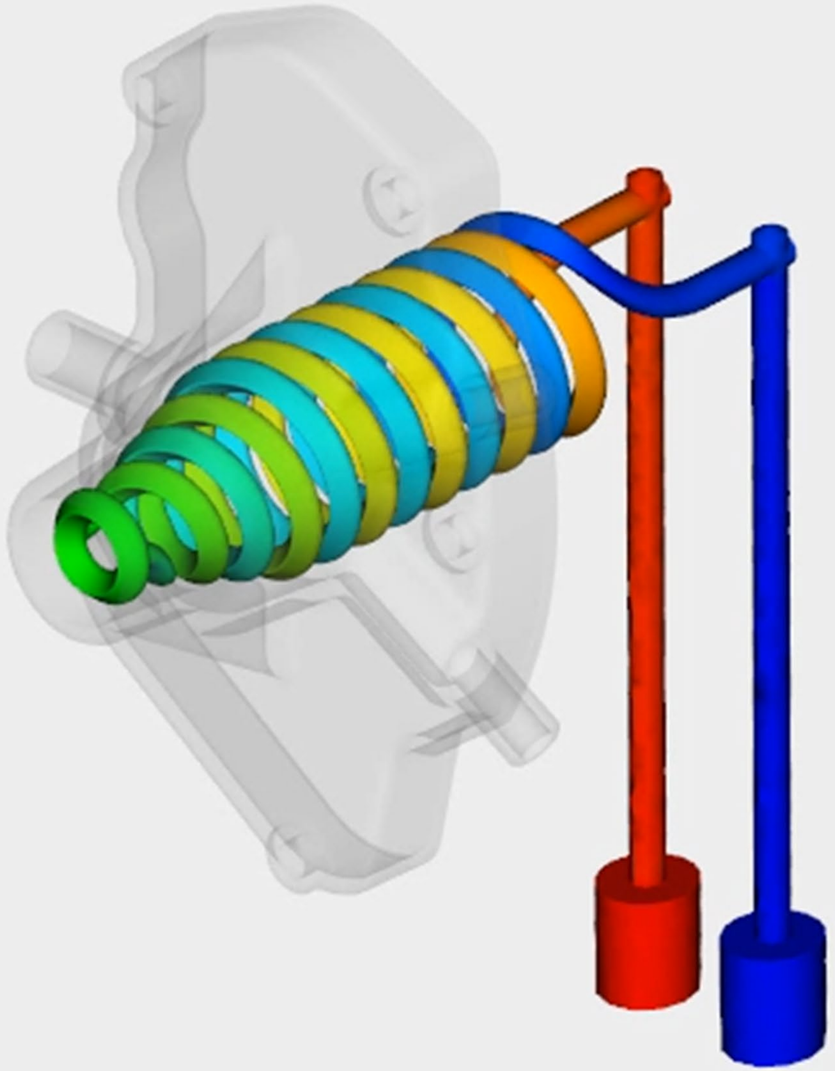
- **Molds traditionally cooled using simple water circuits**
- **Most heat expected around the ribs and cylindrical feature**
  - Also near gating location
- **Consider other cooling options?**
  - Cost of production versus reduction in cycle time
  - What additional processes will be needed?





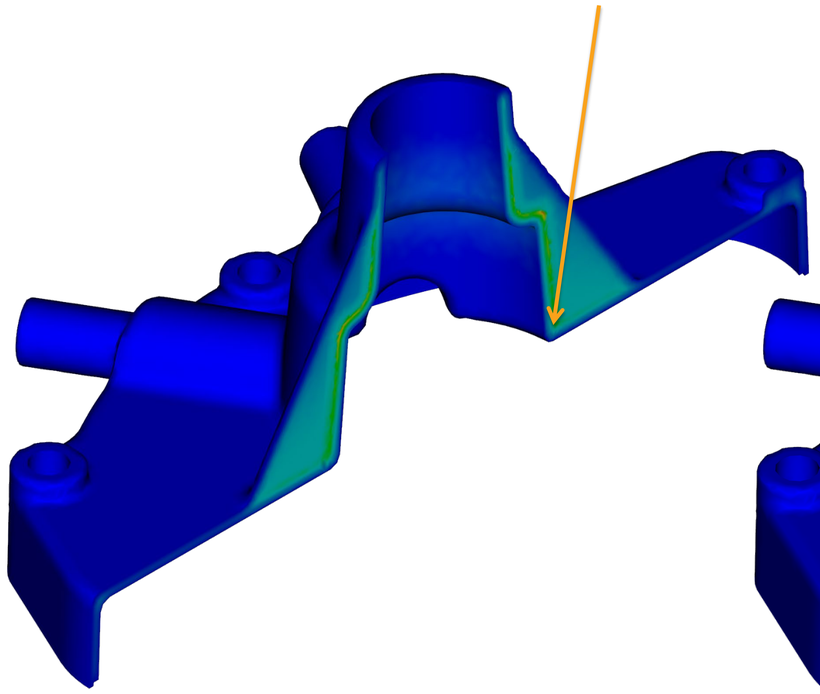
Conformal Cooling

- **What is it?**
  - Cooling channels that conform to the shape of a mold
- **Why use it?**
  - Temperature uniformity for the purpose of minimizing cycle time
- **How do we manufacture it?**
  - Previously difficult, costly and time consuming
  - The growth of 3D metal printing is increasing flexibility of designs
  - Still costly, so must simulate



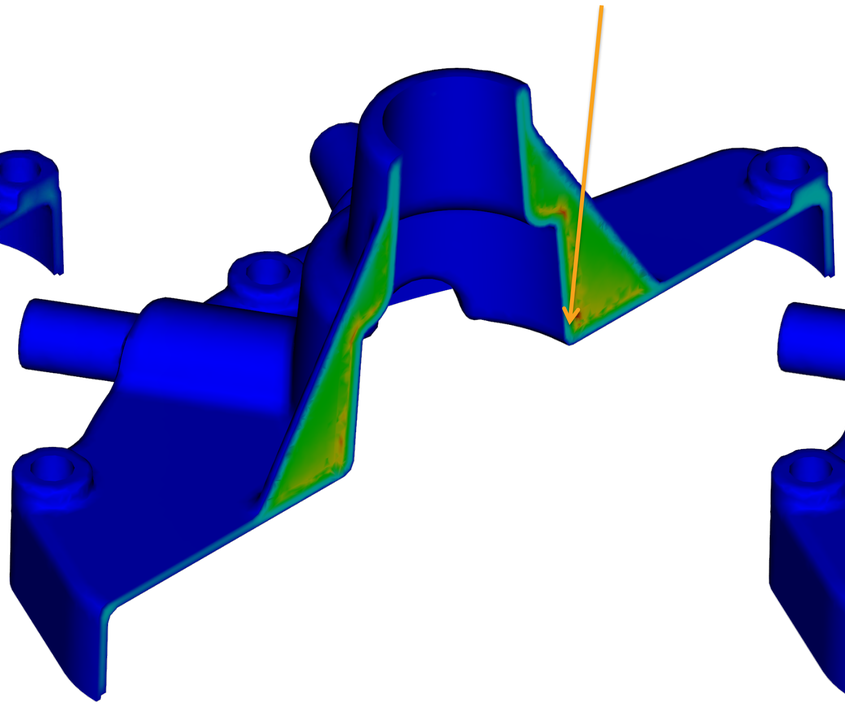
Simulation Results

TRE Temp. 248 s



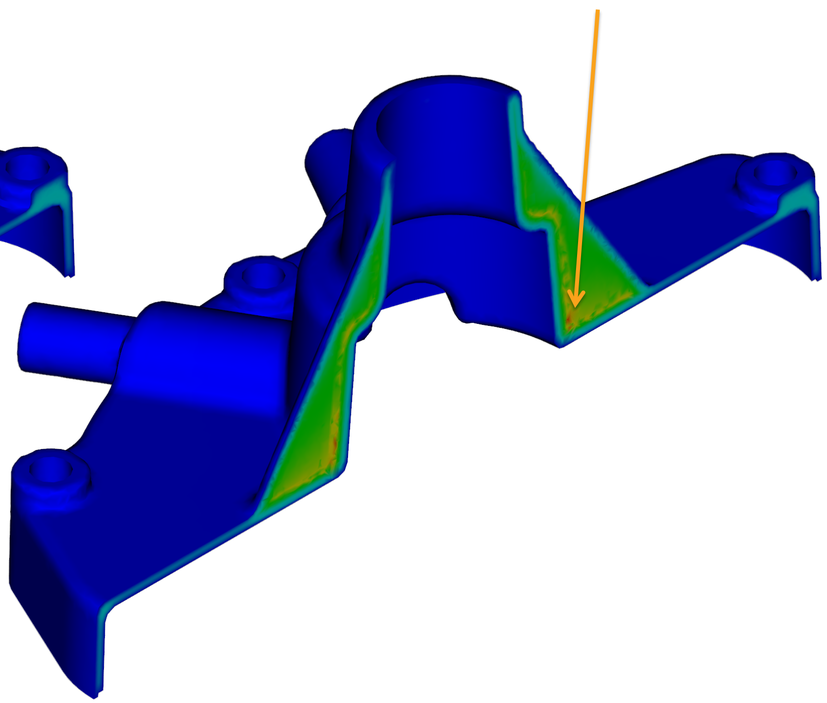
Simple Channels

TRE Temp. 134 s



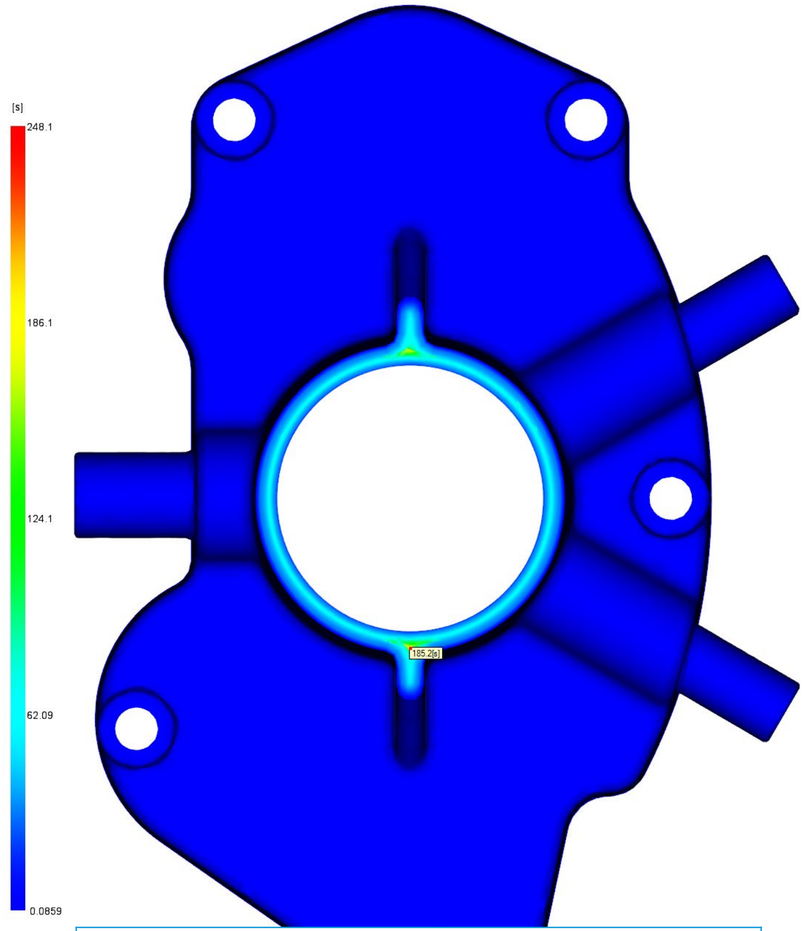
Complex Machined Channels

TRE Temp. 124.4 s



Conformal Channels

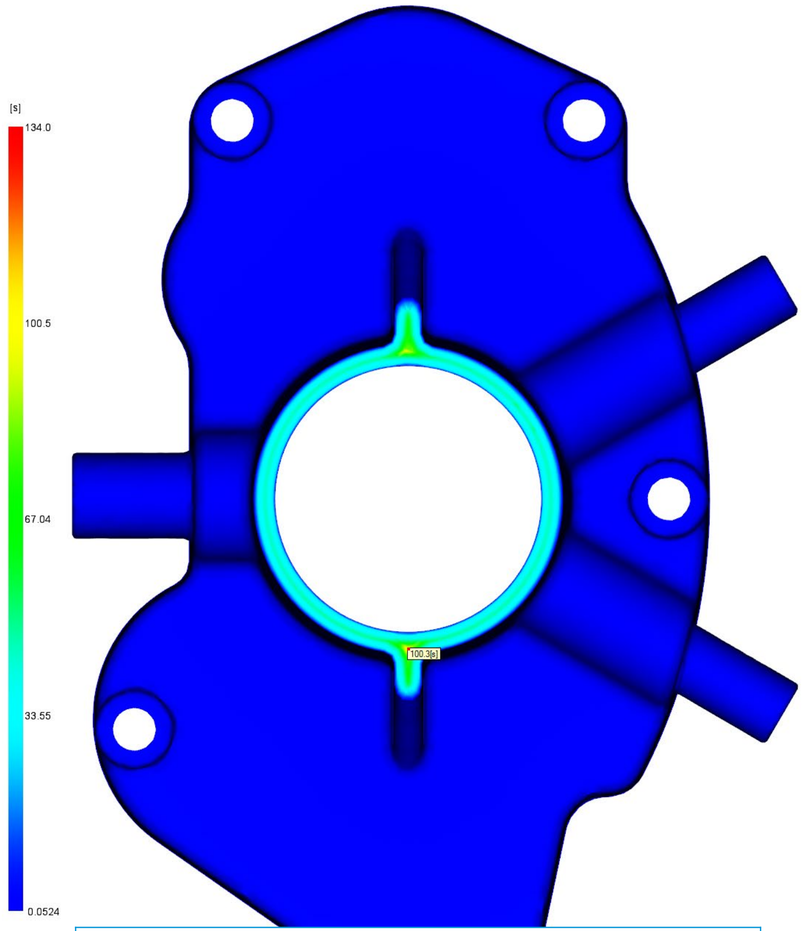
Comparing Results



Basic Cooling

TRE: 248.1 s

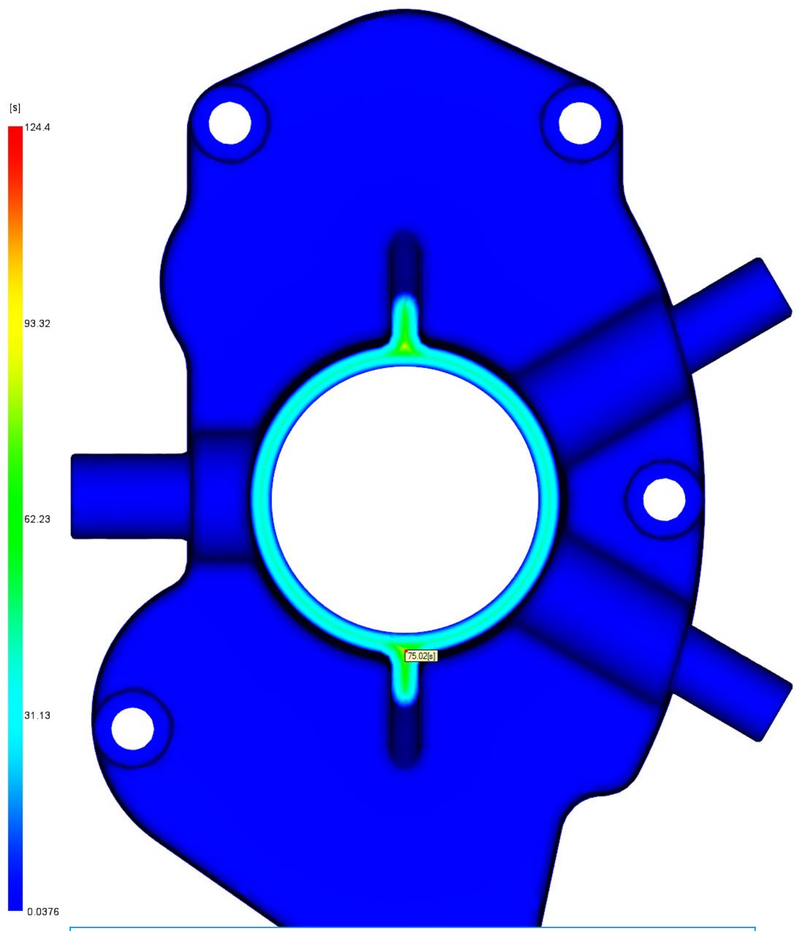
Queried Spot: 185.2 s



Complex Cooling

TRE: 134.0 s

Queried Spot: 100.3 s



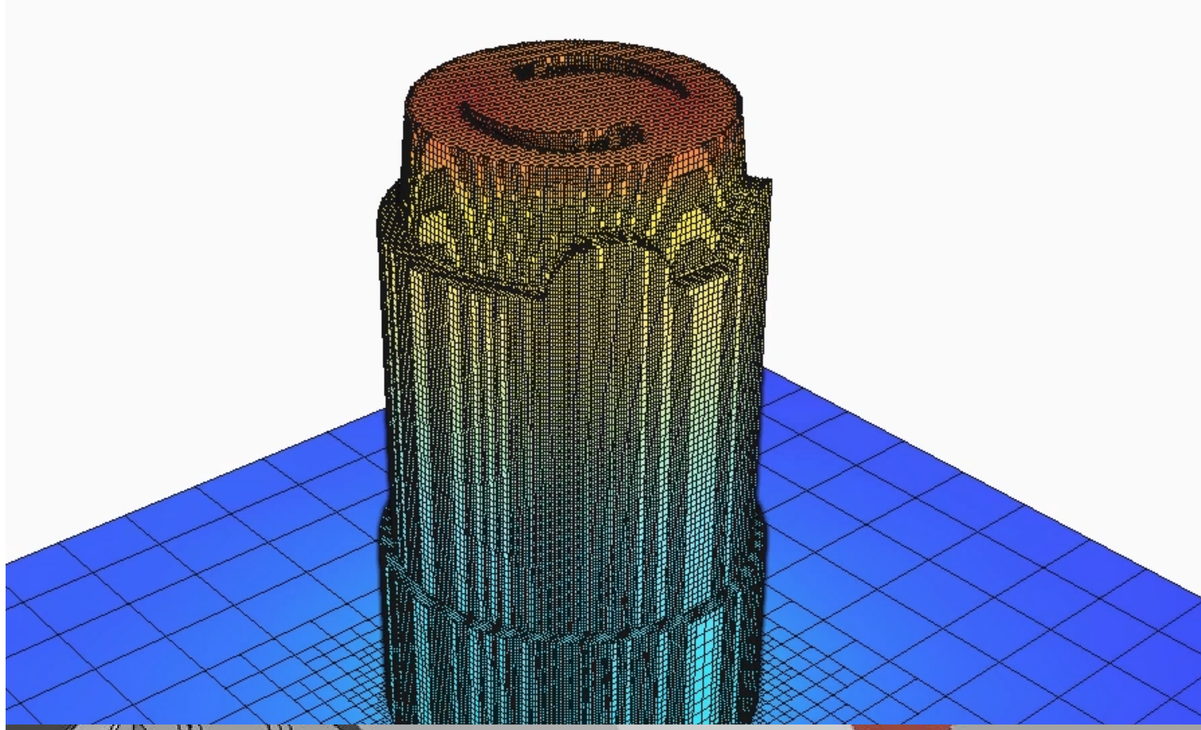
Conformal Cooling

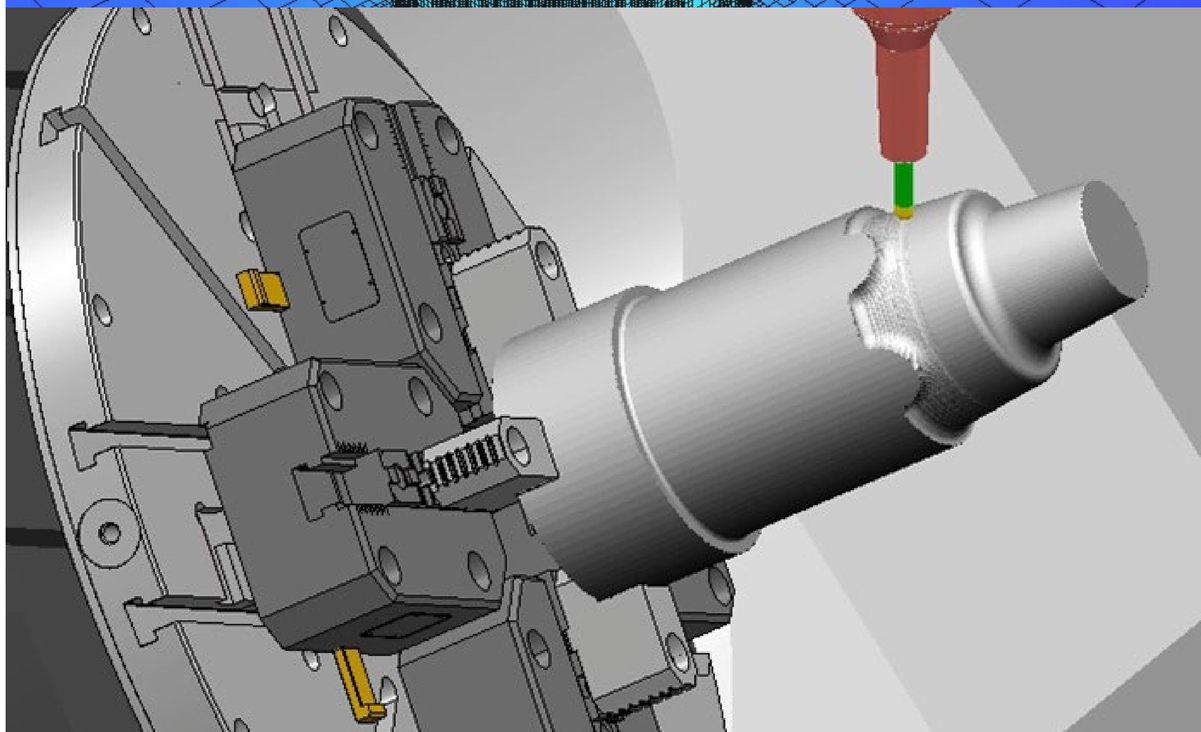
TRE: 124.4 s

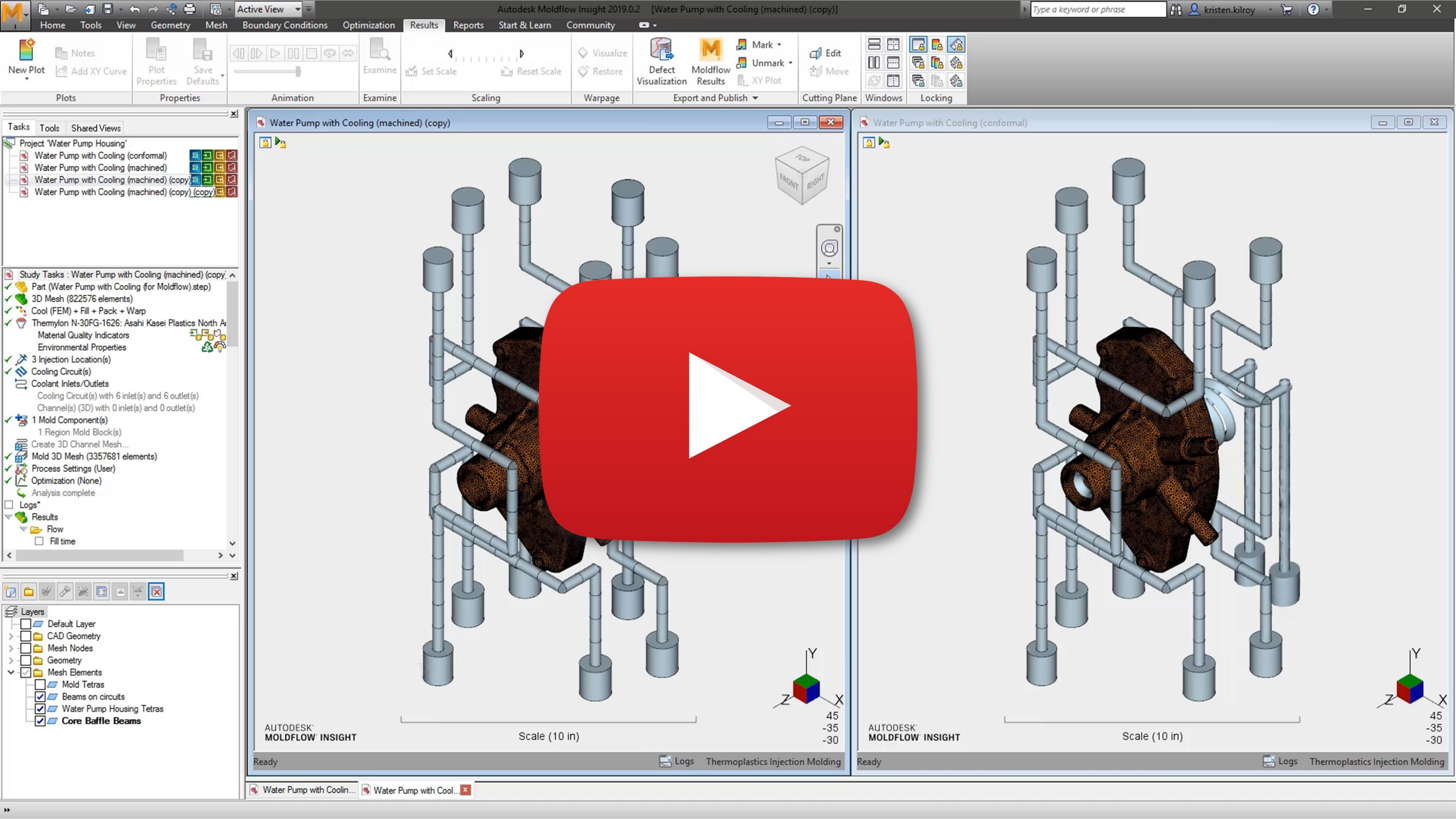
Queried Spot: 75.0 s

Conformal Cooling Insert Manufacturing

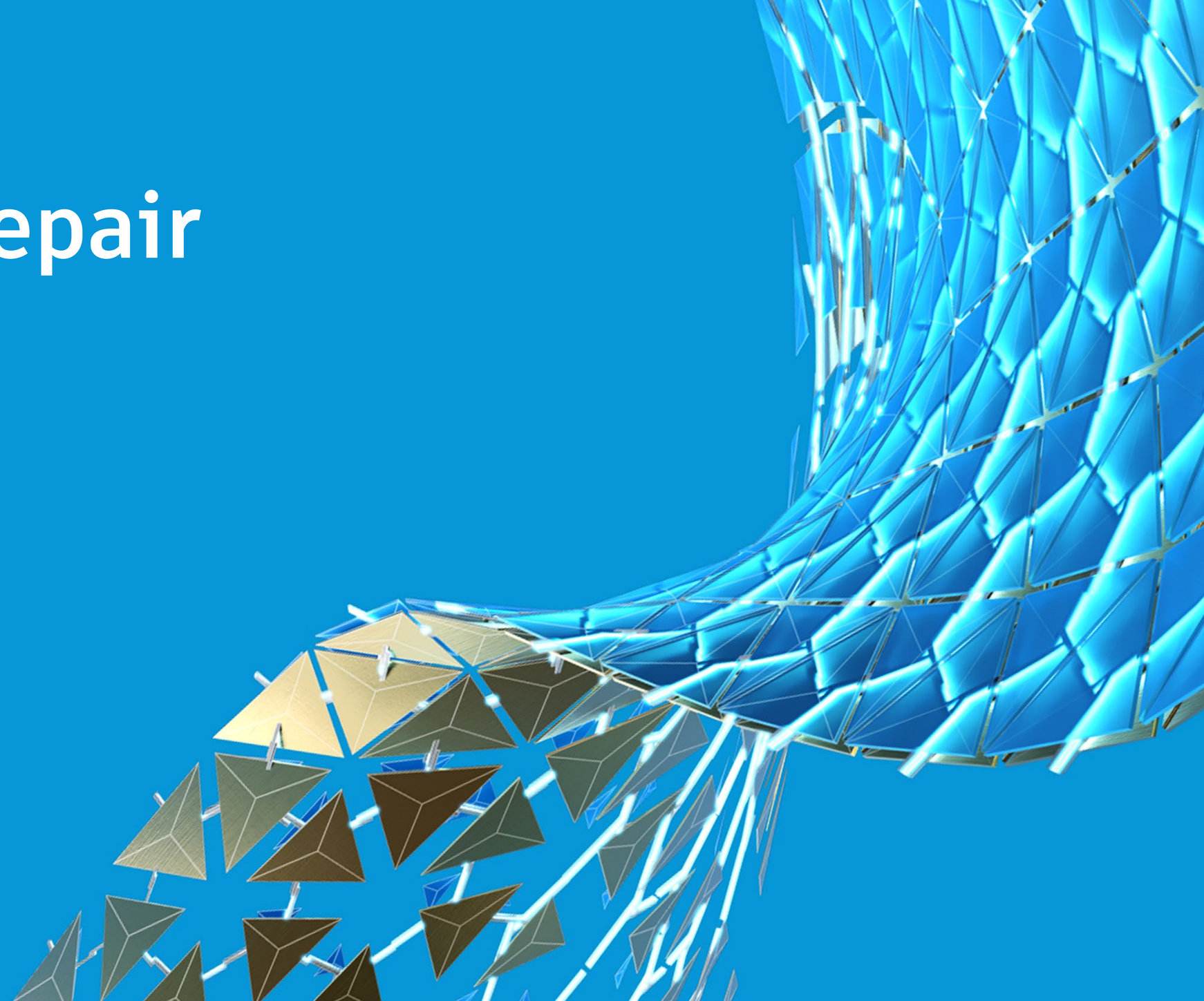
- Use additive to builds inserts layer by layer
- Add machining allowances at the design stage
- Machined to produce desired surface quality






Active View
Autodesk Moldflow Insight 2019.0.2 [Water Pump with Cooling (machined) (copy)]
Type a keyword or phrase
kristen.kilroy
Home Tools View Geometry Mesh Boundary Conditions Optimization Results Reports Start & Learn Community
New Plot
Notes
Add XY Curve
Plot Properties
Save Defaults
Examine
Set Scale
Reset Scale
Visualize
Restore
Defect Visualization
Moldflow Results
Mark
Unmark
XY Plot
Edit
Move
Plots
Properties
Animation
Examine
Scaling
Warpage
Export and Publish
Cutting Plane
Windows
Locking
Tasks Tools Shared Views
Project 'Water Pump Housing'
Water Pump with Cooling (conformal)
Water Pump with Cooling (machined)
Water Pump with Cooling (machined) (copy)
Water Pump with Cooling (machined) (copy) (copy)
Study Tasks : Water Pump with Cooling (machined) (copy)
Part (Water Pump with Cooling (for Moldflow).step)
3D Mesh (822576 elements)
Cool (FEM) + Fill + Pack + Warp
Thermylon N-30FG-1626: Asahi Kasei Plastics North A
Material Quality Indicators
Environmental Properties
3 Injection Location(s)
Cooling Circuit(s)
Coolant Inlets/Outlets
Cooling Circuit(s) with 6 inlet(s) and 6 outlet(s)
Channel(s) (3D) with 0 inlet(s) and 0 outlet(s)
1 Mold Component(s)
1 Region Mold Block(s)
Create 3D Channel Mesh...
Mold 3D Mesh (3357681 elements)
Process Settings (User)
Optimization (None)
Analysis complete
Logs*
Results
Flow
Fill time
Layers
Default Layer
CAD Geometry
Mesh Nodes
Geometry
Mesh Elements
Mold Tetras
Beams on circuits
Water Pump Housing Tetras
Core Baffle Beams
Water Pump with Cooling (machined) (copy)
Water Pump with Cooling (conformal)
TOP FRONT RIGHT
Y Z X
45 -35 -30
AUTODESK MOLDFLOW INSIGHT
Scale (10 in)
Ready
Logs
Thermoplastics Injection Molding
Water Pump with Coolin...
Water Pump with Cool...

Additive Repair



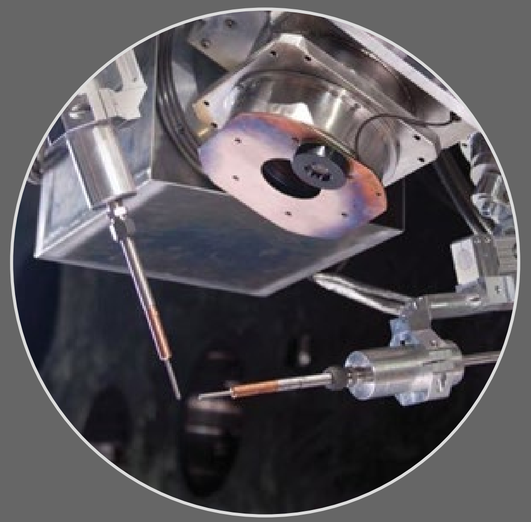
Challenges

- **Molds, tools and dies can suffer from wear or damage**
- **Replacing can be costly**
  - New tooling
  - Loss of production
- **Mold repair**
  - Accuracy & repeatability
- **Manually intensive**
  - Growing skills gap

Directed Energy Deposition (DED)

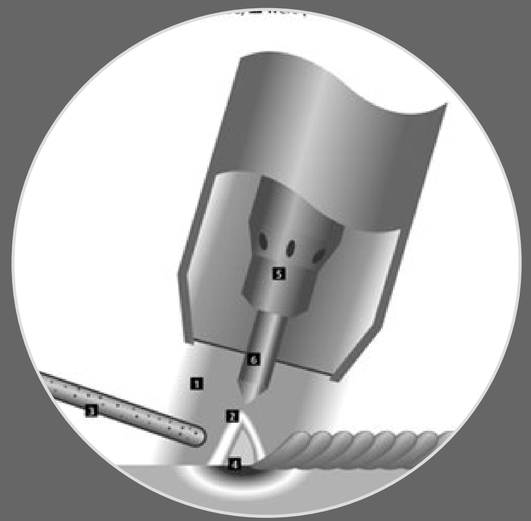
Arc & Wire

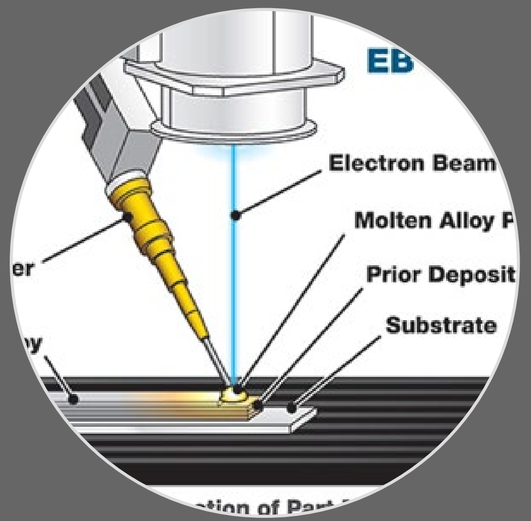
EBM & Wire

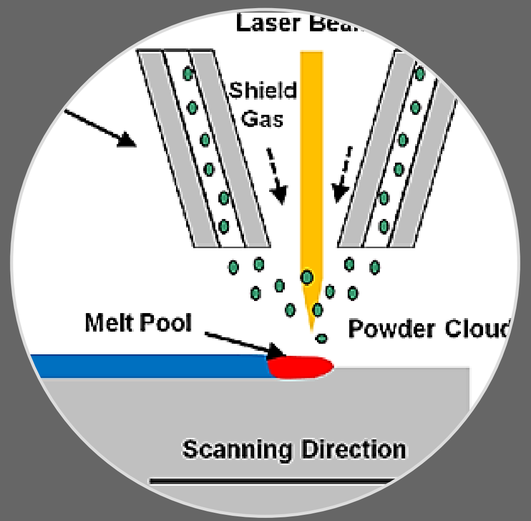


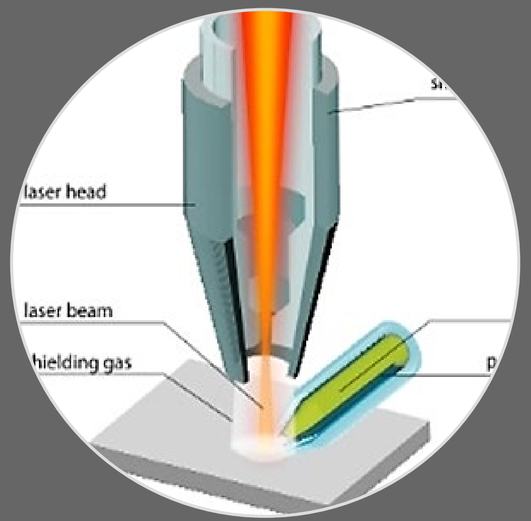
Laser & Powder

Laser & Wire



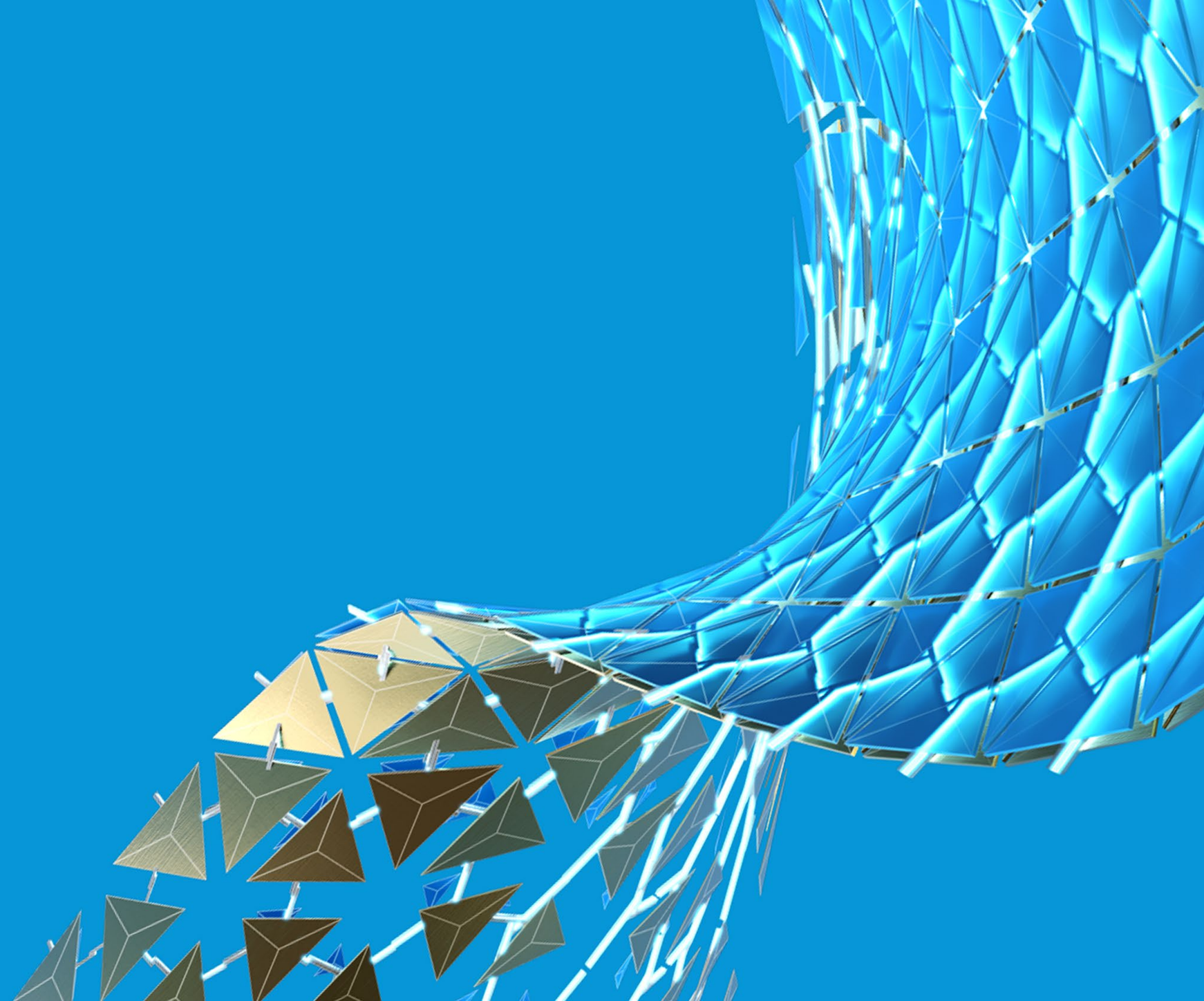







AUTODESK
PIER 9

Summary



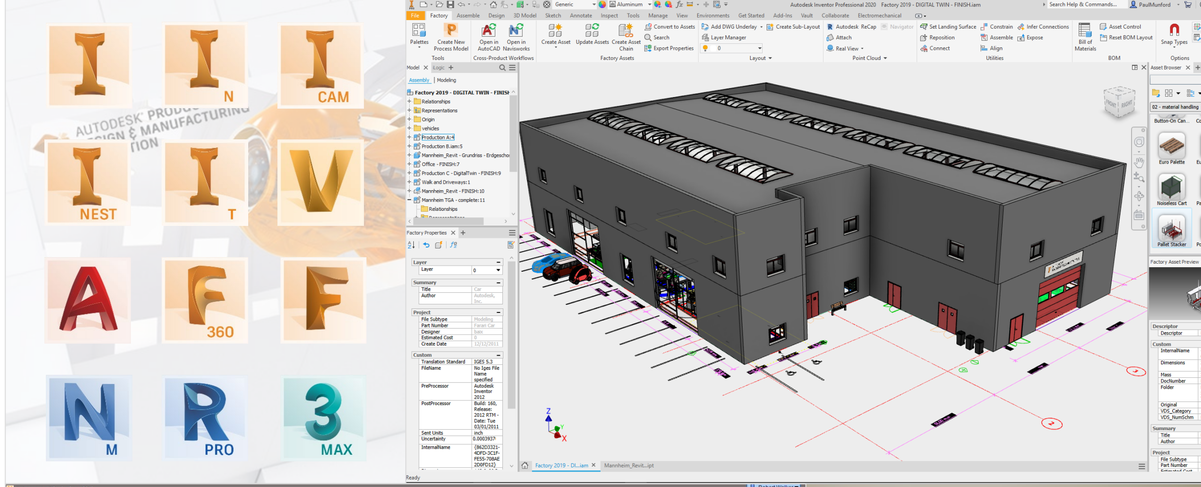
Summary

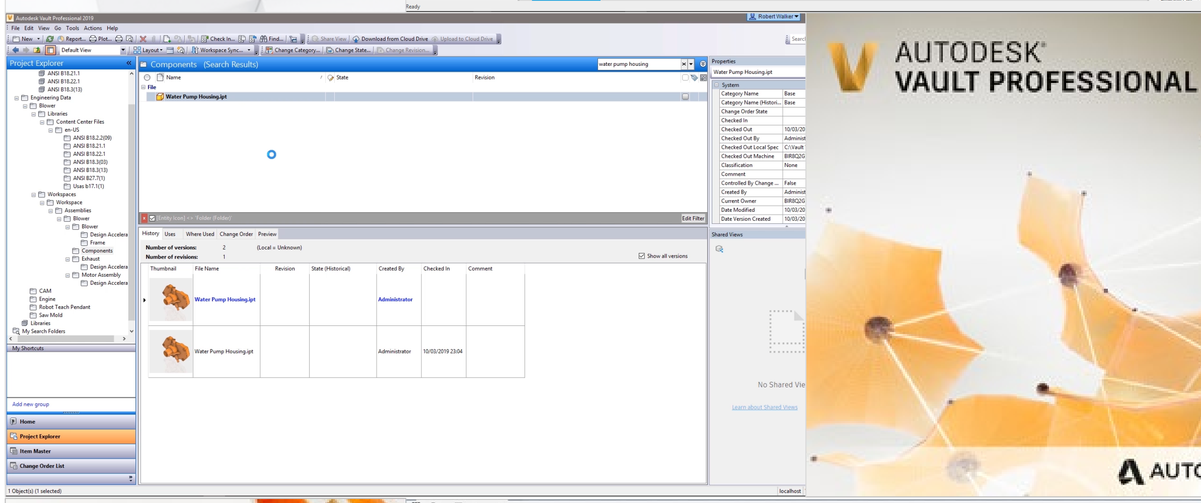
- **Software solutions can improve the quality of automotive tooling and the parts they produce**
- **Challenges that drive change in manufacturing facilities**
  - Unified digital model to manage projects, equipment and production
- **Automation can be utilized in manufacturing processes to improve production consistency**
- **Emerging technology can be used to improve component performance and efficiency**

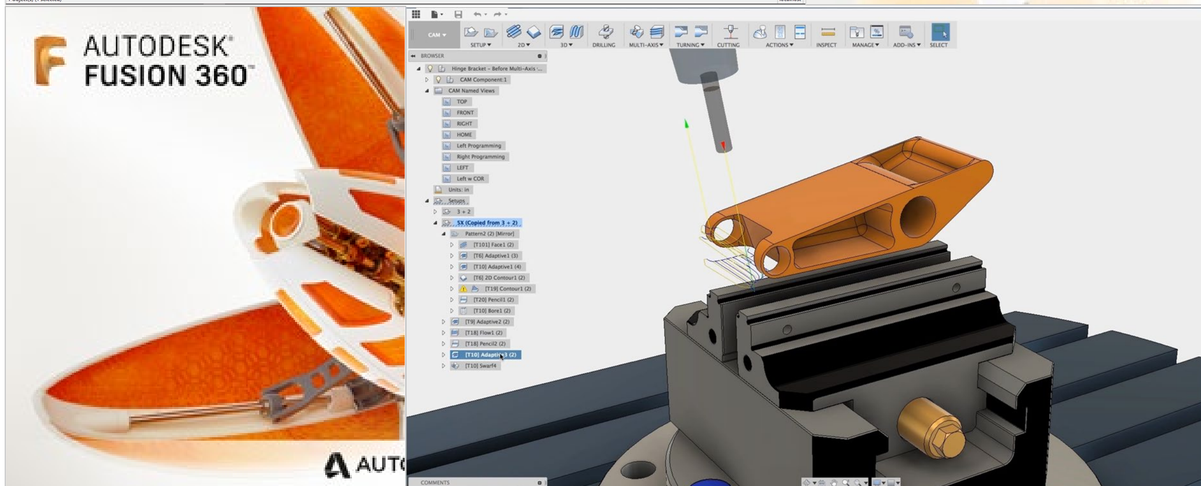
Image courtesy of Galaxy Kalip

Summary

- Autodesk Product Design and Manufacturing Collection, which includes Autodesk **Inventor**, and the **Factory Design Utilities**
- Autodesk **Vault Professional** for data management and collaboration
- Autodesk **Fusion 360** for generative design, but which also unifies design, engineering and manufacturing into a single platform

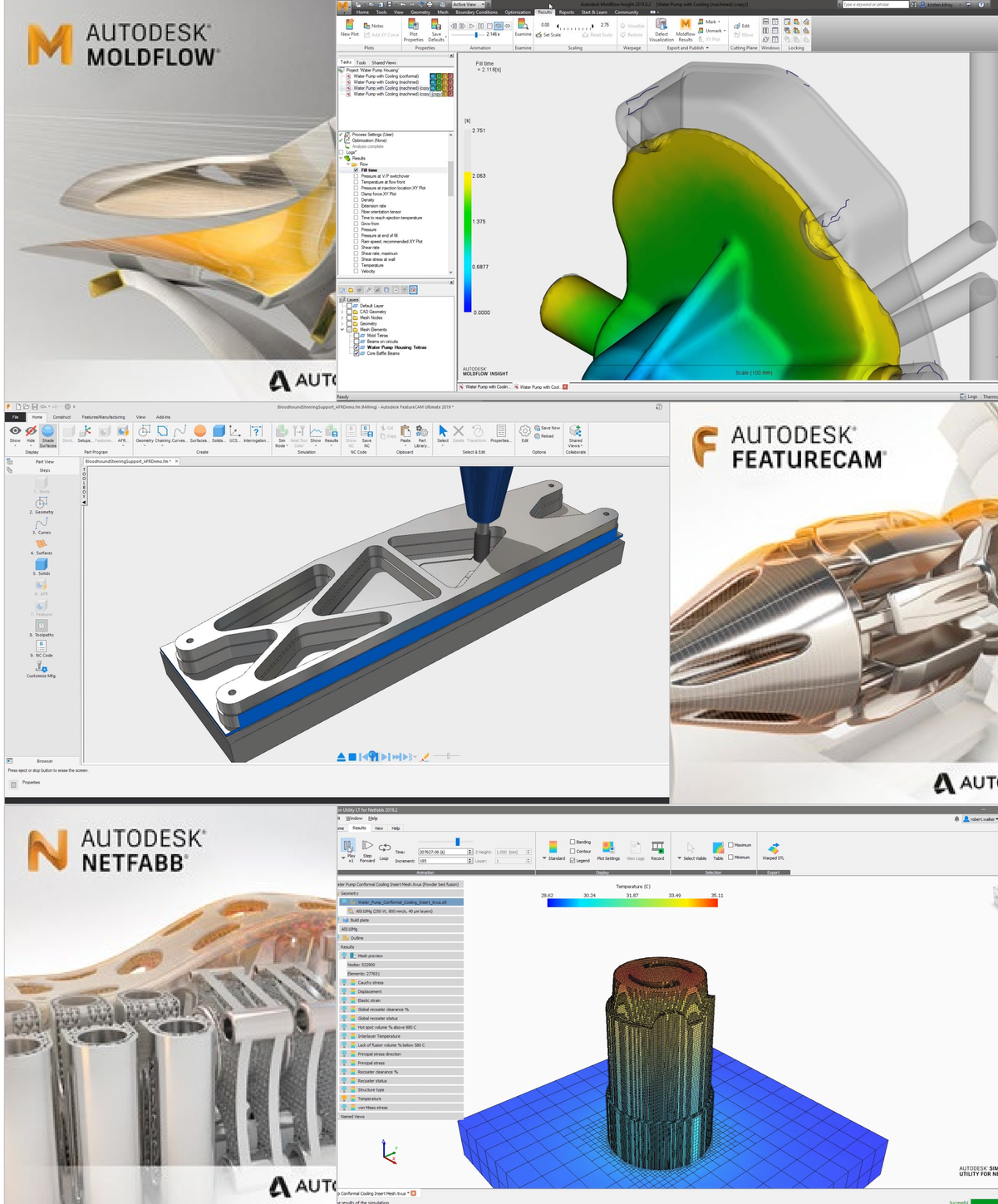






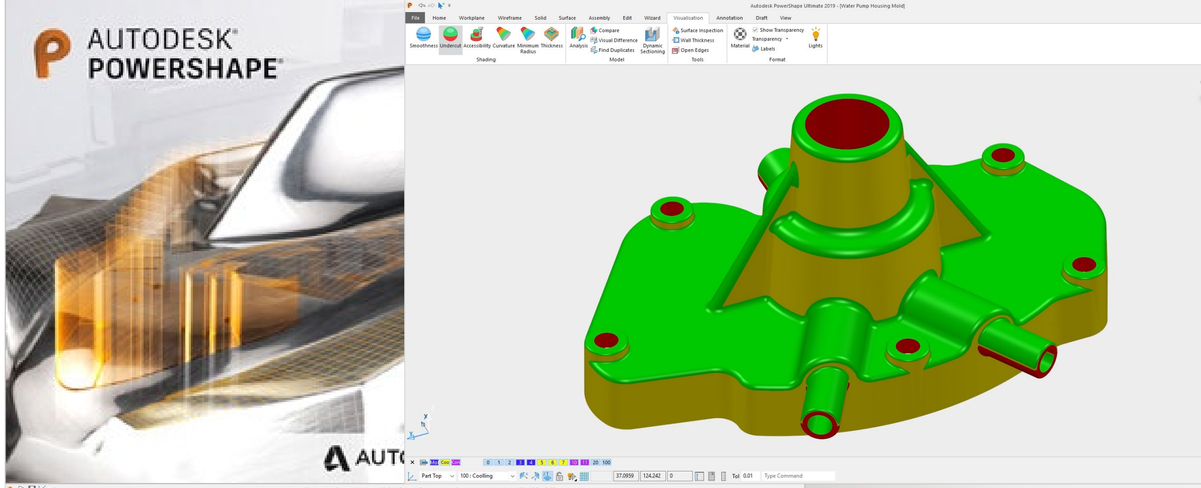
Summary

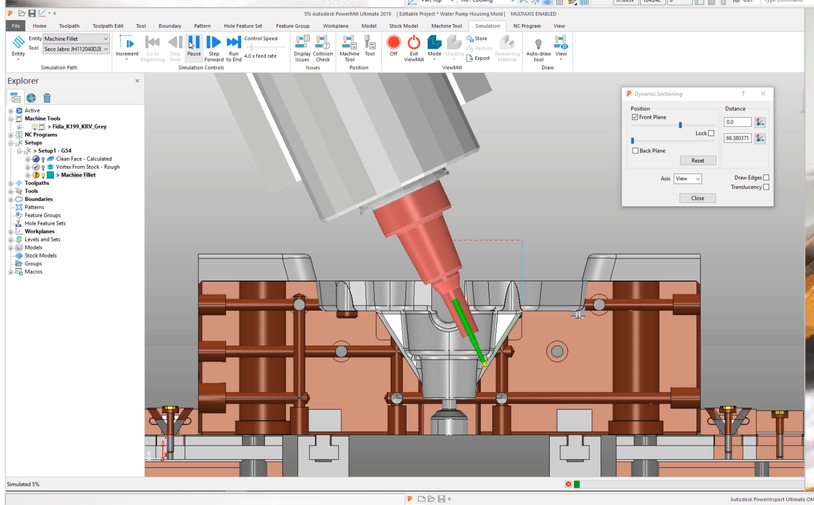
- Autodesk **Moldflow** for advanced simulation of injection and compression molded parts
- Autodesk **FeatureCAM** for automated CNC programming
- Autodesk **Netfabb** for additive part manufacturing, lattice optimization and build simulation

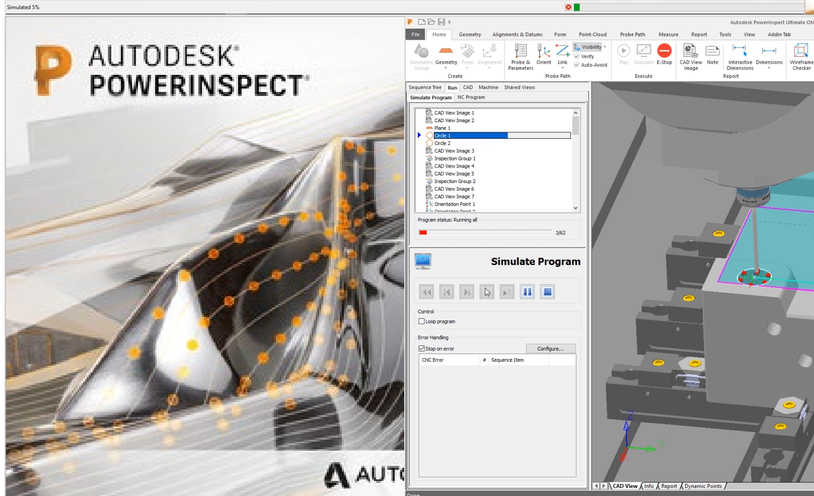


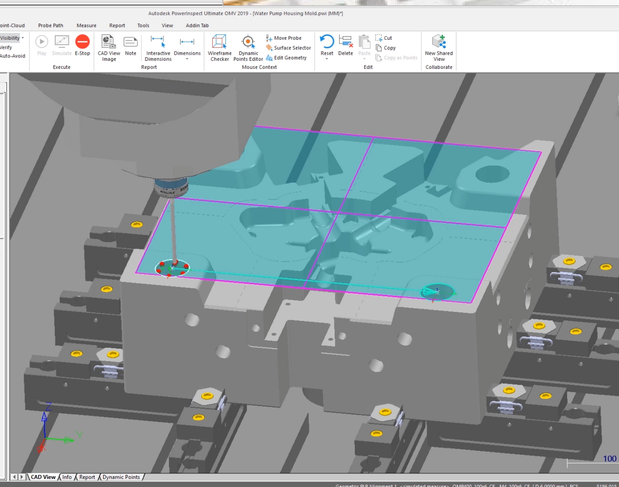
Summary

- Autodesk **PowerShape** for mold tool creation and modelling for manufacture
- Autodesk **PowerMill** for 3 to 5 axis subtractive milling, and additive manufacturing using directed energy deposition
- Autodesk **PowerInspect** for hardware independent automated setup and 3D measurement
- Autodesk **Electrode** for a closed-loop system between electrode design, manufacture and metrology









Want To Know More?

- Visit the dedicated Autodesk Automotive Manufacturing page:

http://autodesk.com/automotive-make

- See how Autodesk can help you reach your automotive manufacturing goals