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Generative Design in Fusion 360: 2022 and Beyond

IM501943

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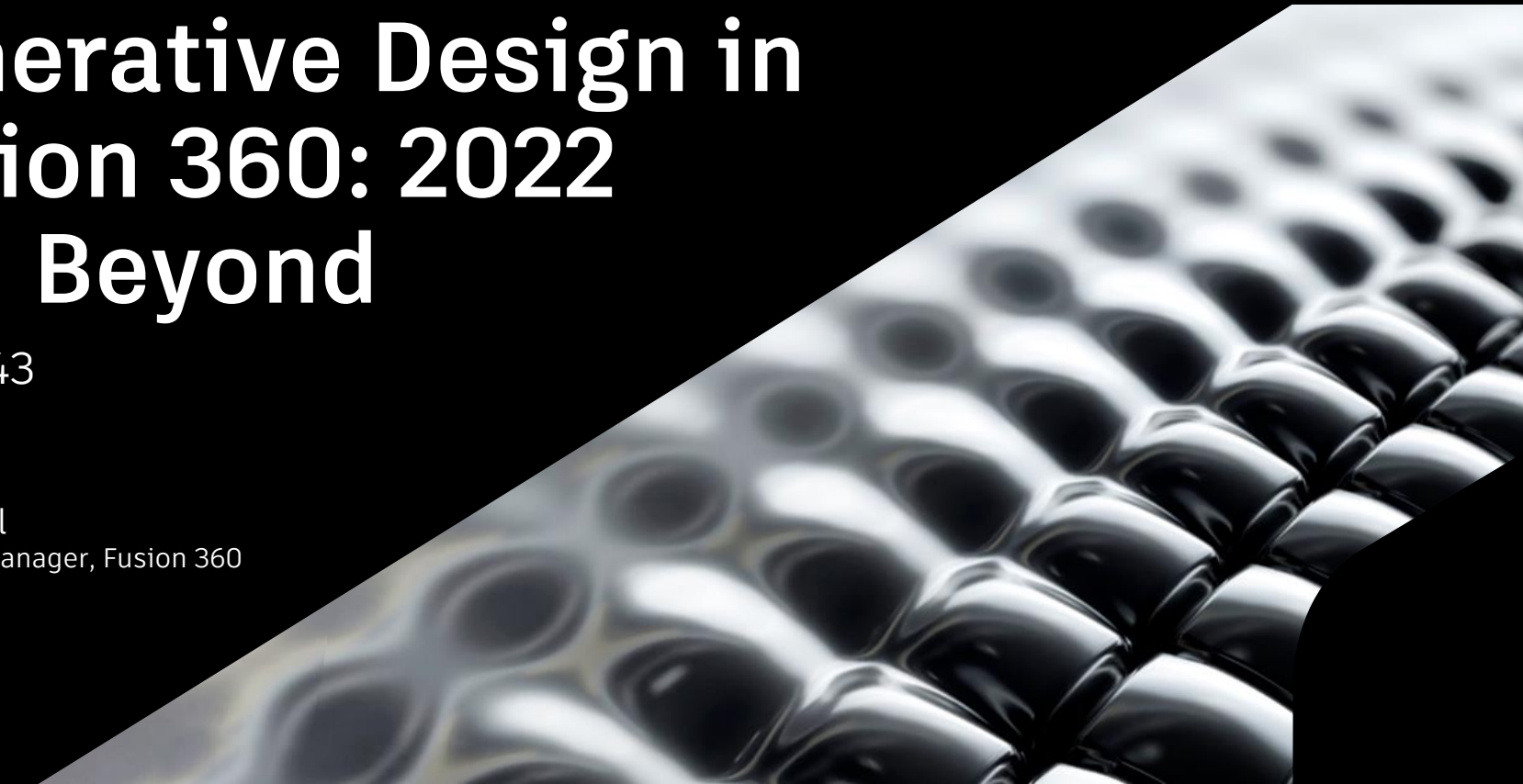
Sr. Product Manager, Fusion 360



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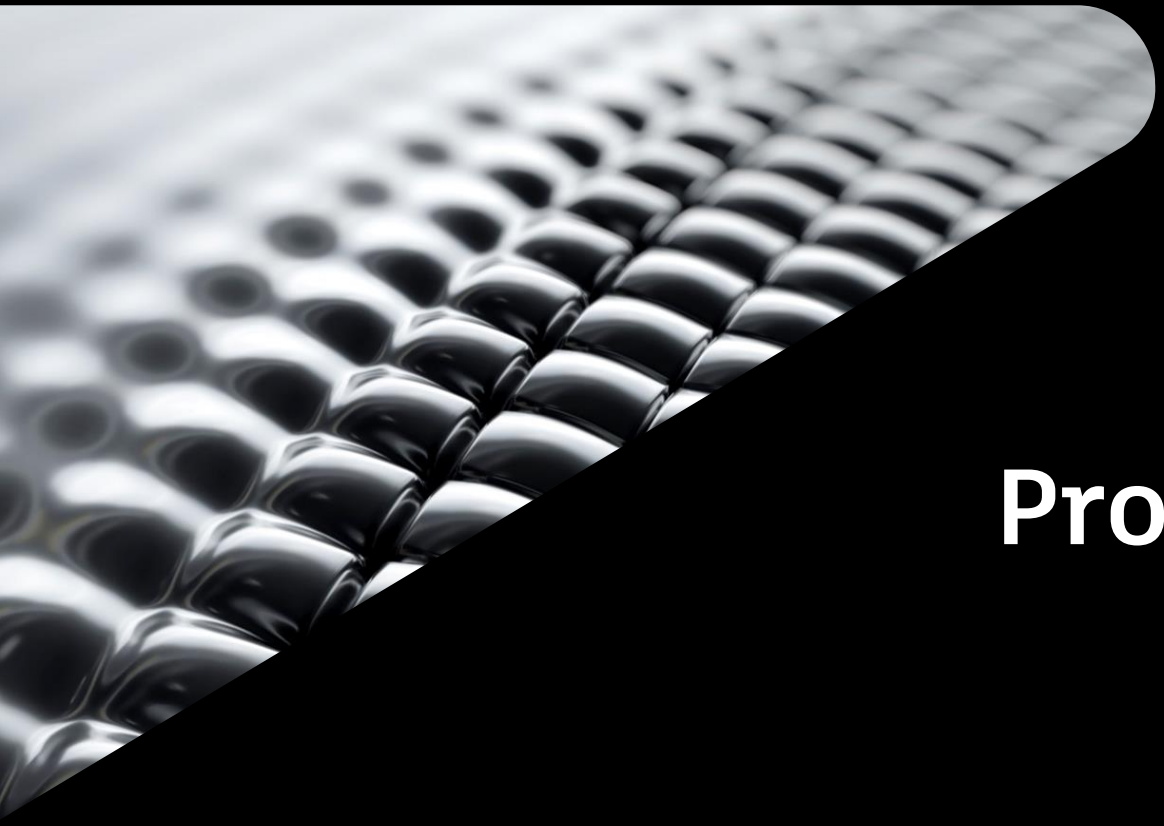
Agenda

Generative Design in Fusion 360

Development Progress in 2022

Customer Spotlight

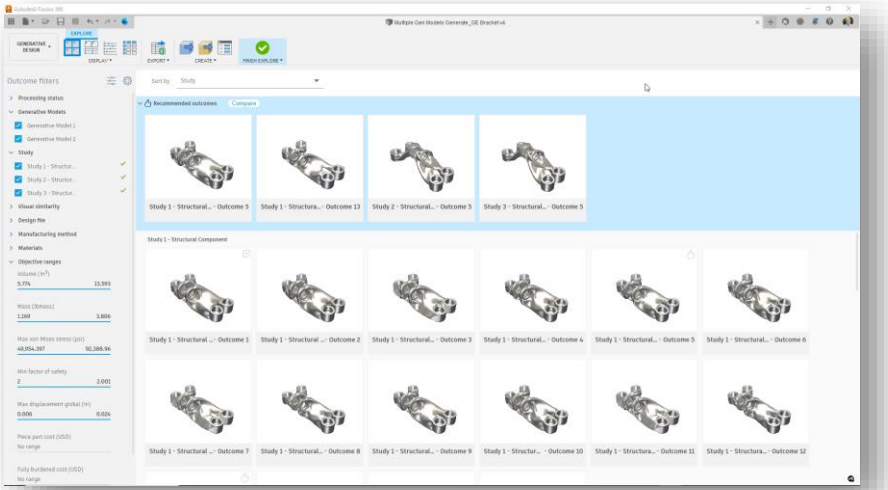
Over the Horizon



Development Progress in 2022

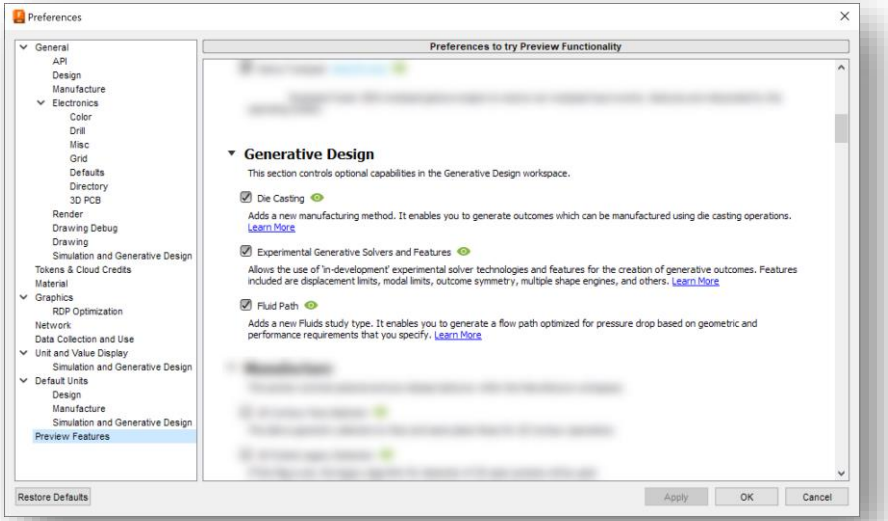
Multi-Export of Generative Design Outcomes

- March 2022
- Enables users to create up to 4 editable designs in a single job submission
- Speeds up comparing designs in context and the path to downstream workflows like editing, simulation and manufacturing



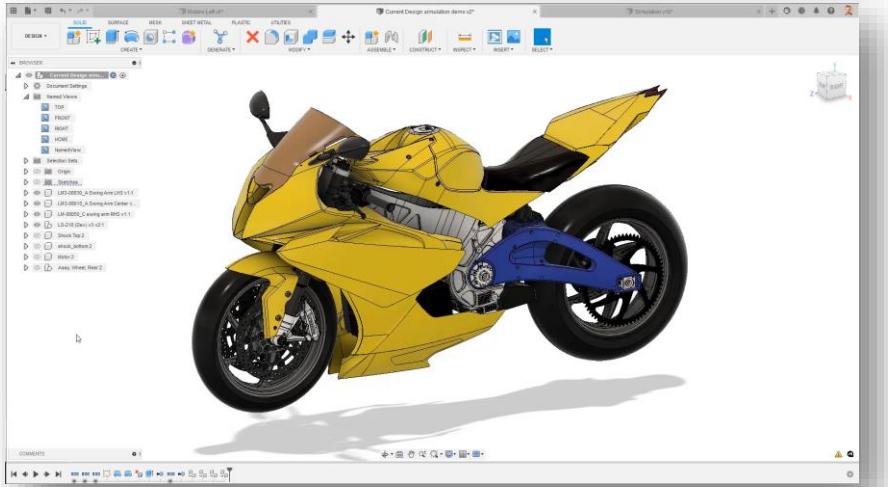
Experimental Solver Performance

- March 2022 and May 2022
- Brings more modern solver technology and performance to existing functionality – *up to 2x faster*
- Added an additional outcome to basic setups to validate technology with production workloads



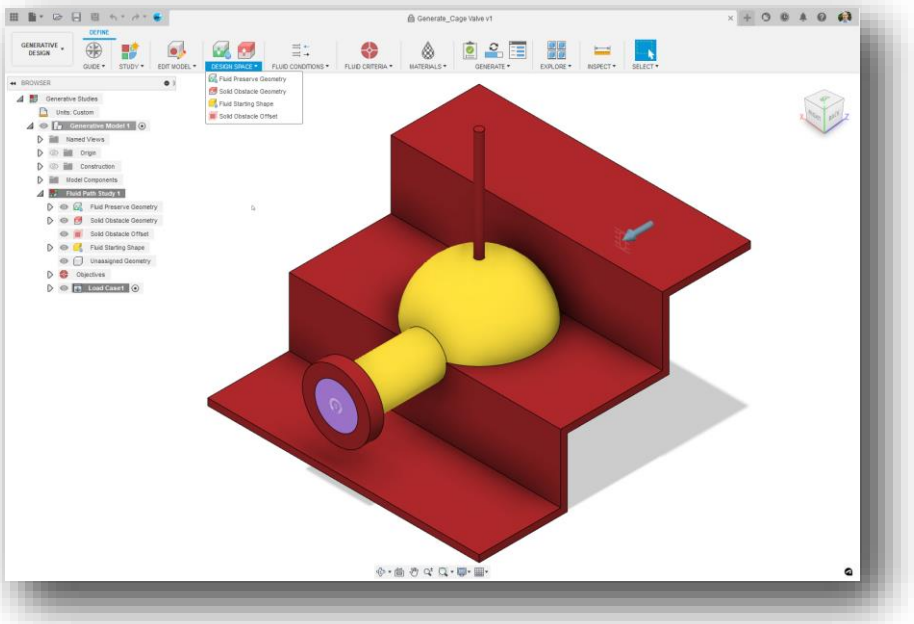
Simulation Contact Forces

- May 2022
- Reaction force and moment data can now be extracted from contact pairs in Linear Static Stress simulations
- Can be useful in gathering force data from assemblies to support more accurate generative design setups



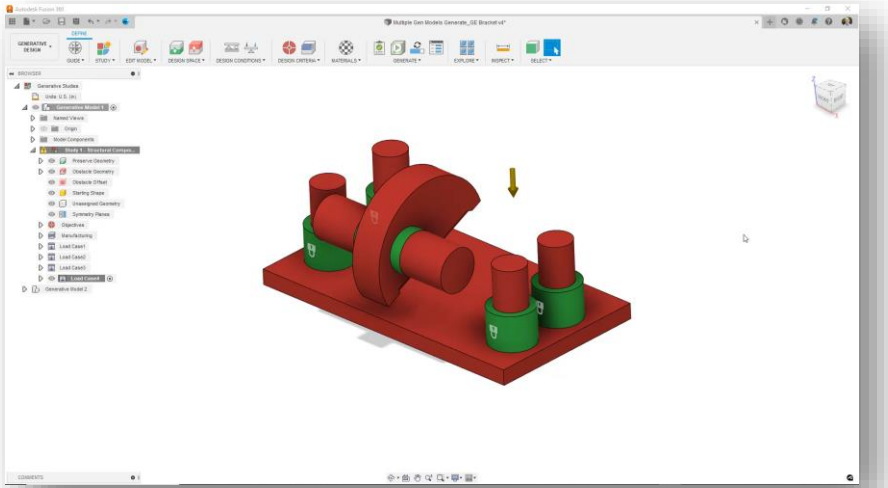
Fluid Path Study Terminology Update

- July 2022
- Improved clarity on the design space definitions for the interaction between fluids and solids
- Additional coloring on boundary condition faces to differentiate flow sources from flow openings or fluid pressures



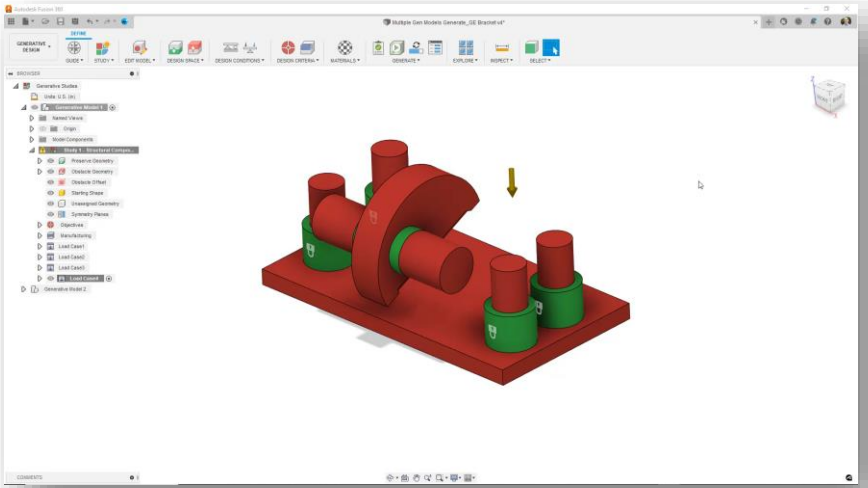
Generative Model Filter in Explore

- July 2022
- Generative Models make it easy to expand the exploration space
- Filters in Explore make it easier to zero in on the best outcomes and understand result came from what setup



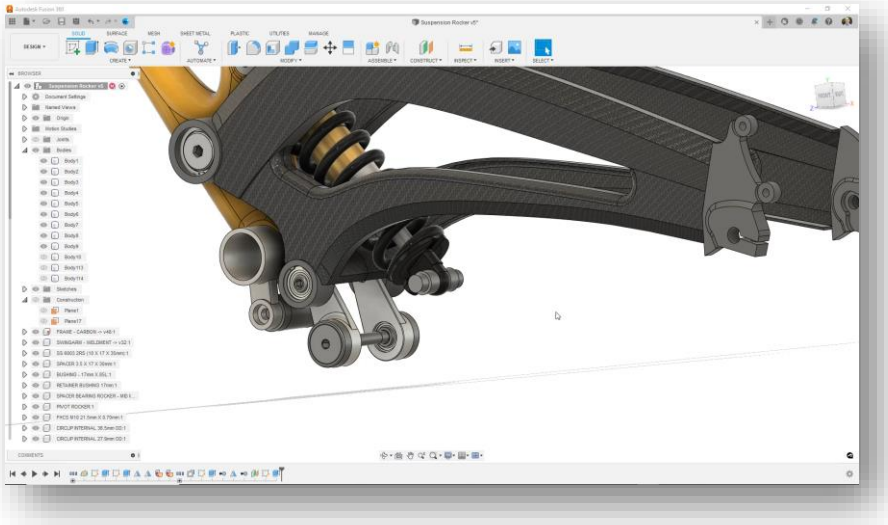
Real-Time Study Name Syncing in Explore

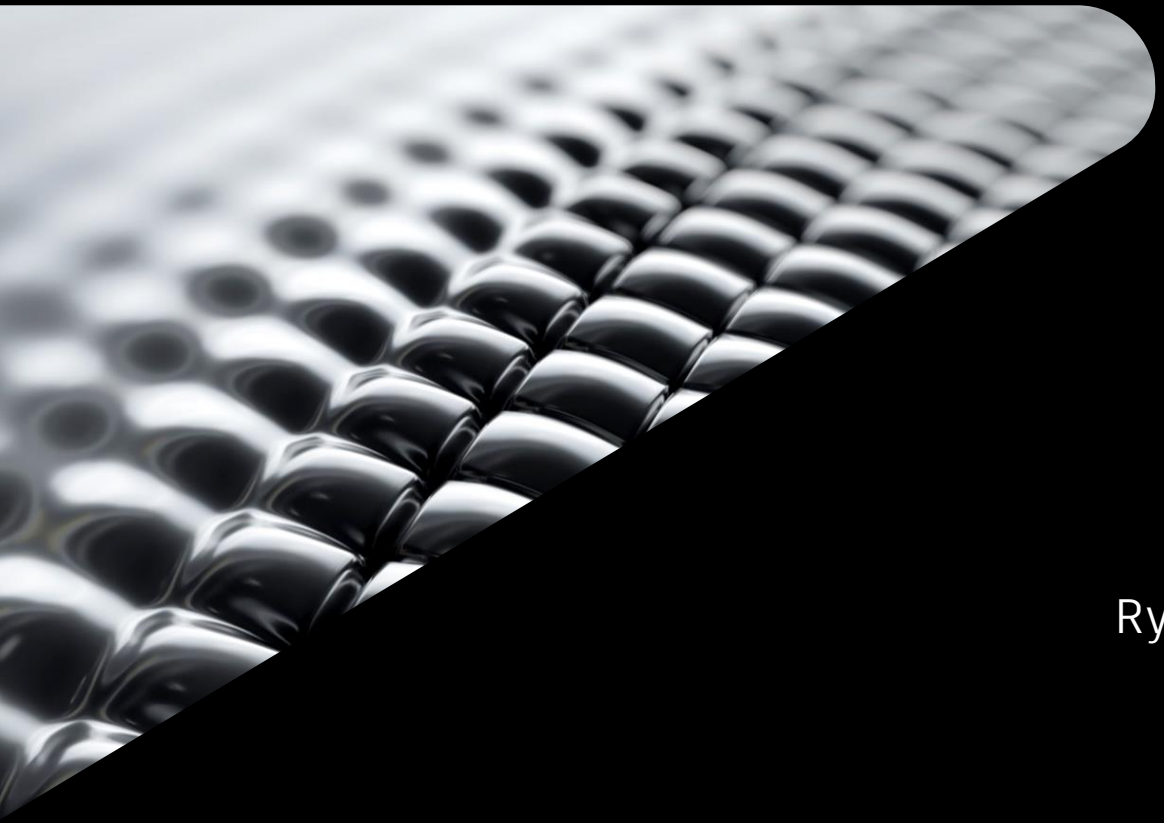
- July 2022
- Multiple studies allow additional exploration through varied study configurations
- Keeping study names in sync between setup and results improves the ability to understand what result came from what setup



Automated Modeling as Public Preview

- July 2022
- New tool in the Design Workspace
- Automates exploring and creating new design concepts based on simple definitions of what to connect and what to avoid
- Great for the early stages of the design process



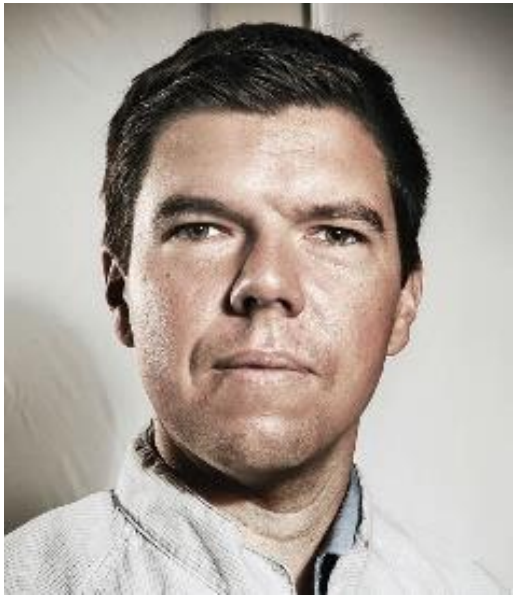


Customer Spotlight

Ryan McClelland, NASA Goddard

Generative Design at NASA Goddard

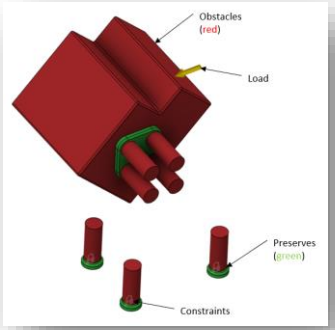
- Ryan McClelland is a Research Engineer in NASA GSFC's Instrument Systems and Technology Division (ISTD) focused on developing and applying Digital Engineering technologies
- Goal: Create and infuse a process to rapidly develop lightweight spaceflight structures using commercial software tools
- Progress: Used Fusion 360 Generative Design to develop 20+ parts



Why Generative Design

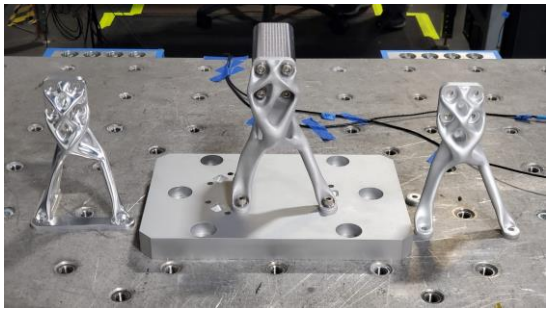
- Current development methods are too costly and time consuming to optimize designs for performance while considering alternative manufacturing processes and materials

- Generative Design automates the design exploration of manufacturing process and materials while optimizing design performance for a given set of requirements



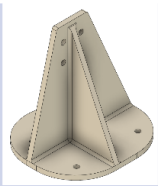
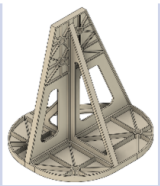
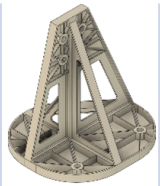
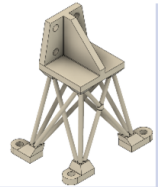
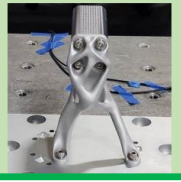
Encode Requirements
~1 hr

Evolve Designs
~1 hr

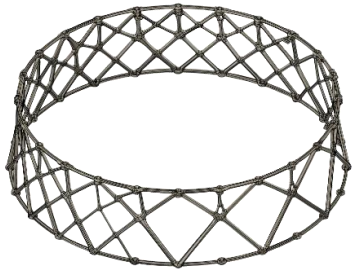


Fabricate Parts
1 day – 3 weeks

Case Study

Human Design Exploration ~2 days					Design/analysis/DfM ~2hrs	
Designer / Iteration	**Drew/Ryan 1**	**Drew/Ryan 2**	**Drew/Ryan 3**	**Drew/Ryan 4**	**Generative 31 CNC**	**Generative 31 AM**
Design (Aluminum)						
Mass (kg)	0.59	0.18	0.27	0.18	0.2	0.2
1st Mode (Hz)	137	37	65	108	147	177
Stiffness/mass (Hz/kg)	232	205	240	600	735 ~3x better	885 ~3.5x better
Max Stress (MPa)	26.3	189	103	60.7	14.8 >4x better	11.2 >5x better
Manufacturing	CNC	CNC Difficult to machine hog-outs	CNC Difficult to machine hog-outs	Not machinable/ printable	$1000 3 days	$2000 3 weeks
				Results verified by test		

Additional Example Applications

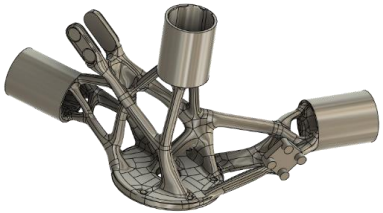


DraMS: Carousel base

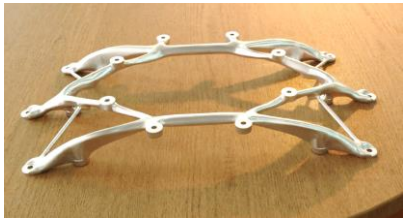
EXCITE: Radiator mount

MSR-CCRS: Diode Mount

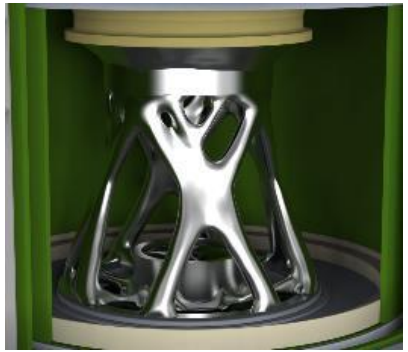
NGXO: Mirror mount



RST: OBA node



STAR-X Detector bench



ALTIRS: Mirror mount

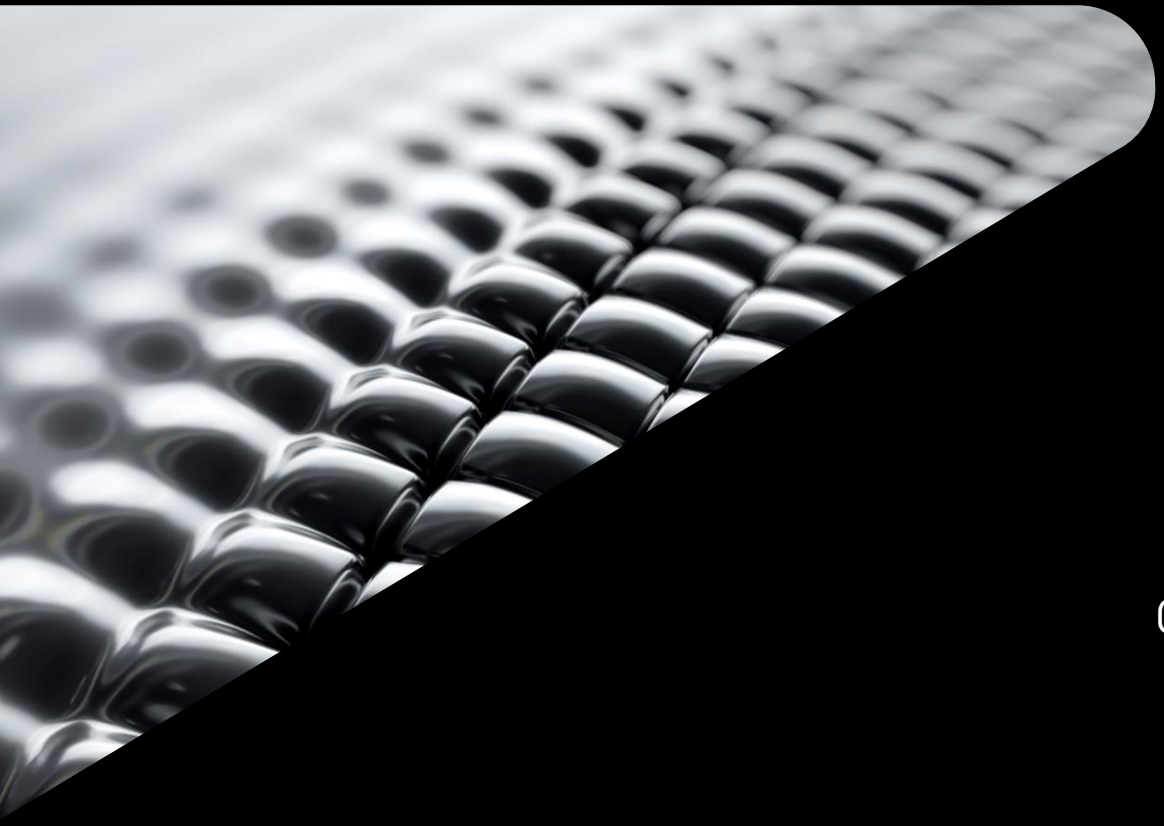
HERMES: MAG Stanchion

Results

- Generative Design has automated the design process for metallic structural components
  - Can get from requirements to parts ready for fabrication in ~1-2 days
  - Parts can be developed for CNC machining or additive manufacturing
  - Parts are typically ~3x stiffer/lighter/stronger than human designs, as validated through physical testing

5 axis machined

Additive metal



Over the Horizon

Generative Design Technology

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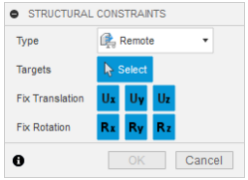
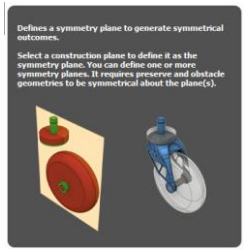
Generative Design

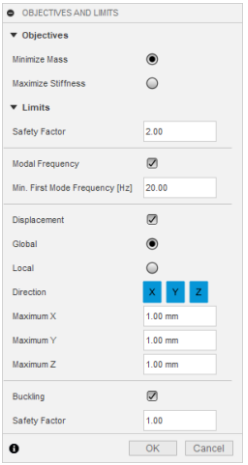
Structural Component Study

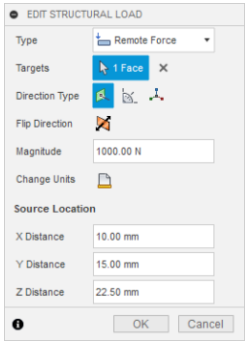
Commercializing Experimental Solvers

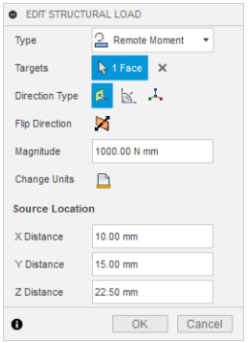
- Phase 1 – Bring modern solver technology and performance to existing functionality
- Phase 2 – Remote forces, moments and constraints, symmetry, displacement constraints
- Phase 3 – Modal frequency constraints, rigid body mode support (inertial relief) and buckling constraints

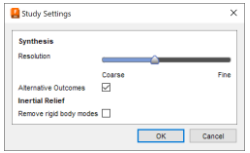






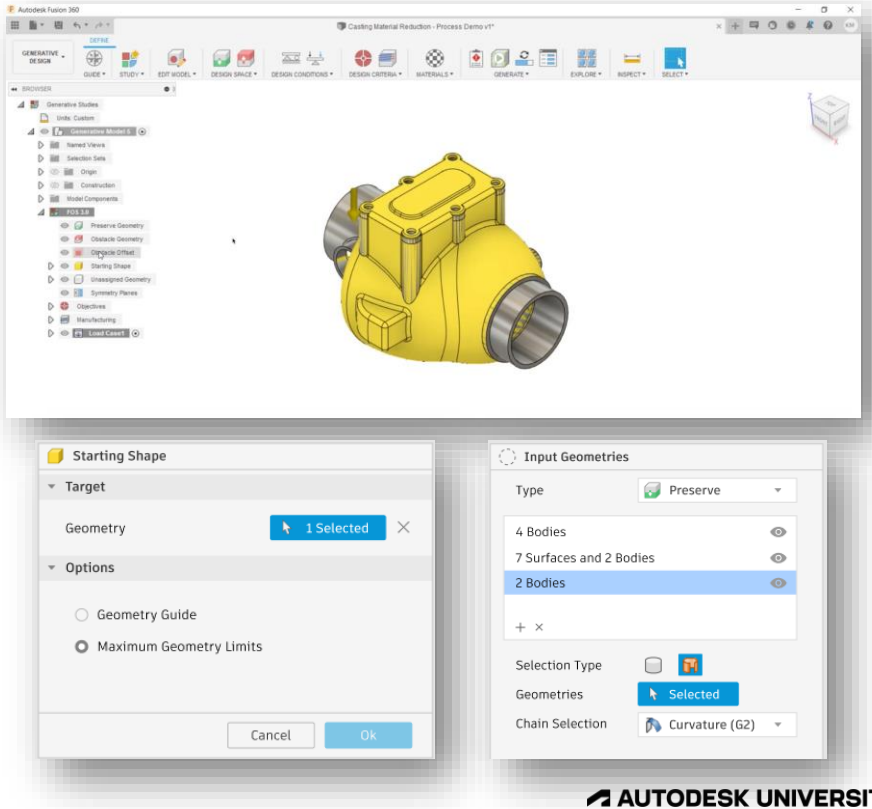






Light-weighting of Existing Designs

- Streamline the setup workflow when working with existing designs
- Reduce requirements around modeling preserves and obstacles to capture existing design intent
- Quicker time to results

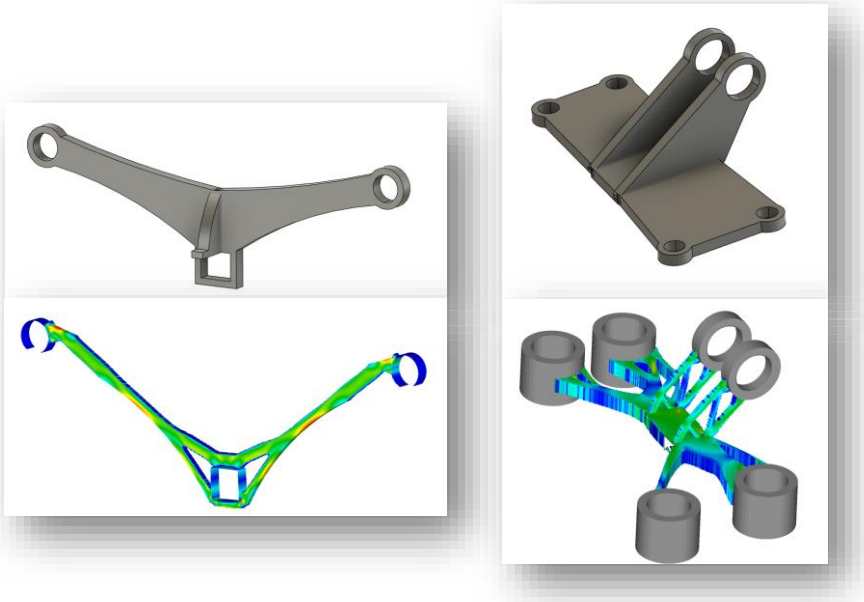


Casting Manufacturing Constraint

- Improve the quality and flexibility of the current Die Casting preview
- Expand to support sand casting design requirements
- Path to using Generative Design in high production volume applications

Weldment MFG Method and Light-weighting

- Path to using Generative Design for more common manufacturing processes and higher production volume applications
- Optimize for material thickness and profiles



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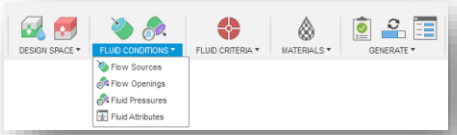
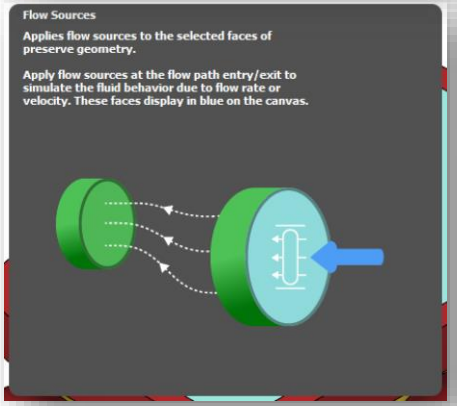
Generative Design

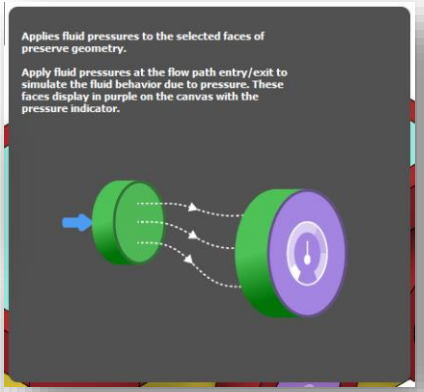
Fluid Path Study

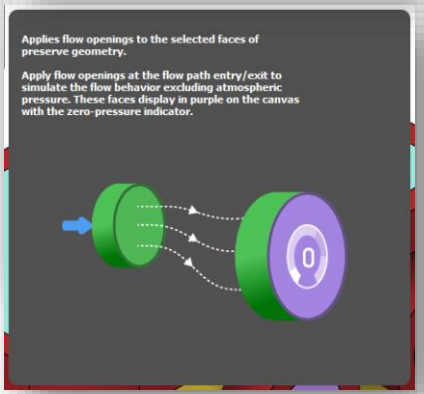
Fluid Path Boundary Condition Refinement

- Improved naming and command isolation to align with user intent
- Simple combination of input requirements to ensure proper setup
  - Flow Source(s) + Flow Opening(s)
  - Flow Source(s) + Fluid Pressure(s)
  - Flow Source(s) + Flow Opening(s) + Fluid Pressure(s)





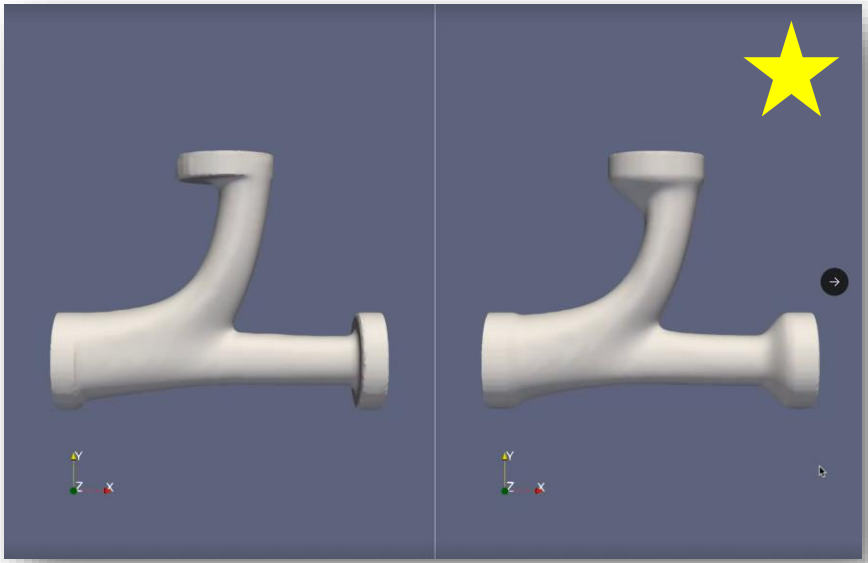




Improved Fluid Path to Preserve Transitions

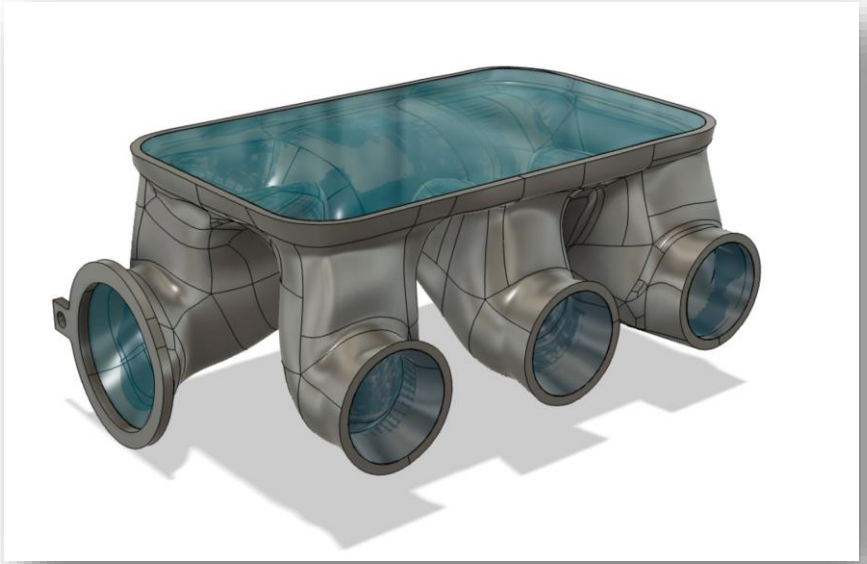
- Improved geometry transitions at the interfaces between preserve fluid preserve geometry and generated shape

- Reduces required design editing and anomalies in downstream validation



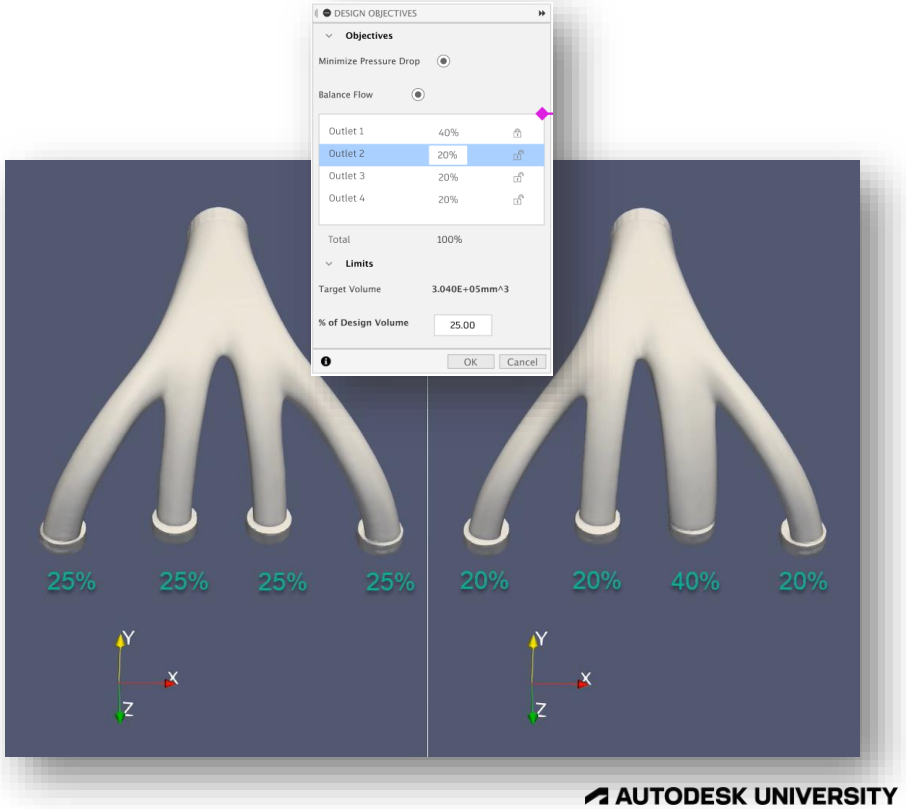
Solid Wrapper Geometry for Fluid Path Outcome

- Automatically generates an editable solid body with an approximate user defined thickness that contacts the wetted surface of the generated fluid outcome
- Sets up a downstream workflow to Generative Design for Structural Components to optimize the solid design for expected fluid loads



Flow Opening Biasing in Fluid Path Study

- Allows for user defined distribution of flow across defined Flow Openings while minimizing pressure drop in the system



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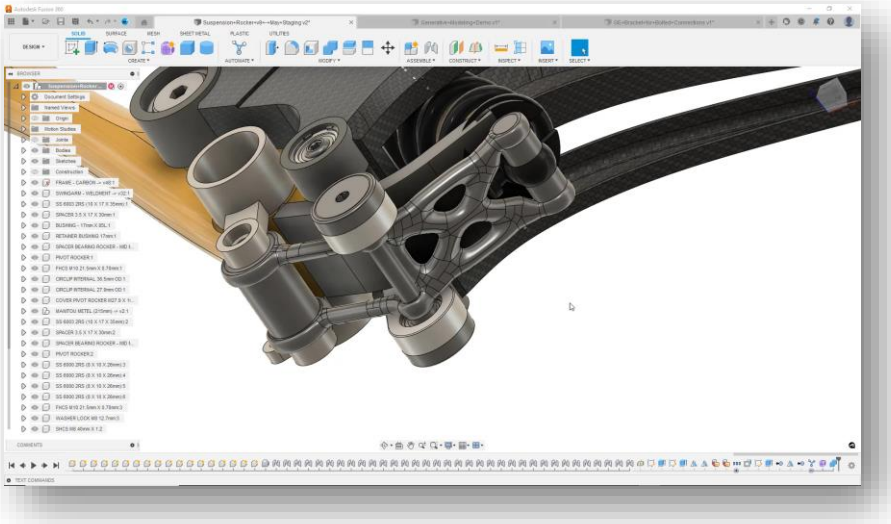
Automated Modeling

Design Workspace

Thickness/Volume Control Slider

- Provides variation in the resulting alternatives
- Increases the number of potential design solutions
- Easily create thicker or thinner designs
- Reduces the potential amount of downstream editing required to get a desired shape



Context Switching Support

- Prevents unintended cancelling of alternative generation
- Allows multi-tasking while Automated Modeling is running
- Clear indicator that Automated Modeling features need to be completed before additional downstream modeling

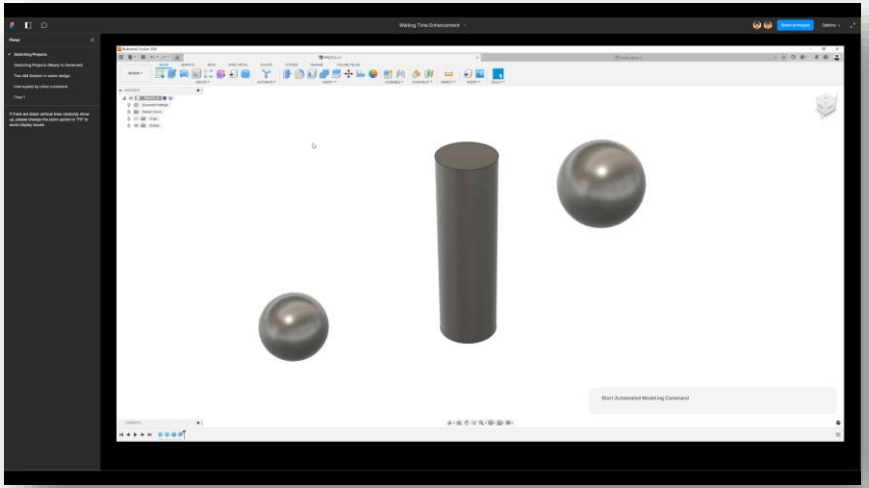
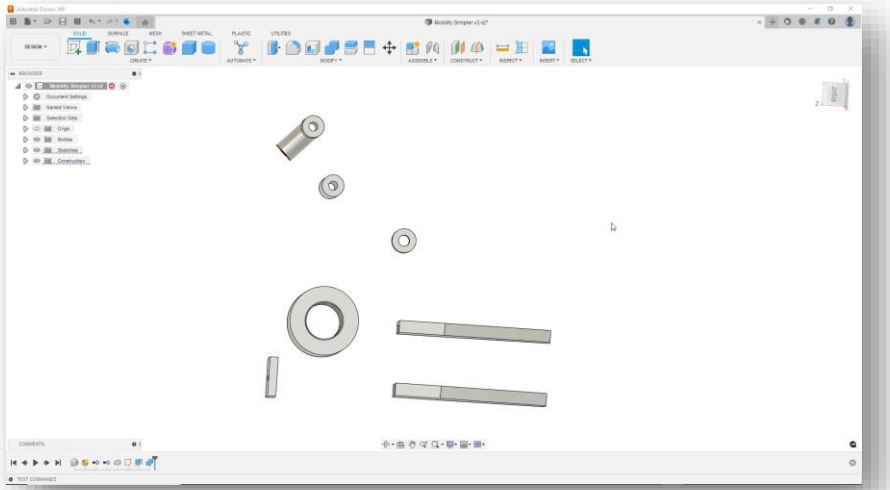


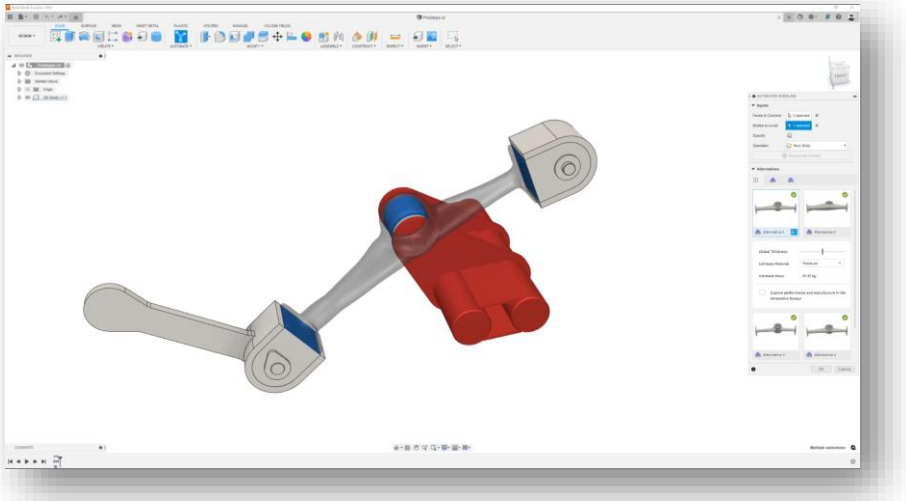
Plate-style Alternatives

- Provides a totally different, simpler style of design alternative
- Simplified editability with sketch and extrude based construction
- Path to simpler manufacturing processes



Push to Generative Design

- On-ramp to objective-based design exploration
- Translation of Automated Modeling setup into Generative Design setup
- Create refined alternatives informed by performance, materials, manufacturing and production volume requirements



Additional Resources

- Product Overview
- Product Documentation
- Product Certification
- Generative Design + AM: Building Lightweight Structures for NASA EXCITE Webinar
- Generative Design x Digital Manufacturing at NASA for AM & CNC Webinar
- Fusion 360 Insider Program Focus Groups
  - Automated Modeling
  - Generative Design - Fluid Path Study