

APSC **AUTOMOTIVE PARTS SUPPLIERS CONFERENCE**

SEPTEMBER 11-12, 2024

PONTIAC, MI

PRODUCED BY **PMA** PRECISION
METALFORMING
ASSOCIATION

MetalForming
Magazine



MACHINA LABS

ABOUT MACHINA

First and only Commercially-Available Robotic Sheet Metal Forming Technology



Mission & Vision:

Unlocking manufacturing for all with robotics + AI



Team:

Technology & manufacturing industry execs from companies including SpaceX, Relativity Space, Novelis, Carbon, Stratasys, nTopology, etc.



Business Model:

2022-2023: Machina Parts Manufacturing

2024+: Parts Manufacturing + Deployable Systems



Location(s):

HQ: Los Angeles, CA (30,000 Sq ft, 22 Robots)

- 9410 Owensmouth Ave, Chatsworth, CA 91311

Expansion Facility: Los Angeles, CA (60,350 Sq ft, X Robots)

- 20559 Prairie St, Chatsworth, CA 91311



ROBOFORMING™



Leveraging precise industrial robotics and AI-driven process control, Roboforming™ rapidly shapes sheet metal into large, complex parts that are extremely expensive and slow to produce with conventional manufacturing tools.

Video available at www.MachinaLabs.AI

ROBOSCANNING™

A robot-mounted laser scanner creates a 3D map of the surface of the part and then Machina software compares this to the CAD model to determine accuracy across every dimension. Any deviations are compensated for in our AI-powered process model to optimize the next manufacturing iteration until the part is within spec.

Video available at www.MachinaLabs.AI

ROBOCUTTING™



The 7-axis robots autonomously pick up and precisely manipulate cutting tools to remove material, drill holes, and trim the part geometry from the surrounding sheet. Data from the prior part scan provides an exact datum to the formed surface for an accurate, adaptable toolpath.

Video available at www.MachinaLabs.AI

SYSTEM CAPABILITIES

1st Generation - ROBOCRAFTSMAN™ Deployable Cell

12 x 5 x 4 ft part size

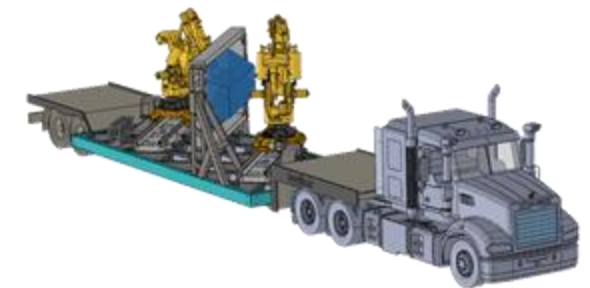
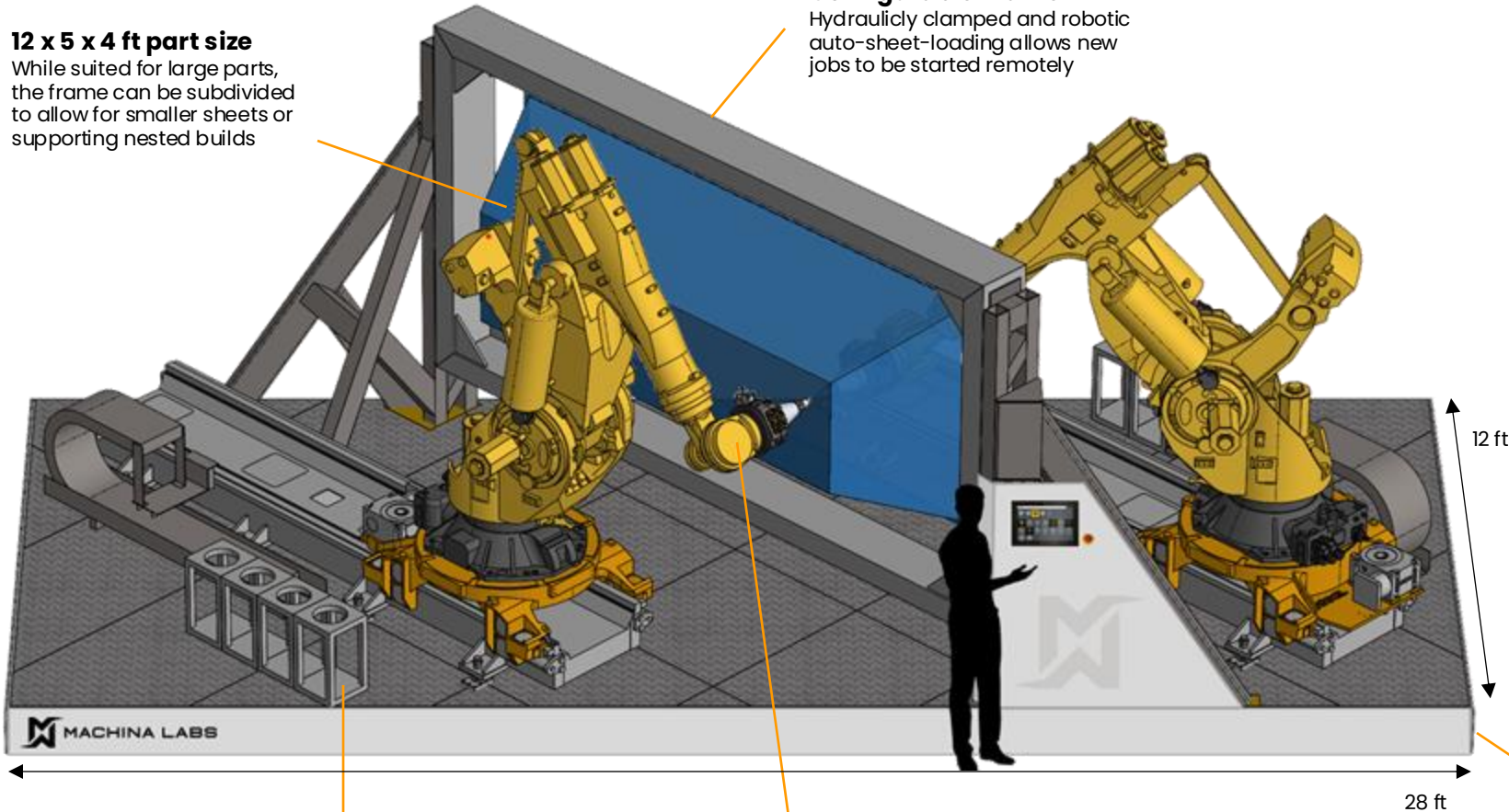
While suited for large parts, the frame can be subdivided to allow for smaller sheets or supporting nested builds

Configurable Frame

Hydraulically clamped and robotic auto-sheet-loading allows new jobs to be started remotely

AI-driven Process Control

Proprietary software stack drives process from CAD to final inspection. AI Machine learning models constantly improve process



Tool changing Corral

Holds forming, trimming, and other tools, enabling the robot to automatically switch between them

7 axes Robotics

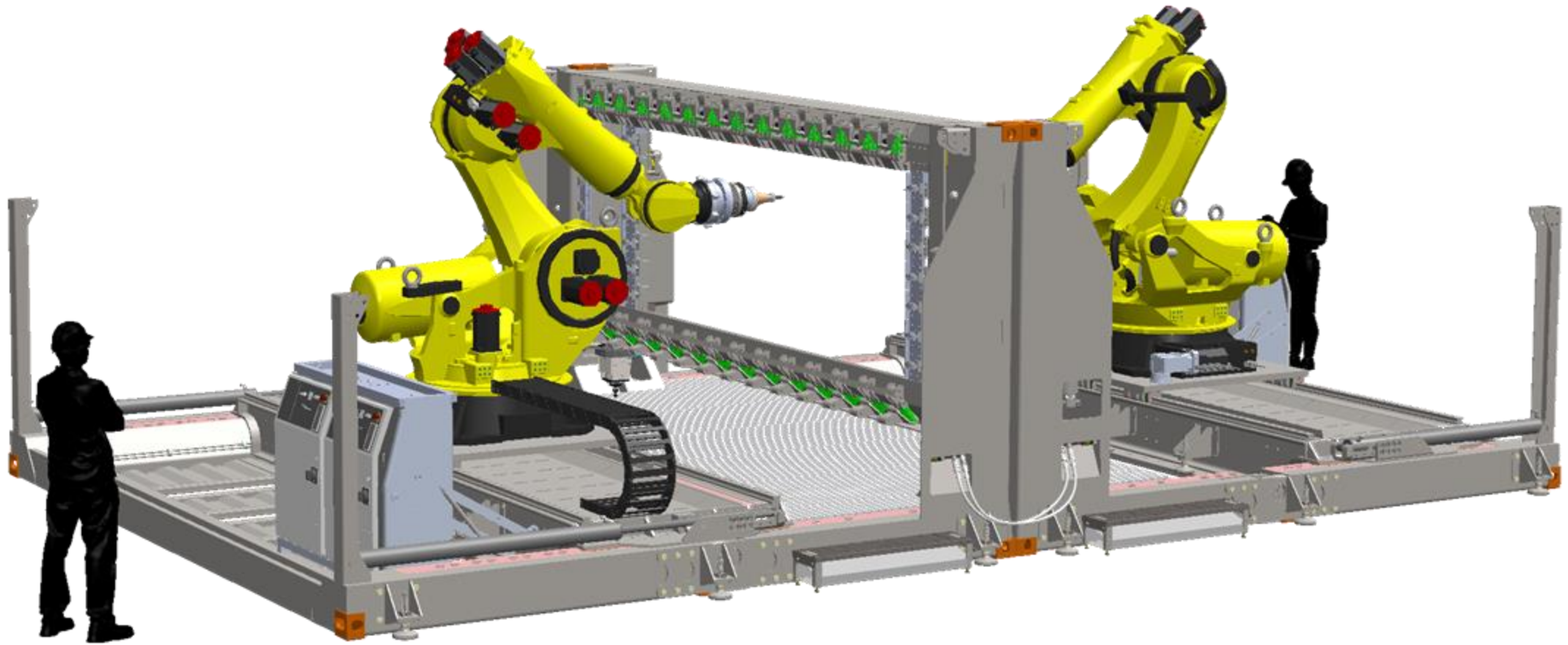
6-axis precise industrial robots + rail system allow for ultimate spatial freedom for optimal poses and material processing

Portable Platform

Mounted to its own base, the self-contained system is easy to deploy to any geography or environment

SYSTEM CAPABILITIES

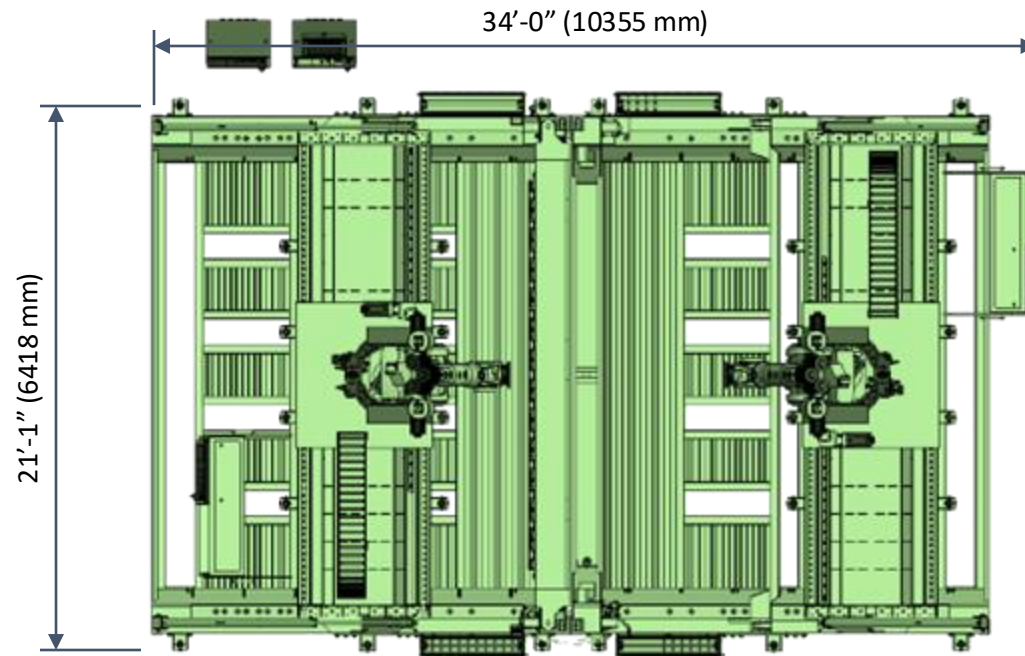
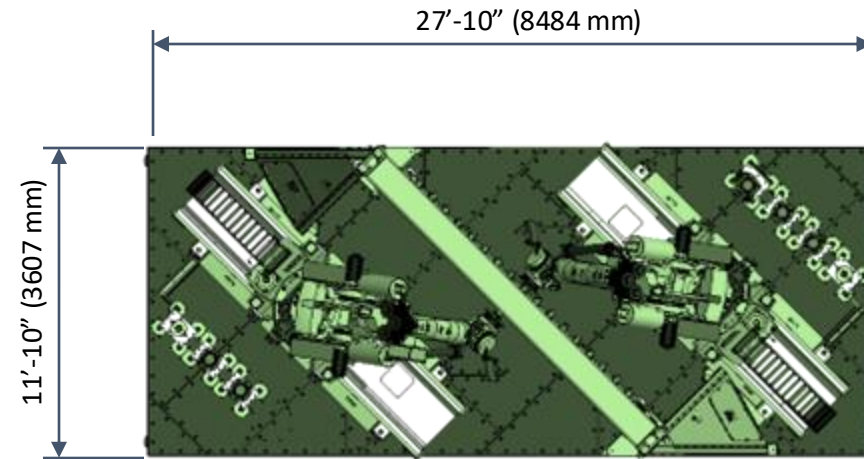
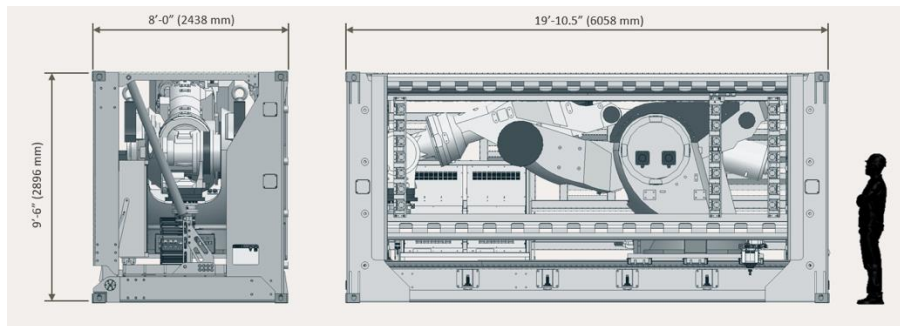
2nd Generation Rapid Deployable Cell – 2 ISO Containers



Rapid Deployable cell

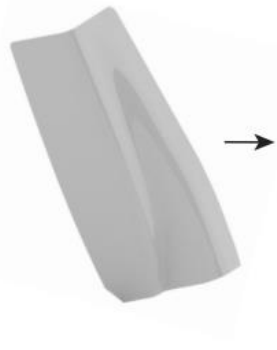
V1 vs V2

- **Main Functional Differences:**
- Increased sheet forming size from 60" x 12' to 60" x 15'
- Robots maintain normal orientation to sheet frame to a significant forming depth (>1m)
- Foldable frame for easier transport
- Integrated control cabinets
- Easier technician access. Sheet frame can be approached from either side of the main frame.
- Slightly lower forming frame (~7" lower)

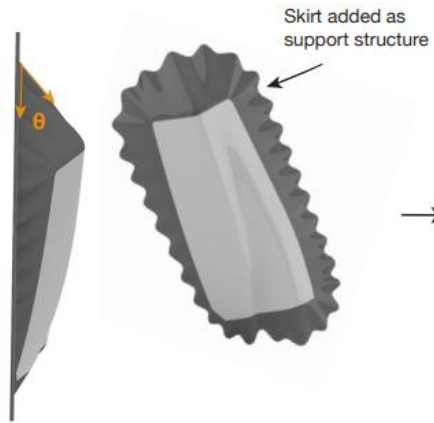


Roboforming Workflow

1 CAD DESIGN

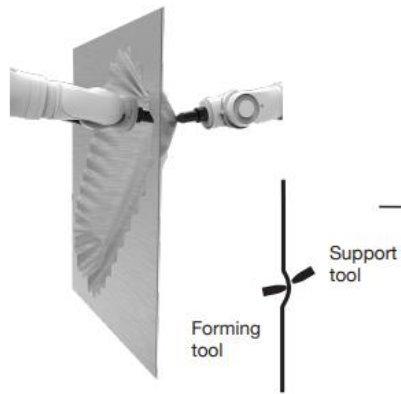


2 ORIENTATION AND SKIRTING



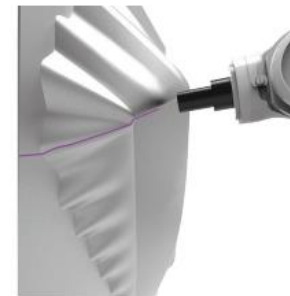
Orient to minimize wall angle and skirt area

3 ROBOFORMING



Incremental forming with two robots that can interchange roles as forming and support tools

4 SCANNING



Formed sheet metal design scanned in cell to measure accuracy and deviation from CAD design

5 TRIMMING



Final part trimmed from the skirt and unformed sheet

6 FORMED DESIGN

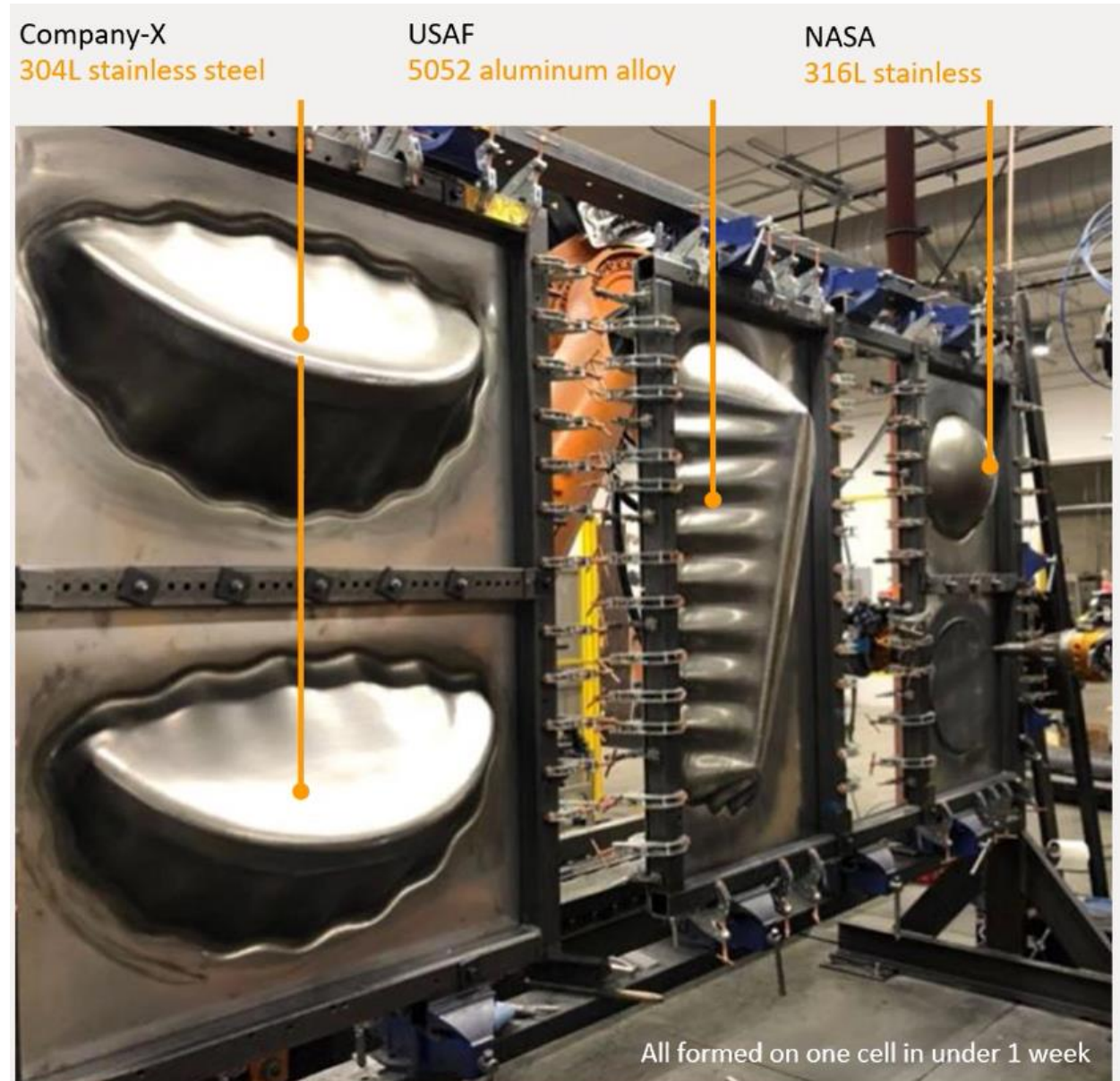


In-line Process Flexibility

Three separate parts

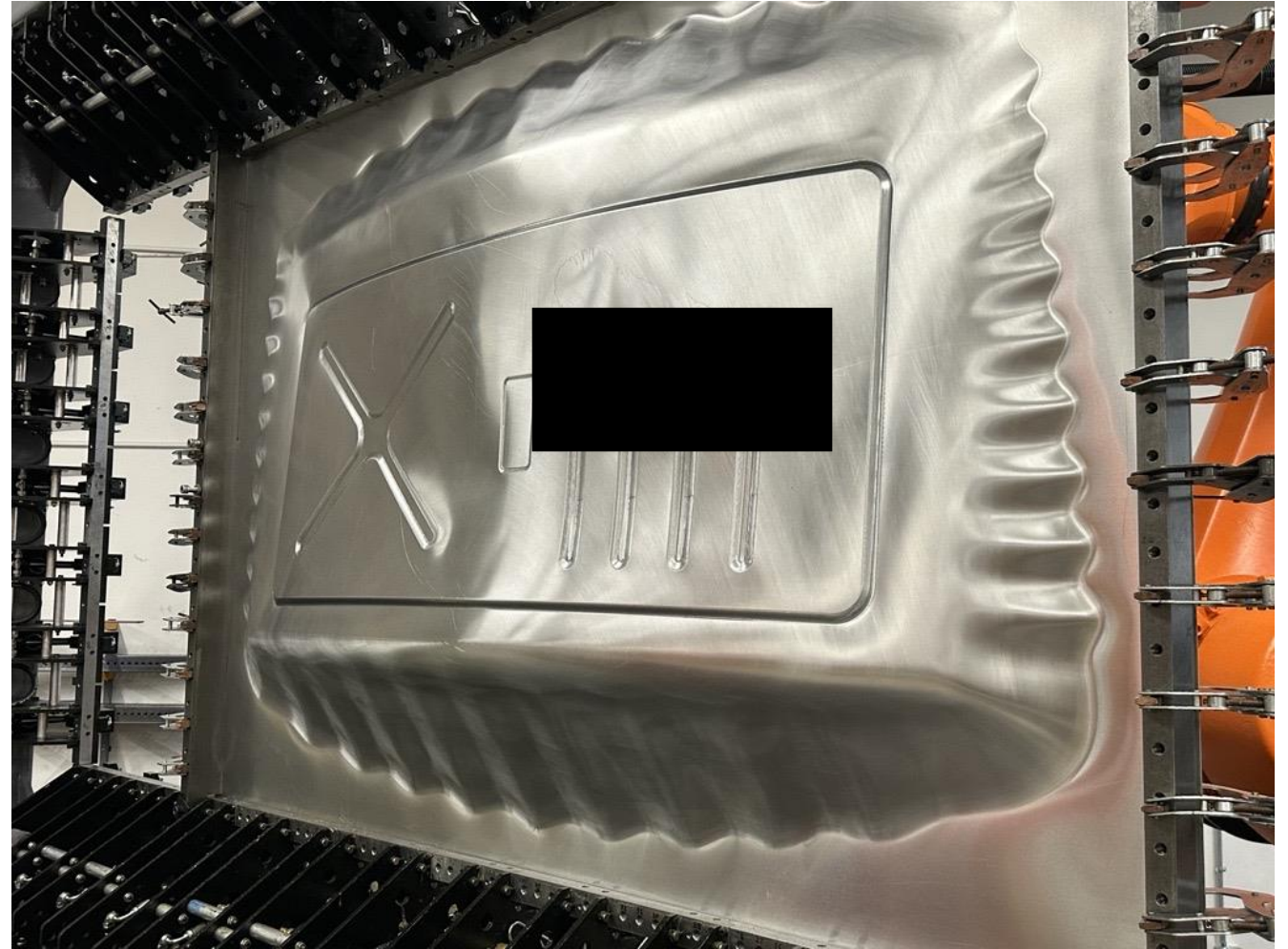
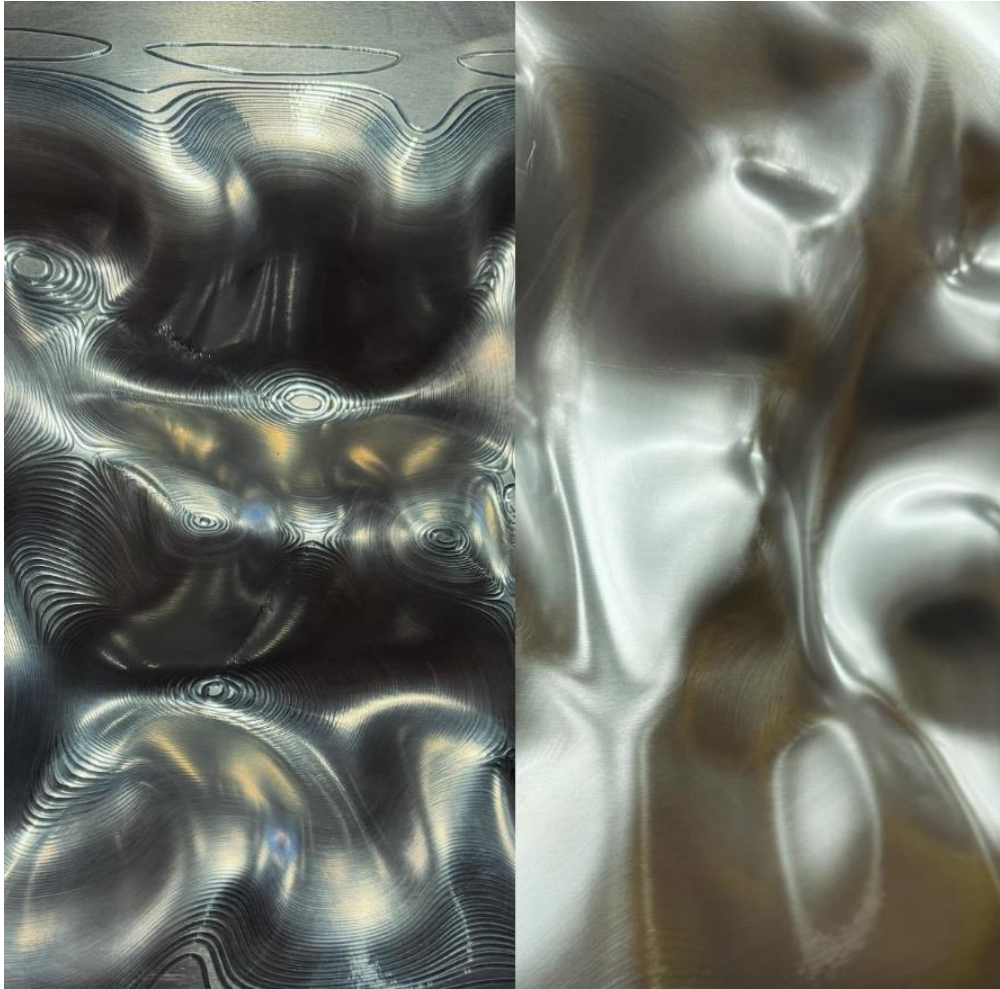
Three discreet materials

Eliminates the need for SMED (Single Minute exchange of Die)



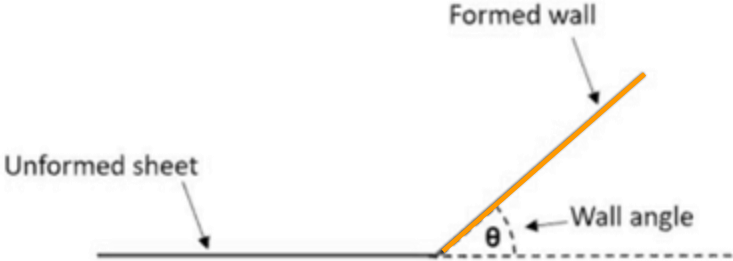
Surface Finish Development

Digital and Physical improvements to on-cell surface finish

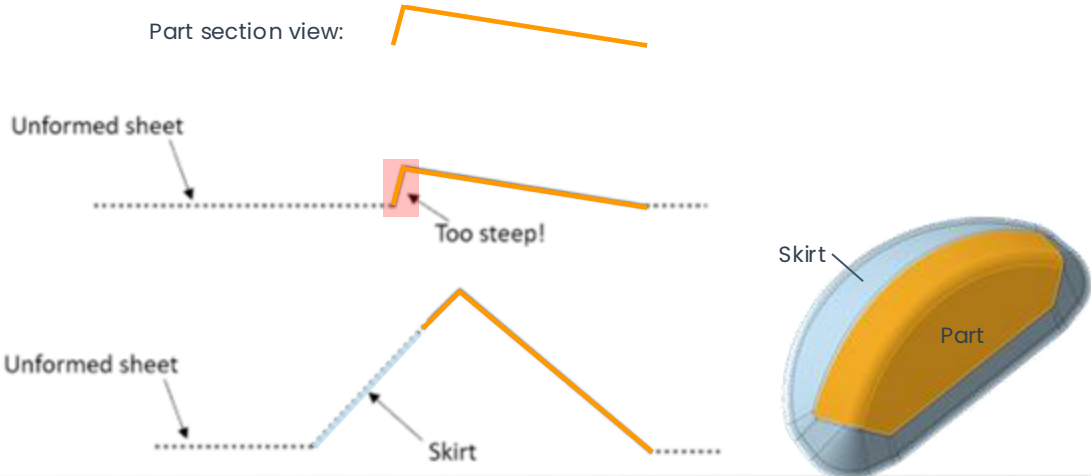


Design Guide

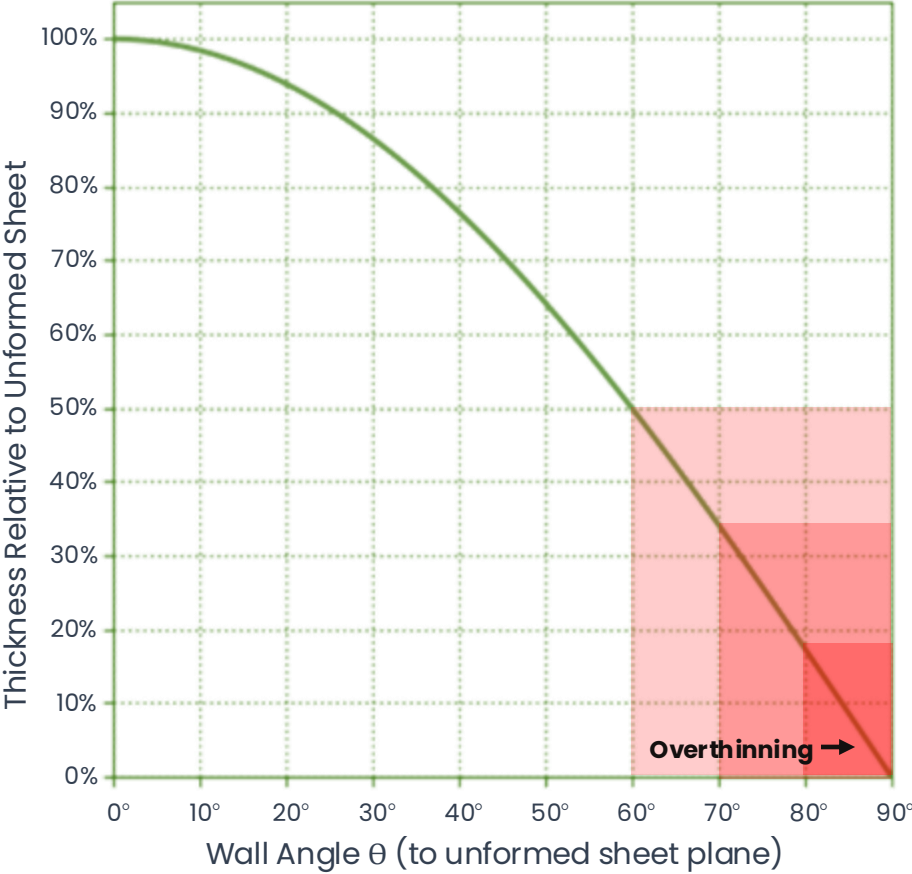
Wall angle is an important design factor



Part Orientation & Skirt Design:



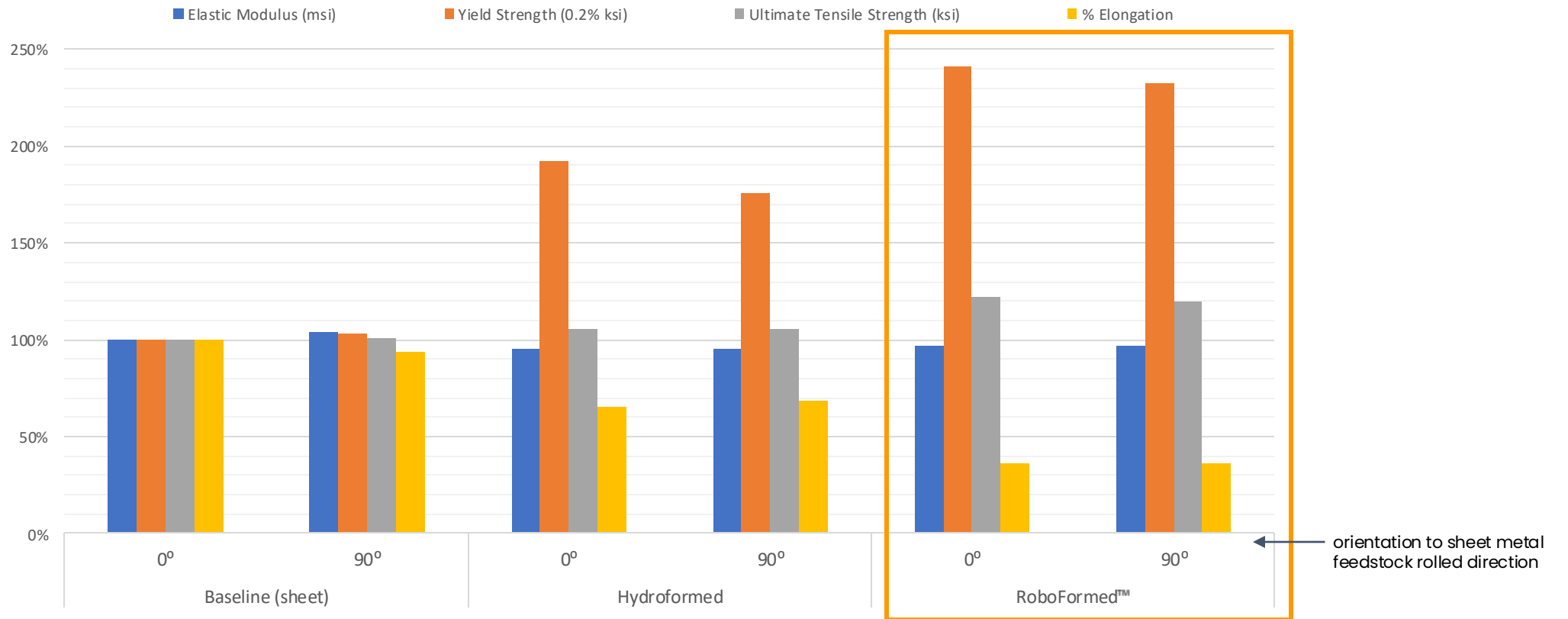
Thinning as a Function of Wall Angle:



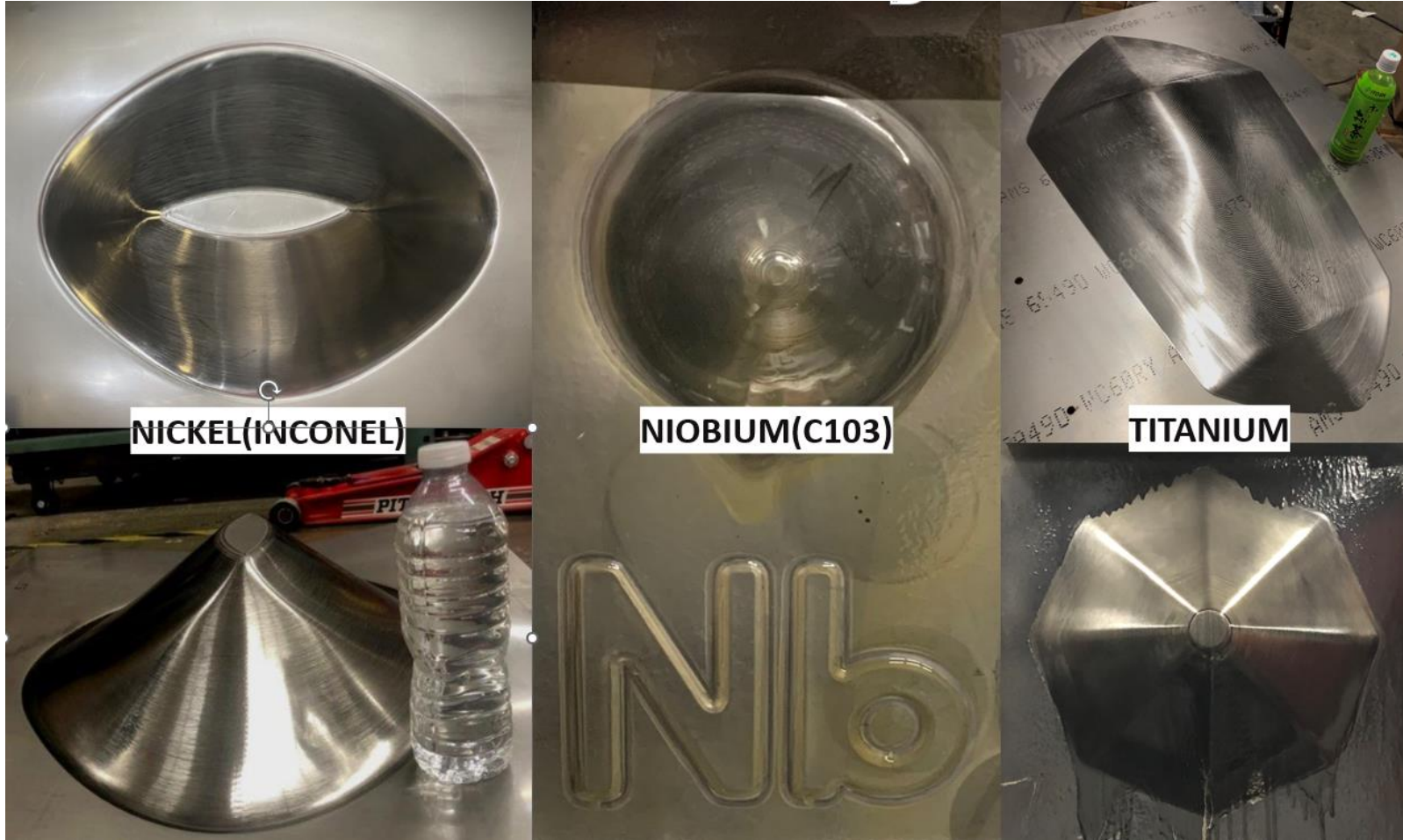
Machina Roboforming™ - Material Properties

Roboforming™ is performed at room-temperature and involves “cold-working” sheet metal by robotically and incrementally stretching and thinning it in a highly predictable and consistent process.

Tensile Test Data (Aluminum 2,6,7XXX alloys):



Exotics Forming



Anvil

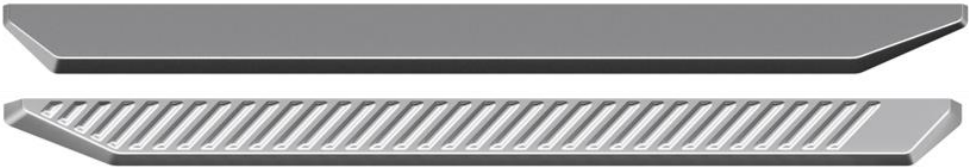
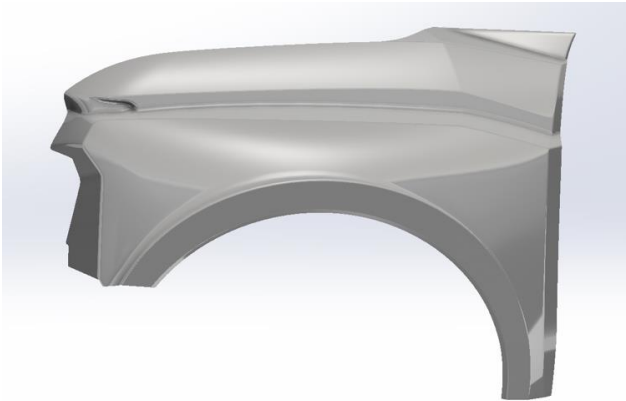


Machina enables complexity with a low upfront investment

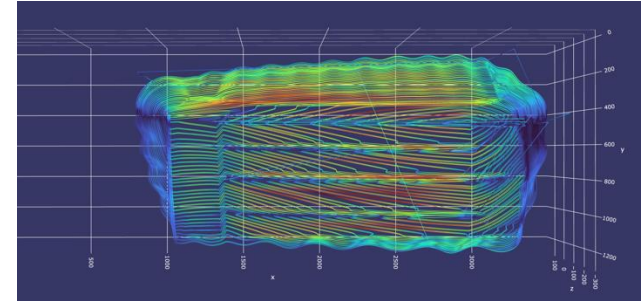
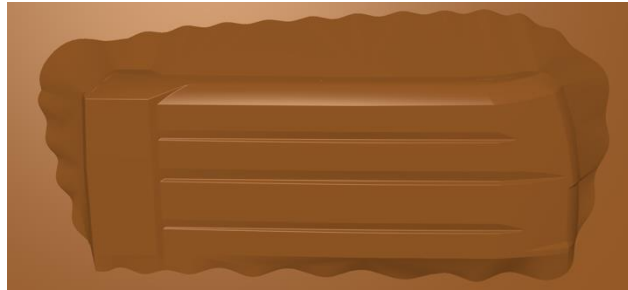
Full Panel Customization



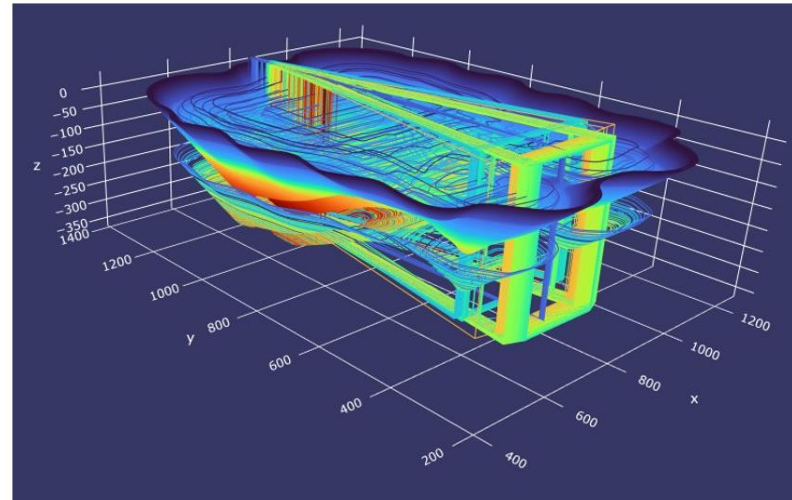
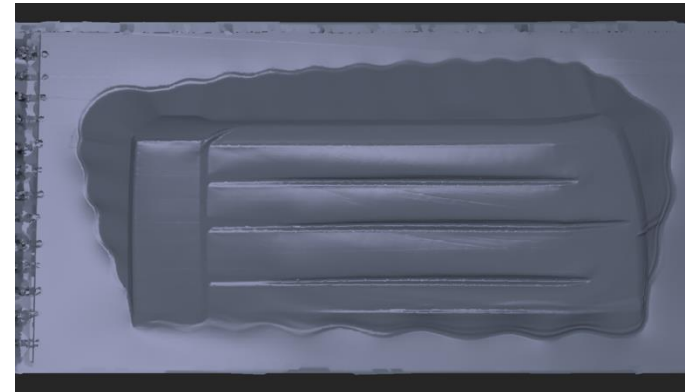
Anvil Program



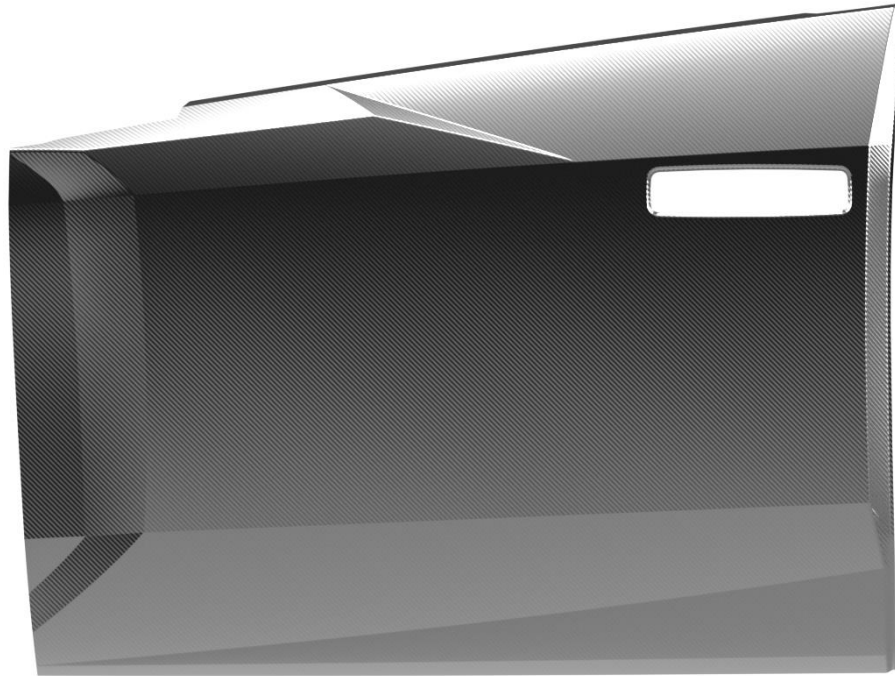
Digital Workflow for Anvil roof panel



Once the final shape to be formed including the part surface and skirting has been generated, the entire geometry is "sliced" into layers and converted to a sequence of points representing each layer. Path Planning turns the point sequence into a set of instructions representing the path for the pair of robots to follow, subsequently forming each layer of the geometry.



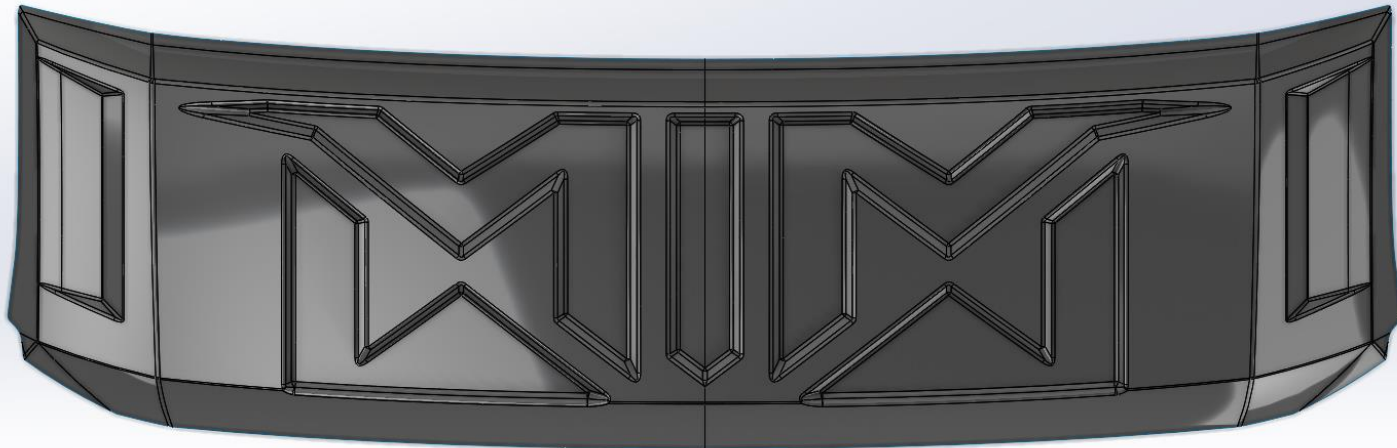
ANVIL



Part: Passenger Door
Surface Area:
Trim length:
Sheet: 60"x80"



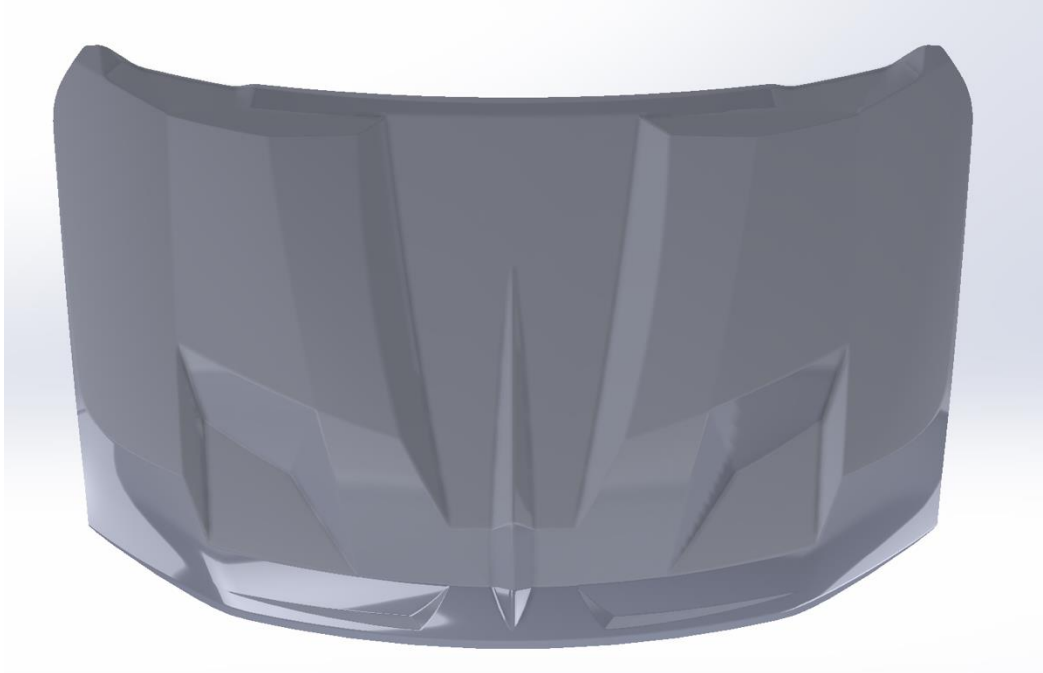
ANVIL



Part: Front Grill
Surface Area:
Trim length:
Sheet:



ANVIL



Part: Hood
Surface Area:
Trim length:
Sheet:



Enabling design combinations per theme

Mix & match custom design panels within each theme or personalize with your own artwork



Hood

Select from options designed by world-class designers – or go completely custom.



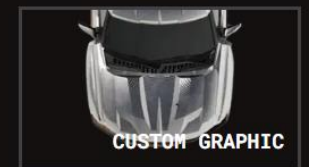
SWEPT



VAULTED



SMOOTH

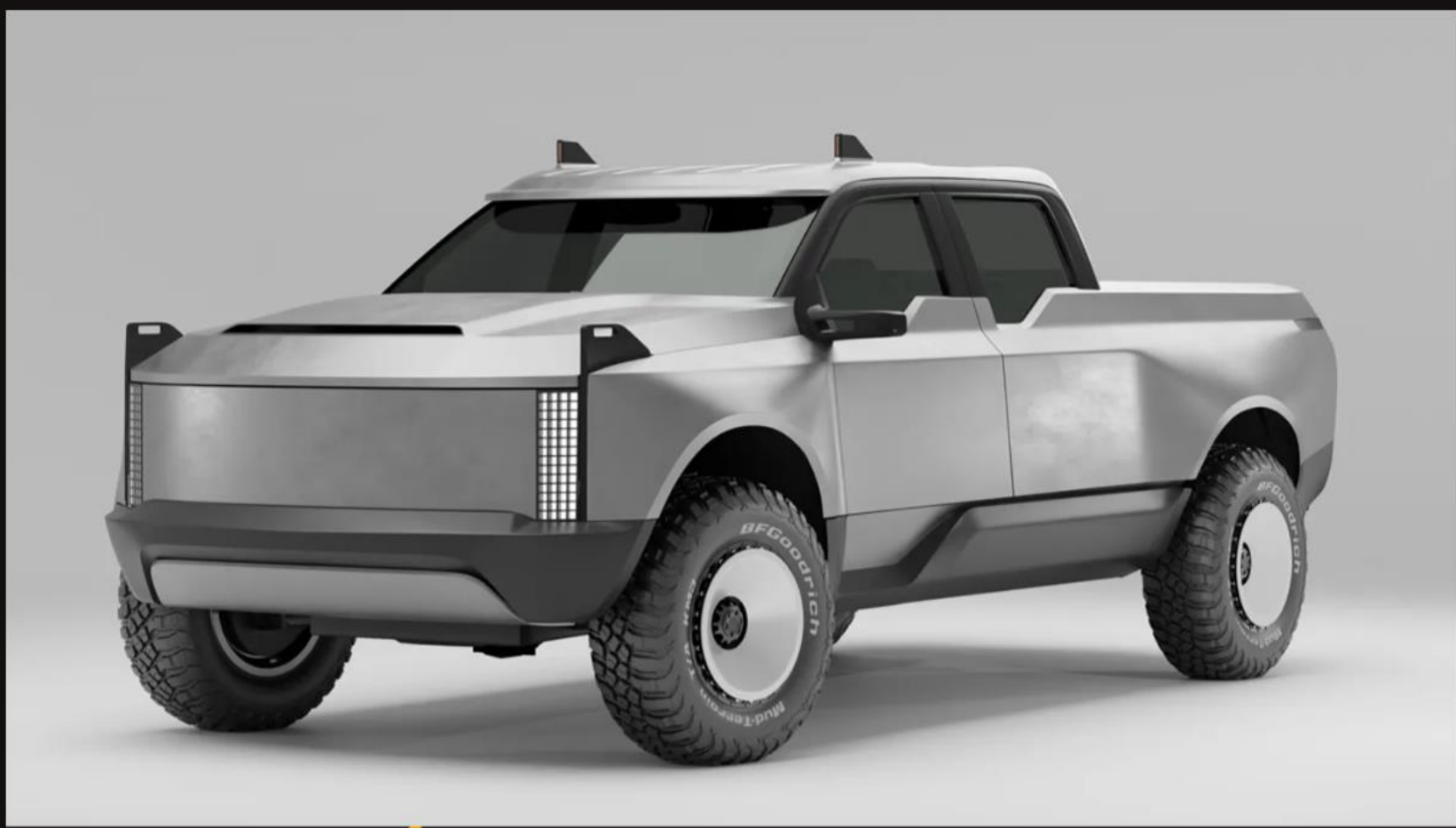


CUSTOM GRAPHIC

*Custom graphic allows you to upload your own artwork for a truly personalized design

Enabling design combinations per theme continued...

Mix & match custom design panels within each theme or personalize with your own artwork



Fenders



ANGULAR



STREAMLINE



LOS ANGELES (CUSTOM GRAPHIC)



YOUR CUSTOM GRAPHIC*

* Custom graphic uploads available during pre-order

THE NEXT CHAPTER IN CAR INNOVATION

Design and drive your dream car with the Anvil platform



ABOUT ANVIL

Anvil is a design-to-order automotive platform by Machina Labs. At the moment we use F-150 as a base. Our groundbreaking manufacturing platform allows you to design and drive a car unique to your tastes.



Vacuum jig
w/ window



Custom
emboss/deboss



Automotive Customization with Stamped Body Panels



Vacuum jig
w/ window



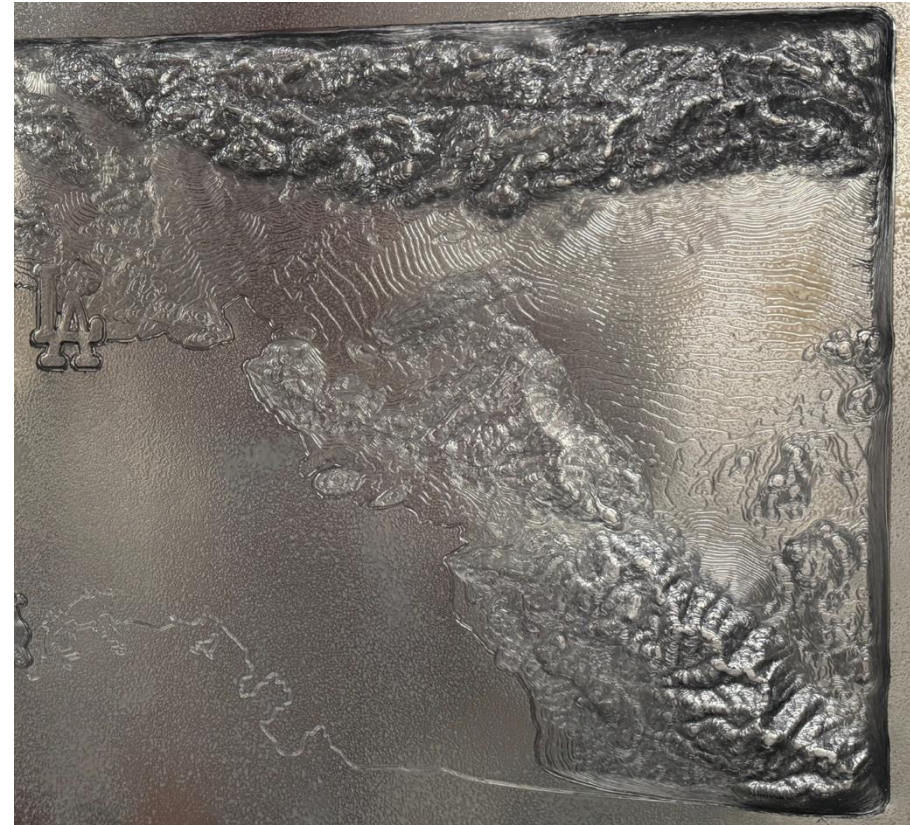
Custom
emboss/deboss



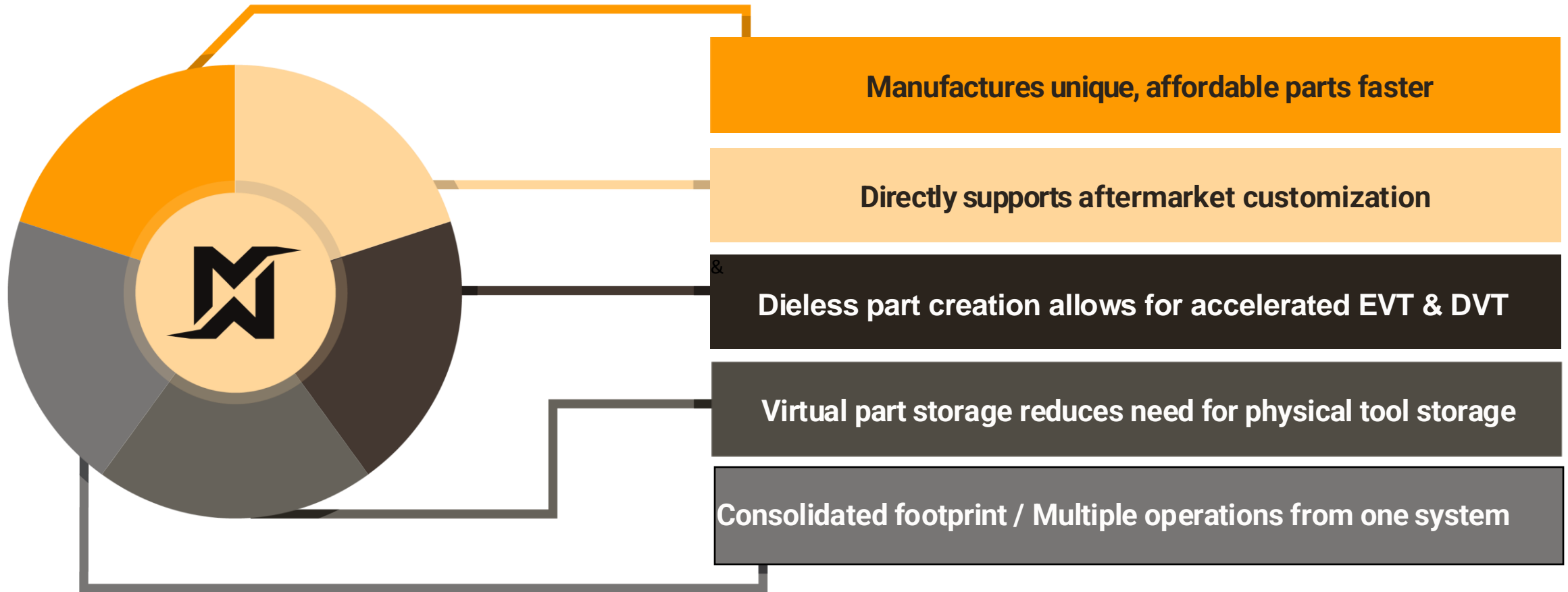
15-minute
restrike

Los Angeles Topology Example

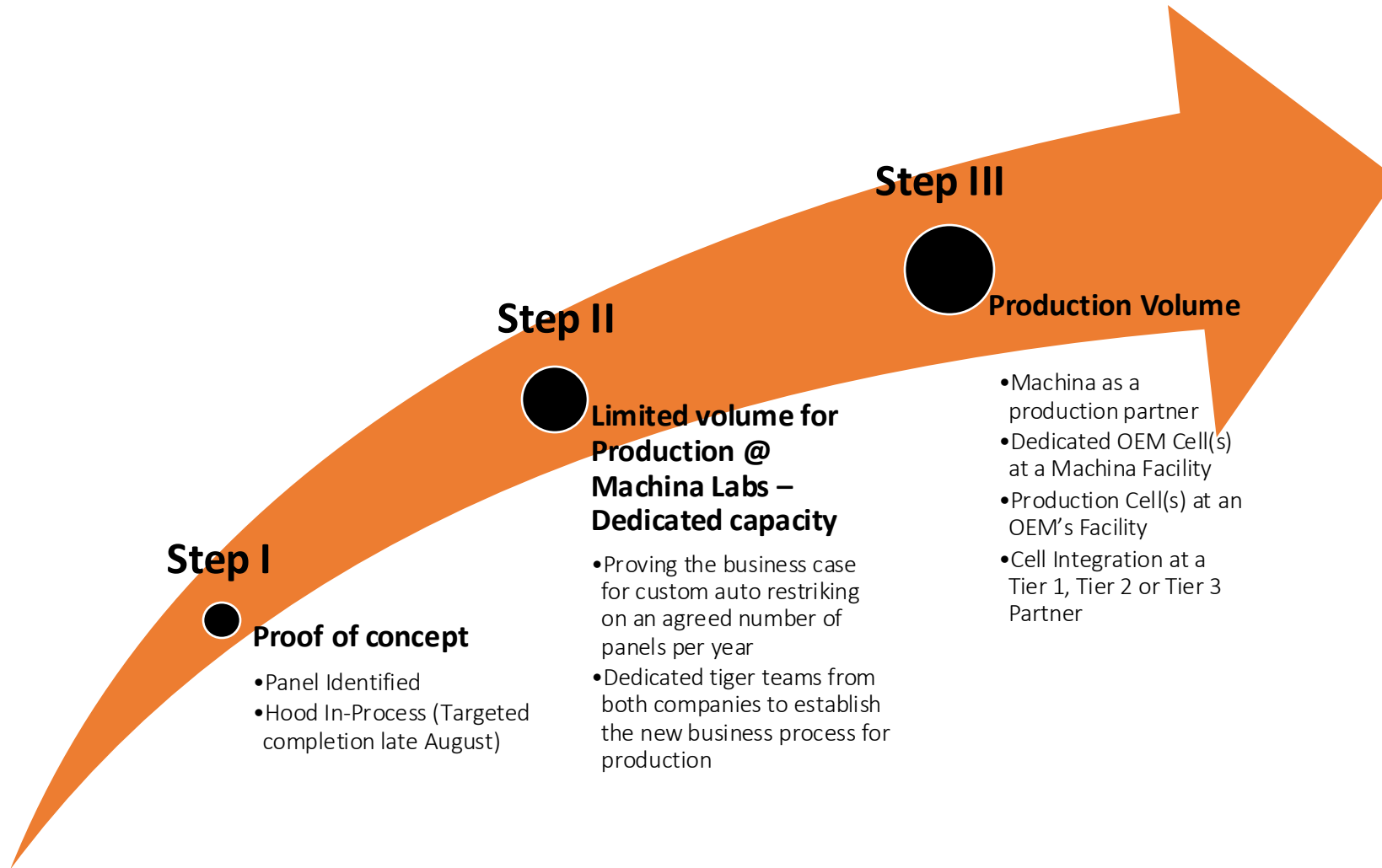
Customizing Panels

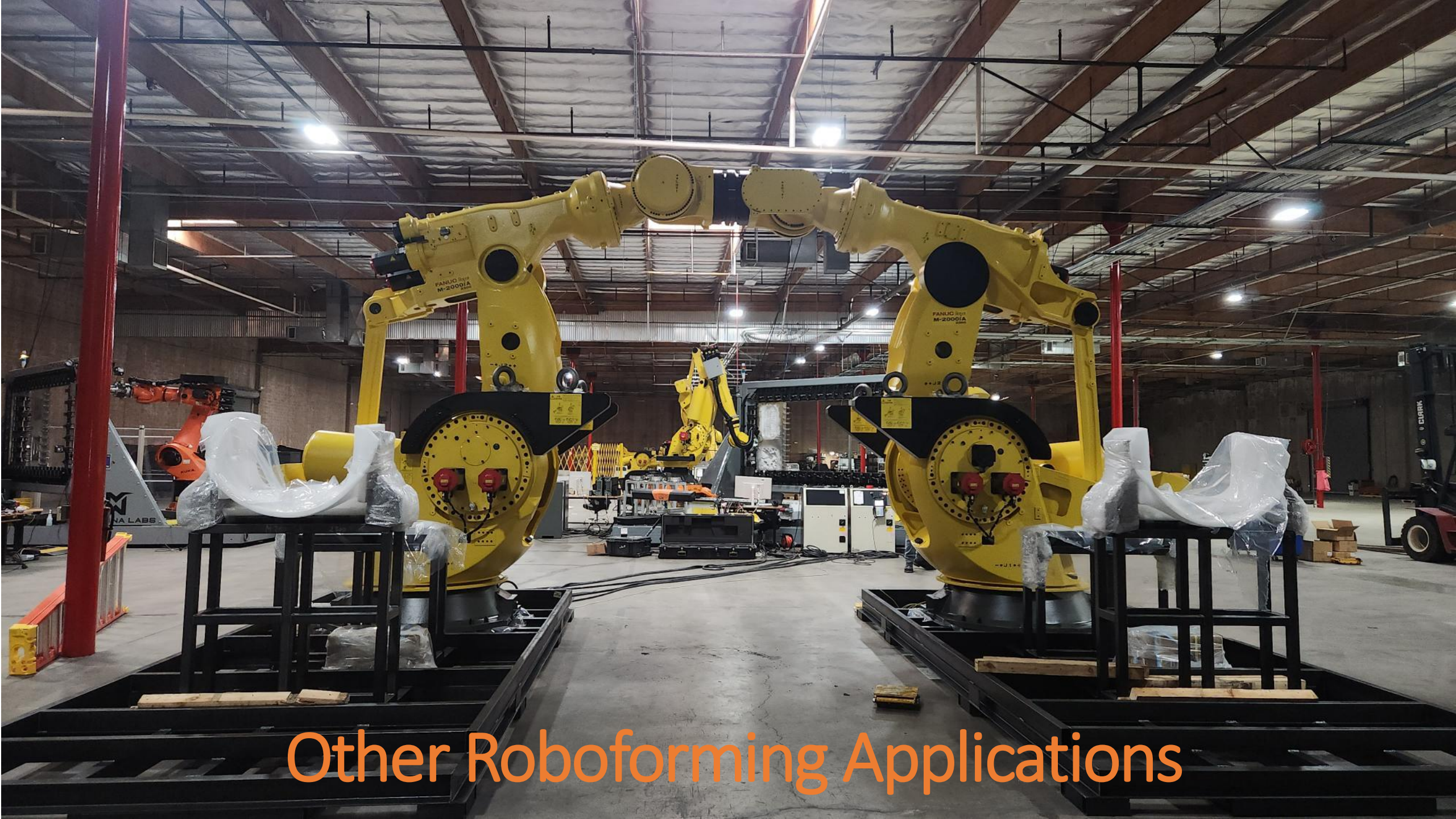


A NEW AUTOMOTIVE APPROACH: THE AI-DRIVEN ROBOCRAFTSMAN



How will Machina bring this new product category to customers?

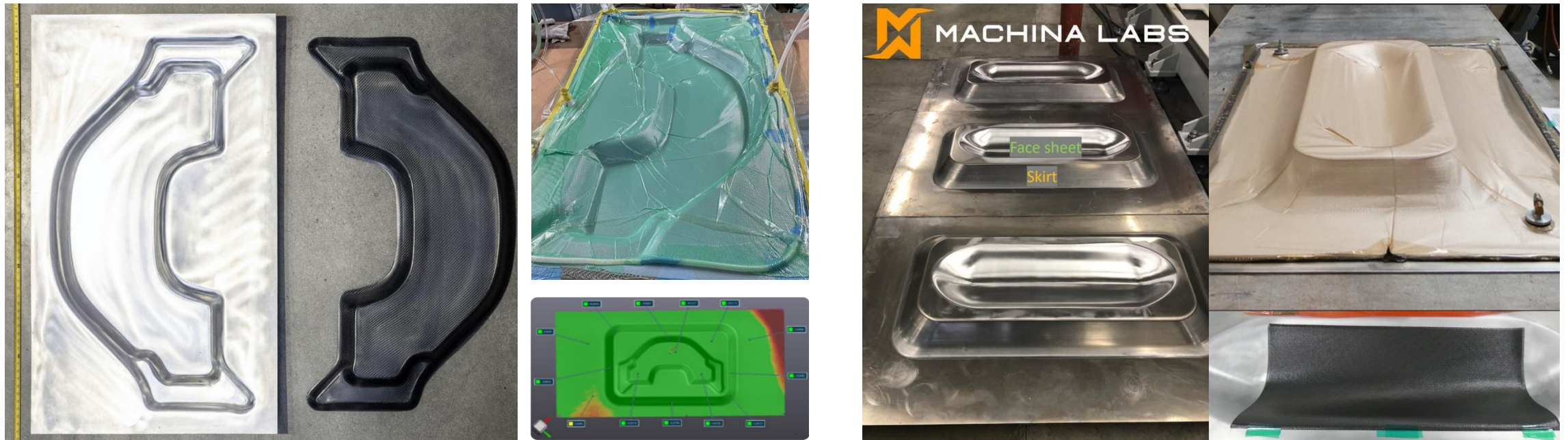




Other Roboforming Applications

Sheet Metal Composite Molds

Machina Labs' manufactured tooling has demonstrated high dimensional stability during autoclave cycling tests performed by independent laboratories



Reduction in lead time – weeks not months

90+% lighter than exiting tools = easier, manual handling

Faster autoclave cycles enabled by thinner molds with lower thermal mass

Available materials: Aluminum, Steel, and Invar

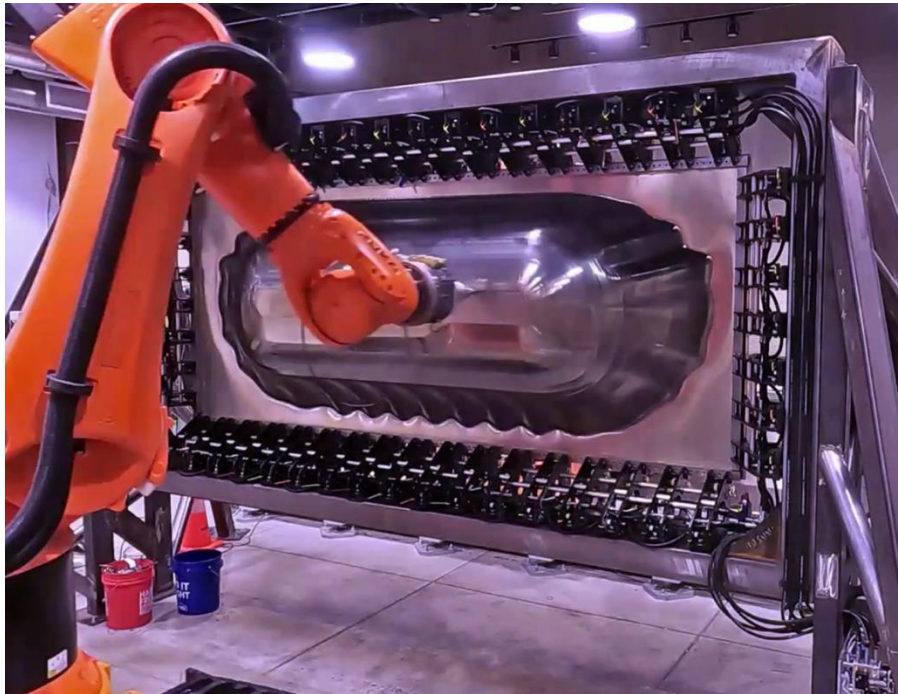
Aftermarket and Sustainment

Adding >90° features with restriking

A 2-step process involving global forming and feature addition (USAF C130 MRO)



1 Initial Forming

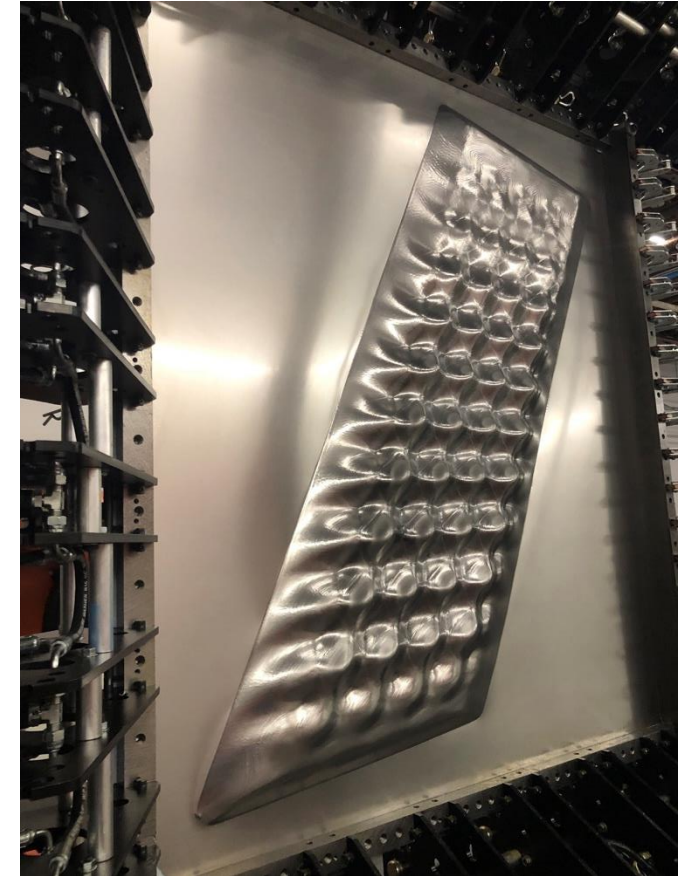


2 Feature Restriking



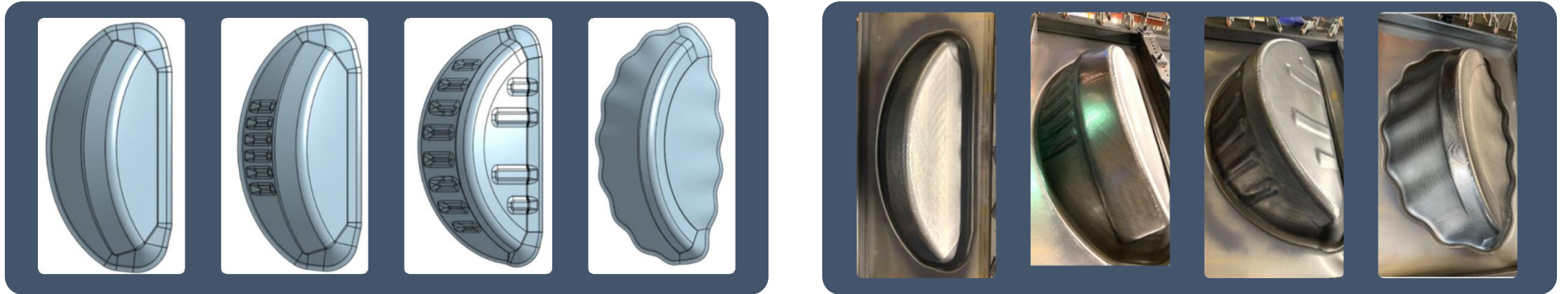
Machina Enables N-of-1 Feature Integration

Conformal cooling, stiffening structures, topology optimization



Stiffened and Lightweight Enclosures

Stiffening features (such as iso-grids and ribs) can readily be integrated into the design of enclosures.



This design iteration was completed for a space application over the course of 6 days.

Various stiffening features were added to the part to maximize the structural integrity of the component while allowing for lightweighting through the use of a thinner gage material.

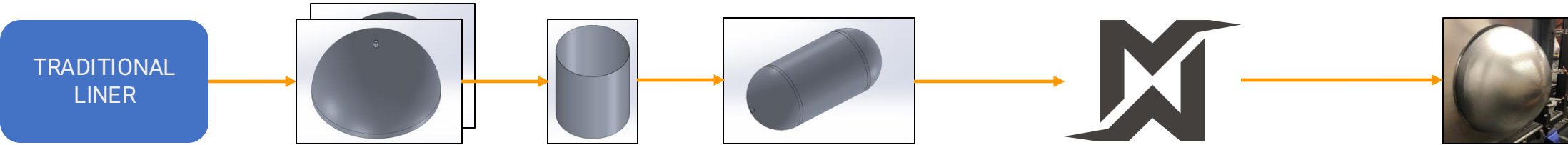
Tanks and Welded Assemblies

DEMONSTRATOR, SCALED TOROIDAL TANK BUILD



Tanks and Welded Assemblies

DEMONSTRATOR, PILL TANK



ABILITY TO FORM 90° DOME

Machina Enables Bridge Testing

50 production material parts for testing during tool fabrication



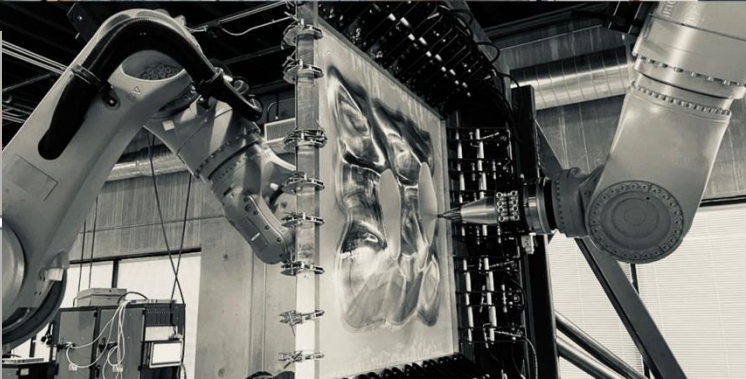
Art and Architecture

Development of high mix custom installations



Scans

Generative Curves



Natural Surface Simulation

MACHINA LABS, INC.



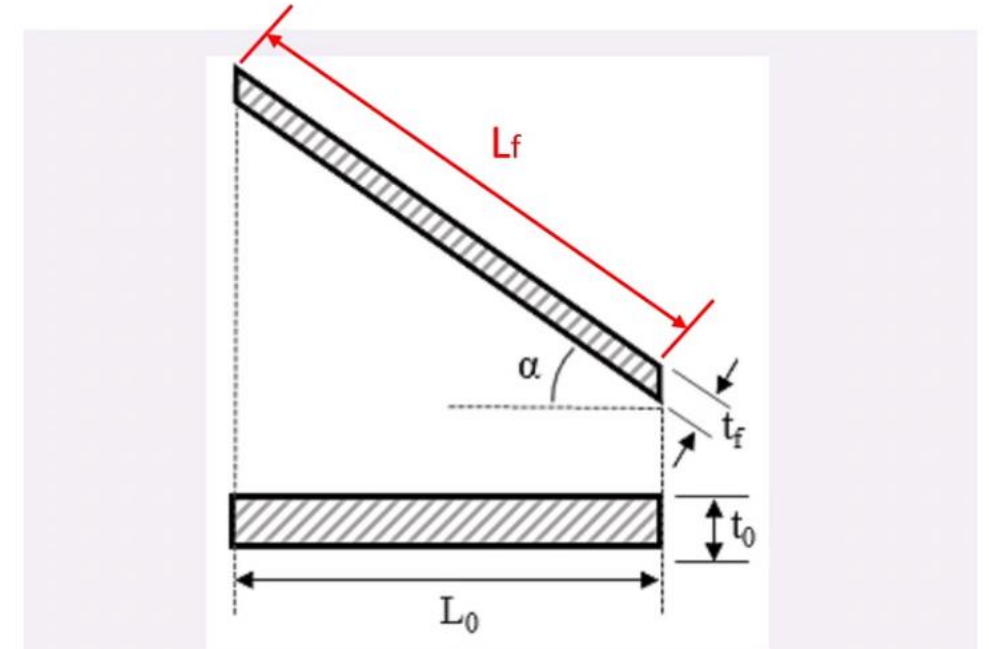
General Design Guide

Materials	Thickness	Wall Angle	Radius	Accuracy
Aluminum	0.5 – 6.0 mm 0.02 – 0.25 "	Max: ~60°	Minimum: 3-5x sheet thickness or 6 mm / 0.25"	Minimum: ± 0.3% of max dimension or ± 1 mm / 0.04"
Steel (stainless & HS)	0.5 – 3.0 mm 0.02 – 0.12 "	Max: ~70°		
Steel (mild) Invar, Inconel	0.5 – 5.0 mm 0.02 – 0.20 "			
Titanium	0.5 – 3.0 mm 0.02 – 0.12 "	Max: ~50°		

Productionized Design Guide

Materials	Thickness	Wall Angle	Radius	Accuracy
<i>*soft tempers only</i> Aluminum 1/2/3/4/5/6/7xxx*	1-5 mm 0.04-0.2"	Max: 60°	Minimum: 5x sheet thickness	± 1% of max dimension
Mild Steel A36/1011/1018/1045	0.5-4 mm 0.02-0.16"	Max: 65°	Or 6 mm/0.25"	Or ± 2.5 mm / 0.1"

- To get started right away, we stock materials:
 - Aluminum 5052 H32 (2 mm)
 - Mild Steel A36 (1 mm)
- You can provide the sheet metal or we can source it for you
- Machina maintains a \$9,950 minimum total project size



Sine Law (proposed originally for Shear Spinning)

$$t_f = t_0 \sin(90^\circ - \alpha) = t_0 \cos \alpha$$

where: α - Wall Angle

