Overview
A multi-part pressure forming project that meets the high cosmetic requirements and target price points of the customer and serves as a durable, easy-to-service solution for a new-to-market medical cart product application.

Features and Benefits
Material: 0.187” PVC/Acrylic (KYDEX T); Custom, Molded-In Color
Tooling: Machined aluminum, negative cavity tooling, temperature-controlled, acid-etched texture

A customer wanted to develop a new and innovative medical cart featuring a highly cosmetic finish, maximized space utilization, ease of serviceability, and durability in the healthcare environment. Working together in the design (DFM), we successfully achieved each project-defined goal.

Primary challenges
1) Designing a durable yet easily removable part: For servicing the underlying equipment, the customer wanted a rigid, yet highly cosmetic assembly that could be disassembled and reassembled easily by the service technician without sacrificing finished part cosmetics.

Solution: Through extensive DFM collaboration with the customer’s design teams, we arrived at a cover system that can be conveniently and securely assembled while maintaining high-cosmetic finish and functionality. The unique interlocking tab and slot design allowed us to achieve the goal of self-attaching and self-supporting plastic skins with limited mechanical fasteners.

2) Achieving highly cosmetic and functional part designs: Each of the six pressure-formed parts presented a design challenge, but the removable door (located and used in the side panel) was the largest challenge. The customer desired a handle with enough undercut to provide the service technician with a “grab surface” and the outside perimeter to have a “locking and un-locking feature.” Most importantly, the door design was required to be durable enough to withstand serviceability without marring the cosmetic finish.

Solution: We developed the necessary processes to achieve the part cost requirements without sacrificing the part rigidity and performance in the field the customer required.
3) Surface Durability: The parts must withstand a constant-use environment, potential impact scenarios, and harsh cleaning agents.

Solution: Customer molded-in-color PVC/Acrylic material (KYDEX T) was selected to eliminate the need for uniform colors between the mating parts, chemical resistance, and high-impact rating.

**CUT SHEET HEAVY GAUGE VACUUM FORM GOLD**

**Formed Plastics, Inc., Carle Place, New York**

**Medical Laboratory Equipment Covers**

**Overview**

A series of cosmetic covers with value-added assembly for medical laboratory equipment.

**Features and Benefits**

The assembly of covers service a highly modular system which permits multiple configurations to fit any size laboratory footprint. The initial breadboard product phase used cast urethane covers that did not hold up well in the environments where machines are used. The production parts were originally planned to be produced using injection molding processing. However, considering the modularity of the product, manufacturing each of the assemblies would be very cost-prohibitive.

A tailored solution to manufacturing under this condition was thermoforming through the use of universal tooling and material blank sizes. This provided a more streamlined, cost-effective, high-quality approach to satisfy any production run size or finish our customer may require.

**Material**

Each of the top covers are vacuum-formed using grey-tinted Lexan polycarbonate at 0.236” starting thickness. Each of the bottom covers are pressured-formed using PVC-Acrylic (Kydex T V-103 recycled sheet) at various material gauges ranging from 0.187” to 0.400”. This maintains uniform finish thicknesses across each of the bottom covers regardless of size or orientation. Custom color and textured paint finishing was required to match with other parts on the same equipment produced in different processes.

**Tooling**

A total of 17 production-grade molds produces 36 different parts. Molds that vacuum-form the top covers were made from CNC-machined aluminum billet with cast aluminum bases. Each of these molds contain 1- or 2-up articulated mold cavities with multiple independent temperature-controlled zones. Automated articulated cavities provided successful de-molding of undercut features and consistency.

Molds that pressure-form the bottom covers were made from cast aluminum with CNC-machine finishing for tighter tolerancing with embedded temperature-control as well. These molds are either negative or positive with 2-cavities each and equipped with syntactic foam plug assists where needed.
Design & Challenges
The customer emphasized the overall aesthetics of the product and required peer-through clarity. This was achieved through uniform material distribution of each of the top covers, localized heating zones, and careful consideration of the mold design to mitigate marring when de-molding.

In addition, each cover assembly was held within tight tolerances due to tolerance stack-up considerations. The timeline to roll out initial production units was very restrictive. Speed to market was critical with very close communication between all involved. Weekly meetings were held to communicate updates both internally and externally to ensure on-time delivery.

CUT SHEET HEAVY GAUGE VACUUM FORM SILVER

2P Support & Focaccia Group, Udine, UD, Italy
LCV Tail Light

Overview
This is an eighteen thermoformed parts plus four polyurethane parts project to transform a standard commercial vehicle into a pickup for the LCV (Light Commercial Vehicle) sector.

Features and Benefits
The thermoformed parts are all produced with textured ABS certified for automotive use.

The 18 thermoformed parts, OUTER and INNER Shells, all in the same material, are pre-assembled into eight finished components. All components are designed for a best LCA (Life Cycle Assessment). The finished components are durable, assembled with screws or rivets to the car body to allow easy installation, replacement, and recycling.

Two of the most challenging parts of the project were the right and left rear corners that integrate with the original back lights. In the first easier original design version, the two parts were composed by multiple outer and inner parts with poor edge design. The final products are made by one outer and one inner shell each. The inner parts’ purpose is to reinforce the outer ones, to be the base to install the lights and the interface with the car body.

The right and left rear corners are formed in a two-cavity articulated mold. The mold was designed to release the formed shell without any marks on the part. To release the heavier undercut five inches (130mm) deep and the many opposing ones, the standard machine forming process was also modified.

With strong risk analysis in place, it was possible to move forward directly and successfully with the serial aluminum billet and cast post machined thermo-controlled molds.

Thanks to the accurate design that considered the vacuum forming machines available, the forming and trimming processes, the assembly, the car body, and the part tolerances, it was possible to assemble all parts without any kind of modification. The assembly result is a precise and smooth final product with all parts edges not directly visible.
CUT SHEET HEAVY GAUGE PRESSURE FORM GOLD

Profile Plastics, Lake Bluff, Illinois
Covers for Medical Cart Product Application

Overview
A multi-part pressure forming project that meets the high cosmetic requirements and target price points of the customer and serves as a durable, easy-to-service solution for a new-to-market medical cart product application.

Features and Benefits
Material: 0.187” PVC/Acrylic (KYDEX T); Custom, Molded-In Color
Tooling: Machined aluminum, negative cavity tooling, temperature-controlled, acid-etched texture

A customer wanted to develop a new and innovative medical cart featuring a highly cosmetic finish, maximized space utilization, ease of serviceability, and durability for the healthcare environment. Working together in the design (DFM), we successfully achieved each project-defined goal.

Primary challenges
1) Designing a durable yet easily removable part: For servicing the underlying equipment, the customer wanted a rigid, yet highly cosmetic assembly that could be disassembled and reassembled easily by the service technician without sacrificing finished part cosmetics.

Solution: Through extensive DFM collaboration with the customer’s design teams, we arrived at a cover system that can be conveniently and securely assembled while maintaining high-cosmetic finish and functionality. The unique interlocking tab and slot design allowed us to achieve the goal of self-attaching and self-supporting plastic skins with limited mechanical fasteners.

2) Achieving highly cosmetic and functional part designs: Each of the six pressure-formed parts presented a design challenge, but the removable door (located and used in the side panel) was the largest challenge. The customer desired a handle with enough undercut to provide the service technician with a “grab surface” and the outside perimeter to have a “locking and un-locking feature.” Most importantly, the door design was required to be durable enough to withstand serviceability without marring the cosmetic finish.

Solution: We developed the necessary processes to achieve the part cost requirements without sacrificing the part rigidity and performance in the field the customer required.

3) Surface Durability: The parts must withstand a constant-use environment, potential impact scenarios, and harsh cleaning agents.

Solution: Customer molded-in-color PVC/Acrylic material (KYDEX T) was selected to eliminate the need for uniform colors between the mating parts, chemical resistance, and high-impact rating.
Overview
A structural rail and support component located underneath a patient’s chest on surgical tables.

Features and Benefits
The part offers extreme rigidity and support all throughout the geometry of the product to reinforce the rated weight capacity of each table. In addition, the rail system allows for adjustment from patient to patient to properly position and affix their spine within the guidelines for each procedure.

Material
Each part is pressure-formed using textured PVC/Acrylic (Boltaron #4335) at 0.312” starting thickness to comply with required mechanical properties and V-0 flame rating.

Tooling
The single cavity negative mold is constructed using cast aluminum with CNC-machine finishing and temperature-controlled elements. To best service the material distribution, the pressure box is equipped with two plug assists machined from syntactic foam billets that contour to the profile of both rail features in the part.

Lastly, the mold cavity contains a single articulated member to produce a necessary undercut embedded within the part design.

Design & Challenges
The main requirement imposed to us from a processing perspective was the overall integrity of the finished product. This meant consistent and adequate thickness distribution across the entirety of the part. This was achieved by implementing both plug assists to build up material thickness at focal stress areas where they would normally thin out.

Lastly, by billowing the heated sheet of material prior to forming, we were able to effectively allocate more material in other areas of the part outside what is captured by the plug assists. This allowed us to consume as much of the starting material thickness as possible for optimal thickness yield.
CUT SHEET HEAVY GAUGE TWIN SHEET GOLD

Vantage Plastics, Standish, Michigan
Pallet and Lid

Overview
This returnable packaging assembly substantially prolongs the freshness of fruit, vegetables, and flowers that are shipped and stored throughout the world.

Features and Benefits
The material for the pallet and lid is extrusion-grade high molecular weight polyethylene with black colorant.

The pallet and lid are produced from the same tooling with bent steel tubes formed between the two sheets, and a stainless-steel plate bridges the bent tubes for structural requirements from the vacuum pressure in the cavity between the pallet and lid.

After several design renditions between R&D and our customer, we produced a commercial pallet and lid that are twin sheet thermoformed with a starting thickness of .300”/.300” utilizing aluminum temperature-controlled production tooling.

The flat surface of the pallet and lid interacts with a seal to support the vacuum pressure within the cavity to adequately store perishable goods.

The stainless-steel support bracket has a hole that is sealed with a brass fitting that applies vacuum. It connects to an automated measurement instrument to monitor and control the inside of the cavity with an injection molded cone on the top surface to align with a vertical tube for support that meets the stainless-steel bracket.

The pallet and lid are provided with injection molded legs and alignment latches with stainless-steel fasteners to complete the assembly.

Using the patented returnable container dramatically extends the postharvest life of perishables. Studies have shown that fruit, flowers, and other commodities can be stored for four to six weeks longer than normal and were fresh enough to be saleable. This is of tremendous benefit to agriculture and consumers alike.
CUT SHEET HEAVY GAUGE TWIN SHEET SILVER

Duo Form, Edwardsburg, Michigan
Twin Sheet Door

Overview
This is a sliding pass-through door for a utility vehicle.

Features and Benefits
Our customer needed a sliding door designed for a utility vehicle that would be sturdy, fit existing latches and hardware, and could be produced at high volumes. To eliminate the need for laborious gluing and multiple fixtures, the part was designed to be twin sheet formed. This also brought the structurally-sound qualities the customer was looking for.

Using GP ABS at a specifically dialed-in thickness of .143, we were able to meet the customer’s request as well as provide an unexpected weight savings of 71lbs. The door was provided as part of an overall solution to eliminate metal fabrication, which, in turn, increased the customer’s capacity. The new twin sheet door gave our customer the ability to promote less fuel consumption, increased fleet efficiency, and a decreased environmental impact due to the weight savings of our part.

The twin sheet tooling is a two cavity, temperature-controlled aluminum tool requiring 4’ x 6’ sheet. After forming, the part is trimmed to specification with our Fanuc robot arm.

ROLL FED THIN GAUGE MEDICAL GOLD

CMI Plastics, Ayden, North Carolina
Pharma Tray

Overview
Two trays that hold several different vials sizes. When one tray is not used to hold components, it is used as a lid.

Feature and Benefits
The customer tasked us to create four trays with a lid for each tray (eight thermoforms in total). We took the common diameter components and grouped them together. We then designed a cavity to hold varying length components that had similar diameters. By doing this, we reduced the need down to two base trays. We then took one tray and offset the cavities so that they did not line up with the other tray. We also added a line up post so that the trays could not be assembled incorrectly. This took the project from needing eight different thermoforms down to two. This saved money on tooling. It also increased the run size for the two base molds, allowing the customer to receive a better piece price. Both trays are made using FDA Recycled PET.
PRODUCTION PARTS FROM 3D-PRINTED TOOLING GOLD

**Duo Form, Edwardsburg, Michigan**

**Wet Bath for Truck Camper**

**Features and Benefits**

Our customer needed a finished part for a prototype unit in less than two weeks. To quickly make this happen, we designed a 3D printed tool. The tool was printed in house on our 3D Pellet Fed Printer with glass-filled polycarbonate pellets, which eliminated the need to add vacuum holes in the tool due to the porosity of the material.

The Wet Bath is formed with .250” ABS material with 90% regrind ratio for sustainability. The sheet is printed in-house with latex thermformable ink and coated in-house with a hard thermoformable coating to achieve a residential marble look for the bath.

Utilizing our 3D printer for the tooling allowed us to meet the very tight deadline for our customer and created an aesthetically pleasing part that cannot always be obtained with soft prototype tooling. By utilizing a 3D pellet extrusion process, we are able to print up to 10X faster than similar 3D filament fed printers. By utilizing pellets instead of filament, it helped keep costs down for our customer without impacting the timeline or integrity of the tool.

PRODUCTION PARTS FROM 3D-PRINTED TOOLING SILVER

**Plastics Unlimited, Preston, Iowa**

**Agriculture Equipment Wheel Cover**

**Overview**

This wheel cover is produced using 3D printed tooling.

**Features and Benefits**

This wheel cover is formed to provide a highly aesthetic, structurally rigid part that can also pass high wear requirements. This part also had to be able to withstand all durability tests that large equipment encounters, including extreme temperatures testing, accelerated weather testing, and corrosion testing with many different extreme chemicals. The material is .250” HMWPE material.

The innovative design provides the same tool for all four tires and different options including a vent to allow heat to escape without collecting debris. We designed the optional vent to be formed in the scrap area. This allowed a low-cost option. Another benefit is that we do not need to have to source the vents. This helps our supply chain because we don’t have to worry about lead times or suppliers not wanting to supply us with low volumes. We designed and manufactured all of the assembly fixtures in-house to ensure we can meet our customers tight tolerance.
This part replaces the previous stainless-steel parts, and these new parts represent large cost savings. It is also much easier and safer to install and service.

The tooling is a single cavity 3D printed tool. The tooling was so large that the tooling supplier could not print it in one part. The tooling was printed in two different sections and then bonded together.

SUSTAINABLE THERMOFORMING GOLD

**Vantage Plastics, Standish, Michigan**
Returnable Recyclable Shipping Tray

**Overview**
This returnable packaging assembly holds automotive components that are shipped within North America by our customer.

**Features and Benefits**
The tray is single sheet thermoformed, with a starting thickness of .200", utilizing aluminum temperature-controlled production tooling.

Patented material compatible injection molded stacking columns are inserted into the tool and captured in the tray walls during forming to provide increased load capacity, packaging capacity, and to meet ergonomic and recycling requirements.

Material for the tray is extrusion grade high molecular weight polyethylene with black colorant and extrusion grade high molecular weight polyethylene with green colorant for the stacking columns.

The stacking columns provide both horizontal alignment of the trays and support the weight of the returnable packaging with the thermoformed shell holding the stacking columns without using any fasteners.

The design allowing the stacking strength through the stacking columns and running a lighter gauge allowed the customer to meet ergonomic standards with a full-size tray, allowing for an additional part in the tray.

Using the patented stacking columns formed into vacuum formed trays improved the density from four per layer to five per layer.

A density of 30 versus a steel flip rack with a density of 24 had a freight savings for the customer of approximately $2 million per year.
SUSTAINABLE THERMOFORMING SILVER

Good Natured Products, Brampton, Ontario, Canada
GoodGuard™ Tamper-Evident Containers

Description

Features and Benefits
These multi-purpose clamshells offer an exclusive tamper-evident locking tab and dual hinged design.

The locking tab stays attached to the clamshell with no tearaway strips or clips that can escape into the environment as plastic pollution.

With the two hinges and unique seal, there is no need to double up with a wrapping label to achieve tamper resistance.

After opening, both the lid and base remain attached with fewer sharp edges and nicks that can be a risk for both employees and customers.

GoodGuard™ containers are offered in both 99% plant-based, BPI certified compostable* PLA and our unique curbside recyclable Bio-PET with up to 30% bio-based content.

The containers are for use in food packaging in wholesale and retail environments. The starting gauge of samples is 0.020” using PLA (TFF02005). Parts were produced from a production tool utilizing a steel rule die. Challenges included engineering the nicks in the tamper seal hinge area to a point where the package is easy to close, seal, and open while retaining strong leak resistant properties. The tool is 8up, aluminum and gun drilled for temp-control and utilizes inserts for size and material changes with 3rd motion plug assist.

*Commercially compostable only, where such facilities exist.
Electro-General Plastics, Grove City, Ohio
Ford Maverick OEM Spoiler and Door Skirt

Critical Elements of Design
OEM Fit and Finish: Ensuring that the parts fit and look like original equipment manufacturer (OEM) components.

Cost Reduction
Replacing labor-intensive fiberglass parts with these components, resulting in reduced component costs for the customer.

Design Criteria and Addressing Challenges
Door Skirt Challenge: Addressing the challenge of matching the OEM swirl texture for the door skirt.
Seamless Look Challenge: Addressing the challenge of achieving a seamless look for the door skirt when it is next to the glass.
Spoiler Challenge: Meeting the challenge of designing a spoiler that mimics the appearance of an SUV on a pickup truck cap.
Hidden Assembly Challenge: Solving the challenge of designing a hidden assembly method for inner and outer parts while accommodating threaded inserts.

Intended Use:
The designed parts (door skirt and spoiler) are intended for use in automotive applications, particularly for pickup truck caps.

Materials Used
Door Skirt: Material: ABS, Starting Thickness: 0.250”, Finish: Solarkote with Swirl Texture or DR / ABS Smooth
Spoiler: Material: Standard ABS, Starting Thickness: 0.187 inches

How the Part Provides a Solution to Customer Requirements
Door Skirt: The swirl texture matches the OEM texture, meeting the customer’s aesthetic requirements. The smooth finish closely matches the glass, providing a seamless appearance.
Spoiler: The innovative hidden assembly method with threaded inserts offers ease of installation. By replacing labor-intensive fiberglass parts with these components, the customer achieves cost savings.

Tooling
Spoiler: Tooling Type: Common inner and outer aluminum water-cooled mold.
PARTS PRODUCED FOR ELECTRIC VEHICLE (EVS) AND BATTERY APPLICATIONS SILVER

DALB, Inc., Kearneysville, West Virginia
Car Grille

Overview
Used in many appliances, industrial equipment and now automobiles, this product is an example of how our technology is able to streamline and incorporate many different technologies and features into one. This car grille is the exterior grille that allows for various types of functionality to be present on the front of the car by limiting cut throughs, multiple smaller parts, and assemblies.

This product was designed to meet the growing demand for the following features and benefits across many markets such as Automotive, Robotics, Industrial, Mass Transit, and Appliance:

1. Large - Seamless design aesthetics
2. Impact resistance
3. Multi color and decoration
4. Backlit logo
5. Dead front or hidden til lit features
6. Lidar/Radar transparency

Large – Seamless Design Aesthetics – Tool size is – 47” x 80” x 21” to create this one-piece part. The only way to make a large decorated three-dimensional part.

Impact Resistance – Part is made of 70% LT Gray Tinted Polycarbonate

Multi-Color Decoration – Part is made with 10 screen print passes to create the backlit logos, opacity, lidar and radar filters, light diffusion, and hidden to lit features.

When utilizing our technology, the need for inlays, overlays, cut outs, or multiple combined assemblies to accomplish the balance between aesthetics and functionality are eliminated. While they can still work within this technology, they simply are not needed.

MFG Details
Material: 70% LT Gray tinted PC
Starting Thickness: .118”
Tooling: Temperature controlled aluminum
Sheet size: 49” x 82”