Using Rigid Engineered Foam for Consumer Products

Paper Outline of presentation for

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Intro:

Having come from the world of product design, in most educational programs we are commonly taught the typical manufacturing processes, such as injection molding, blow molding, thermoforming, metal casting and stamping, machining parts, etc. Surprisingly, most educational programs do not really teach anything about foam molding, specifically steam chest foam molding, unless it's something you happen to require as you're working on a development project.

Early in my career I had the chance as a young industrial designer to work on a new program called "Engineered Resin" (GE's new high strength resins such as Noryl®, Xenoy®, Ultem®, Geloy®). I was part of a team that not only helped write new design guides, but assisted GE with helping convert the automotive industry over from stamped and cast metals, to these new plastic materials for dash boards, window regulators, bumpers, under the hood parts, etc. While I didn't realize it at the time, this was the start of how cars and eventually more consumer products were designed and manufactured.

I currently feel like I am at the same point again, with some of the new foam materials and processes that are now making their way into the consumer products market.

Summary of the Presentation for International Forum on Design for Manufacture and Assembly

DMAF is focused on Design for Assembly and Design for Manufacturing, where the end goal is reducing cost while achieving functionality, reliability and speed to market. While this can be done in lots of different ways, in the presentation we will cover lots of different examples that show how using structural foams can open up a new world of design that allows for reduction in the number of parts, reduced labor and more durable solutions.

Molded Foam Computer

Working together to make it happen:
Design Team / Material Supplier / Tooling Designer / Processing Team / Customer

Molding technology, materials and creative design combine to make new and unique products that are light weight, impact resistant, and lower in overall cost.

Typical Desk Computer Housing
Stamped Metal and Injection Molded Plastic

Benefits over conventional design approach:
- Lower Tooling Cost
- Less Components
- No Fasteners
- Less Labor
- Integrated Ducting
- Reduced Noise

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In this example, we show a computer can be created using 3 pieces of EPP foam to make the case and air-cooling system, while at the same time eliminating all the fasteners, and internal / external sheet metal structures.

HVAC Air Handler

Working together to make it happen:
Design Team / Material Supplier / Tooling Designer / Processing Team / Testing Team / Customer

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Molding technology, materials and creative design combine to make new and unique products that are light weight, impact resistant, and lower in overall cost.

Typical Fan Coil Design
Stamped Metal, Insulation and Fasteners

Benefits over conventional design approach:
- Lower Tooling Cost
- Less Components
- No Fasteners
- Less Labor
- Integrated Ducting
- Integrated Insulation
- Integrated Dain Pan
- Reduced Noise
- Fewer Gaskets

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Our HVAC design not only reduces the number of structural parts, fasteners and cost of labor, but the EPP also provides the insulation needed without having to add additional material inside the unit.

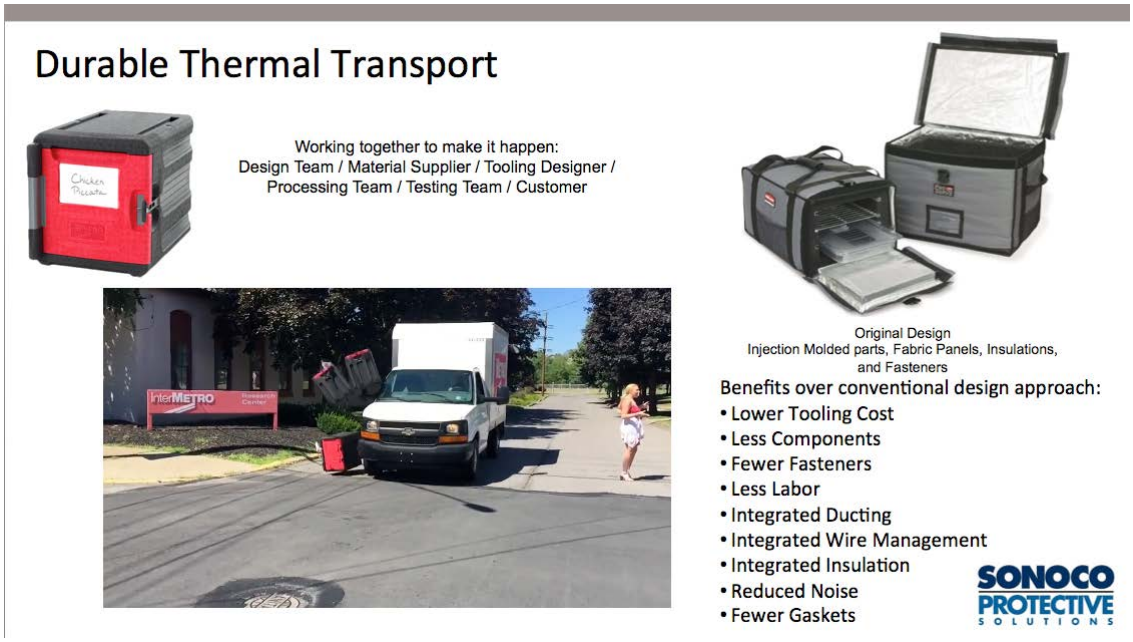
In this example of a “cooling system” we worked with our customer to help design a unit that not only reduces the cost of the materials and labor, but also provides them with a complete assembly that can be pre-packaged. This allows the customer to build a unit in advance then slide it into refrigerated / vending systems when needed. It also allows for easy maintenance in the field or just swapping them out when needed.

In the furniture market, we are using foam to replace custom shaped wood structures. This process, while sometimes more material expensive, is offset greatly by the reduced labor savings. The EPP foam also allows for furniture manufactures’ to use existing building techniques, such as stapling.

In this example, the office furniture manufacturer worked with us to develop a replacement for the standard office wall partition. Replacing fabric, wood, steel, glue and fasteners with a one-piece, molded, custom color, lightweight foam wall.

In our concept / prototype battery pack example, we were able to eliminate almost all of the metal substructures, wire-routing hardware, attachment screws, injection molded ductwork, etc. by designing all these features into the molded foam parts.

In our vent / product duct program for a yogurt machine, we were able to help a customer replace an existing duct system that consisted of 2 sheet metal parts, 2 injection molded parts (to handle the yogurt tubing), 8 screws, wrapped insulation and tape with two simple snap together EPP parts. Not only saving cost and labor, but also making servicing of the machine and replacing the tubing much easier in the field.

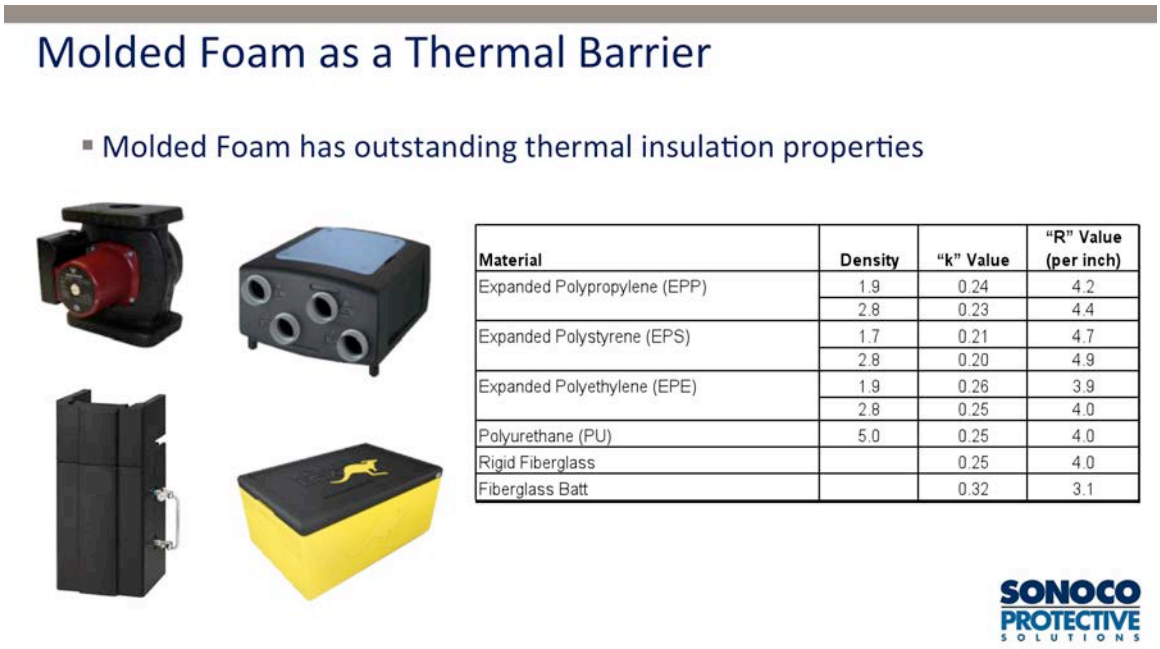


In this example, we molded a highly durable EPP carrier for food. It replaced a multi-material system that used different layers of materials combined with insulation that was glued and sewed together, with a simple 2-part EPP case and door with snap in hinges and flexible latch.

General Overview of Structural Steam Chest Molded Foam and the details that help make designs

While above are some of the examples shown in our presentation, we also will be talking more about structural foam and how some of the performance and details come together.

This slide represents the range of materials and flexibility that we offer into the industry that allows for design flexibility.



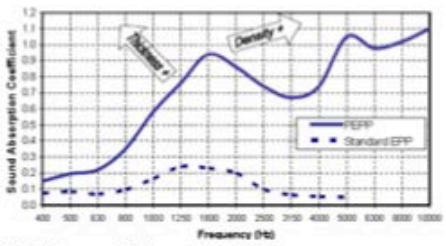
Material	Density	"k" Value	"R" Value (per inch)
Expanded Polypropylene (EPP)	1.9	0.24	4.2
	2.8	0.23	4.4
Expanded Polystyrene (EPS)	1.7	0.21	4.7
	2.8	0.20	4.9
Expanded Polyethylene (EPE)	1.9	0.26	3.9
	2.8	0.25	4.0
Polyurethane (PU)	5.0	0.25	4.0
Rigid Fiberglass		0.25	4.0
Fiberglass Batt		0.32	3.1

Showing how the foams also provide Insulation for products.

Sound Management via Molded Foam

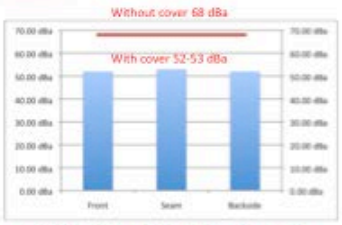
Ingersoll Rand

- Depending upon the frequency of the sound, molded foam has good sound absorption characteristics



PEPP (Pourous EPP)

EPP Compressor Cover Features:
- Dramatic Noise Reduction
- Easy snap fit assembly
- Easy disassembly for service work
- Easy upgrade fit in the field



A 15 dBa drop = 2.6X reduction in sound

EPP, with an added sound absorbing material

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This shows some examples of how foam can provide sound reduction.

EPP and EPE chemical resistance

Classification	Chemical Name	Observation/Effect	
		EPP	EPE
Mineral Oil	Lubricating Oil	1	1
	Engine Oil	1	1
	Gasoline	2	2
	Kerosene	2	2
	Heavy Oil	1	1
Organic Solvent	Toluene	2	2
	Benzene	2	2
	Acetone	2	2
	Ethyl Alcohol	1	1
	n-Heptane	2	2
	Carbon Tetrachloride	2	2
	Trichloroethylene	2	2
	Ethyl Acetate	1	1
	Methyl Ethyl Ketone	2	2
	Formaldehyde	1	1
Inorganic	10% Sol. Sulphuric Acid	1	1
	10% Sol. Nitric Acid	1	1
	10% Sol. Hydrochloric Acid	1	2
	10% Sol. Sodium Hydroxide	1	1
	Ammonium Solution	1	1

Key: 1 = No Effect
2 = Slight Swelling
3 = Significant Swelling
4 = Dissolved

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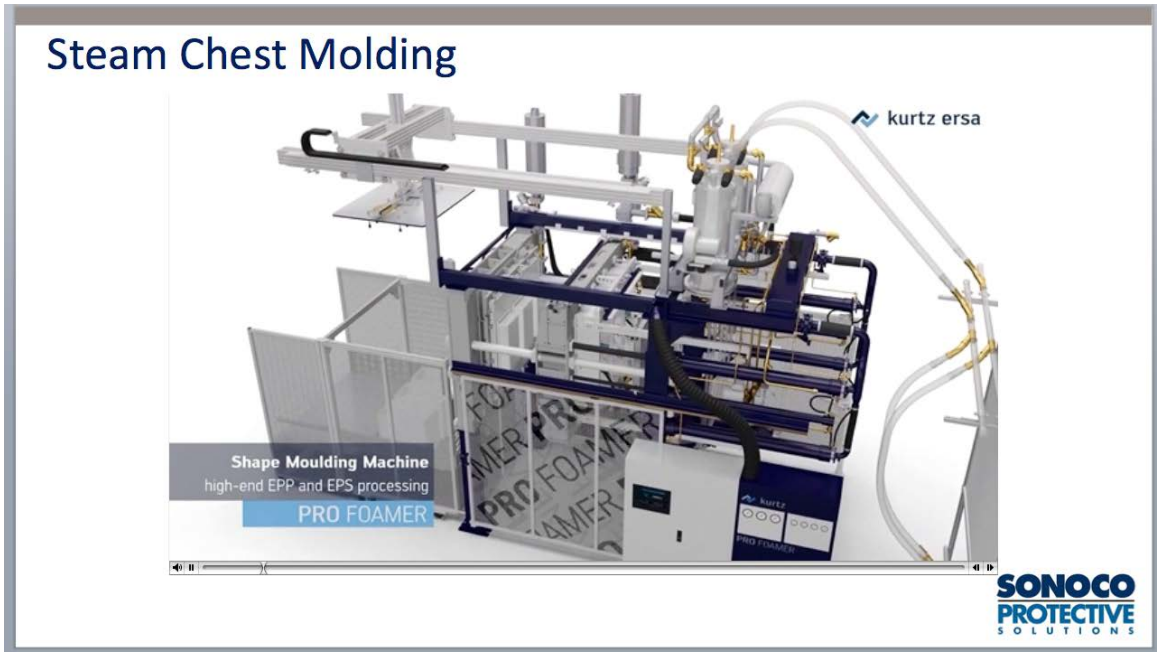
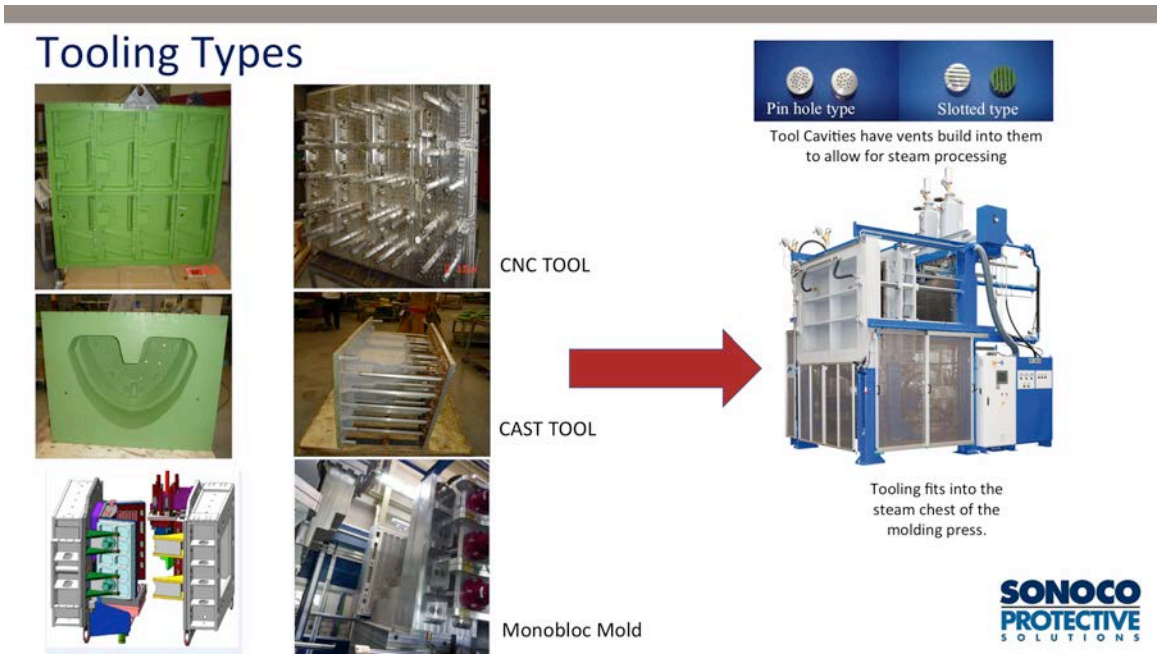
EPP Chemical Resistance allows for use in many harsh environments.

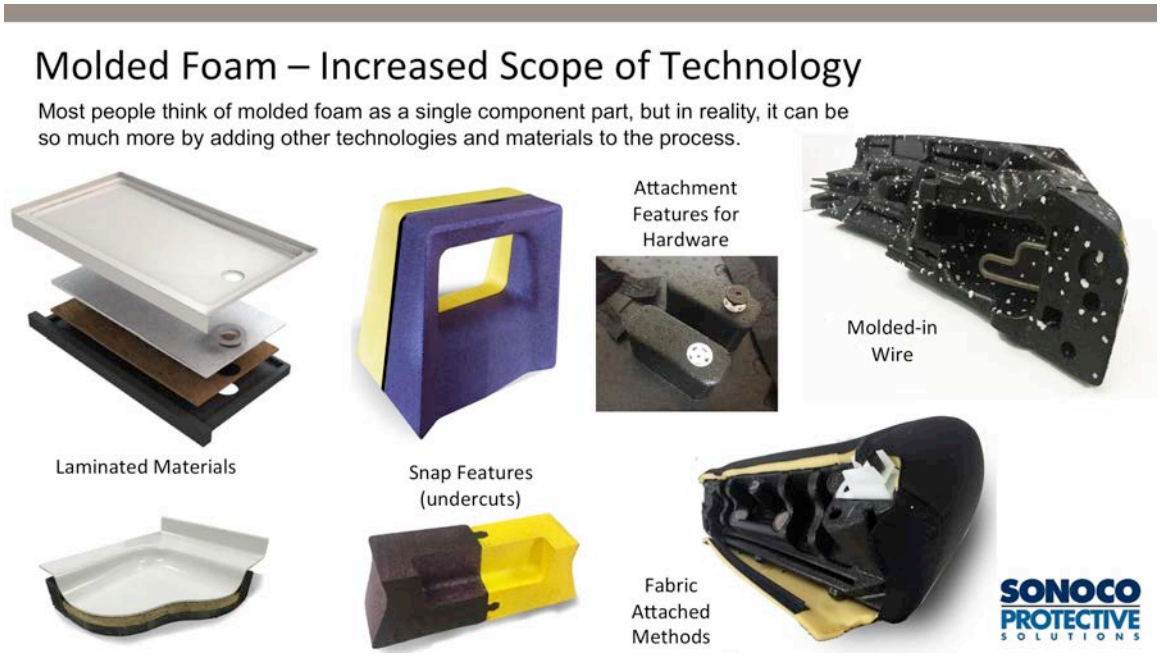
We cover the basic types of foam molding, and then focus down on steam chest molding.



Short video of how steam chest-molding works, to help explain the process so that it is easier to understand how the final products produced.



We cover the different types of tooling, and explain that tooling cost is a fraction of the cost of traditional injection molds or metal stamping tooling.



While having a molded foam part is great, in many cases you will need to attach, insert, and or add other parts to the foam to make it usable. In this slide we show some examples of the design features and how they can be used in conjunction with the molded foam parts.

Ways to insert or use fasteners help complete the design.

We hope this overview was informative and helped open your mind to new and different ways that you might be able to reduce cost while achieving functionality, reliability, and speed to market by using molded structural foam.

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