



Grow & Optimize

SONOCO
PROTECTIVE
SOLUTIONS

DFMA[®]
BOOTHROYD DEWHURST



Using Rigid Engineered Foam for Consumer Products

33rd International Forum on Design for Manufacture and Assembly
September 11 and 12, 2018
Providence, Rhode Island

Founded in 1899, Sonoco is an estimated \$5.8 billion global provider of consumer packaging, industrial products, protective packaging and packaging supply chain services.

Some items you may know us by...



SONOCO PROTECTIVE SOLUTIONS

2 0 1 1 0 1 1 2
БКОЕСИАЕ



Washer and Dryers



Dish

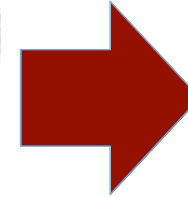


Packaging

Adding value by providing total solutions!

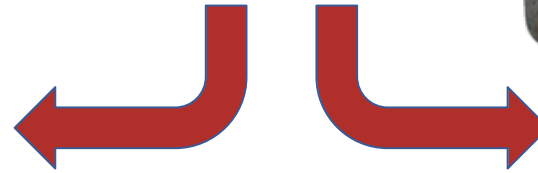


Components



*Today's
Discussion*

Innovation



ENGINEERED
SOLUTIONS



INNOVATIVE
MATERIALS



SUSTAINABLE
CULTURE

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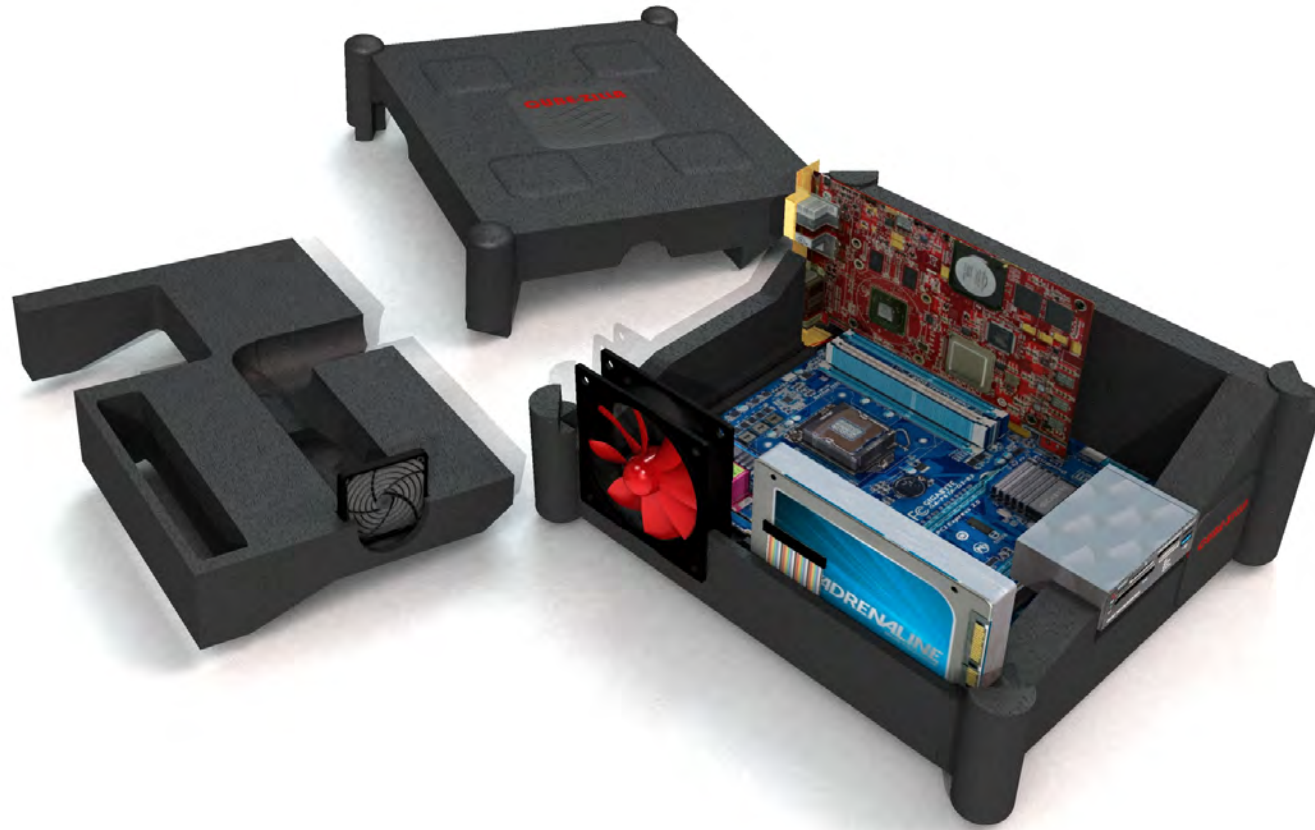


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Molded Foam Computer

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

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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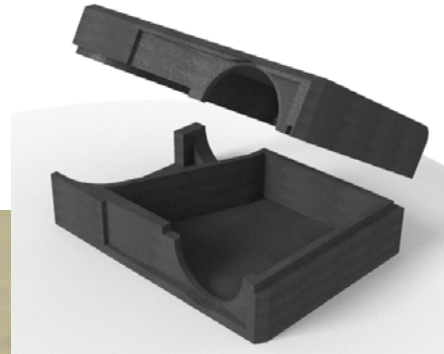
Refrigeration Compressor Pack

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

The new way..



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



The old way..



Compressor coil layout 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
- Easy serviceability

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Furniture Components

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



EPP Foam Substructure



Foam Components

EPS Foam Components



Typical Chair Substructure
Cut / Formed Wood, Foam, Fasteners

Benefits of EPP Molded Components

- Ease of assembly / reduced labor
- Lightweight
- Can be molded into complex shapes
- Lower tooling costs
- Can be molded with undercuts to allow for application of t-strips and fabric tucking
- Highly durable / can withstand flexing and impact without fracturing

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

Office Walls

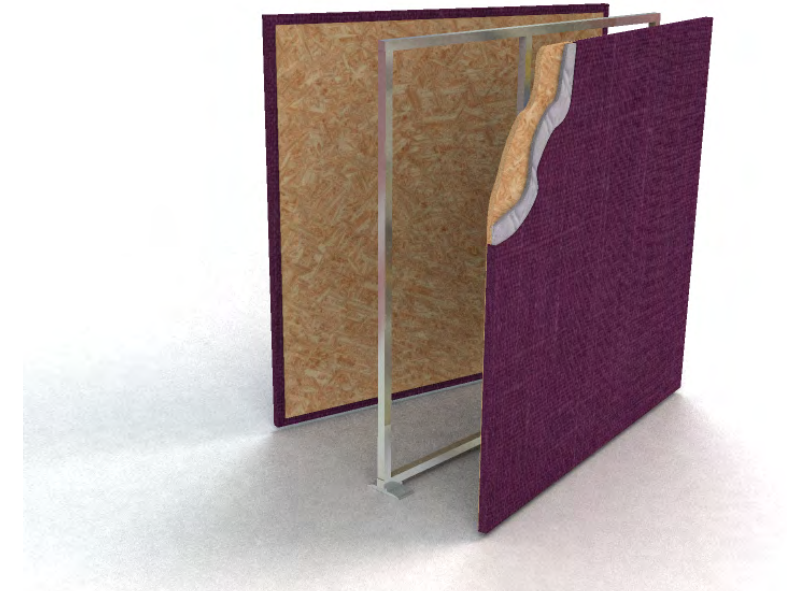
Working together to make it happen:
Design Team / Material Suppliers / Tooling Designer / Processing Team /
Equipment Manufacturer / Testing Team / Customer



Colored EPP Foam Walls



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 Office Wall Structure
Cut Metal and Wood, Foam, Fabric, Fasteners

Benefits of EPP Molded Components

- New Product Format
- Lightweight
- Custom Color
- Durable
- Large Format Molding Available

Recreational Components

Working together to make it happen:
Entrepreneur / Design Team / Material Suppliers / Tooling Designer



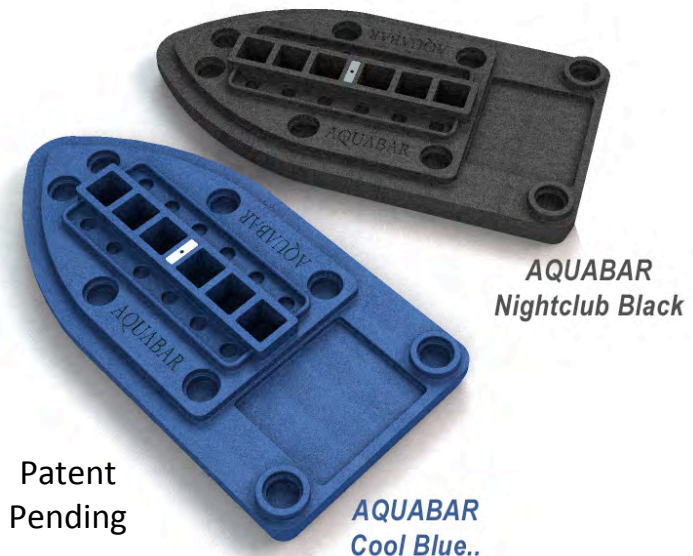
Typical Floating Bar
Blow-Molded, Thermoformed, Blow-Up, etc..



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

Benefits of EPP Molded Components

- Durable
- Color is all the way through the product
- One Step Molding
- Low-cost Tooling



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Condensing Boiler Cover

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



Cover & Frame – Side View



Frame – Front View



Typical Design

Injection Molding Housing, Stamped Metal, Insulation and Fasteners

Benefits over conventional design approach:

- Lower Tooling Cost
- Less Components
- No Fasteners
- Less Labor
- Integrated Ducting
- Integrated Insulation
- Reduced Noise
- Fewer Gaskets

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

Nature's Mill Composter

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



Original Design
Injection Molded parts, Insulation and Fasteners

Benefits over conventional design approach:

- Lower Tooling Cost
- Less Components
- No Fasteners
- Less Labor
- Integrated Ducting
- Integrated Insulation
- Reduced Noise
- Fewer Gaskets

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

Car Battery Pack

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



Original Design
 Injection Molded parts, Metal Brackets and Fasteners

Benefits over conventional design approach:

- Lower Tooling Cost
- Less Components
- Fewer Fasteners
- Less Labor
- Integrated Ducting
- Integrated Wire Management
- Integrated Insulation
- Reduced Noise
- Fewer Gaskets



Durable Thermal Transport



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



Original Design
Injection Molded parts, Fabric Panels, Insulations,
and Fasteners

Benefits over conventional design approach:

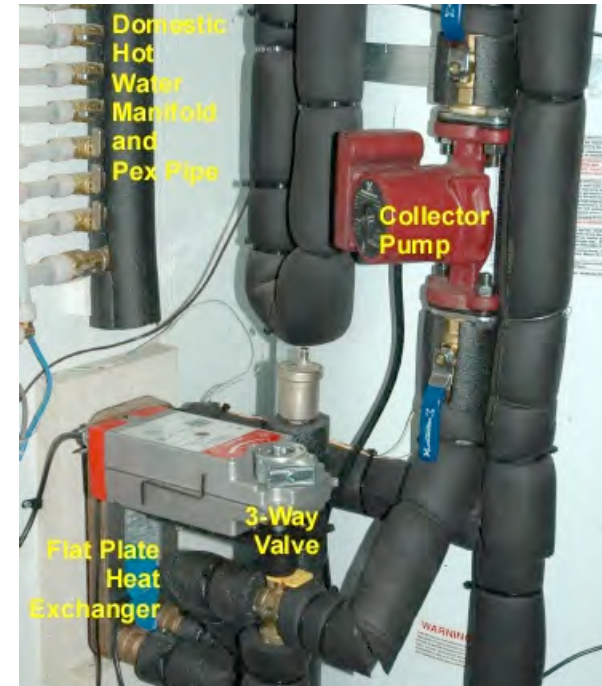
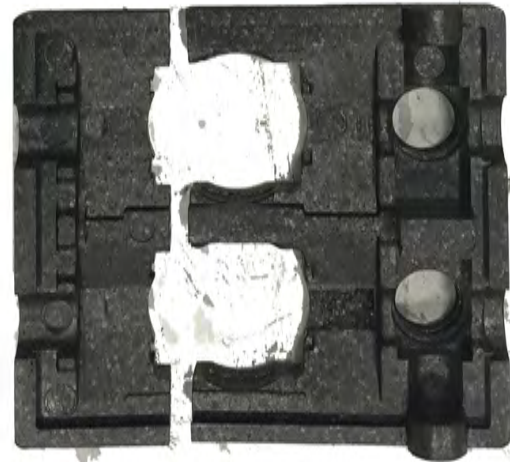
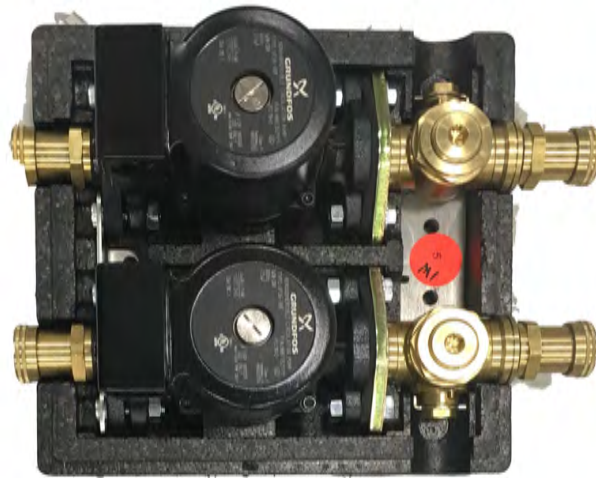
- Lower Tooling Cost
- Less Components
- Fewer Fasteners
- Less Labor
- Integrated Ducting
- Integrated Wire Management
- Integrated Insulation
- Reduced Noise
- Fewer Gaskets



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Insulated Pumps

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



Typical Design
Insulation wrapped around the pipes, exchanger
and pumps

Benefits over conventional design approach:

- Less Components
- Fewer Fasteners
- Less Labor
- Integrated Wire Management
- Integrated Insulation
- Reduced Noise

Insulated Appliance Vent

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



Original Design
Sheet Metal, Insulations, Injection Molded Parts
and Fasteners



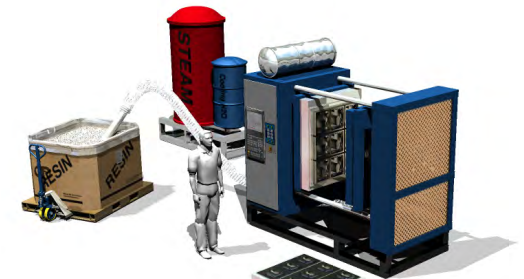
Benefits over conventional design approach:

- Less Components
- Fewer Fasteners
- Less Labor
- Easier to Clean
- Integrated Ducting
- Integrated Insulation
- Reduced Noise



Molded Foam – Increased Scope of Technology

Most people think of molded foam as a single component part, but in reality, it can be so much more by adjusting the materials, density, and additives.



Custom Steam Chest Molding



Material
Property

- EPS
- EPP
- PEPP
- EPE
- EPS/EPE
- EPTU
- PU
- And more to come..

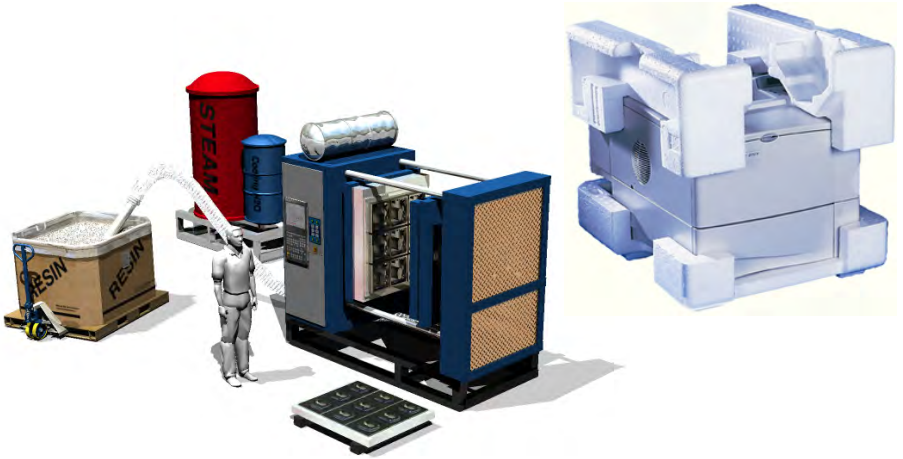
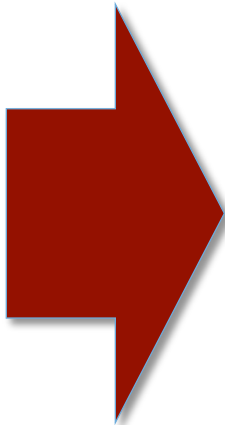
Part Density
Single or Dual Density

Additives



Typical Foam Molding Processes

Custom Steam Chest Molding



Block Molding



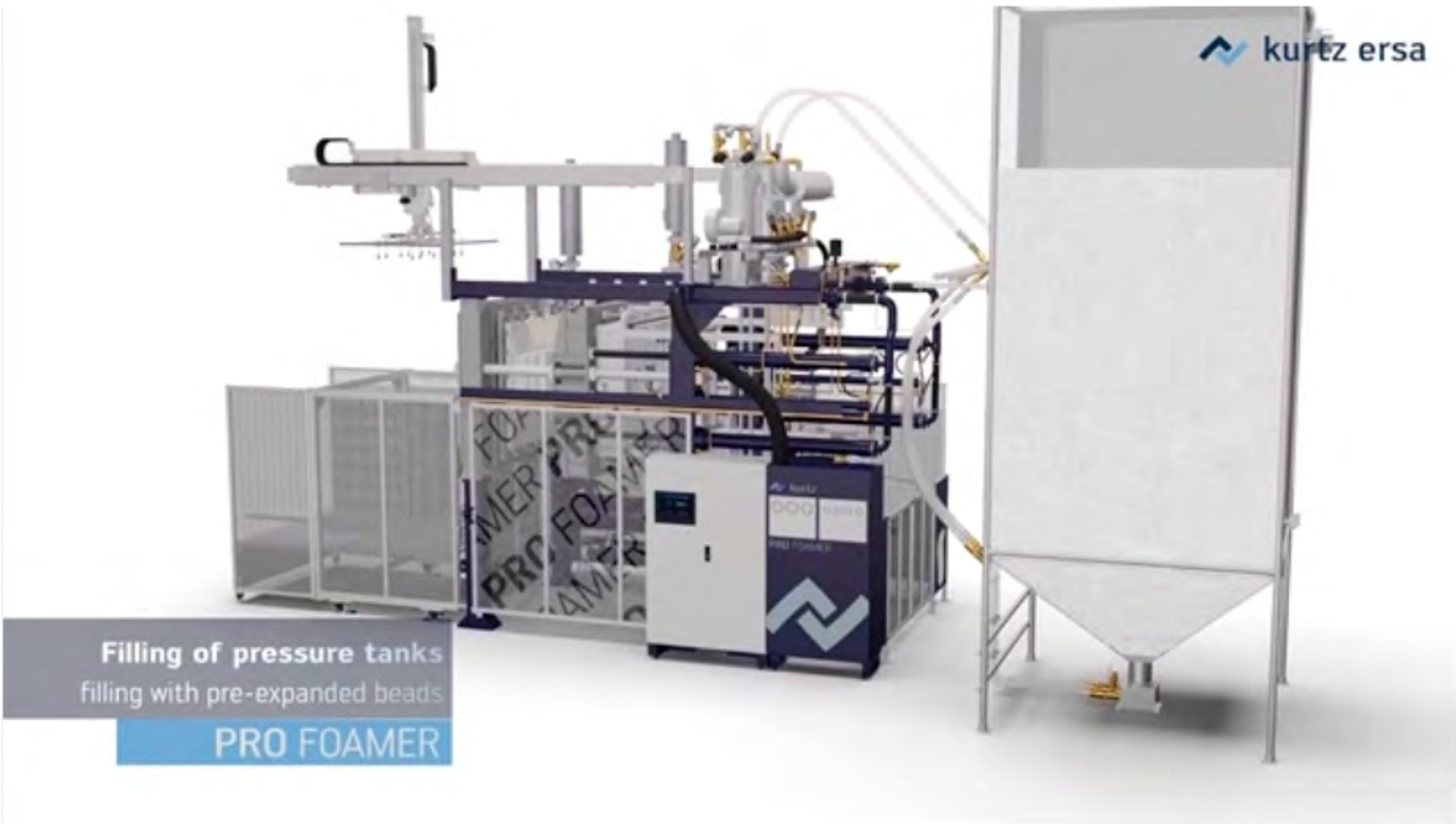
Extruded Foam Molding



Two Part Urethane



Steam Chest Molding



Filling of pressure tanks
filling with pre-expanded beads

PRO FOAMER

Molded Foam as a Thermal Barrier

- Molded Foam has outstanding thermal insulation properties

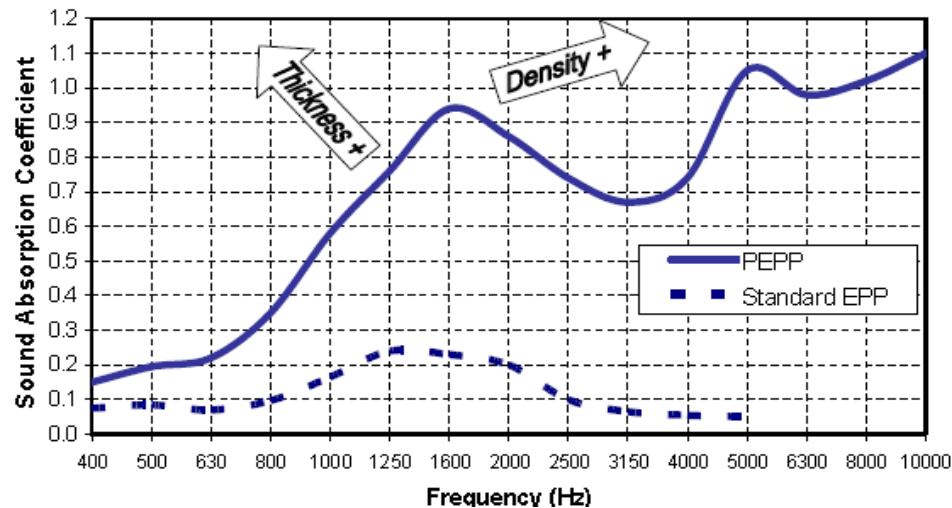


Material	Density	"k" Value	"R" Value (per inch)
Expanded Polypropylene (EPP)	1.9	0.24	4.2
	2.8	0.23	4.4
Expanded Polystyrene (EPS)	1.7	0.21	4.7
	2.8	0.20	4.9
Expanded Polyethylene (EPE)	1.9	0.26	3.9
	2.8	0.25	4.0
Polyurethane (PU)	5.0	0.25	4.0
Rigid Fiberglass		0.25	4.0
Fiberglass Batt		0.32	3.1

Sound Management via Molded Foam



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

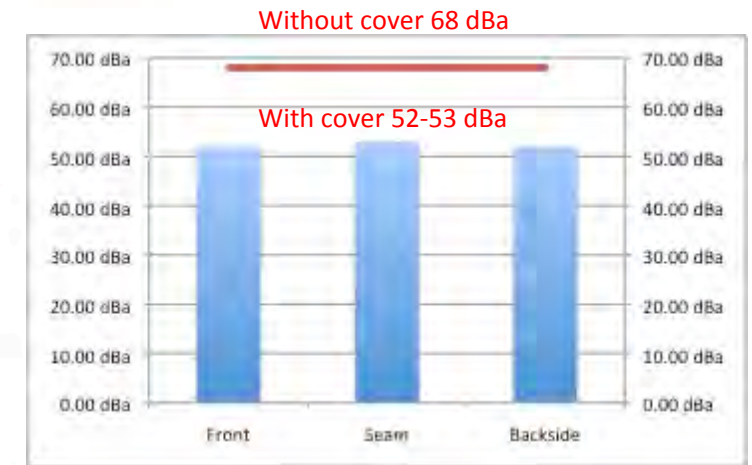


PEPP (Pourous EPP)



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



Molded Foam Property Comparison

Property	EPS	EPP	EPE	PS-PE
Cost	○	●	◐	◐
Resiliency	○	●	●	◐
Compressive Strength	●	◐	○	◐
Service Temperature Range	◐	●	●	◐
Gas / Chemical Resistance	○	●	●	◐
Flammability (UL)	● HF1 HF2	● HF1 HF2 VO UL 94 Listed	● HF1 HF2	○ N/A

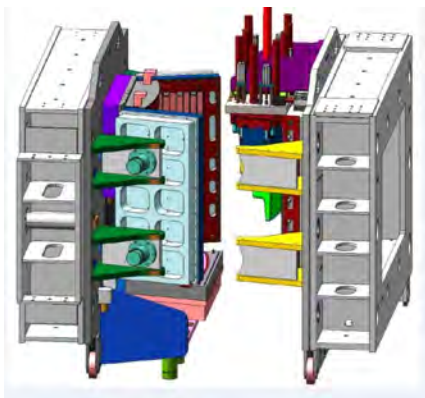


EPP and EPE chemical resistance

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

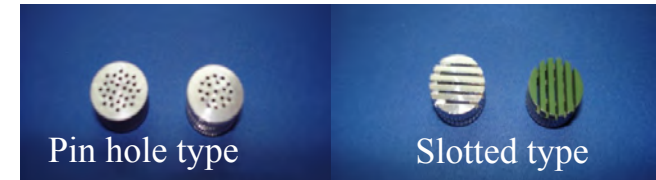
Tooling Types



CNC TOOL

CAST TOOL

Monobloc Mold



Tool Cavities have vents build into them to allow for steam processing



Tooling fits into the steam chest of the molding press.

*Tooling cost:
\$10,000s of thousands vs
\$100,000s of thousands for other molding
processes*

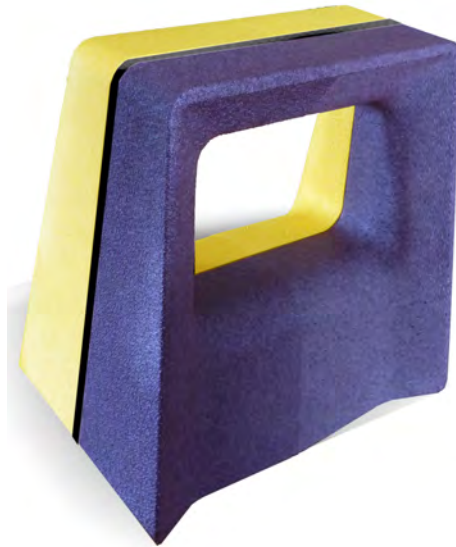


Molded Foam – Increased Scope of Technology

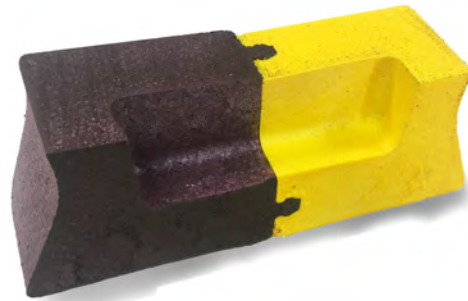
Most people think of molded foam as a single component part, but in reality, it can be so much more by adding other technologies and materials to the process.



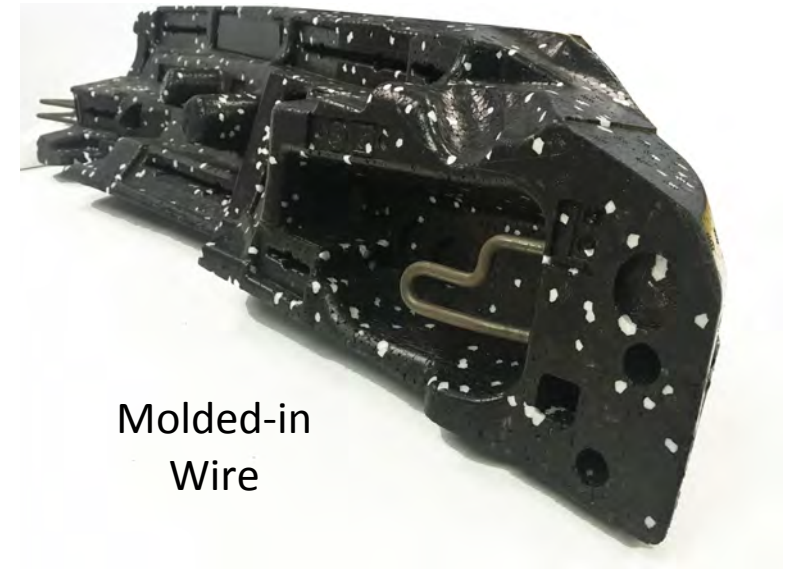
Laminated Materials



Snap Features
(undercuts)

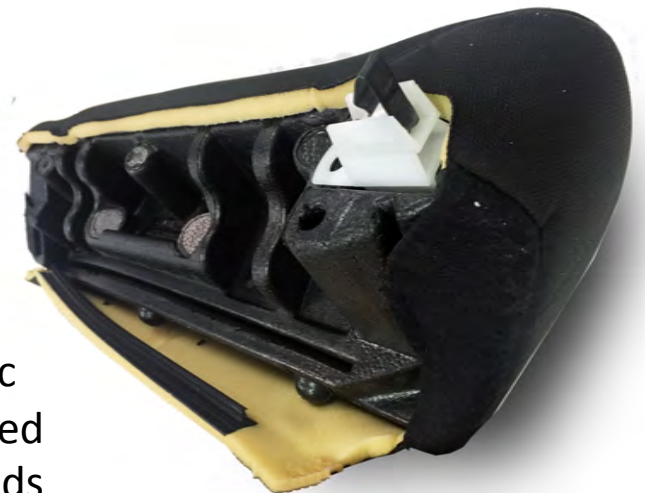


Attachment
Features for
Hardware



Molded-in
Wire

Fabric
Attached
Methods



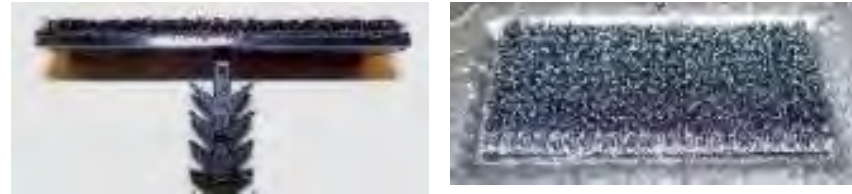
Molded Foam – Increased Scope of Technology

Ways to transition between parts of other materials.

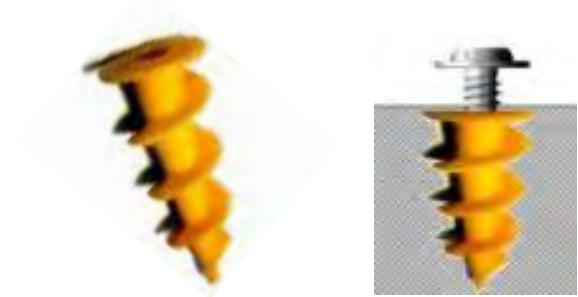
Auger Screw Blind-Hole Fasteners



Inserted Push Type Fastener



Inserted Blind Screw Type Fastener



Push-Type Blind-Hole Fastener



Inserted Screw Type Fastener



Spin-Welded Insert Fastener



Molded Foam – Increased Scope of Technology



Skinned EPP



Laminated to Foam



Injection Molded
Inside Case

Now, do I have you thinking differently....?

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BOOTHROYD DEWHURST

- ✓ Design for Assembly
- ✓ Design for Manufacturing
- ✓ Reducing cost
- ✓ Achieving functionality, reliability and speed to market.



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*New Business Development
Marketing and Technology*

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