Advantages of Using Molded Foam in Product Development

2012 International Forum on Design for Manufacture and Assembly

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Business Unit Within Sonoco

- Sonoco founded in 1899
- Global manufacturer of consumer and industrial components and packaging products
- 2011 sales: $4.5B
- 300+ Plants Globally
- Acquired Tegrant Corporation including Protexic Brands in November, 2011

What does Protexic do?

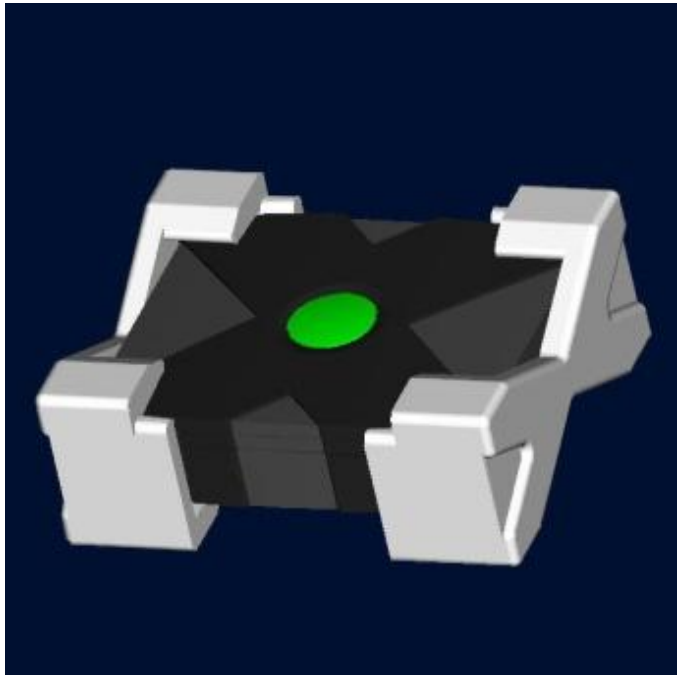
- Develop & manufacture custom molded and fabricated foam packaging & components

- Primary Processes are:
  - "Steam Chest" molding of expanded foam resins.
  - Fabrication of foams, wood, corrugated & paper

- Primary applications of these processes:
  - Protective Packaging
  - Returnable Packaging
  - Components

Traditional High Volume Molded EPS Foam Applications

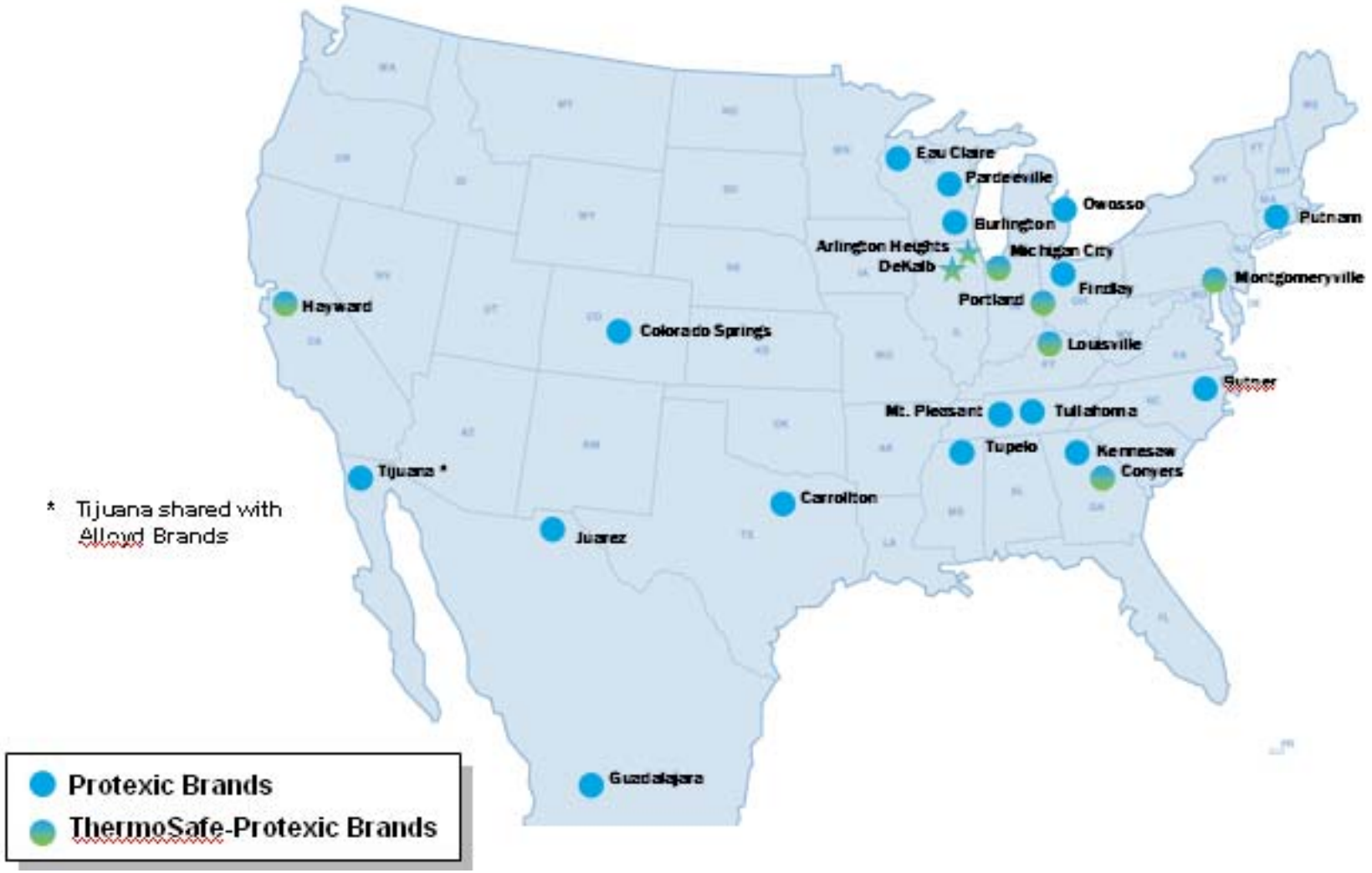
Worldwide X-Box Design



Typical Flat Screen TV Pack

“Steam Chest” Molding Machine & Tooling

Protexic Footprint



Protexic Applications

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Specialty Components





Protective Packaging




Material Handling




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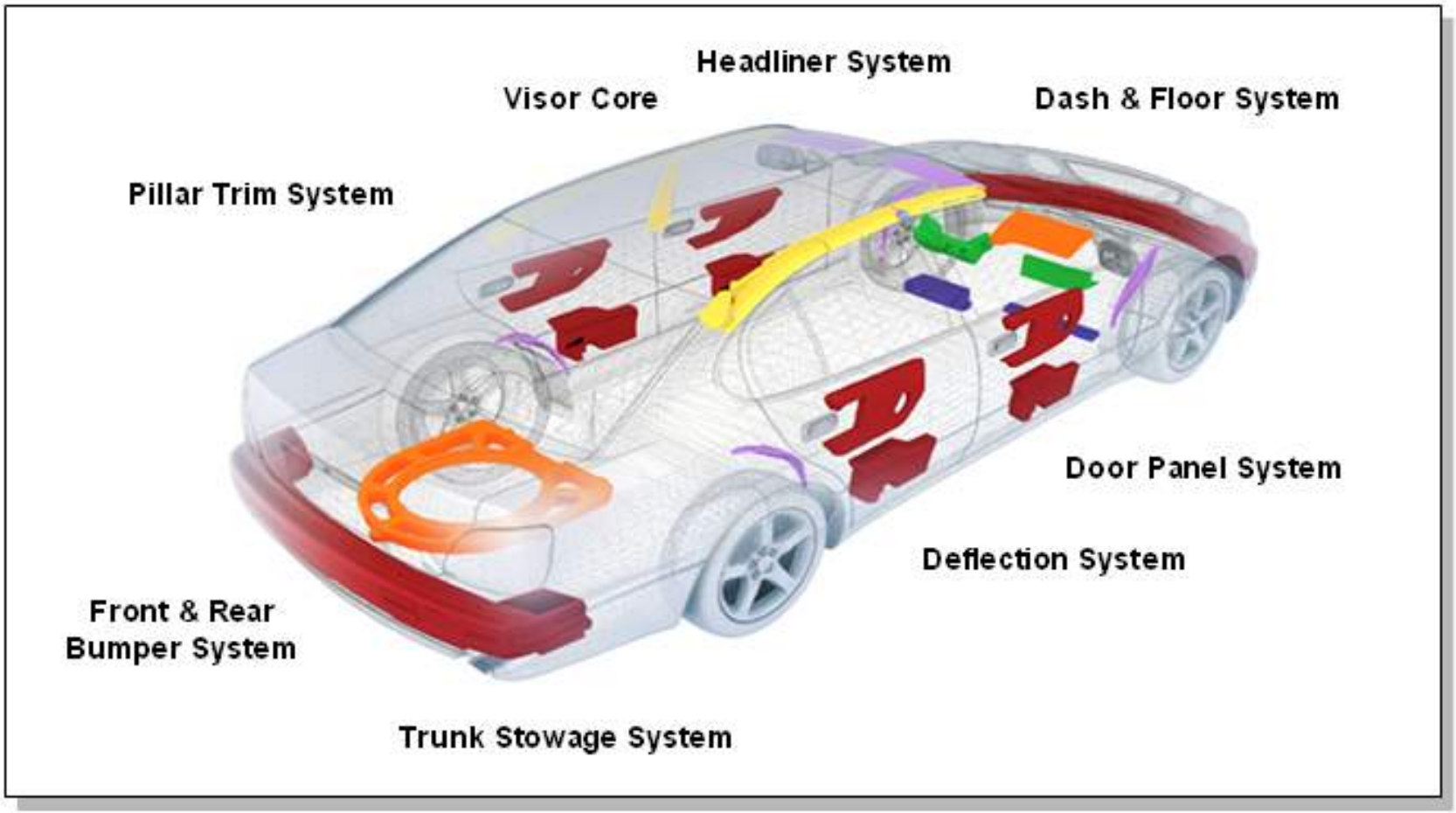
EPP Components

Auto Components- Driving Innovation



Expanded Polypropylene (EPP)

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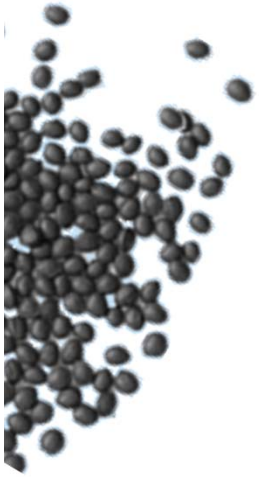

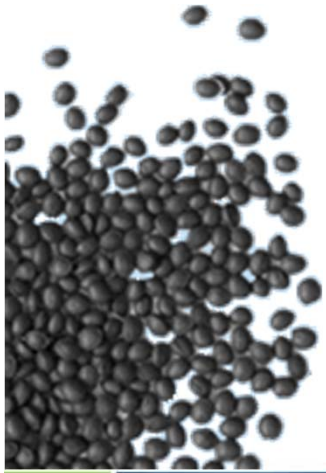

- **EPP** is a resilient closed-cell plastic foam bead produced by combining polypropylene resin with heat, pressure and CO2 in an autoclave

- **EPP Properties**
  - Chemical and solvent resistant
  - Minimal water absorption
  - Good UV resistance
  - Thermally stable: -30°C to 85°C
  - Available in an anti-static grade
  - Can meet the UL-94 HF1 / HF2 requirements
  - Fully recyclable

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EPP Molding Process

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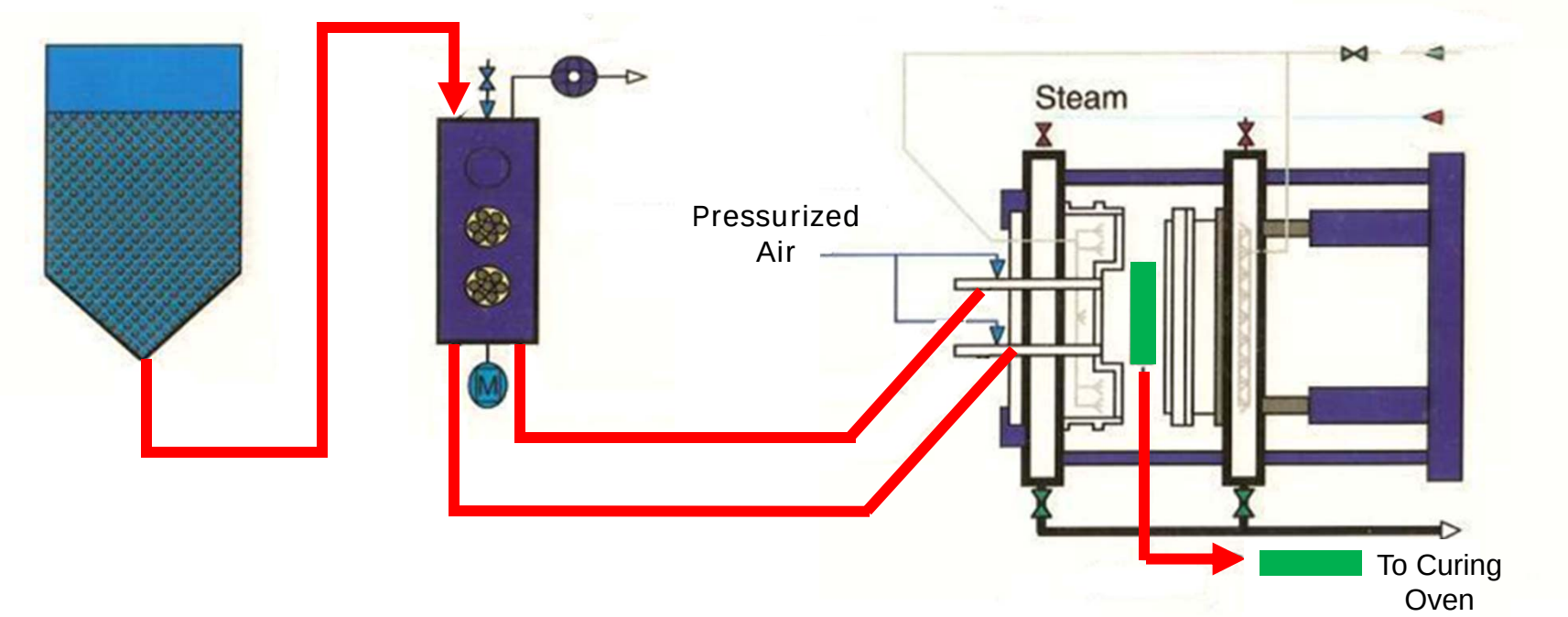
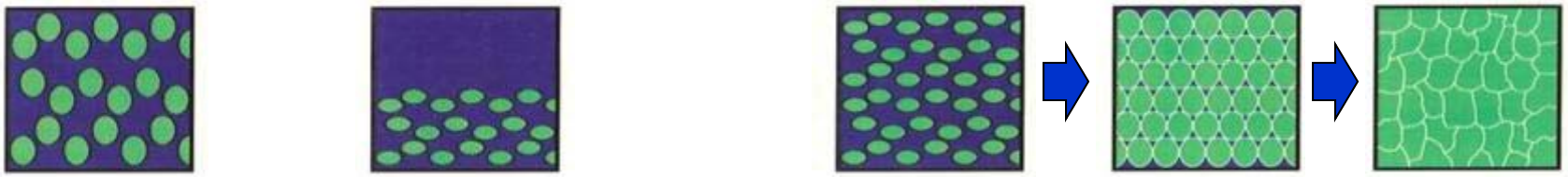
Storage Silo **Filling Device** **Molding Press**



EPP Bead Response



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Growth in Molded Foam Applications in Automotive

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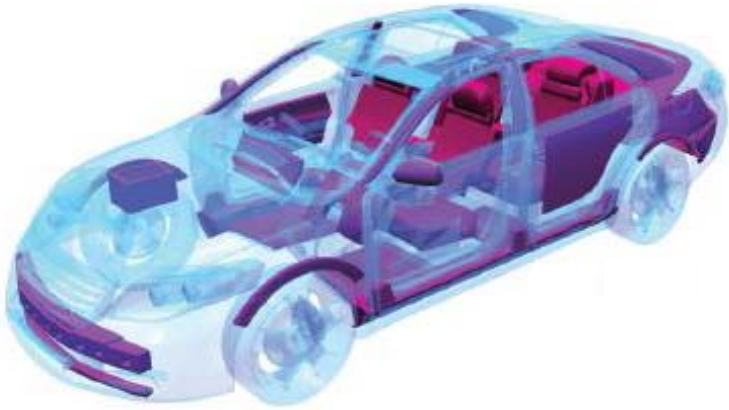
1996

Bumper systems

- Bumpers
- Exterior Energy Absorbers

2012



Head Impact Systems

- Pillars
- Head Rests
- Sun Visors
- Headliner Rails

Impact Systems

- Interior Energy Absorbers
- Door Panels
- Knee Protection

Components

- Tool Kits
- Trunk Liners
- Load Floors
- Console Components

Seating Systems

- Bolsters
- Seat Cores
- Seat Backs

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Part Count, Product Complexity Reduction

A typical electromechanical product secures the ‘good “ parts with:

- Screws
- Brackets
- Wire tires
- Etc.

Source: resonetics.com

Disadvantages of Extra Parts

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- Adds Manufacturing Complexity
- Labor Intensive Assembly
- Larger Bill of Materials
- Each one of the screws and fasteners must be purchased, inventoried and tracked
- Puts the product designers at odds with those responsible for sourcing the components and manufacturing the products
- Difficulty servicing/cleaning

What if there was an innovative solution?

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EPP As An Internal Structure

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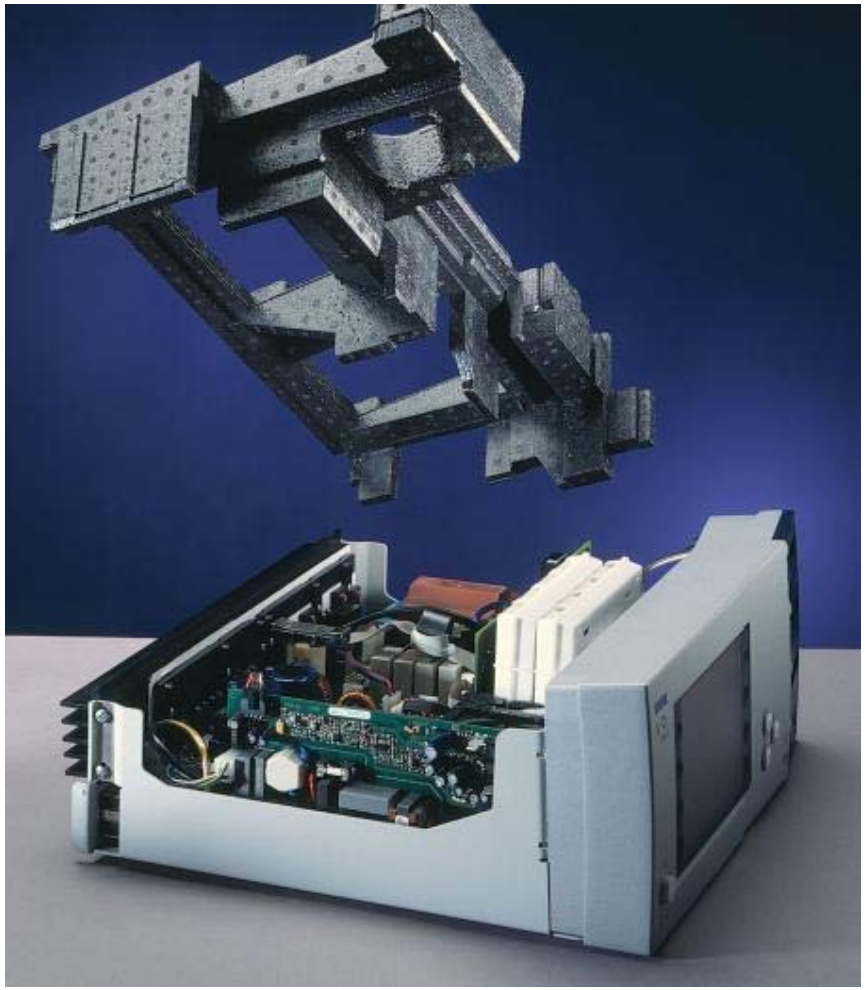
- EPP is used to replace a conventional “chassis” or internal construction of a product with a “sandwich” of custom molded EPP parts
- Pioneered & patented by Hewlett Packard engineers - in Germany in early 90’s
- Concept used in early mid 90’s in products such as:
  - Engineering Workstations
  - Peripheral Devices
  - Portable Defibulators
  - Analytical products



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Use of Form Fits in a Product Design

- **Fixture** the product components without use of fasteners
- **Create wire/tube routing channels** with easy undercuts
- **Create improved Air flow** management by using complex shapes
- **Reduce** external product housing costs by using the internal foam chassis to support the housing

Components Form Fit

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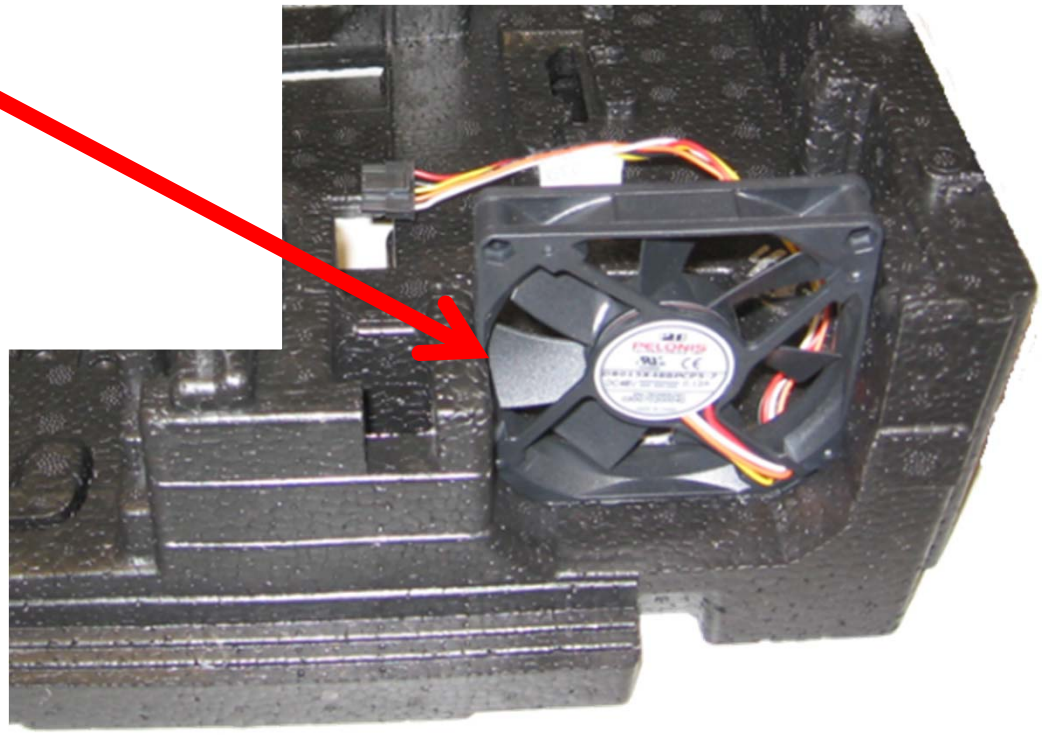
Fan drops into slot – no screws or fasteners are needed



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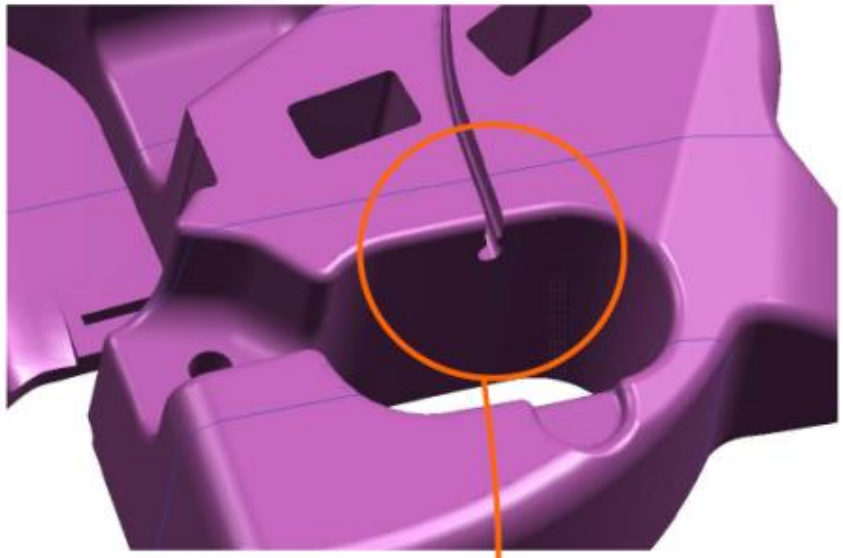
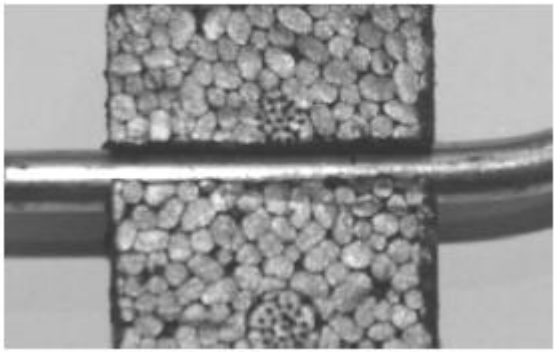
Tube Routing



*Can be used for metal wire frame or electrical wiring harness

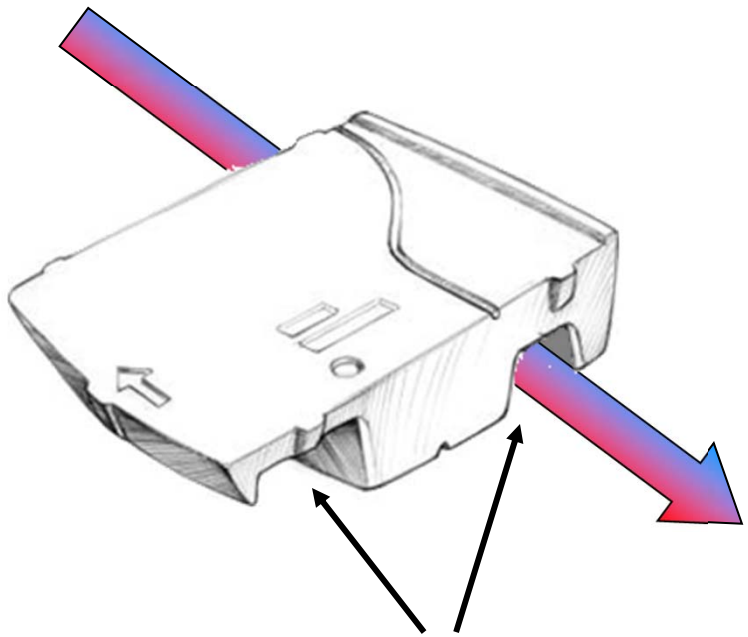
Cross-Section (photo)

Rear View (photo)



Airflow Management

- Channels can be molded into the foam to manage airflow
- Provides pinpoint cooling exactly where it is needed
- Allows the use of smaller fans
  - » Quieter Operation
  - » More energy efficient
  - » Especially beneficial for portable devices



Molded in
Airflow Channel

Stronger Inner Chassis

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- Decouples the functionality of the inner chassis and the outer housing
- Reduces the strength required from the outer housing – allows thinner gauge materials to be used
- Different interior configurations to be made without having to change the outer housing
- Protects the internal components in case of drops and falls

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EPP Design Guidelines

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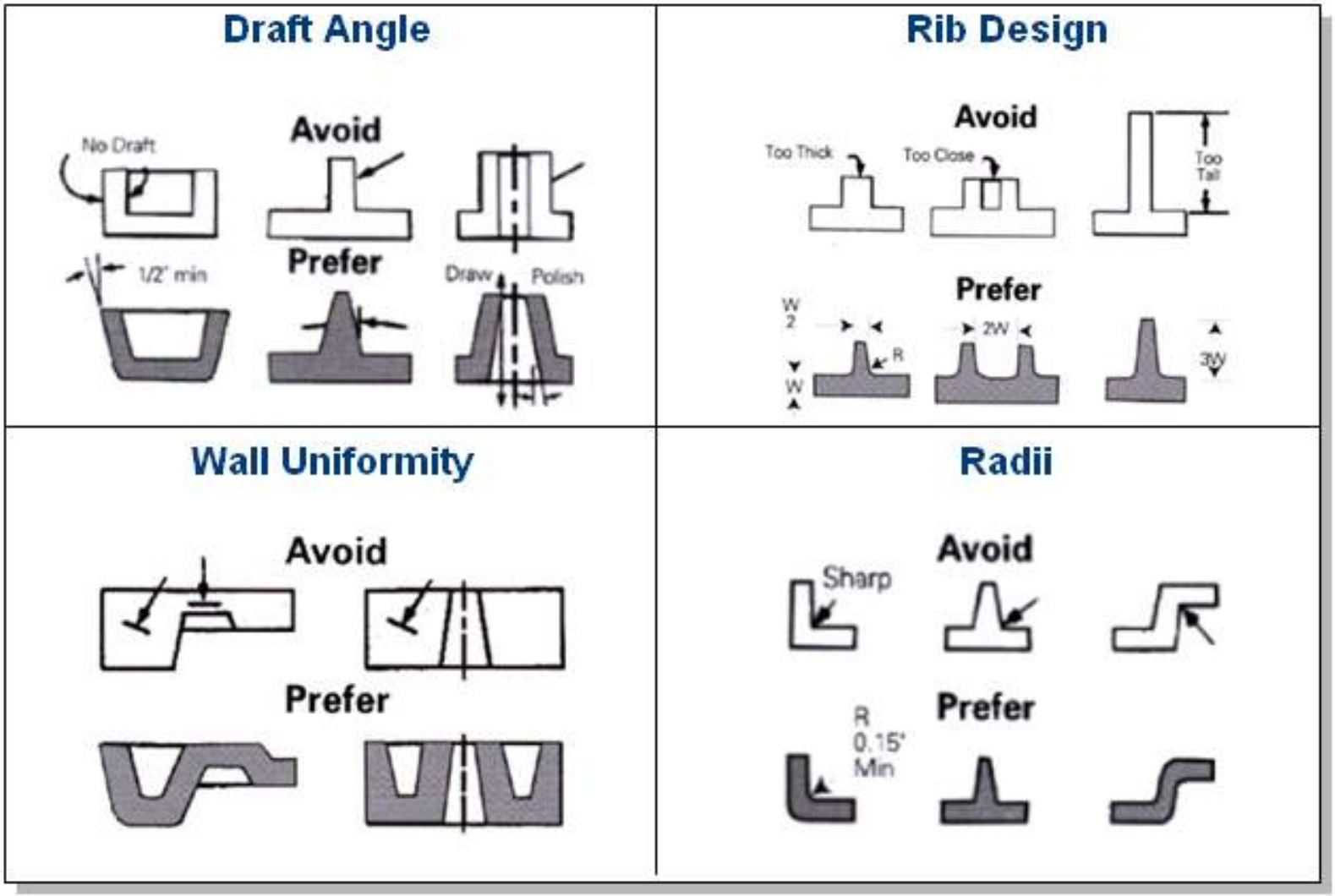

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Flammability Properties

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Test Method	Units	Results
Federal Motor Vehicle Safety Standard (FMVSS) 302	< 4.0 in/min[1]	Pass
ASTM-E84	Flame Spread Index[2]	Class A Rating (per NFPA)
ASTM-E84	Smoke Development Index[2]	Class A Rating (per NFPA)
ASTM-E162	Flame Spread Index (Fs)	Class A (I) Rating[2] Fs = 10.87 Class B (II) Rating[3] Fs = 56.64
ASTM-E662	Smoke Optical Density(Ds)[2,3]	@ 1.5 min = 2.0 to 2.8 @ 4.0 min = 14.5 to 20.3
ASTM-D635 (as referenced in ANSI Z87.1)	Burn Rate	Pass[3]
UL-94	Flame Class	V0[3a] HF-1[3a]
FAR 25.853(a) [Appendix F, Part 25]	Burn Rate	Pass[5]
CAL-117	Max. % Weight Loss	Pass

Note[1]: Both EPP (Standard Grade; density >20 g/l) and FR-EPP (all densities) pass FMVSS-302.
Note[2]: Testing performed on ARPRO FR-EPP at 45 g/l molded density at 1" thick.
NFPA (National Fire Protection Association) rating based on test results.
Note[3]: Testing performed on ARPRO FR-EPP at 30 g/l molded density at 1" thick.
a = Flame Class Equivalent
Note[4]: Testing performed on ARPRO FR-EPP at 40 & 60 g/l.
Note[5]: 60 Second Vertical Burn (30 & 45 g/l molded density).

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Material Properties - EPP

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PHYSICAL PROPERTY	TEST METHOD	UNITS	TEST RESULTS						
Density	ASTM-D3575	grams/liter	20	30	45	60	67	82	90
Compressive Strength	ASTM-D3575	MPa							
@25% Strain			0.10	0.16	0.28	0.39	0.44	0.60	0.69
@50% Strain			0.16	0.23	0.37	0.53	0.58	0.80	0.93
@75% Strain			0.31	0.44	0.77	1.07	1.26	1.80	2.08
Compression Set	ASTM-D3575	%	14	12	12	11	11	10	10
Tensile Strength	ASTM-D3575	MPa	0.26	0.38	0.46	0.62	0.71	0.87	0.97
Tensile Elongation	ASTM-D3575	%	15	15	14	14	13	13	12
Tear Strength	ASTM-D3575	KN/m	1.74	2.13	2.73	3.25	3.51	4.07	4.35
Flexural Strength	ASTM-D790	MPa	.21	.38	.54	.72	.86	1.08	1.16
Flexural Modulus	ASTM-D790	MPa	9.8	11.6	14.5	19.0	22.2	28.9	31.1
Coefficient of Linear Thermal Expansion	ASTM-D696	mm/mm/°C x 10^{-5}							
20°C to -40°C			6.8	5.9	5.5	4.3	4.1	3.9	3.7
20°C to 80°C			10.8	10.2	9.8	8.7	7.9	7.5	6.8
Water Absorption	ASTM-C272	gms/cc x 10^{-3}	10.4	8.1	6.2	5.1	4.5	4.2	3.5
Flammability	FMVSS 302	< 100 mm/min.	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Chemical Resistance (Auto fuels, fluids, solvents)	Various	1 hr exposure	Pass	Pass	Pass	Pass	Pass	Pass	Pass

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EPP Fasteners

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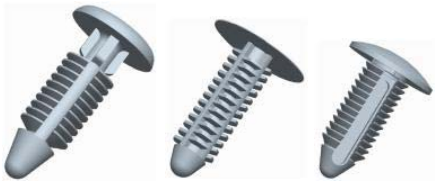
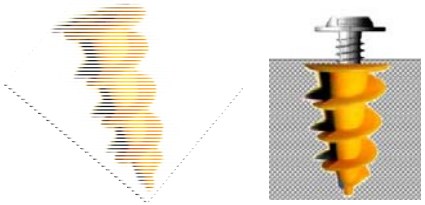
Auger Screw Blind-Hole Fasteners

Inserted Push Type Fastener

Push-Type Blind-Hole Fastener

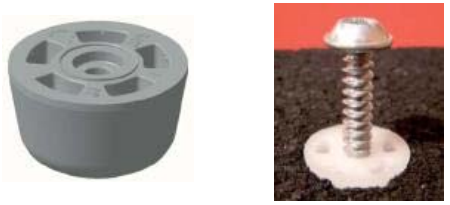


Inserted Blind Screw Type Fastener



Inserted Screw Type Fastener

Spin-Welded Insert Fastener



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Case Study #1

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PUR Case

53 Fasteners / Brackets

EPP Chassis with PP Cover

13 Fasteners / Brackets

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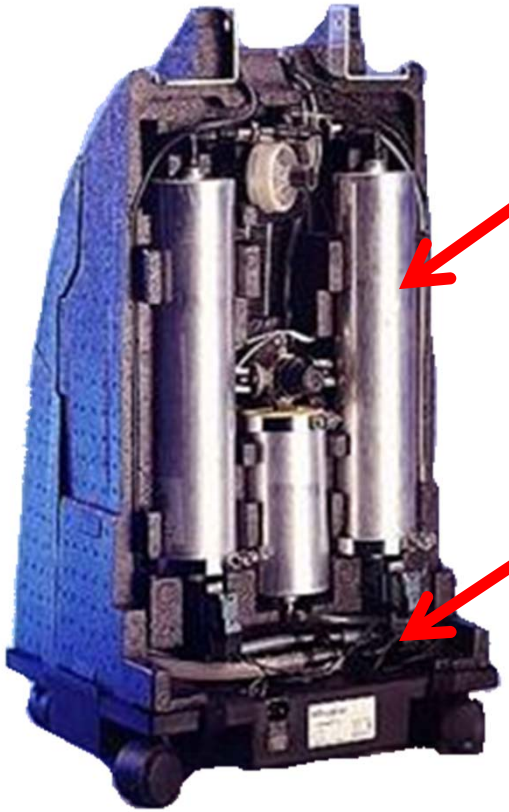
Case Study #1

- Air ducting
- Noise encapsulation
- Easy access for service
- Improved thermal properties due to forced airflow



Snap-fit for filter modules

Tube routing integrated

Case Study #2

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Solar Hot Water Heater Control Panel

EPP Outer Cover provides protection and insulation

Components "Snap Fit" into place

Cover snaps together using undercut molding

Back molded to follow water heater contour

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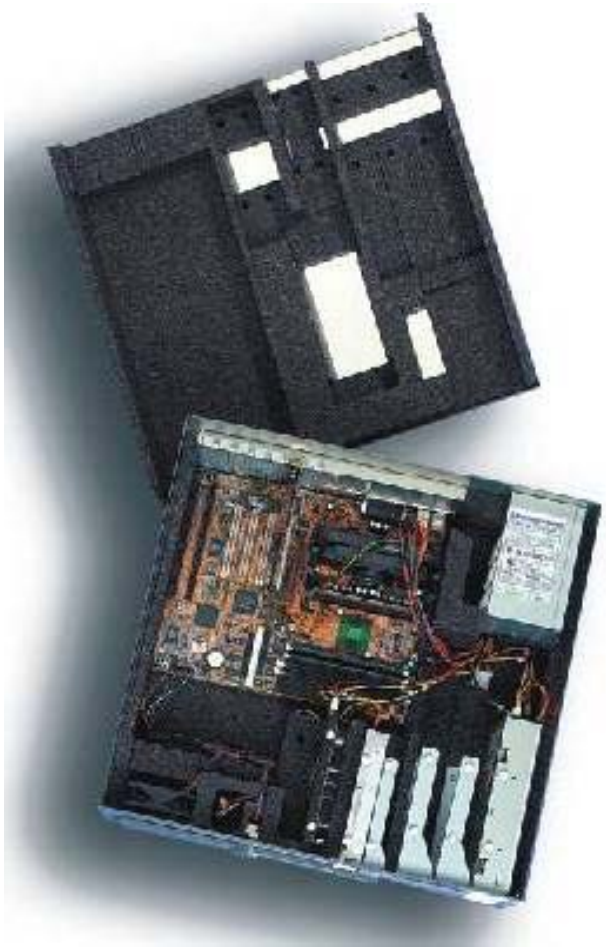
Case Study #3

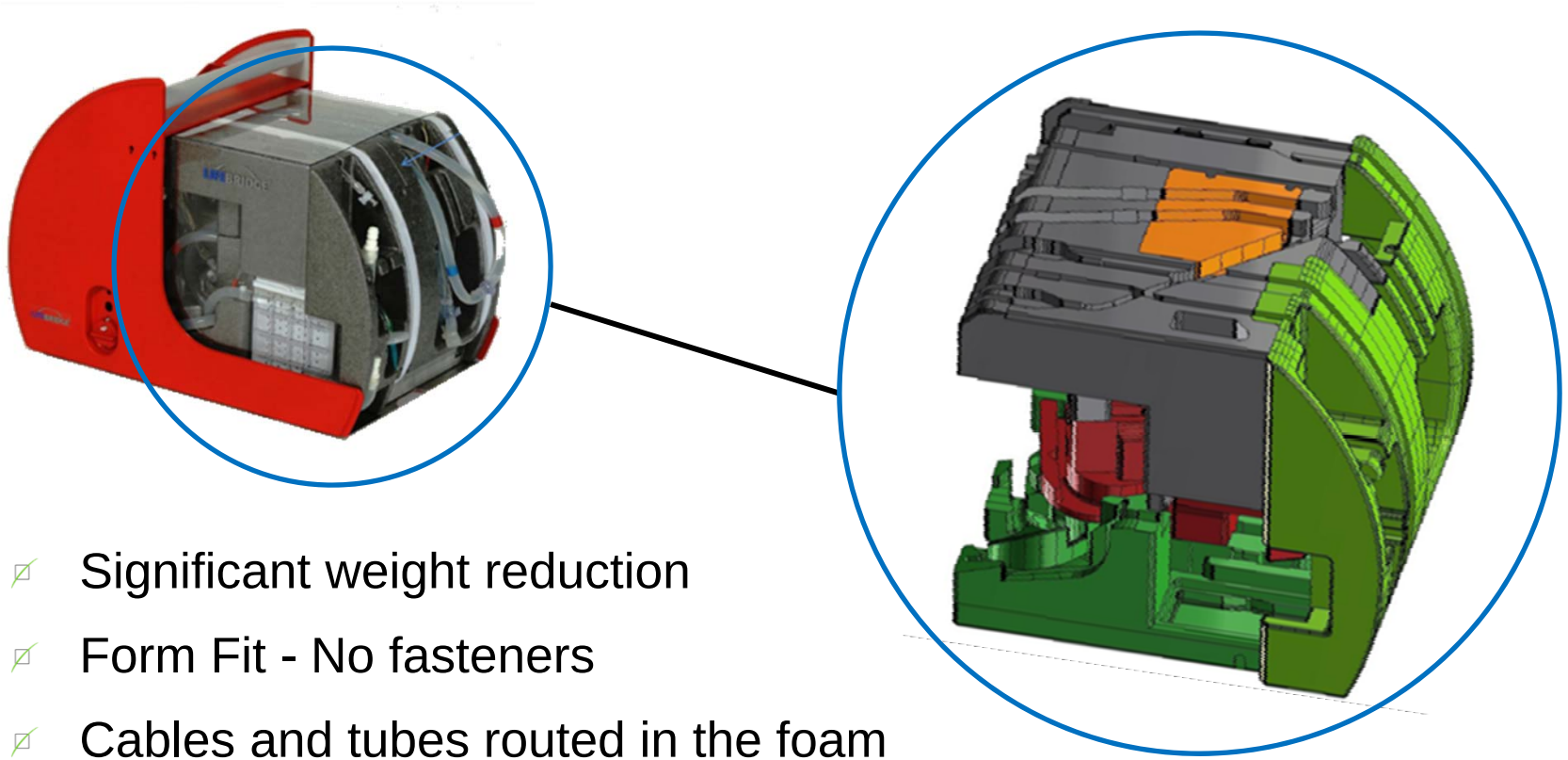


Benefits from Using EPP

- 70% reduction in housing mech. parts
- 95% reduction in screw joints
- 50% reduction in assembly time
- 90% reduction in disassembly time
- 30% reduction in protective packaging
- 50% reduction in engineering time for mechanical development of housing
- 50% reduction in weight of plastic

Case Study #4

LIFEBRIDGE Disposal Patient Module



- Significant weight reduction
- Form Fit - No fasteners
- Cables and tubes routed in the foam
- Recycling after use faster - no disassembly tools required

E-PAC Summary

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Design and Manufacturing

- Internal structure can change without changing external enclosure
- EPP blocks CNC'd for ease of prototyping

Assembly of Final Product

- Simple, fast and cost-effective assembly of components
- Reduction in the number of parts
- Significant reduction in assembly time
- No additional joining elements or assembly tools needed

Product Performance

- Reduced product mass
- Good protection against mechanical shock and vibration
- On-spot cooling of components as a result of air channels in the foam
- 100% recyclable

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For More Information

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Visit: www.protexic.com/specialty_components **or** www.epac-foam.com

Rob Cole
Rob.cole@sonoco.com
248-245-0494

Scott Novak
Scott.novak@sonoco.com
847-632-9622

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