HOW LIGHT CAN YOU GO?
3 WAYS TO PUSH THE BOUNDARIES OF AUTOMOTIVE AND AEROSPACE LIGHTWEIGHTING
A technical paper by General Plastics Manufacturing Company
Fuel economy is a hot topic for both manufacturers and consumers. In the automotive market, countries all over the world are implementing more stringent fuel consumption standards for passenger cars and light trucks. Specifically in the United States, the Corporate Average Fuel Economy (CAFE) regulations aim to reach a fuel efficiency of 54.5 mpg for passenger vehicles by 2025. However, the latest reports from the U.S. Environmental Protection Agency (EPA) show the current fuel economy for cars stands at 28.5 mpg, so the urgency for innovation is real and ever present. The aerospace industry also holds similar goals for improving fuel efficiency. As the cost of labor and other operating expenses continues to rise for U.S. passenger airlines, lowering fuel costs has one of the most significant impacts on growing profitability and staying competitive.

To meet these ever-increasing demands of cost savings, performance, and sustainability, lightweighting is a common practice used by both automotive and aerospace manufacturers. By decreasing the weight of cars and aircraft, less fuel is needed to move the transportation vehicle. According to the U.S. Department of Energy Vehicle Technologies Office, “A 10% reduction in vehicle weight can result in a 6%-8% fuel economy improvement. Using lightweight components and high-efficiency engines enabled by advanced materials in one quarter of the U.S. fleet could save more than 5 billion gallons of fuel annually by 2030.”

In many ways, the aerospace market pioneered the lightweighting race and therefore has quite the head start. In 2009 the Boeing 787 Dreamliner consisted of a 50% composite structure, whereas in 2013 the Airbus A350 was constructed with 53% composite materials in order to improve fuel economy. Now the automotive industry is also ramping up its lightweighting efforts, as seen by the 2019 GMC Sierra’s advanced carbon fiber/thermoplastic composite truck bed and the 2015 Ford F-150 with its 700-pound-lighter aluminum frame. Ford took a big step into the unknown when replacing steel with military-grade aluminum, but the risk paid off and F-150 sales reached an all-time high after the release of the new lightweighted design, proving that alternative lightweighting materials are a viable option to seriously consider.

Ultimately, manufacturers are looking for materials that satisfy the quality and performance requirements for their project, without adversely affecting the project deadline or budget. The rest of this whitepaper discusses three methods for lightweighting, as well as practical applications for the automotive and aerospace industries.

Three Methods for Lightweighting
At General Plastics, we’ve seen lightweighting solutions successfully implemented using three different techniques. These methods may be used separately or in conjunction with one another.

1. Use Lighter Materials for Each Component
The first approach is the one most people think of when they hear the term “lightweighting.” However, oftentimes design engineers will only consider metals and alloys by default because of their higher strength. Take a look at this chart that compares the strength and density of different automotive materials:
Clearly, materials science has progressed such that there are other viable options in the composites world. Depending on the strength, safety, and other requirements, different, lighter-weight materials can be considered for each component of cars and airplanes. For example, rather than use solid metal or plastic decorative parts in a vehicle, they can be replaced with components made out of high-density polyurethane foam and coated to look like the real thing. If you multiply that lightweighting adjustment across an entire passenger jet, suddenly the weight reduction turns into pounds and the fuel reduction turns into profitability.

2. Use Fewer Components

This second lightweighting method is not just referring to a decrease in overall vehicle parts. If anything, advancements in technology has increased the amount of electronic components in cars – such as for wireless communications, advanced driver-assistance systems (ADAS), and vehicle electrification – making weight reduction even more important to offset these additions. So if making a vehicle with fewer components overall isn’t likely, consider choosing a lightweighting solution where the material itself can have fewer components.

For example, honeycomb panels made out of paper blends and composites are often a popular choice for lightweighting due to their high strength. However, since the core consists of a grid of large, open cells, it must be wrapped in multiple adhesive and skin layers to prevent water and dust intrusion. These films must also be thick enough to create a smooth surface and stop the transfer of the honeycomb pattern from appearing.

Materials such as polyurethane foam can be produced with a closed-cell structure that does not absorb water and therefore won’t rot, warp, bow, or delaminate from water intrusion. Plus, the foam can have self-skinning properties that automatically seals and is ready for painting or coating to achieve the appropriate appearance and texture. The fewer manufacturing steps it takes to create a component, the greater the cost and time savings.
3. Use Processing with Less Waste

Environmental impact and sustainability concerns often go hand-in-hand with fuel economy considerations. How much waste is being produced to achieve a lighter truck or helicopter? With some materials, such as wood or honeycomb panels, parts are created by building up a block with the appropriate dimensions and then machining it down to the actual shape. This method can result in a lot of discarded excess. Depending on the lightweighting material you select, it may be less wasteful and more cost-efficient to use other processing techniques. Consider the following manufacturing methods used for high-density polyurethane foam:

- **Custom molding**: Rather than machining a sheet stock or block into the component’s shape, a custom tool is designed to mold the part from a lightweighting material. This technique produces high levels of detail, complex shapes without machining, and a smooth or textured skin as desired. Parts can be made with naked skins ready for further processing or painting, or in-mold painting can be performed for even greater process efficiency.

- **Thermoforming**: this drape or mold forming process is easy to use and ideal for shaping shallow slopes and angles where machining would be more wasteful or time-consuming. This method can form parts that require large sheets of foam and complexity, all in a matter of minutes.

- **Sandwich panel layups**: Commonly used in composite material production, this process uses standard vacuum bag layup or heated presses at temperatures above 275°F. Note: certain lightweighting materials like poly-ether imide (PEI) may have good strength properties but are not suitable for higher processing temperatures.

Regardless which manufacturing method you use, the end product still has the same weight and compressive strength. However, the ideal solution can produce less waste, have less carbon footprint, use raw materials from recycled goods, and so on.

Real-World Lightweighting Applications

General Plastics offers a wide selection of rigid and flexible polyurethane foams that come in a variety of densities, thermal properties, surfaces, and other characteristics to best fit your application needs.

Lightweighting Applications for Aerospace

For aerospace markets, General Plastics offers the LAST-A-FOAM® FR-3800 FST foam and LAST-A-FOAM® WSF-1121 impact energy absorption foam that meet the latest FAA and FDA requirements. The FR-3800 was specifically developed to meet FST and OSU 65/65/200 safety standards concerning flammability, smoke density, toxicity, and heat release. Due to its unique physical properties of density, strength, stiffness, and FST/OSU compliance, the FR-3800 is a cost-efficient core material alternative to honeycomb panels, poly-methyl chloride (PMI), poly-ether imide (PEI), and polyethersulfone (PESU).

Our build-to-print flight deck and passenger cabin molded parts are found all over today’s aircraft in many different areas, such as:

- **Durable padding** for heads-up display covers, headliners, post pads, kick strips and assist handle covers.
- **Aviation gap** filler that provides cushioning and noise reduction in overhead storage bins, passenger cabin dividers, galleys, and lavatories.
Polyurethane foam can easily be used to substitute metal and plastic decorative items in aircraft. For instance, foam core covered with a brushed metal coating can replace the aluminum trim around seatback screens – reducing the weight by more than 66% and the price by 33%.

In another example, an aerospace OEM customer spoke to us about using polyurethane foam instead of heavier plastics for the armrest extensions under the pad. General Plastics worked with them every step of the way to develop the optimal solution that met their specifications. Because of the cost, weight, and fuel economy savings, the customer was highly satisfied with the result and decided to standardize on our lightweighting material for that component moving forward.

**Lightweighting Applications for Automotive**

In the automotive market, polyurethane foams can be used to replace thermoplastic elements in the car, such as the brackets that hold different components in place in the dashboard and door panels. These pieces are not structural, so replacing these functional parts with polyurethane foam will not compromise the safety requirements of the whole dashboard or door panel.

In terms of General Plastics products, we commonly recommend [LAST-A-FOAM® FR-7100 Multi-Use Core Series](#) because its many available densities make it applicable nearly everywhere in vehicles, such as cores for load floors, seat backs and rigid support components, dashboard, door panels, visors, antenna housings, and headliners. The [LAST-A-FOAM® FP-8000 Energy Absorption Semi-Rigid Series](#) can be used in thin sheets for sound dampening in doors.
For thermoforming applications, the LAST-A-FOAM® FR-4300 Thermoformable Board Series can be used to make bucket seats and speaker boxes. And for custom molded parts, both the LAST-A-FOAM® FR-3700 flame-retardant rigid polyurethane foam and LAST-A-FOAM® WSF-1121 impact energy absorption foam can be used under thermoformed ABS plastic for pads on doors, arm rests, consoles, and visors. These foam series each have unique enhancements and performance improvements to fit a variety of purposes, and can significantly reduce weight and costs compared to other materials.

Push the Boundaries of Lightweighting

In aerospace and automotive markets, lightweighting is becoming increasingly important to OEMs, Tier 1 and 2 suppliers, and manufacturers to create new products that meet growing industry needs and new government standards. Lightweighting materials such as polyurethane foam must offer not only weight reduction, but also enhanced performance and overall cost savings. Also, using these alternative materials is rarely a one-to-one drop-in replacement, due to differences in properties, processing, supply chain, and so forth. However, with the guidance of materials experts like General Plastics, we can walk you through the entire process from planning to design to manufacturing.

With more than 75 years of experience working with manufacturers on complex, cutting-edge projects, General Plastics has the extensive knowledge to help you figure out your lightweighting objectives and solution. Not only do we produce a wide selection of innovative rigid and flexible polyurethane foam solutions, but our team also offers complete in-house production services to deliver full assemblies and parts.

Contact us today to get started on your lightweighting journey.