Technology Forum Highlights Aluminum's Value in Automotive Applications

By Andrew Halonen, Contributing Editor

The Aluminum Transportation Group (ATG), part of the Aluminum Association, hosted an informative technology forum in Detroit, MI, on November 2, 2023 (Figure 1). Hosting such an event in Detroit is intentional, as it is most likely to draw the engineers and managers from the automotive manufacturers (OEMs) as many of their headquarters are located in the vicinity. The event had it all—speakers who lead their respective areas, great product displays, and a friendly venue. Speaker topics ranged from new designs and case studies on major automotive components to new materials, recycling, and joining and fastening. For the engineers, there was a good mix of application details and data to support the claims; for example, a heavier EV needs a more robust bumper beam, one that is double the weight of that on a combustion engine vehicle. A key takeaway from the proceedings was this: "It's not just aluminum by itself. Regardless of extrusion, sheet, or casting, there is a lot of opportunity to tailor the material to the application."

Figure 1. Mark Butterfield, president of Metal Exchange Corporation, speaks at the Aluminum Technology Forum in Detroit, which provided a venue for aluminum companies and OEMs to speak on the use of aluminum in vehicles. (Photo: Mayflower Consulting.)

Highlighted Presentations

The speaker presentations began with the Keynote called "The EV Transition," by Alan Amici of the Center for Automotive Research (CAR). The presentation was timely as the market news was centered on electric vehicles (EVs) and the lack of buyer demand. Amici's message was centered on the long-term, one that would offer payback for the $163 billion invested in the last five years. Despite today's lackluster sales, CAR still predicts 2030 EV sales to be in the 60% range. He also spoke to some of the confusion on EV buying, namely due to the Inflation Reduction Act (IRA). One must be proficient at parsing fine print to understand the definition of "clean" in regard to the IRA, as well as the allowable price ranges and the origination of specific battery materials. He touched on other inconvenient truths, such as the high weight of EVs and the fact that large castings may get market pushback by insurance agencies.

Two brief OEM speakers followed. The first was by Mark Mikolaiczik, former chief engineer at Ford, who spoke of a chrome steel running board conversion to aluminum extrusion. The extrusion can be polished to a chrome-like finish. Of course, this is much more environmentally friendly than chrome, which is increasingly difficult to recycle. This project appeared to win on two important fronts, including weight reduction and, because chrome is expensive, cost reduction.

The second was Shian Jia, materials engineer at Rivian Automotive, who spoke of the large 1.4 m aluminum casting used to reinforce the door on the Amazon delivery van.[1] The casting is made using the semi-solid manufacturing (SSM) process, which is also referred to as rheocasting. The material is 100% recycled aluminum, produced by Eccomelt. The significance of the SSM process is that it delivers a smooth surface finish like high pressure die casting, yet at such low porosity that the material can be heat treated without forming blisters. This is valuable, because heat treating aluminum significantly increases its strength and toughness.

Both Mikolaiczik and Jia were part of a panel discussion, in which one topic of conversation was focused on the steel to aluminum transition in the 2015 Ford F-150. Of course, with any new material, there is apprehension on the repair in the field, and the aluminum-bodied Ford was in the spotlight. As time went on after its launch, however, *Automotive News* and other outlets reported that the aluminum-bodied F-150 was actually easier to repair than the steel body.

Furthermore, aluminum is corrosion resistant. As Mikolaiczik stated, "The aluminum-body Ford F150 still looks great eight years after launch." When you consider the amount of snow, ice, and road salt used throughout Upper Michigan, not many vehicles can still look as good as the aluminum F-150 after eight years. This is something to which the author can attest, being the owner of the older steel-bodied F-150, which now has unsightly brown spots and rust on various areas of the body.

During the panel discussion, the question was posed, "For years, there has been increased use of secondary alloy to reduce alloy cost and sell more metal. Now, this recycled content is promoted for sustainability. Will OEMs pay more for 'green' materials?" The speakers did not comment on the question of cost during the panel, but noted that these secondary aluminum materials are being specified on the drawings, showing OEM interest. However, after the panel, a speaker confided in private that OEMs will not "pay one penny extra" for recycled aluminum—an understandable position to take.

Mark White, technical director at Alumobility traveled all the way from the U.K. to give his presentation, "Re-

alizing the Promise of Aluminum." He introduced well-documented case studies, ranging from doors to B-pillars to aluminum-intensive vehicles (AIV). The EV weight is extraordinarily high compared to vehicles with internal combustion engines (ICE), and this will be accepted by the industry for only so long before there is a collective mission to cut weight for both efficiency's sake and safety. Heavy, fast vehicles are not safe on the road either for other vehicles or pedestrians. "It's not just about saving weight, but about reducing complexity and improving body-in-white attributes and part quality," said White. "It's about making a great car that people want."

White's presentations are rich with data and comparisons—though one might wonder why the data tends to lack cost comparisons of aluminum and the baseline incumbent solution. Mario Greco of Novelis, who serves as secretary for Alumobility, provided some insight into why Alumobility does not offer this information, stating that as a consortium of aluminum producers, they are not allowed to discuss or work on cost analysis directly, because it places them in jeopardy of violating antitrust issues. Rather, the OEMs conduct their own cost analysis directly with the supplier of their choice. In general, Alumobility studies demonstrate that components are the most cost effective when made with aluminum, as they reduce the number of parts, the joining requirements, and the different gauges and grades of materials used in the stamping operations. White stated that "60% usage of body sheet materials is a good estimate," which is why he is adamant about recycling in the stamping shop to keep like materials together. His goal is to achieve 75% recycled-content product.

Generally, not much attention is paid to the wires and cables in cars despite the surprisingly long length of about one mile of wire that is used in the average car.[2] Fred Kelley of the Prysmian Group is an expert on wire and cables, and he spoke to the challenges and opportunities of converting copper to aluminum. Aluminum is much lower density than copper. However, conductors are designed around conductivity and resistance, and for aluminum to compete, it must be made in a larger diameter than copper. This is acceptable for thick battery cables—yet much of the cable is made of wire strands that are bundled together, and if each wire is thicker, the bundle also grows in size, making it more difficult to package. There are options to improve the properties of aluminum wire, but the challenge is commercialization. The big user of aluminum wire is the utility industry, and they are extremely conservative; change is measured in decades, not years. A wire production line will make 400,000 lbs (200 tonnes) of wire a day. So, to say that you need 300 m for a test trial requires a significant business case to disrupt the production line.

Jeff Bugeaud of General Motors shared a great story on the effort to use recycled material to produce a high strength 6082 aluminum extruded bumper beam. There was no compromise needed as the properties exceeded the GM specification and were quite close to the baseline 6082 that requires less than 0.20% iron. The recycled alloy allowed a higher iron content at less than 0.25%. Iron is one of those pesky elements that is difficult to remove as aluminum is recycled, and it negatively affects mechanical properties.

Mark Butterfield of Metal Exchange Corporation and Pennex Aluminum presented "The Power of the Hollow." Butterfield is certainly a leading voice in the conversation on extrusions for a couple reasons. One, he is constantly pushing the envelope to improve the value proposition in extrusions, and two, he communicates well. The advanced topics can be explained to anyone, and this is important because decision makers and influencers come from a variety of backgrounds.

Butterfield explained that "75% of the value of an extrusion is not visible," which is a loaded statement. At first glance, an engineer sees an extrusion as an elegant and efficient component—long, straight, and clean with thin and uniform walls (Figure 2). With all of that immediately visible, how can it represent just 25% of the extrusion's value? At a high level, Butterfield was referring to the material and processing recipes that are tailored to the product application as representing the greatest portion of the value for extrusion profiles—a topic that will be explored more in his paper, "Extrusions are Inherent to Great Vehicle Design," which will be presented at ET '24 in May 2024. With this in mind, the future is bright for extrusions, as these hollow structures are needed to protect passengers in heavier electric vehicles.

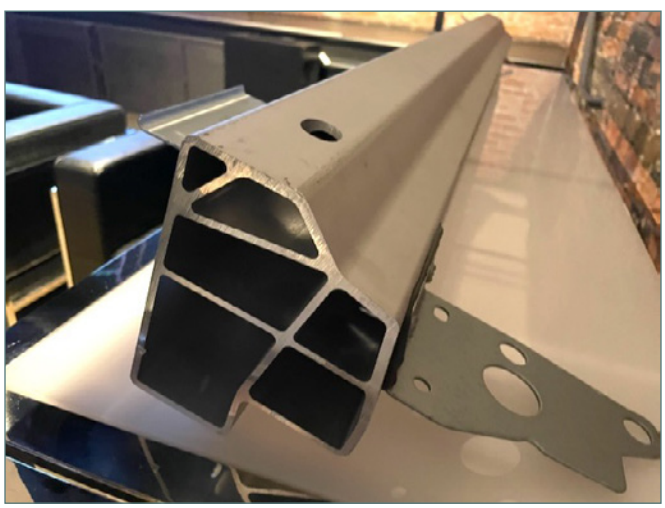

Figure 2. A hollow extrusion used for the rocker of the Volkswagen ID3. (Photo: Mayflower Consulting.)

When Shape Corporation speakers share their thoughts about automotive aluminum, people listen because the company is not just a one-trick pony. Shape offers extrusions, roll forming, carbon fiber composite pultrusion, and injection molded plastics. The variety of products allows the Shape team to bring a robust perspective, as they understand the value proposition of respective technologies. Jason Balzer, former chief engineer from Ford and now working as the director of Engineering at Shape, provided insight on product evolution, which aims towards the best and most economical means to reach the performance. The best solution may be an extrusion, roll-formed shape, or a combination of each.

One particular area of interest that Shape is focused on is the load path of vehicles, which involves managing the vehicle mass and the impact forces entering the vehicle from the front, back, or sides. The impact force is met with an energy-absorbing structure, comprised of a system of components working to prevent the force from entering the passenger compartment. In addition to the weight of EVs causing additional engineering, range anxiety causes the need for the largest possible battery and reduces the available crush zone to protect the battery—further stressing the importance of engineering and manufacturing.

Another area of emphasis at Shape is aluminum roll-forming, which enables the production of components with really thin walls of less than 2 mm—something that is very difficult for structural extrusions. A potential area for roll-formed aluminum are the cross members of the vehicle body, an application that is currently dominated by hot stamped steel. Another advantage of roll form-

ing is that it is performed cold, which minimizes energy consumption.

Sacheen Bekah, PhD and manager of Product Development at Kirchhoff Automotive, presented on the conversion of steel to extruded aluminum bumper beams. Since battery electric vehicles (BEV) are heavy, the bumper beam needs to be designed to protect the vehicle and passengers under a higher load. Compared to an ICE vehicle, the BEV bumper beam needs to increase from 10 kg up to 24 kg to achieve the same level of protection. Another example of how everything is heavier on an EV.

On stage during all of the presentations was the body of the 2018 Jaguar I-Pace. To best demonstrate the multi-material construction of the car, look closely at the door (Figure 3). The A-pillar area is clearly a casting with the thin structural ribs, but extending up the sash, there appears a formed extrusion. Then further down the B-pillar, there is another die casting. The door showcases mass-produced aluminum components, with the best material being utilized in the best location and joined together by welding—a perfect visual of automotive innovation.

Figure 3. The door structure of the Jaguar I-Pace. (Photo: Mayflower Consulting.)

Conclusion

The day was filled with interesting presentations, high quality networking, and details showing success stories, and a promise for a better tomorrow. Innovation is coming on every front, from alloy development to joining to material utilization and increasing level of recycled content. The applications evolve with the combustion engine to the electric powertrain, and likely to grow with electrification challenges, the hybrid powertrain.

References

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