

Transcript: "Lightweight Metal-Based Vehicle Structures: Innovative Design and Agile Manufacture"

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Lightweight Metal-Based Vehicle Structures: Innovative Design and Agile Manufacture
Alcoa Foundation
The Ohio State University
Institute of International Education

Glenn Daehn, The Ohio State University Sustainability and manufacture are really closer than anybody would ever think. For every 10% of weight saving you get in a car, you get about 7% fuel-economy savings, so if you add that up over all the cars that are out there, it's a massive ability to save energy and become more domestically reliant, and that's the ultimate pay-off of this work.

Anthony Luscher, The Ohio State University These vehicles will be able to meet future CAFÉ standards, and fuel economy will be much, much higher than in the past. The future is multi-material vehicles. So, right now they are primarily steel, ferrous alloys. In the future, they're going to be aluminum, magnesium -- still some steel, some thermal-plastics, composites. And one of the big challenges is how we put it all together. If you want to make one, there are some well-known solutions. If you want to make a quarter-million of 'em, and you want to do it for the cost you do today, we need creative solutions. We need new ways of doing it.

Glenn Daehn For us, the Alcoa Foundation partnership is really all about sustainable manufacturing and design, so the really big thing we're after is really lightweighting of vehicle structures -- kind of vehicles of all classes, from bicycles to cars, to aircraft, to boats. All have similar challenges that if you start to minimize weight you run into using combinations of materials, where you might have lightweight alloys like magnesium and aluminum, high strength steel, and carbon fiber composites. And how you design to make it economical and to make it crash-worthy and to make it long-term sustainable with respect to both use and corrosion and fatigue and recycling and all of those things is a wonderful long-term engineering problem, and that's what we're really excited to be working with the Foundation on.

So the challenges with respect to lightweighting vehicles -- joining turns out to be a big deal because if you just put, for example, aluminum and steel together, you have a couple problems. Number one, you can't weld them together because they form these compounds -- these iron-aluminum inter-metallic compounds which are very brittle. The other issue is that if you put them together directly you get all these corrosion currents that basically want to eat up the aluminum. So we have to find ways of physically separating things, that makes for a very difficult design challenge.

So with this project, we're looking at a few separate things. Professor Tony

Luscher, he's really looking at conformal interference joints, and this is partly enabled by high-speed deformation. In my group, we're working on a couple of things -- we're working on measuring material properties at high strain rates that can be used as part of that, that can also go into crash-worthiness modeling, I've also got a student who is looking at designing processes where you marry stamping and electromagnetic forming to enable parts like aluminum door inners for example. It opens up lots of opportunities for forming lightweight materials and getting them into automobiles, economically.

Anthony Luscher

One of the vehicle types that's a strong potential for the future is a space-frame. For example, the Audi A-8 uses an aluminum space-frame. It's primarily welded though, which is expensive, and it destroys the hardening of the aluminum alloys, so there's a certain heat-affected zone. It's not optimum for cost or for strength. What we're doing here is pioneering some ways to create space-frames. For example, recently we created a rod where we took an aluminum center-section and then we took steel end-section. And just using structural optimization, we were able to create three curved sections, using what's called elastic averaging to share the load among the joint. We made as far as I know, the first joint where, actually, we achieved over 100% of the base material's strength. It didn't fail in the joining areas, it failed actually in the center section of the tube, so that was quite a breakthrough.

Glenn Daehn

We're using Alcoa Foundation support really to evangelize these techniques, and we think they have wide application, particularly in light structure manufacturing and other manufacturing processes.

Anthony Luscher

The way we've built structures and vehicles and pallets has been the same for 50-60 years. And we're really looking to smash that paradigm, get some new ideas, engineer them well and move forward to create better products that people can buy and use, and they're also better for the environment.

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