Technology

The Lighter Side of Heavy Transport

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Composite materials have been around for a long time. In the aviation industry, carbon fiber composite has been an integral part of the airplane hull for many years, along with steel, aluminum and other materials. The boat building industry has been constructing fiberglass vessels for decades. The definition of a composite material is that it has an overall structure with properties that are better and stronger than the sum of the individual components. Composite materials come in different shapes and sizes, but the most common composite consists of a load-bearing fiber reinforcement surrounded by a protective material. In carbon fiber composites, the carbon fiber threads are weaved in different patterns depending on the desired properties of the material, and then reinforced with plastic that protects the fiber and holds the material in place. "Most of the time, the desired end result when you use a composite material is to bring down the weight in a moving structure to lower energy consumption," says Malin Åkermo, Associate Professor of Lightweight Structures at the Department of Aeronautical and Vehicle Engineering at KTH Royal Institute of Technology, Stockholm. Historically, the problem with the likes of carbon fiber is that the raw material is costly, which in turn makes the finished composite material expensive compared most metals. But, as of late, production techniques have been developing so that costs are reducing in line with the increase in usage in high-volume products in different parts of the world.

"The large-scale production of carbon fiber composites didn't really exist until very recently," says Åkermo. "But lately, there has been a rapid development in production in countries such as Germany and the UK. Manufacturers in Sweden are also beginning to produce car components in carbon fiber." Åkermo explains that low demand is one key reason for construction costs of carbon fiber remaining high. "So far, the reduction of fuel consumption hasn't been enough to motivate the cost of lowering the weight of the car for the producers. But with tougher EU regulations on fuel emissions we will see an increase in production."

Yet lower weight is only one of the many benefits of composite materials. When constructing a material from scratch, you have the opportunity to add more functionality directly into the material. "The most exciting 'future application' right now is using multi-functional materials," says Åkermo.

"A good example that I often use is structural batteries. Carbon fiber can be charged with lithium ions and, with the right kind of plastic, you can make a material that is both load-bearing and works as a battery at the same time. "Another example is energy harvesting. We can embed actuators into the composite material that convert vibration and movement into energy. During a flight, the wings of an airplane move slightly up and down. We could use that energy to run the air conditioning in the plane, for example. This way, you build smartness into the product."

The construction methods required for composite materials and those used for steel and aluminum differ greatly. For example, drilling in a composite material is a more delicate matter.

"When drilling into a composite material you drill through plastic and fiber at the same time," explains Åkermo. "The materials don't have the same rigidity so it's very easy to damage the softer plastic. And if you apply too much pressure, you will get cracks between the layers." The softness of the plastic material also means that nuts and bolts cannot be used in the same way as they are with steel or aluminum. "When connecting two pieces of metal, you commonly use a torque wrench to apply a certain pressure on top of the hole. But creep [slight movement] means that you can't guarantee such a pressure with composites, so you will have to use a screw joint with nuts and washers that will support the structure without friction on the material."

The car industry is among those who choose to glue the material together instead of drilling into it. Another solution is to make bigger and better integrated parts to avoid the need for joining them together. Indeed, researchers from Volvo are looking into how to find the perfect balance between

part complexity and size to make it cost-effective.
“There have been experiments with making the body of the car all in one piece, but the problem is that you will need a very large press,” says Åkermo.
For car manufacturers, a viable way towards making carbon fiber cars is to introduce carbon fiber parts in premium cars to learn and refine the production process. “BMW built the i3 which is comparatively very expensive but was mainly made from carbon fiber composites. Now they are incorporating carbon fiber into the pillars of some of their other cars,” says Åkermo.
In the rapidly-changing world of transport, there’s no doubt that making vehicles smarter and more sustainable is imperative as part of the effort to cut emissions and energy consumption. If the growing use of composite materials is anything to go by, we’re looking at a future with smartness built in.

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