FEATURE

What does the future hold for composites in transportation markets?

Django Mathijsen

As a rule, predicting the future should only be done in the privacy of your own mind, or if need be: verbally. Writing predictions down and publishing them is risky business, because they will inevitably come back to haunt and ridicule you. So we are not going to make any predictions here. Instead we will highlight a few noteworthy facts that should enable you to make your own predictions and expectations, and thus prepare for what is to come.

The fact that composites can be made to have a very high strength and stiffness to weight ratio is one of the main reasons why they are an ideal construction material for any means of transport: planes, trains, automobiles... composites can make them lighter, improving their performance, energy efficiency and eco-friendliness. So, we should see their use ever increasing in this field of technology, shouldn't we?

Automotive: battling high strength steel

Take cars for example. In our article 'Developing a new front undertray for the Jaguar F-type' in the September/October 2016 issue we saw how more and more knowledge and technology is being put into automotive composites and their processing. The materials not only reduce weight, they also enable function integration and they can be tailored to their applications in ways impossible with metal.

The BMW i3 and i8 are currently the poster children for composites in the automotive industry. Carbon fiber reinforced monocoque chassis have been around in exotic supercars since they first appeared on the McLaren MP4 Formula One racing car in 1981. And now the i3 and i8 are finally showing how these materials can be employed in relatively high volume. Surely, carbon fiber composites are set to become the new normal in the automotive industry?

To make that happen, the manufacturing cost still has to come down substantially. But that is certainly possible. Ford's model T, popularizing mass production techniques, was introduced in 1908. So, the technology to mass produce steel car bodies has been developing for over a century. That has set the bar high: the technology to mass produce carbon fiber reinforced composite bodies has a lot of catching up to do. But there is room for developing faster and more cost-efficient manufacturing techniques for composites bodies and there is a lot of innovation going on in this field.

Recycling carbon fiber bodied cars as they hit their end of life is also a concern. In theory, a BMW i3 can be 95% recycled. But if carbon fiber bodies become the new normal, can the breaker's

FIGURE 1
The Jaguar F-type bumper and under tray assembly which was the subject of our September/October 2016 article 'Developing a new front undertray for the Jaguar F-type'. All parts are produced by different POLYTEC business units with a different technique (photo: POLYTEC GROUP).

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yards obtain the necessary knowledge and technology to deal with them all?

And steel is fighting back. In 1994, when the Audi A8 was introduced, it had an innovative aluminum space frame chassis, making the car relatively light and corrosion proof. So, the aluminum gave the car many of the advantages the carbon fiber reinforced composites give the BMW i3 and i8. The Lotus Elise, sporting a bonded aluminum monocoque, followed in 1995. It seemed the change had started and that a large part of the automotive industry was going to turn to aluminum as the new material.

Instead, the arrival of this new contender intensified a different change that was already going on: the quest to use ever stronger steel. Starting with the bumper assembly of the CX-5 in 2011, Mazda has already made components out of steel with a tensile strength of 1800 MPa which can still be formed using a press. That is around six to seven times the strength of the traditional mild steel that cars have traditionally been made of.

Aircraft: keeping the momentum

An area where the transition from metals to composites has been made to a very large extent is aviation. Composites have been flying for decades, especially in the form of small aircraft. And now they have largely replaced aluminum in airliners as well. The Boeing 787 Dreamliner is estimate to consist of: 50% composites, 20% aluminum, 15% titanium, 10% steel and 5% other materials. The Airbus A350 XWB is going one step further again: 53% composites, 19% Al/Al-Li, 14% titanium, 6% steel, and 8% miscellaneous. Also, Airbus claims that the noise levels inside the A350 are 9 dB lower than in the 787.

Composites not only lead to lighter aircraft. The composite structures also have a lower fatigue sensitivity, which means they require less maintenance. The Boeing 787's heavy maintenance interval was increased from 6 to 13 years.

Still, that is no reason to be complacent. Composites are expensive, so manufacturing costs must be reduced, for example by employing thermoplastic composites, welding innovations and co-consolidating techniques as we saw in our July/August 2015 article 'Leading the way in thermoplastic composites'.

And the change to composites has not resulted in all the weight reduction that can be achieved, because the new technology still comes with higher safety factors. To prevent the aircraft industry from going back to metals in the long run, those safety factors have to be lowered. And that takes a lot of fundamental research into failure mechanisms, as we saw in our July/August 2016 article 'The adhesive bond is not the weakest link in current carbon fiber reinforced plastic stiffener to skin structures'.

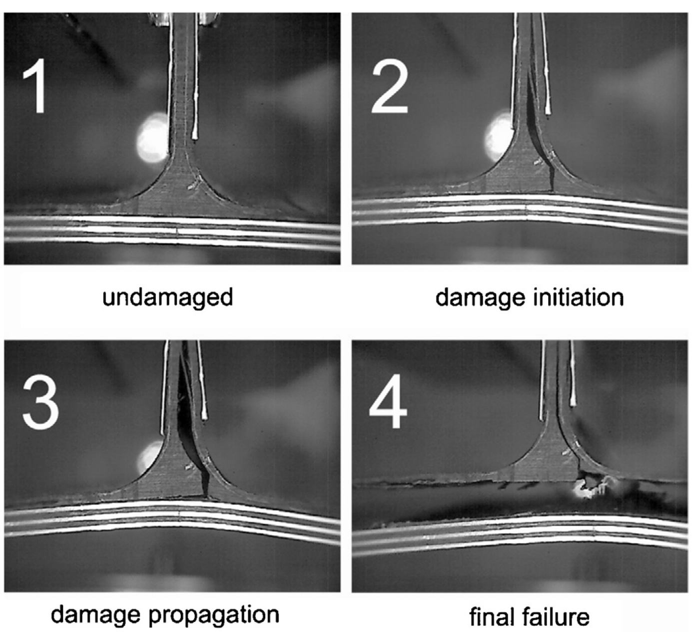

FIGURE 2

One of the surprising results of the research discussed in our July/August 2016 article 'The adhesive bond is not the weakest link in current carbon fiber reinforced plastic stiffener to skin structures', is that failure in a typical bonded hybrid joint initiated in the noodle of the stiffener, not in the adhesive bond.

Marine composites: teetering on the verge

For ships, boats and other naval vehicles the advantages of composites are so clear, it is surprising that metal hulls are still the standard in many types of ships, especially the larger ones. In 'Now is the time to make the change from metal to composites in naval shipbuilding' in our September/October 2016, experts from Damen Naval Shipbuilding showed some of the reasons for that.

It also showed how ship builders and organizations like E-LASS (the European network for lightweight applications at sea) are trying to change the tide. There is a sense of urgency that composites technology should make the breakthrough now. Manufacturing cost is a large factor again.

Damen Schelde Naval Shipbuilding switched from building composite vessels to aluminum a few decades ago because that enabled cheaper production. But that was then. Since the turn of the century they have been switching back to composites, even for larger ships, because modular design and series production techniques have now made them cheaper to produce than aluminum ones.

Although a composites vessel turns out to be inherently safer than a metal one in many respects, the biggest challenge in realizing large composites vessels is proving to clients that these ships are at least as safe as metal ones. So just as in aviation: fundamental research to prove the properties of composites constructions is key.

FIGURE 3

A Damen interceptor flying over the waves in our September/October 2016 issue: light and fast, thanks to composites.

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