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About the Cover: The first horizontal tailplanes for the Airbus A350-1000, made from composites, shown on the final assembly line in Getafe, Spain.
Photo courtesy of AIRBUS S.A.S., © Pablo_Cabellos
From the ACMA Chair

Heading Back to Orlando

Every year, I’m taken aback by the diversity of great things happening in our industry. Soon, we’ll have the chance to see the latest innovations at CAMX – The Composites and Advanced Materials Expo. One thing my company in particular will be interested in is everything happening in the automotive market. Before you hit the show floor, check out our interviews with leaders from Honda and Volkswagen to see how they view the state of automotive composites (page 18).

The CAMX show floor is also going to be rife with aerospace innovation. (The article on page 14 provides a preview of some of the industry’s newest aerospace applications.) You will also have a chance to learn about disruptive innovation in our industry and how we can embrace it to grow our companies and the industry. Examples will be shared from the building, marine and aerospace industries during the CAMX Live! General Session.

You might learn things during education sessions that may not seem immediately applicable to your target market, but have crossover potential. A few years ago, representatives from my company sat in on a CAMX session on reinforced thermoplastics. We later bought a company in that space, and the early exposure to the topic at CAMX helped us during the acquisition and helped grow our company.

CAMX is also a great opportunity to learn more about ACMA and how you can get involved. Stop by ACMA’s booth (D88) to talk with experts about how you can become engaged with ACMA to develop your career and grow your business. Being part of ACMA helps you understand the broad issues facing the industry and gives you a chance to influence them. I also encourage you to celebrate the association’s member volunteers during ACMA’s awards ceremony and reception – September 11 at 5:30 p.m., at the Orlando Hyatt Regency.

If you’re attending CAMX for the first time, figuring out how to juggle everything you want to do can be tricky. Join fellow new attendees at our First Timer’s orientation breakfast on September 12 – the first full day of the event. You can also sign up for MyCAMX online (http://camx17.mapyourshow.com) ahead of time to plan out your experience. In addition, you’re also welcome to contact ACMA staff if you have any questions.

I hope to see you in Orlando!

Kevin Barnett
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Best Practices

Peroxide Selection:
An Applications Perspective

By Sandeep Vennam and Ryan Emerson

When this column debuted in January 2015, the first article discussed mixing organic peroxides into composite materials and focused on the supplier’s point of view. This column is intended to provide insight into the selection and use of peroxides from a user’s perspective.

A Look at Chemistry

Composites are made with a wide variety of organic polymers broadly categorized into thermoset and thermoplastic. In most applications, resins – essentially monomers or copolymers – are cross linked to form a cured resin. Polymers and vinyl esters are widely used because of ease of processing and comparatively lower cost. These resins are cross linked into a solid by free radical reactions. This cross linking is achieved by introducing an initiator, which are chemical compounds that decompose into free radicals when promoted by reactive metal salts. This free radical generation is perpetuated until all the initiator is decomposed. Typical chemical reaction steps involved are as follows:

\[ R - COOH + Co^{2+} \rightarrow RO^{-} + OH^{-} + Co^{3+} \]

\[ R - COOH + Co^{3+} \rightarrow ROO^{-} + H^{+} + Co^{2+} \]

The generated free radical bonds with reactive sites in the resin, which then creates another reactive free radical that continues the cross-linking process.

Typically, organic peroxides are used as initiators with polyester, vinyl ester, acrylic and some liquid thermoplastic resins. For more in-depth information on the chemistry aspect, consult with your peroxide supplier to assess suitability for different resin types.

What Is My Process?

Applications most often associated with polyester and vinyl ester resins are pultrusion, resin transfer molding, filament winding and spray-up. A variety of peroxides are available for use with polyester and vinyl ester resins, and selection or suitability of these is dictated by the type of applications or processing. These applications or processing parameters also dictate the pot life requirements (the period the two reactive chemicals remain usable when mixed) and, in turn, selection of resin and peroxide combination.

Because peroxides are very reactive (and sometimes even shock-sensitive), special consideration may be needed to process them safely. To mitigate shock sensitivity and process them safely, peroxides are sometimes supplied as suspensions. Some suspensions are water-based. If your resin or process is moisture-sensitive, be mindful to avoid water-based suspensions.

What Is My Pot Life?

For processes like resin infusion, hand lay-up and spray-up, where shorter pot life is acceptable, room temperature activated peroxides are suitable. An example is ketone peroxide like methyl ethyl ketone peroxide (MEKP).

For applications like pultrusion and filament winding that require long resin pot life, peroxides that are heat activated are suitable. An example is peroxyester like tert-butylperoxybenzoate.

How Much Peroxide Should I Use?

Generally, a small amount of peroxide (about 0.5 to 2 percent by weight) is sufficient to start a curing reaction. Peroxides should be selected that produce sufficient free radicals at the applied temperatures and result in complete or higher degree of cure. The rate of cure is also dependent on the presence of promoters/accelerators and inhibitors in the resins. Resins are often supplied with promoters or inhibitors premixed in the system, or end users can choose to add specific ones based on their cure requirements.

Part-size Considerations

In pultrusion and filament winding applications for processing thin composite parts, a single peroxide like benzoyl peroxide (BPO) may be sufficient. A single fast-decomposition peroxide may not produce enough free radicals to complete the cure in some cases. For moderate to thick parts, multiple peroxide systems may be required. Also, highly exothermic reactions often cause problems with heterogeneous temperature distributions in the part that can lead to residual stress and cracking, especially in thick parts.

To combat such problems, one feasible approach is to use a combination of high-temperature slow-reactivity peroxides in addition to low-temperature fast-reactivity peroxides.
peroxides simultaneously in a resin/initiator system. In this way, line speeds and cure time can be coordinated and controlled. Figure 1 shows an example of cracks in the center of a part where these considerations may not have been properly controlled.

Summary
While hardly exhaustive, the above considerations touch on the main points an end user should consider when selecting a peroxide initiator. For illustrative purposes, we have attempted to separate the factors of process type, speed, part thickness, etc. In reality these factors are interrelated, and proper peroxide selection is not a trivial exercise. We hope this column provides food for thought to help an end user work with a peroxide supplier to choose the right one for their application.

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Disclaimer: Opinions, statements and technical information within the Best Practices column are that of the authors. ACMA makes no warranty of any kind, expressed or implied, with respect to information in the column, including fitness for a particular purpose. Persons using the information within the column assume all risk and liability for any losses, damages, claims or expenses resulting from such use.

Learn More about Peroxides
To access the Best Practices column on mixing peroxides that was referenced in this article, visit www.CompositesManufacturingMagazine.com, then click on Best Practices under the Columns tab. You can read more than a dozen articles on best practices related to fibers, resins, gel coats, composites repair, tooling, pultrusion and more. For more information on a wide range of composite materials and processes, visit www.compositeslab.com.
In Canada, thousands of commuters rely on the TransCanada highway – a continuous highway system that travels through all 10 provinces of Canada from coast to coast. Like many highways in America, TransCanada has a lot of bridges made with steel-reinforced concrete structures. However, when the steel corrodes, bridges are left with major durability problems that lead to structural degradation and costly repairs. One bridge over the Nipigon River on the Highway 11/17 corridor east of Thunder Bay, Ontario, has become proof that composites can be a viable alternative to steel.

In 2013, the Ministry of Transportation of Ontario (MTO) began a $106 million project to replace the Nipigon River bridge with two parallel spans carrying four lanes. The result was the first cable-stayed bridge in the Ontario highway system and the world's first cable-stayed bridge with glass fiber reinforced polymer-reinforced concrete (GFRP-RC) deck panels. The GFRP features vinyl ester resin and boron-free E-glass fibers.

According to Brahim Benmokrane, Ph.D., a civil engineering professor at the University of Sherbrooke who helped the project come to fruition, the use of GFRP-RC for the 252-meter bridge deck was as much a matter of necessity as it was innovation. Since the bridge is the only way to travel from eastern to western Canada by car, a shutdown for repair would force cars to take a southbound detour through the United States. Therefore, instead of using piers to secure the bridge, engineers opted for a cable-stayed design.

However, cable-stayed bridges are much harder to design than traditional bridges from an engineering standpoint due to their exposure to compression forces up to 9,000 psi. Those forces, Benmokrane says, make it logistically impossible to repair a cable-stayed bridge deck in the event the concrete starts to deteriorate.

That’s why, he adds, it was important for the MTO to approve a design with a structural component like GFRP that would prove extremely durable and would not need any major repairs for more than 100 years. “Even if there aren’t any problems [with GFRP], the declination can come from the concrete itself,” Benmokrane says. “So you really have to choose composite materials.”

Last year, Benmokrane and his team published a study about the specific combination of materials that went into the bridge. They constructed eight panels – six GFRP-RC panels and two steel-reinforced panels – and tested them...
for cracks. They concluded GFRP rebar connected by a 220-millimeter-wide ultra-high performance fiber-reinforced concrete (UHPFRC) joint did not show significant cracks because of their very high tensile strength and modulus of elasticity.

Benmokrane reached out to MTO, MMM Group (now known as WSP) and Buckland & Taylor to design 480 3 x 7-meter GFRP-RC deck panels, as well as sidewalks with 15- and 20-millimeter-thick GFRP-RC rebar. A total of roughly 350,000 meters of GFRP bars were used in the bridge deck. The GFRP was supplied by V-Rod Canada, which has supplied composite materials for hundreds of bridges for the MTO and other owners across the country. All of the panels were fabricated and cast at a precast facility (M CON Pipe & Products Inc., Ayr, Ontario, Canada) and then shipped onsite.

Two construction firms, Bot Construction and Ferrovial Agroman, accelerated construction by precasting the panels in pylons and connecting them with UHPFRC joints. After building the deck, Bot and Ferrovial drove 182 steel piles 50 to 70 meters deep for a cast-in-place substructure that is 75 meters high when measured from the bridge’s foundation footings. They then placed the precast, multi-beam center pier about 51 meters above the deck. The beams are connected to the bridge by 66 steel cables.

The bridge has been built in two halves. The westbound section was finished in November 2015, while the eastbound span is scheduled for completion this year.

Benmokrane and his research team at Sherbrooke have made recommendations to install fiber-optic sensors on critical parts of the bridge to measure strain and temperature data. The data, he says, will allow his team to assess the bridge under actual service conditions. The team will also conduct live field tests to assess the bridge’s long-term durability and serviceability in a wide range of environmental and traffic conditions.

Benmokrane believes the bridge is a landmark achievement for the composites industry as it looks to further expand into the infrastructure market. During the International Bridge Conference in National Harbor, Md., Benmokrane made a presentation on the design of the bridge and the benefits of FRP. He says he was happy with the feedback he received from engineers at the conference and is optimistic that applications like the Nipigon River bridge can open doors for many composites businesses.

“Based on the feedback I’ve been getting, I’m really expecting that in the future we will see many more bridges all over the world that use this kind of reinforcement,” says Benmokrane. “These bridges are very economic, elegant and have a great aesthetic.”

He says concrete bridges reinforced with GFRP rebars have an initial cost that is almost the same as concrete bridges reinforced with epoxy-coated or galvanized steel rebars. He adds stainless steel rebar is also two to four times more expensive than GFRP rebar.

“This is really bringing in millions of dollars to the industry with just one bridge,” Benmokrane said. “Can you imagine if the industry made 100 bridges of this kind per year?”

Evan Milberg is communications coordinator for ACMA. Email comments to emilberg@acmanet.org.

For more stories like this, visit CompositesManufacturingMagazine.com and check out the Infrastructure articles under the “Market Segments” tab.

On Wednesday, September 13, Benmokrane will host an education session at CAMX on the technical details of his research and how the Nipigon River application demonstrates the potential for greater use of composites in bridges throughout North America. Next February, during ACMA’s annual Infrastructure Day, ACMA staff and representatives from its member companies will present applications like Nipigon River to members of Congress and their staff to advocate for composites in infrastructure.
It looks like smooth sailing for Netherlands-based Damen Shipyards’ new Waterbus 2407 after its May launch. Damen received its first order for four of its urban water shuttles in July from Aqualiner, an urban ferry service provider. The vessels will provide commuter transportation for the port city of Antwerp, Belgium, connecting the center of Antwerp with the southern reaches of the city via the River Scheldt. Eventually, the routes will expand to connect to Antwerp’s northern end, too.

The project results from Damen’s 2013 investment in a composites shipbuilding facility in Antalya, Turkey, where the composites knowledge center joins three other Damen facilities to form a 538,196-square-foot shipyard in a boat-building tax-free zone. “When we first took over the composites factory, there were four people in the building. Now we have 100 employees including composites specialists, engineering project management and support, working in air-conditioned lamination, production and material storage areas,” says Marko Paš, Damen’s business development manager for composites.

Damen has built more than 80 aluminum and steel passenger ferries, but this is its first water bus made from composite sandwich construction for the urban transportation market. Model sizes range from 52.6 to 78.9 feet long and accommodate 20 to 120 passengers. The vessel needed to meet several key production and operation objectives, including flexibility, streamlined and efficient manufacturing, passenger comfort, reduced fuel consumption and low cost per seat. That drove the decision to go with GFRP sandwich composites for the hulls, engine room, superstructure and deck.

The GFRP twin hulls reduce water displacement, lower resistance and contribute to speed, energy efficiency and safety. “We conducted testing to compare 5- to 6-millimeter aluminum hull plates with composite sandwich panels, and the composite panels outperformed the aluminum,” says Paš. “When the metal vessel hit floating objects such as debris, the aluminum skin was cut and the hull would take in water. With composite sandwich construction, even when the outer skin was penetrated, the closed-cell core absorbed quite a bit of energy, the inner skin stayed intact and water
absorption remained localized.” This is a benefit for use in urban transportation settings, where floating objects are likely to be encountered.

Depending on the loads required and the length of span, the sandwich construction’s PVC foam core ranges from 20 to 40 millimeters thick with an average outer skin thickness of 3 millimeters and inner skin thickness of 2 millimeters. “The growth of the wind energy industry has made the supply of PVC core challenging, so we maintain relationships with both Diab International and Gurit to ensure quick delivery of the core,” Paš says.

The history of the garment making and fiber industry in Antalya means Damen can source directional glass fiber from local suppliers. The company typically gets glass fiber from Turkish company Metyx, a manufacturer of unidirectional, multiaxial and hybrid reinforcement fabrics. Metyx recently announced an increase in its knitting production lines in Turkey to supply an additional 12,000 metric tons of glass and fiber multiaxial fabric knitting capacity to the industry.

Molds for the Waterbus 2407’s modular segments are made by Damen in Antalya using a 3-D milling machine. Manufacturing begins with placement of multiaxial glass fibers into the mold for the outer skin without using a gel coat. “It does mean additional lamination of the outer skin, but we save some 2 kilos per square meter of weight, which is substantial,” notes Paš.

Following placement of core and multiaxial fibers for the inner skin but before impregnation, the construction is placed in a vacuum bag for compaction of the dry fibers and core at an air pressure of 9 tons per square meter (1,843 pounds per square foot), limiting or eliminating gaps between the fibers and core. One-shot vacuum-assisted resin infusion impregnates the core and fibers with epoxy resin.

“Ninety-five percent of the composite components for the Waterbus are handled with one-shot infusion. Vacuum infusion reduces the amount of resin needed, leading to a high-fiber, lower-weight component that helps to prevent water penetration,” says Paš. “We use a computer controlled mixing machine to consistently define the ratio between resin and hardener. With the quantity of resin we process every year, the automation has paid off in less than two years.” The result, he says, is efficient, standardized serial production with a 6-month delivery schedule for the Waterbus – 30 percent shorter than for a comparable metal-welded vessel.

Paš says the use of composites also contributes to the Waterbus 2407’s versatility. “If we want to build efficiently, composites allow for more changes than the aluminum or steel alternative,” Paš says. The modular design of the hulls and deck can be lengthened based on the passenger count specified. The catamaran design provides a large platform to maximize the number of seats, giving operators higher revenue per trip. The composite platform also can be fitted with different finishing styles and levels depending on end use, ranging from benches for basic urban public transportation to luxury finished interiors for sightseeing, dinner cruising, business conferences or lounging.
Fuel costs are a top concern for operators, even with currently reduced fuel prices. The lighter weight GFRP Waterbus 2407 is fitted with a smaller, more cost-efficient engine to achieve a desired speed of 21 knots, lowering fuel consumption. This is an important development for customers in northern Europe, where some cities are aiming for zero emissions in the next five years.

Antwerp’s four urban water shuttles should be delivered by next August, moving the city one step closer to meeting its goals as an innovator in multi-mode transportation.
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When the U.S. Navy needs to transport a large number of sailors at the same time, they often use a hovercraft. However, that presents a challenge. “You can’t go on the hovercraft deck while it’s flying across the water, so you have to put a portable building on the deck to accommodate up to 180 people,” says Rob Banerjee, president of NexGen Composites LLC in Franklin, Ohio. “That’s where we come in.”

NexGen supplies the U.S. Navy with 21 x 42-foot personal transport modular (PTM) shelters made from composites. The shelters are constructed from individual panels measuring approximately 7 x 7 feet that connect mechanically. Once assembled on the hovercraft deck, the PTM shelter is anchored to the deck with chains. “Everything for the shelter fits in one 20-foot ISO container. It’s basically a building in a box,” says Banerjee. “You can put up the building with four people in about six hours with simple hand tools and without crane or forklift.”

In 2015, NexGen delivered a prototype shelter system, including panels, frames, doors, seats, lights, ventilation fans, electrical control panels and tools. It was deployed immediately and has served several missions, says Banerjee. NexGen received a production contract from the U.S. Navy last year for up to 10 shelters. The company delivered the first production shelter in March 2017 and is scheduled to deliver another one in October.

The panels, which are approximately 2 inches thick, feature balsa core and fiberglass phenolic facings and aluminum edges. They are produced using NexGen Composites’ proprietary vacuum assisted resin transfer molding (VARTM) process, then cured at temperatures ranging from 150 F to 220 F for several hours. While constructing square panels may sound simple, they needed to meet several requirements. “The building is designed to take a very high load while traveling at up to 60 knots in high sea conditions, including waves coming over the bow and hitting the shelter,” says Banerjee. “Beyond the structural issues, the biggest challenge was ensuring the panels passed the fire test.”

The U.S. Navy requires a very high fire rating for its PTM shelters, so the shelter had to pass the ISO 9705 full-scale room corner fire test. Prior to that testing, NexGen did a lot of coupon level testing on 3 x 3-inch and 4 x 4-inch samples. “You can learn a lot from those tests about fire behavior, but there is no substitute for starting a full-blown fire in an 8 x 8 x 12-foot room and watching it burn,” says Banerjee.

Based on the coupon testing, NexGen
tweaked the phenolic resin chemistry and curing profiles. Moving from coupon testing to the room corner test was “a big leap of faith,” says Banerjee. “There’s a real need in the composites industry to come up with an intermediate test method between small coupon level testing and the full-scale room fire test.”

In 2011, NexGen’s panels passed the ISO 9075 fire test at the Southwest Research Institute in San Antonio. “To the best of our knowledge, this is the only composite modular building that has passed the full-scale room corner fire test,” says Banerjee.

In addition to the military, the fire-resistant composite panels are well suited for other industries where users need a portable building in a fire-critical application, such as oil and gas. “The intention is to move into industrial and commercial applications to compete with standard metal panels,” says Banerjee. “Obviously, pricing is a challenge there, but we believe we can offer a better value proposition.”

NexGen’s standard panels are 8 x 20 feet and can be cut into smaller sizes, like they are for PTM shelters. The panels are typically four inches thick, but can range from two to eight inches. Aside from panels, NexGen also manufactures fire-resistant composite plates, channels and other shapes.

“I think we will move into other niches,” says Banerjee. “We continue to increase our capacity in terms of making larger panels, reducing the costs, improving product performance and getting the word out. At the same time, we look for niche market applications where we can provide tangible value.”

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For more stories like this, visit CompositesManufacturingMagazine.com and check out the Military articles under the “Market Segments” tab.
In many areas, the aerospace design and manufacturing industry — with its tight tolerances and sizable demands for new production equipment and processes — sets process and technology standards that other industries strive to reach. It has led the development of virtual design tools now being used to simulate automobile performance. It sets the pace for machinery development, such as setting new limits in autoclave size that have since been put to use in creating previously unheard of sizes for all-glass façades.

And yet in other areas aerospace has moved slowly. Case in point: aluminum and other metals have been a core part of most commercial aircraft since the beginning.

You might say that the Wright brothers understood the challenges aerospace designers face today — balancing light, efficient frames with high material costs. The high costs of aluminum meant that the Wright Flyer was a balance of wood types, covered with canvas, with sparing use of aluminum. But since the German aircraft designer Hugo Junkers launched the first full metal aircraft in 1915, aluminum has dominated as the primary material in many aerospace applications.

Since the 1980s, composites have had a role to play in aircraft, in applications ranging from the fuselage to the tailplane.
Airbus’ A350 XWB CFRP wing takes a new approach to aerodynamics through its ability to adapt while airborne. Pilots can move the flaps while cruising to boost efficiency during various phases of flight.

But now carbon fiber blends are poised to play a bigger role than ever. The wings of Airbus’ innovative new A350 series, made up of more than 50 percent CFRP, is testament to the growth expected in use of this material.

The reasoning is clear. As Carl Holt, aerospace and composites marketing manager for Huntsman Advanced Materials says on the company website, “Every pound on a plane – from passengers and luggage to airplane parts – equates to about $10,000 in fuel costs every year. If you can reduce the weight of the airplane, you will reduce your fuel needs and lower operating costs.”

But the addition of carbon fiber materials has largely followed processes put in place decades ago for manufacturing aluminum-based aircraft. “The design principles and methodologies adapted for composite material look and feel very much like the metallic equivalents,” says David Hills, vice president research and technology, Airbus Americas in Herndon, Va.

Today, that is set to change as manufacturers like Airbus and Boeing have launched research centers dedicated to exploring the potential of using composite materials in aerospace design through a complete rethinking of aircraft manufacturing.

Setting Up to Innovate

Airbus is set to open a Wing of the Future program in Filton, U.K., in 2018 that has been tasked with the tall order of looking at this critical component completely anew. As Hills puts it, the program is about recognizing that composite components offer completely fresh possibilities – and challenges – that need to be addressed in processes that don’t simply mimic metallic wing design and manufacturing.

“A lot of the basic principles [we use] are from the 1950s onward, so Wing of the Future is trying to take all of the learning we’ve gathered so far around this material and to understand, if you put all that on the table on a clean sheet of paper, what does this wing look like?” Hills says.

New designs will be geared toward further improving fuel efficiency, an area where lightweight composite materials naturally excel, while addressing high material costs and comparatively slower production times.

Not to be outdone, Boeing opened its Composite Wing Center in Everett, Wash., at the end of 2016. The facility now houses construction of the 777X wing, set to be the longest wing Boeing has ever built, as well as research for advancements in carbon fiber technology. The innovative new carbon fiber-based wings will feature a folding wing-tip that will increase the wingspan by 23 feet while in flight. This increase provides a higher lift-to-drag ratio that could improve fuel efficiency while, when folded away, still meets airport regulations for maximum wing length. Flight testing and certification programs for the 777X are set to be complete by 2020. The three-year turnaround may be an ambitious goal.

Airbus began producing its XWB wings for the A350-1000 in 2015, but it’s been less than a year since the unique design took to the skies in tests. The nearly 105-foot-long wing for the latest aircraft in the A350 XWB family is the largest carbon fiber composite material-based component in civil aviation today. Approximately 70 percent of the frame is made from a combination of carbon composites (53 percent), titanium and aluminum alloys. The company is hoping to deliver its groundbreaking wide-body plane by the end of the year, but as of June 2017, the company listed a complete backlog of the 211 total orders received for the A350-1000.

There are a number of reasons for delays, and many lessons have been learned during this process, Hills notes. But certainly improvements within the composite supply chain on
manufacturing technology will be needed to achieve the low costs and rapid production that will be in demand on any future iteration of a largely composite plane.

“As everybody’s understanding of this material continues to develop, we’re trying to find the best way of using this material to achieve goals,” Hills says. “That’s not just in terms of how strong these components are, but also how [composites] fit into the total process of manufacturing, in terms of cost and maintaining these things out in the field.” As Hills points out, repairing a damaged composite panel is not the same as repairing a metallic panel. Research is underway in this area to speed the repair process, often done by hand, and explore ways to replace heavy metal or pre-cured composite patches with a bonded patch that keeps weight to a minimum, among other activities.

“There’s an awful lot of learning, and that shapes your view of how to use this material intelligently,” Hills adds. “And a lot of lessons are learned when you try to produce these big structures very quickly.”

### Addressing Production Time Demands

The complete time to manufacture components is one of the biggest drivers of Airbus’ current manufacturing research, Hills says. “Associated with that is the cost of materials and the total cost of the production of those components,” he adds.

One area where researchers are seeking to speed processes is by developing new strategies for improving manufacturing repeatability. “All parts of the composite process are very heavily controlled and confined, but even so there’s probably greater variability than we would prefer,” Hills says.

As Hills explains: “Basically, you do all the testing on a given material in a given environment, and you look at the spread of the results you get. The tighter the spread, the closer you’re able to get to the full potential of the material. If in the [fabrication] process you get a broader spread than you’d like, then … you can’t guarantee you’ll always hit exactly the optimal properties of that material that, as a system combination, it should be able to deliver.”

Aircraft face extremely tight tolerances, far more so than automotive manufacturing for example, and variations can impact the overall aircraft performance. In addition, these levels of variation can lead to higher than typical levels of post-build diagnostics and inspections, which leads to increased manufacturing costs.

It’s a challenge the research team seeks to address across the board, in all of the varying manufacturing processes. “If you look at all aircraft components, we use probably every possible composite process that you can think of,” Hills says. “We’re either using a matte or winding the carbon fiber around a particular shape. In order to do that, of course, you need to know things like exactly how those mattes or fibers actually lay in terms of the uniformity of how they’re distributed. There’s a lot of different elements of that process that go to give you perfectly aligned and [evenly] distributed set of fibers. You want that degree of repeatability.”

Rapidly achieving a degree of repeatability that meets the extreme tolerances of aircraft manufacturing is the challenge that companies like Airbus are posing to equipment manufacturers.

Hills points out, “If you use an autoclave, how uniform is the heat distribution with respect to these parts? You can cook and cook and cook, which will distribute [well], but at the end of the day it all takes time and time is money.” Reducing time, and costs, is key to broader use of composite components.

Hills acknowledges, “That puts an awful lot of constraint on the systems manufacturers, the people who put together the fibers and resin systems or the machines that allow you to wind or lay those systems into shapes.” But while Hills is close-lipped about the specific manufacturing areas where Airbus is pushing equipment manufacturers, the implication is that research and development is currently underway in the aerospace industry that has the potential to broaden use of composites across a number of industries where production time has previously posed problems.

### Airbus Innovation Areas

Given the multitude of challenges that need to be addressed by aerospace designers and manufacturers, companies like Airbus and Boeing have formed partnerships with a range of component fabricators, as well as universities and research...
groups around the world.

Among other partnerships, Airbus is working closely with the University of Dayton Research Institute (UDRI) in Ohio to explore ways to enhance the basic carbon fiber-resin system through the addition of various forms of nanoparticles. One area that UDRI researchers are exploring is the potential for adding nanomaterials to enhance composite components to address issues such as “the lightning strike problem,” Hills says.

Not surprisingly, civil aircraft get hit by lightning on a fairly regular basis. With traditional metallic underwing components, aircraft have benefited from a natural conductor that safeguards the aircraft exterior. Because carbon fiber doesn’t conduct electricity, a bolt of lightning could potentially rupture whatever CFRP component it hits.

Today, the risk is addressed by adding a copper mesh into the composite structure that aids the electricity in flowing through the aircraft without causing major damage. But that mesh adds weight. A nanoparticle additive to the CFRP wing presents an opportunity to eliminate the risk of damage while reducing overall aircraft weight and, consequently, improving fuel efficiency.

Nanoparticles also present an opportunity for adding shielding from electromagnetic interference. Interference can come from events ranging from lightning to solar flares to communication devices, and can damage electronic systems. That interference has been traditionally mitigated by encapsulating the aircraft in conductive metal.

“You don’t want to have to wrap every piece of avionics in a metal box to shield you from potential electromagnetic interference,” Hills points out. Yet, essentially, that has been the strategy, even if that “metal box” is found integrated as a mesh within the wing or other components.

Tomorrow’s Wing

On a broader scale, aerospace designers are looking at how a future wing might perform differently as designers stop viewing CFRP materials under the lens of metallic performance properties.

Already the largely CFRP A350 XWB wing adds to the aerodynamic performance through new improvements such as the ability to adapt while airborne. Pilots are able to move the flaps not only for take-off and landing, but also while cruising in order to reduce wing drag and boost aerodynamic efficiency during various phases of flight. The wing design has also been streamlined with features such as adaptive dropped-hinge flaps, which increase the aircraft’s efficiency at low speeds. In addition, Airbus notes that the wings can produce more lift and automatically handle loads across their surface, which helps to further reduce the aircraft’s drag and fuel burn.

It’s a rethinking that has broad implications for the future of air travel. But as companies like Airbus and Boeing pour more money into solutions to production efficiency solutions, it’s a rethinking that could have major benefits for all industries exploring composites as a viable material.

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Insight from OEMs

Two automakers share their vision for composites growth in the industry.

By Susan Keen Flynn

Global sales of passenger cars are forecast to reach 77.7 million vehicles this year, according to the statistics internet portal Statista. The company adds that 6.9 million passenger cars were sold to U.S. customers in 2016, and approximately four million cars were manufactured here in the same year. That offers big market potential for the composites industry. However, composites only represent about 1 percent of all materials used in light vehicle production by mass, according to the firm Industrial Market Insight.

To better penetrate the market, it’s critical to understand what OEMs want. Composites Manufacturing magazine talked to two of the top 10 automakers – Volkswagen and Honda – about the role of composites in their products, the future of FRP materials and how composites suppliers can team with them.

The Volkswagen Group

Headquartered in Wolfsburg, Germany, the Volkswagen Group has 12 brands, including Audi, Lamborghini, Porsche and Bentley. Its 2016 sales revenue was €217.3 billion (~$255.4 billion USD). Volkswagen has 120 production sites worldwide, including a facility in Chattanooga, Tenn., that manufactures
the Passat and Atlas. Two spokespeople from Volkswagen of America Inc. shared insight on composites: Dr. Hendrik Mainka, lead engineer and project manager, and Michael Rademacher, materials research engineer.

Q: How has composite use on Volkswagen automobiles grown in the past several years?

The use of composites has seen a constant growth within our vehicles. Advanced composites, like carbon fiber, have seen a sharp increase in high performance and/or luxury vehicles. On the other hand, our large volume vehicles have been using glass fiber and natural fibers (flax reinforced polypropylene) composites since 2015. In the coming years this will continue to grow, with the introduction of composite into exterior body panels and structural members.

Q: Which of your car models features the most composites?

Certainly, the highest percentage of FRPs will be found in our vehicles that use composite or hybrid chassis or structural members. FRPs can also be found in every new Atlas, Golf, Jetta, Passat and Tiguan sold, from interior panels to components within the engine bay. Currently, you will see approximately 5 to 7 percent of the vehicle's mass is composites. Over the next years, it will grow substantially.

Q: Can you provide examples of where composites have replaced other materials, such as high-strength steel or aluminum?

The Modular Sportscar System (MSS) platform by some of our performance brands is a great example. Introduced in 2014, it replaced the complete aluminum construction of the previous platform with a hybrid aluminum/CFRP design. The new chassis now utilizes resin transfer molded (RTM) B-pillars, chassis tunnel and rear firewall. The resultant was a chassis that is 15 percent lighter than the previous platform, now weighing exactly 200 kilograms. What is more interesting is that the torsional rigidity has increased by 40 percent, meaning that by only replacing 13 percent of the chassis with CFRP, we have gained tremendous performance without breaking the bank for our customers.
Q: What challenges remain that prevent further use of composites in the automotive industry?

Just recently the University of California, Santa Barbara published research on plastic waste. The fact that over 8 billion [metric] tons of plastics have been created [since large-scale production began in the 1950s] – and more than 5.5 billion tons are now in the waste stream – is staggering. Out of all that plastic, only 9 percent has been recycled, which as an industry we need to address. This is why we are looking heavily into thermoplastic solutions, natural fibers and the use of recycled fibers.

In the case of repairs or replacements, a study our team conducted with Hult International School of Business has shown that it may be more cost effective to just replace damaged components. This allows us to recycle the material and eliminate the potential for incorrect repairs. We want all of our cars to provide excellent protection to the occupants, so it is crucial we get the chance to assess the damage in case of an accident.

Q: What research is Volkswagen doing to advance composites technology?

Composites research is and has been a part of the Volkswagen Group Worldwide for many years. The Product Innovations team here in the U.S. is very proud of our work with the Institute for Advanced Composites Manufacturing Innovation (IACMI). Our biggest project is the formulation of an ultra-low density, low volatile organic compound (VOC) Sheet Molding Compound (SMC) and a post-processing free Class A SMC for exterior body panels. With this research, we will have the production technologies and material for our first large-volume application of composites not just for the vehicles produced here in the U.S., but all of our vehicles worldwide.

Q: What's the biggest threat to composites usage in the automotive sector?

The biggest threat for OEMs is cost. This is why we have seen its use limited to performance and/or luxury vehicles. It really breaks down to two topics – material costs and manufacturing costs. This is what we are attempting to change with our IACMI research, though. A solution that not only saves weight but is cost effective for large volumes. Altogether, with increased emission standards and the push for more efficient vehicles, OEMs have a driving force toward the future of lightweight and e-mobility.
As a group, we plan to launch more than 30 new battery electric vehicles (BEVs) by 2025.

Q: What can composites suppliers and manufacturers do to help Volkswagen better utilize composites?

Suppliers and manufacturers have a difficult task, there is no denying that. Fortunately, we found some great partners whom we have joined forces with in our IACMI projects. Through these kinds of projects and partnerships, we can quickly evaluate technologies from suppliers and manufacturers, which is typically a longer process under normal circumstances. These partnerships also help us to reach a production capable technology quicker, which is necessary for today’s faster moving industry.
Q: Where do you envision composites usage in the automobile industry headed in the future?

The future is promising for composites – no matter what industry – and at Volkswagen, we are very excited. We are developing new manufacturing processes and broadening our materials catalog to include recycled and recyclable options. These solutions will enable composites to be implemented into an intelligent multi-material design. In the future, vehicles will still have to use steel and aluminum, but composites will be that perfect supplement that helps achieve a more sustainable future.

Honda Motor Co. Ltd.

Honda Motor Company is headquartered in Tokyo and has nearly 70 manufacturing facilities worldwide, including seven in the United States. The company's sales for fiscal year 2017, which ended March 31, were $125.6 billion. The automotive product line accounts for 72 percent of total sales, with the remainder in motorcycles, power products (such as lawnmowers, snow blowers and outboard engines) and other miscellaneous products. Jim Ryan, manager of the Materials Research Department within the Materials Research Division at Honda R&D Americas Inc., discussed the composites industry.

Q: How has composite use on Honda automobiles grown in the past several years?

On our recent launches, you’ve seen some larger and more visible parts. The Acura NSX has a number of Class A body panels made from composites, including a factory option for a CFRP roof. The second-generation Honda Ridgeline launched last year, and the truck bed construction has moved from primarily a painted structural SMC system to a multi-piece, multi-composite material construction. As a third example, the 2016 Honda Civic incorporates a fiber reinforced thermoplastic front-end module.

Q: Which of your car models features the most composites?

In terms of overall new technology applications – for a number of technologies, not just composites – the Acura NSX sets the benchmark for us. Specific to composite applications, there are several Class A SMC body panels, including the fenders and quarter panels. It has a carbon fiber roof option that’s manufactured using an RTM process. Within the engine room many of the beauty covers utilize FRP composites as well.

Q: What is the most innovative use Honda has made of composites to date?

In my opinion, it’s the Ridgeline. The first-generation model broke new ground in terms of having in-bed storage, and that was something that was achieved using the design flexibility that composite materials – in this case SMC – afford. The second-generation took that material system and built upon it, which tends to be Honda’s philosophy – using the right material in the right place and continuing to incrementally improve in terms of performance, quality and overall customer value. With the Ridgeline, we moved from basically a single, painted SMC
formulation material system to a multi-material composite system. The side walls and headboard are made of a molded-in-color black polypropylene-reinforced fiberglass system. The load-bearing surfaces remain SMC, but we’ve also added scratch toughness by eliminating the paint system while retaining the strength and durability of the original system.

Q: Can you provide examples of where composites have replaced other materials, such as high-strength steel or aluminum?

I can give you two examples. Quite frankly, it’s just not possible to make the in-bed trunk of the Ridgeline via metal stamping, considering the draw of the trunk and how the overall system is put together. Additionally, the robustness that composites offer made it a perfect fit for us to maximize the value we could give the customer. The second example is some of the body panels on the NSX. There was both a style and weight advantage by moving to composites. For that vehicle, considering the customer usage and our overall manufacturing environment, composites were a great fit.

Q: What challenges remain that prevent further use of composites in the automotive industry?

Of course, with any material you will have plusses and minuses. There’s not one material that’s always the right fit for every application across the board. One thing with composites compared to steel, and in some cases aluminum, is that these materials are younger in terms of total use for the automotive industry. So I believe one of the big challenges that exists industry wide is just educating people from design to test to manufacturing, etc. Another aspect that’s extremely important for Honda is guaranteeing overall quality, safety and robustness for our customers. To do that, we need to be able to accurately predict performance up front. When we’re going through our wide battery of confirmation tests to ensure we meet all those properties, it’s really important to have reliable predictive capabilities for all the materials we use.

Q: What can composites suppliers and manufacturers do to help Honda better utilize composites?

We work very closely not just with Tier 1 suppliers, but down to Tier 2 and Tier 3 suppliers as well. Approaching [our work] as a team is very important to us. Having a supply base that’s willing to partner with us and generate solutions all through the value chain is really important. For us, the No. 1 thing we’re trying to keep in mind is the value we give to the customer. So we look for our partner suppliers to also keep focused on overall value to the customer when we’re talking back and forth about design changes, material changes and things like that.

Q: Do you have an example of a specific composites-related partnership that has worked well?

Both generations of the Ridgeline truck bed have been award-winning, and the bed contributed to the truck being named the 2017 North American Truck of the Year. The success of that composite application didn’t just happen because Honda had an idea and went to a supplier with a blueprint. For example, we worked with the molder Continental Structural Plastics, as
If you want to become more involved in the automotive industry, join your peers on ACMA’s Automotive Composites Alliance (ACA). This specialty industry committee is focused on growing composites in the automotive market and educating engineers and designers at OEMs.

Since 1988, the ACA has had many accomplishments, including publication of the SMC Design Manual and the SMC Paint Manual for Exterior Body Panels to assist automotive designers and engineers. It organizes Technology Days with OEMs and academic institutions and works with IACMI—The Composites Institute to coordinate industry input into critical research avenues pertaining to automotive applications.

For more information, contact Sarah Boyer, manager of the Composites Growth Initiative Committees, at sboyer@acmanet.org or 703-682-1653.

Susan Keen Flynn is managing editor of Composites Manufacturing magazine. Email comments to sflynn@keenconcepts.net.

Q: Where do you envision composites usage in the automobile industry headed in the future?

There are a lot of entities out there trying to get their hands around where the overall industry is going. What does the customer envision, and how are we even going to use cars in 10 to 15 years? It’s a bit of a generic answer, but the key is finding that value proposition to the customer – and not just always the most cost-efficient product. How do we maximize value? [We need to] find where composites can enable quality, safety and robustness. You get some cues from where Honda is headed with composites based on the products we’ve already launched. Hopefully, we continue to grow those applications by finding the right fit and expanding the applications from there.

The Trusted Source for Composites Manufacturers

North American Composites (NAC) has stocking locations across the United States and Canada providing local, personalized service to composites manufacturers. We deliver high-quality composite materials, accessories and equipment from the top suppliers. For nearly 40 years, our knowledgeable sales representatives have served manufacturers in aerospace, ballistic, construction, corrosion, energy, marine, transportation and other industrial and consumer applications.

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The composites industry will benefit as manufacturing robots become more intelligent, flexible and versatile.

By Mary Lou Jay

Aerospace and automotive companies appreciate the strength and light weight of composite parts, but currently use them only in relatively limited ways. One reason is because composite part producers can’t currently deliver enough product at the speed and quantities required for large-scale production. But the increasing use of automation and robotics in composites manufacturing could remove those obstacles.

Composites manufacturers began experimenting with robotics for both thermoset and thermoplastic production about 30 years ago, with companies concentrating their efforts on automated tape laying (ATL) and automated fiber placement (AFP). Manufacturers gradually overcame the initial hurdles — the need to develop a targeted heat source for structure consolidation, software and materials suitable for testing — and today many use AFP and ATL to make parts. But limitations remain. The throughput rate is relatively slow, and AFP is restricted by the type and shape of structures it can produce.

The recent introduction of lasers as a heat source is helping to speed production, especially with thermoplastics, according to Ralph Marcario, vice president of sales and marketing for Automated Dynamics, a supplier of automation equipment. With laser heating systems, manufacturers can make products about four or five times faster without sacrificing any quality of consolidation, he says.

“In the automotive model, where generally there’s going to be some kind of secondary operation such as thermoforming or stamping and they don’t need to worry about consolidating on the fly, a laser heat source will enable extremely fast lay-up of preforms,” says Marcario. “That has garnered some particular interest lately from the automotive community, where high-volume production has historically ruled out AFP.”

But automotive and aerospace manufacturers are now most interested in automated inspection. “Although AFP has found more widespread use in production environments, one of the factors that limits its use is the need to still manually inspect the quality of the lay-up between every ply,” says Marcario. He adds that AFP machines actively perform lay-up only 25 to 35 percent of the time a tool is in the machine. The balance of cycle time is spent inspecting the lay-up, reworking tapes as needed, resupplying material and performing both scheduled and unscheduled maintenance. “Usually manual ply inspection takes the most time, often exceeding the machine lay-up time,” says Marcario.

Automated Dynamics is currently working with Flightware, a technology development company, to produce an automated inspection system. And according to Marcario, there’s an interesting difference between what they are doing and what others are doing. “Unlike other systems that would perform an inspection after a ply has been laid, our system would employ a sensor that’s mounted directly to the AFP head itself and would perform the inspection as the tape is being placed in real time,” says Marcario. “So ostensibly, in an ideal world, you would drive the down time for inspection down to zero.”
The system employs a sensor that dumps a data cloud into a computer program. “Most of the magic is with the computer taking these reams and reams of data and, in real time, being able to make sense of it,” he adds.

The increasing use of 3-D composite printing also opens up possibilities for robotics and AFP. Composites manufacturers could build an AFP structure on top of 3-D printed tooling, 3-D print features onto an AFP structure or overwind 3-D cores with selective AFP reinforcement. “That’s one of the big benefits of AFP technology. You can selectively reinforce in whatever angle or path or section that you want robotically,” Marcario says. The combination of manufacturing methods makes it possible to produce structures that couldn’t be made with just one technique.

**Automation Advantages**

At Concordia University in Montreal, researchers have been using AFP and robotics for many different types of products. “You can do things that are unique and that cannot be done using any other technique,” says Suong Van Hoa, professor in the Department of Mechanical and Industrial Engineering and editor of the book “Automated Composites Manufacturing”.

Hoa says automated production offers many other advantages. For example, using robots to produce large parts like an airplane fuselage will eliminate the variability and waste that result when many different people do lay-up. Operators can also steer the fiber, varying the orientation from place to place to optimize the design and performance of a structure.

Concordia University’s researchers are also using automation to develop new types of fabric laminates, bypassing the weaving machine by strategically laying down different tows in different position.

The university has recently been exploring robotics for the 4-D printing of composites. In 3-D printing, a robot can deposit composite materials to build, layer on layer, a product of very complicated geometry. With 4-D printing, a robot can deposit the layers down flat and the part changes shape as it cures. “You can make a curved shape without having to make a curved mold,” Hoa says.

**Sensory Feedback**

Robots have traditionally been used for teach/repeat functions; once they learn what spot to go to, they return to it every time. But composites manufacturing is not exact and product tolerances can be large, so companies may have to change robot positions to work on each part, according to Christopher Blanchette, national account manager, aerospace and assembly for FANUC America, a company that specializes in robotics automation.

Today’s intelligent robots can provide the flexibility needed to adapt to composite parts’ changing geometries based on feedback from sensors. Using the automated systems that monitor and control the robot’s input, operators can achieve more precise results than they can through mechanical adjustments or general calibrations.

FANUC is working on dynamic path modification and sensory tools to improve robots’ responsiveness. Integrated vision tools will allow a robot to locate a part using cameras; integrated touch sensing tools will enable the robot to “feel” the part so that it applies constant pressure in a single direction regardless of the part’s geometry.

FANUC has built intelligent robots to perform several tasks for stringer manufacturing in the aerospace industry. The robots affix the stringers to be trimmed and cut and routered with the proper holes using fixtures – devices that hold the composite parts in place. Since the composite parts are often flexible, the fixturing needs to be flexible, too. “You have to consider the stresses that you put on the part when you're manufacturing. You don't want to cause damage to the part when you're fixturing it,” says Blanchette. Robots can also build up or sand down the parts based on feedback from tactile sensors, prep their surfaces for painting and precisely control paint application.

“You can reduce the amount of paint on the surface, significantly improve the appearance and still have the same protection and effect, thus further reducing the weight of the end product,” says Blanchette.

**Improved Accuracy**

Using robots for many different tasks in metal parts production is a familiar practice for the automotive industry, observes Chris Greaves, operational manager at Factory 2050 at the University of Sheffield’s Advanced Manufacturing Research Centre (AMRC) in England. However, many of the jobs that
robots have traditionally performed – pick and place, spot welding, gluing – require repeatability but not accuracy. For a project with an automotive manufacturer, however, Factory 2050 researchers wanted to use a robot as a stand-in for a large CNC machine for edge-of-part trimming. That required greater accuracy. The AMRC team recalibrated the robot’s programs, relying on its repeatability. If the robot always missed a particular point by a millimeter in a certain direction, the researchers moved it the same amount in the opposite direction.

“We did have some very good results with that,” Greaves says. The project demonstrated that robots can be used for manufacturing if operators take their dynamic operation into account.

The design of most robots makes it difficult for them to achieve accuracy. A robot can’t really cut a straight line, for example. “The reason is twofold. One is that a serial arm robot is made of six rotary joints. If you are trying to draw a straight line with six things spinning round, you essentially will never get a straight line. You will get your best attempt at a straight line,” Greaves says. The other problem is that a standard robot consists of two big beams. “If you put any weight or force back through from your machining process through the arm, [it] tends to deflect out of the way. The robots are not very stiff,” he continues.

To overcome the stiffness problem, AMRC worked with the Swedish system manufacturer Exechon on the development of a lightweight parallel kinematic robot, which resembles an upside-down tripod. “By using the Exechon-style robot you get a very stiff structure, meaning that if you want to machine with it and put force through that structure it can resist the force and keep its position accuracy,” says Greaves. “That’s a massive advantage over a serial arm robot.”

AMRC took this research a step further by building a parallel kinematic robot out of carbon fiber. That’s resulted in a 75 percent weight savings, allowing operators to change direction more quickly and achieve faster machining. They can dismantle the machine, move it to a new location and put it back together in less than an hour. That’s a real advantage over traditional machining when it comes to big tasks like fitting airplane wings.
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Composites Manufacturing

Materials Optimization

At its new research application center in Derbyshire, England, Solvay is taking a holistic approach to the challenges of automating composites manufacturing. “We work very closely with our customers to bring together the perspectives of the material, the design and the manufacturing process, with the view of developing and industrializing a solution that is really aimed around manufacturability as well as performance,” says Rob Blackburn, director of application engineering within Solvay’s composites materials business unit. Optimizing materials by making them more robust and compatible with automation will help ensure consistency and repeatability in the material/machine interface.

In its ACCOMPLICE project, Solvay demonstrated that it was possible for a robot to handle the cutting, picking, placing, curing and trimming of a composite component. “That was all done within four minutes; doing it manually, that component from start to finish – including its curing cycle – would probably take in excess of a day,” says Richard Hollis, applications technology engineer. Since that project, Solvay has further optimized the robot manufacture process, reducing takt time – the average time between the start of production of one unit to the start of the next unit – to around 150 seconds.

“With that project, we have been particularly successful in validating the art of the possible with automation and high-rate processing,” says Blackburn. Solvay works with its customers to transfer these technologies into actual component production facilities.

But Blackburn cautions that automation is only part of the solution. “There are cure times that need to be optimized as well, which is an area where we’re progressing quite significantly from our chemistry development standpoint,” he says.

Will Robots Rule the Composites World?

Robots and automated manufacturing will play a larger role in composites manufacturing going forward and may take over the dirty and difficult jobs that people don’t like to do – sanding airplane panels, for example. But they will not eliminate the need for human workers. “I think there’s definitely a place for manual processes in the composites world. I don’t think it will ever go away,” says Blanchette. Automation wouldn’t be appropriate for low-run or complex geometric parts, for instance.

Blanchette believes that robotic manufacturing will actually create jobs because the ability to mass-produce composite parts will open new markets for the industry, such as the production of Class A body panels for vehicles.

Hollis sees robots as fundamental in obtaining the manufacturing volumes for composite parts that the auto industry requires. But the composites industry has to find a way to make its automated processes compatible with OEMs’ current infrastructure and equipment. That will likely require more changes in composites materials.

“We are developing and have developed technologies that enable composites to be used within that environment by adding increased levels of robustness and localized environmental control on the material. That really makes it a realistic possibility,” says Blackburn. If OEMs only have to make a relatively minor capital investment in a robot to manufacture composite parts – and if the production speed and the price of the composite parts are competitive – the industry could see a real boost in its sales not only to the automotive industry, but to aerospace and other markets as well.

Mary Lou Jay is a freelance writer based in Timonium, Md. Email comments to mljay@comcast.net.

Learn More at the Global Composites Conference

From Jan. 31 - Feb. 1, 2018, ACMA and NetComposites will host the first-ever Global Composites Conference at Caesar’s Palace in Las Vegas. The conference will explore the industry from a worldwide perspective and examine the global supply chain, with a particular focus on carbon and glass fiber manufacturing and resin production. It will also look at emerging technology trends from around the world, such as automation, and highlight global market information. Sign up today at http://globalcompositesconference.com/register.
The fourth annual CAMX will highlight innovation and show how composites are changing markets as we know them.

By Evan Milberg
Two years ago, during CAMX 2015 in Dallas, Dr. J. Gary Smyth, executive director of global research and development at General Motors, offered composites industry leaders some important advice: It is not enough to embrace the path less travelled. In order to change markets as we know them, we must take the path that doesn’t exist yet.

As Smyth explained, when GM first introduced fiberglass to the Corvette back in 1953, it caused a major disruption in the automotive market and changed the landscape of the industry’s supply chain. While “market disruption” may sound like a negative phrase, Smyth advocated for composites manufacturers to embrace the idea of disruption as a vehicle for innovation.

“Disruption isn’t bad if you’re a part of it,” said Smyth. “Ask yourself what you can do to be a part of the disruption.”

Since the show’s debut in 2014 in Orlando, CAMX has been a platform for the industry to showcase its innovative products and processes that have potential to disrupt markets. This year’s show, making its return to Orlando Sept. 11-14, 2017, will not only change the way you look at composites, but also how you experience a trade show.
This year’s exhibit hall will feature an all new area – Innovation Park – that will give attendees a unique experience beyond simply looking at products. At Innovation Park, industry professionals will be a part of the action through specialized meetups and campfire sessions.

**CAMX Live!**

This year’s lineup for CAMX Live! during the General Session features three innovators who have been on the front lines of engineering and design teams of companies using composites to reshape aerospace, construction and catamaran building.

“The CAMX Live! session is going to be particularly exciting this year,” says Steven Mead, chief commercial officer at TenCate Advanced Composites. “Disruptive innovation is not typically associated with the advanced materials industry. Today, however, we are witnessing a massive change in the pace of adoption and application of advanced materials, which is introducing the whole concept of disruptive innovation to the industry.”

Boom Technology, for example, is taking an entirely new approach to the commercialization of a supersonic aircraft, the XB-1, which in the past would have taken years. But with their unique approach, the company is condensing the process into a much more reasonable and affordable model by using carbon fiber composites from TenCate and 3-D printed components from Stratasys. When it flies next year, the XB-1 will be the world’s fastest civil aircraft, and it will demonstrate technologies that could make mainstream supersonic travel a reality. CAMX Live! attendees will have the chance to learn more about this application from Bryce Knight, the structural engineer leading the company’s aircraft structures division.

Down on the ground, an idea from another CAMX Live! speaker, James Antonic, could potentially change the way the world views construction. Instead of relying on skilled labor, why not build houses and other buildings the way Henry Ford built cars – through an assembly line? While the concept of creating modular housing through traditionally prefabricated parts isn’t particularly novel, doing it with composites is.

Antonic, president of Ft. Myers, Fla.-based Composite Building Structures, describes his work as “creating a new paradigm in building and construction.” For the past 15 years, he and his company have developed sustainable, pultruded GFRP composite panels to replace wood, steel and concrete and assemble these panels into custom buildings.

“What [Antonic] has done is take the standard of pultrusion and taken it to a whole new level,” says John Busel, vice president of the Composites Growth Initiative at ACMA. “His

“We are witnessing a massive change in the pace of adoption and application of advanced materials, which is introducing the whole concept of disruptive innovation to the industry.”

—Steven Mead, TenCate Advanced Composites
vision wasn’t just to impact the U.S., but globally in third world countries, where construction is a hard thing to do.” Many of these countries face the constant possibility of being ravaged by natural disasters. Antonic says his technology helps withstand hurricane and tornado force winds greater than 350 mph.

The last speaker of CAMX Live!, Kurt Jordan, will be traveling from New Zealand to explain how his country has stood at the epicenter of composite catamaran construction for the America’s Cup. Jordan has engineered composite yachts for the last eight America’s Cups, including two for Oracle Team USA, which won the cup in 2007 and 2013. Unlike traditional boats, these racing catamarans feature carbon fiber prepreg instead of traditional fiberglass construction.

Innovation Park
As always, the CAMX exhibit hall will be teeming with new products and processes at the forefront of the composites industry. In the awards pavilion, you will have a chance to see Local Motors’ self-driving, autonomous 3-D printed car; Vartega’s first-ever composite overwrapped pressure vessel made with recycled continuous carbon fiber; and a demonstrator of IACMI’s 9-meter wind turbine blade. There also will be some 3-D printed molds for boats. And like last year, you will not want to miss the live manufacturing demonstrations happening on the show floor at the “Lean Mean Molding Machine,” an area co-produced by Composites One, Magnum Venus Products and the Closed Mold Alliance.

However, what truly sets this year’s CAMX apart from other
industry conferences is the addition of Innovation Park, located in the center of the exhibit hall. Innovation Park was created to provide attendees with the option to do more than simply walk around a hall, look at products and equipment, and sit in a classroom.

The park is comprised of four specialized “zones” tailored to the learning, networking and inspirational needs of CAMX attendees. Inside the park’s Consultants Corner, attendees can get trustworthy, constructive answers to important questions from industry consultants and experts. No questions will be off limits here.

Another way for attendees to get valuable information will be through Innovation Park’s Presentation Theater, which will include presentations from exhibitors on their products and services, technical presentations from universities and companies, and more. In addition to new products, attendees will get to learn more about companies and startups new to CAMX in the park’s New Exhibitor Zone and the xC Start-Up Pavilion. These areas will present opportunities to find out what these new companies are doing in the industry and how their work can impact your business.

Another great way to network is through Innovation Park’s Connection Zone. Each day, the area will hold specialized meetups for young professionals, educators, chemists, sports enthusiasts and other geographic and demographic niches within the composites and advanced materials industry. Innovation Park will also host “campfire sessions” on trending topics, including workforce development, knowledge transfer, emerging technologies and global trends.

The Digital World

One emerging trend that has had a disruptive impact not only the composites industry, but the global economy, is the increasing use of social media in all aspects of business. While the composites and advanced materials industry may not have been an early adopter of social media, there is value in embracing it. As attendees will learn during a special panel session during the CAMX luncheon on the final day of the event, social media has value to engineers, researchers and general managers. Everyone in
the industry can play a role in using social media to communicate the benefits of FRP compared to traditional materials.

According to Marcy Offner, director of marketing communications at Composites One, the more the industry gets on board with social media, the easier it will be to establish a clear “brand” for composites and generate more business opportunities. By looking at the way social media relates to the industry, companies and individuals, the luncheon panel will raise questions such as how to increase awareness about the benefits of composites digitally, how individuals in our industry are using social media to learn and get ahead, how companies could talk about composites and how the industry can use these tools to better position itself against traditional materials.

“We’re hoping that manufacturers and engineers who are attending will see how social media has worked for some companies and think ‘if they can do it, I can do it,’” says Offner. “We want to show that it is not difficult.”

She hopes that the panel will dispel common myths that some people in the industry may have about social media – notably the sentiment that a tool widely used to communicate casually can’t have business value in a niche industry like composites.

“We want to show that social media isn’t just about the party you went to last night,” said Offner. “It can also be about the boat your company built.”

Evan Milberg is communications coordinator for ACMA. Email comments to emilberg@acmanet.org.
In such a tumultuous political era, it can often be difficult to cut through the noise and understand how the actions taken by lawmakers and regulators in Washington, D.C. and state capitals matter to your bottom line and shop floor. As your industry association, it is ACMA’s job to be your eyes, ears and voice on the litany of issues facing the industry. ACMA’s Government Affairs team and our member volunteers work diligently to navigate policy challenges and advance the common interests of every company in our industry.

ACMA’s advocacy programs protect the ability of composites manufacturers to employ the materials and processes they need to supply products for demanding end uses and promote public policies favoring the use of composite products in major markets. The association provides its members guidance and tools for cost-effective regulatory compliance. With the weight of a united industry behind us, ACMA also works aggressively to use legislation to create new opportunities for composites in key underdeveloped sectors.

With this backdrop in mind, let’s review the state of play of some key regulatory/compliance and market growth initiatives.

Communicating with Customers

OSHA’s Hazard Communication Standard requires manufacturers to inform customers if the normal anticipated use of products generates combustible dust. This is an important topic for any manufacturer of products that are polished, sanded, cut, ground or otherwise mechanically worked by downstream customers or end users. ACMA’s guidance helps composites manufacturers prepare safety data sheets that can be used to inform customers of combustible dust hazards and comply with OSHA’s regulation and policy.

ACMA’s research suggests the majority of composite products are exempt from the Prop 65 regulations requiring toxicity warnings for customers and end users in California, but the exemption is product-specific and can be formally established only by taking an enforcement action to court. To best manage compliance uncertainty and minimize the risk of expensive enforcement suits, composites manufacturers can use ACMA’s guidance and tools to prepare Prop 65 mitigation plans for their products sold into California. You can access these tools on the ACMA Education Hub – www.acmaeducationhub.org/regulatory-tools.

Environmental Impact

EPA and state agencies regulate releases to the atmosphere of styrene, methyl methacrylate (MMA) and grinding dust, among other substances found in composites manufacturing shops. Manufacturers need reliable estimates of the emissions of these substances from their operations before they can apply for permits or comply with reporting and emission control requirements. ACMA’s Unified Emission Factors is a widely accepted tool for estimating styrene and MMA emissions, and will soon include emission estimation factors for cast polymer operations. ACMA’s recently issued guidance and workbook for particulate matter emissions was peer reviewed by a major state regulatory agency. You can access the guidance and workbook on the ACMA Education Hub – www.acmaeducationhub.org/regulatory-tools.

ACMA continually works with state and local regulatory agencies, including recently those in Ohio, Indiana and California’s Mojave Desert air quality district, to ensure control requirements for composites manufacturing operations effectively reduce emissions while being both technically and economically feasible.

Workplace Health and Safety

ACMA works with OSHA and other organizations to assess workplace health and safety risks in composites manufacturing operations and to identify appropriate controls and work practices. For example, the association promotes effective and feasible OSHA regulation of hazards, including those associated with combustible dust, flammable liquids and other process elements typically found in the industry.

A longstanding ACMA effort with the National Fire
Protection Association encourages the adoption of effective and affordable fire code requirements for the industry’s use of organic peroxides, storage of flammable liquids and spray application of resin and gel coat. ACMA’s bulk resin storage tank guidance allows efficient compliance with the applicable NFPA requirements.

**Styrene**

The composites industry would be very different if it were not possible for small manufacturers to safely use the thermosetting resins with styrene as the reactive diluent. ACMA works very closely with the Styrene Information & Research Center (SIRC) to support its comprehensive styrene toxicity research program and to advocate for the classification and regulation of styrene health effects based on the best available science.

In addition to SIRC, ACMA works closely with industry partners to promote the adoption of controls and work practices needed to protect employees from adverse health impacts that may result from exposure to styrene. The association’s programs with federal and state agencies encourage the regulation of occupational styrene exposure based on a weight-of-evidence assessment of the full range of scientific data and taking into account the feasibility of control options such as mechanical ventilation.

ACMA’s “Staying Healthy While Working with Resin” bulletin provides a concise summary of the scientific findings and recommendations for controlling workplace exposures to styrene. You can access the bulletin at [www.acmaeducationhub.org/regulatory-tools](http://www.acmaeducationhub.org/regulatory-tools).

Congress’s major 2016 reform of the Toxic Substance Control Act increased the chance EPA will subject the composites industry’s use of styrene to a major risk assessment and possibly issue control requirements if exposures are found to exceed a “no unreasonable risk” standard. The recently issued final rules for TSCA risk assessment adopted ACMA’s recommendations that EPA comply with the risk assessment best practices endorsed by the National Academies. And the agency agreed to consider exempting uses of chemicals already regulated by other agencies like OSHA from TSCA review.

**Opportunities in Infrastructure**

Over the past few years, ACMA advocacy has led to provisions in the Water Resources Development Act and Highway Bill (the surface transportation authorizing legislation) to study the performance of composites among other innovative materials in bridges and water infrastructure. Building off of these successes, and noting the strong bipartisan push to move comprehensive infrastructure legislation during the 115th Congress, ACMA is currently working with partners from key House and Senate offices to develop and advance broader and substantive legislation to advance the use of composites in this market. This effort comes on the heels of testimony by Shane Weyant, CEO of ACMA member Creative Pultrusions, to the House Energy and Commerce Committee on the ways composites can improve American infrastructure.

Specifically, ACMA seeks reforms to existing grant, loan and other infrastructure financing programs that would provide...
additional support to project applications that use composites. In addition, the proposal would direct additional dollars and resources to advance research and development of innovative material solutions at the Turner-Fairbank Highway Research Center, the Technology and Innovation Deployment Program and the Center for Accelerated Innovation.

Further, ACMA and our congressional partners seek the creation of two new programs – one for bridges and another for water treatment facilities – that would provide substantial grant money to municipalities using composites and other innovative materials in new projects. These programs would be operated out of the Federal Highway Administration and EPA respectively. The idea is that these programs would create incentives for municipalities to design new projects with composites and ultimately create business opportunities for ACMA members manufacturing into these markets. In addition, ACMA is seeking authorization and appropriations for the effort on composites standards development currently being initiated at the National Institute of Standards and Technology (NIST).

Energy Legislation

Among the many items on the congressional to-do list is comprehensive energy legislation. Energy packages are generally broad in scope, covering everything from energy production and delivery to energy efficiency. ACMA seeks to leverage forthcoming energy legislation for two key issues – hardening the grid with composite utility structures and expanding federal research on composites recycling.
The proposed energy bill from the House of Representatives during the 114th Congress contained language directing utilities to increase deployment of high-performance utility structures, like composite poles and crossarms, as part of their resiliency planning efforts. ACMA is working with our congressional allies to assure the same provision is picked up in the next iteration of the legislation.

In addition, the Senate’s energy package included language directing federal funding and focus on carbon fiber recycling. ACMA is working with Senate energy leaders to essentially double the scope of this effort to include glass fiber composites recycling as well.

High-Performance Composites

This year, ACMA has begun a concentrated effort to grow our footprint and impact in high-performance markets. While aerospace and automotive OEMs have increased their use of composites in recent years, plenty of work remains. The unique performance capabilities of composites make our products ideal for use in the most demanding strategic federal assets. The Trump Administration and congressional leaders have committed to modernizing and improving America’s military capabilities in the coming years, making now a prime opportunity to engage.

Similarly, as the government considers fuel efficiency requirements for automobiles and trucks, the composites industry has an important story to tell about our ability to lightweight cars for fuel efficiency without compromising performance and safety.

To drive success in ACMA’s efforts in these areas, we encourage you to participate in our inaugural Transportation and Defense Policy Fly-In – Oct. 31 – Nov. 1, 2017, in Washington, D.C. Visit www.acmanet.org/policyflyin for more information.

Leverage ACMA to be Your Own Best Advocate

Simply put, ACMA exists to make your life as a business leader a little easier by tackling issues beyond the scope of any one company. Our compliance tools exist to make it easier for you to focus on profits instead of problems. We engage federal and state legislators and regulators to fight the fights and solve the issues that are too complex to handle on your own.

But it’s up to you to leverage ACMA’s work for your company. Take advantage of our compliance tools at www.acmanet.org/regulatory-compliance and join your colleagues as a composites advocate by participating in our fly-ins and working with us to host a congressional plant tour.

Being a member of ACMA assures that you have access to all of the association’s guidance on regulatory items and have the information you need to stay up to date on issues affecting your business, as well as have the opportunity to influence how ACMA advocates for the industry. Opportunities for composites are out there. It’s up to all of us to work together to grab them. We’re all in to build a stronger industry. Are you?

MJ Carrabba is ACMA’s Government Affairs Director. Email comments to mcarrabba@acmanet.org. John Schweitzer is Senior Advisor to the ACMA President. Email comments to jschweitzer@acmanet.org.
Update on Recycling from Ed Pilpel

In the May/June issue of Composites Manufacturing, we highlighted advances in composites recycling, including ACMA’s work in the area. Ed Pilpel, the chairman of ACMA’s recycling committee of the Green Composites Council, is leading the charge. We caught up with Pilpel to get some high level perspective on the committee’s activities.

CM: Can you briefly describe the recycling technology ACMA is working on and where ACMA stands with its proposal to IACMI for the development of the technology?

Pilpel: Last year, ACMA submitted a proposal to study and test CHZ Technologies’ Thermolyzer™ technology, which separates and recycles or repurposes components of composite materials. The matrix is converted into clean synthetic gases. The fibers are separated and can be repurposed. During the IACMI members meeting in July, the ACMA/IACMI proposal was approved and the project was kicked off. To demonstrate the technology, we will process fiberglass wind turbine blade samples at a Thermolyzer pilot plant in Germany in the middle of October. This process is also being applied to electronic circuit boards and other difficult-to-recycle products.

CM: What would success of the project mean for ACMA members and the industry?

Pilpel: This is the universal first step for recycling composites in our industry. We were looking for a technology that has a positive business case. I’m really excited about this because I feel this is an important step in educating people about large scale recycling of composites and how the technology works. A lot of people we have talked to about composites recycling joined the conversation during what I like to call the “middle of the movie,” meaning that they are not aware of the background, technology and the pathway to bring this project to the point of approval. The project is vital to telling the complete story about how this technology can truly create a business case for composites recycling. Thanks to the work ACMA is doing, I believe we can call ourselves the voice of composites recycling in our industry.

CM: What target markets do you think could benefit from recycled products made through this unique technology, and how will ACMA work to commercialize the process?

Pilpel: There’s substantial potential for recycling CFRP into other markets, such as aerospace, where specification can be achieved with recycled CFRP and carbon fiber competitively. IACMI’s strategic partner, Port Angeles, Wash.-based Composites Recycling Technology Center, has been working with ACMA on ways to tap into new markets and offer recycled composite materials as a viable option. Of course, we are also working to apply this knowledge to recycling GFRP.

CM: Outside of the IACMI project, what other projects is ACMA’s Green Composites Council working on? Does the committee have activities planned for CAMX this year?

Pilpel: During CAMX, we are going to have a roadmapping session led by IACMI as we map out the next key milestone and other technologies for recycling composites. At some point soon, I would like for us to start on a project to develop some guidelines to help practitioners engage in recycling composite material, so we’ll discuss that as well. We also have an ACMA recycling conference planned, which will be April 10-12, 2018, in Knoxville, Tenn. We plan to target practitioners to excite and engage more end users about the prospect of recycling composites. It will be a long road to realizing large-scale composite recycling, but with a sound business case that will motivate success, I am confident we will be able to satisfy our responsibility to future generations.
CONGRATULATIONS TO THIS YEAR’S ACMA AWARDS RECIPIENTS

These awards recognize the exceptional people who have done their part in making the field of composites a great industry.

**Lifetime Achievement**

**BOB LONG**  
*Marine Concepts*

**Hall of Fame**

**ROB HABERLEIN**  
*Engineering Environmental*

**Outstanding Volunteer**

**ROBERT STEFFEN**  
*Western Carolina University*

COME AND CELEBRATE ACMA’S 2017 MEMBERSHIP AWARDS.

Join us during the Recognition Ceremony and Reception at CAMX on Monday, September 11 from 5:30 to 7:00 p.m. in Orlando, Fla.

Get your ticket to the Ceremony and Reception when you register for CAMX at [thecamx.org/registration](http://thecamx.org/registration).
Transportation and Defense Fly-In

Mark your calendar to attend ACMA’s inaugural Transportation and Defense Policy Fly-In Oct. 31 – Nov. 1, 2017. Join fellow ACMA members in Washington, D.C., to advocate for the increased use of composites in aerospace, defense and transportation markets. Don’t miss this key opportunity for your company to gain inside knowledge and to grow your business relationship with federal agencies. By attending, you’ll gain important insights and potential leads in federally-influenced markets, as well as network directly with agency leadership and your industry peers. To register, visit acmanet.org/policyflyin. For more information, contact Brooke Wickham at bwickham@acmanet.org.

Global Composites Conference Reminder

ACMA and NetComposites are co-producing the first ever Global Composites Conference in Las Vegas Jan. 31 – Feb. 1, 2018. Global Composites will explore the industry from a worldwide perspective, looking at high growth areas such as the U.S., China, Brazil and the Middle East. The conference will examine the global supply chain with a particular focus on carbon and glass fiber manufacture and resin production. It will also look at emerging technology trends from around the world and highlight global market information. For more information, visit http://globalcompositesconference.com/ or contact Heather Rhoderick at hrhoderick@acmanet.org.

New ACMA Members

- Advance Coatings Company
  Westminster, Mass.
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For more information on becoming a member of ACMA, email membership@acmanet.org or call 703-525-0511.

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Composites Marketing Update

Over the past year, ACMA has been working on a targeted marketing campaign to promote composites and advanced materials to end users. ACMA’s Marketing and Communications Committee has finalized the messaging behind the public relations component of the campaign and will share details during CAMX. Later this fall, ACMA expects to publish a website for the campaign. For more information, contact Barbara Sadowy at bsadowy@acmanet.org.

Safe, Green Acetone Replacement

Approaching our sixth decade in the marketplace, U.S. Polychemical Corp. is proud to announce the availability of our Polychem Acrastrip line.

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In addition to our Acrastrip line, Polychem has introduced “Bio-Lock” a revolutionary way to eliminate grinding and sanding for secondary bonding!

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Earlier this year, Ukrainian engineer Max Gerbut and his company introduced a new type of housing that allows people to sustainably live in nature away from civilization while enjoying the comfortable conditions of a traditional house. Gerbut and his team created an autonomous, 3-D printed, composite solar powered-house called PassivDom. The PassivDom team claims the 387-square-foot house, made with an industrial 3-D printer, is the first totally autonomous house in the world and can operate in a wide range of climates. According to Gerbut, the PassivDom house creates its own energy with the use of solar panels that cover the entire roof. This energy is stored in batteries for continuous availability to all the electric components of the house: lighting, heating, cooling and water systems. Water is taken from reservoirs from the outside and filtered, or water is produced by condensing humidity out of the air. Gray waste water is recycled through a filtration process. Sewage is sent to a septic system.

Gerbut says he chose composites to make PassivDom strong, light, corrosion-resistant, incombustible and eco-friendly. The house frame, roof and floor are printed as single components using a 7-axis robot. Gerbut says the composite walls “won’t rust like iron or rot like wood.” The composite frame also makes it nine times stronger than steel and helps retain thermal conductivity.

Because of those characteristics, PassivDom comes with a “materials warranty” that insures the thermal properties of the house will be maintained for 40 years. The team says the house itself has a minimum lifetime of 20 years.
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