The Ideas Issue

It’s true, genius may be one percent inspiration and 99 percent perspiration but it doesn’t make the triumph that much less remarkable. Behind every good idea is years of hard work, mistakes, failures, study, training, education and research. In this issue, our Ideas Issue, Composites Manufacturing honors work being done throughout the world. Here you will read about composites that reach new heights, develop new markets and create ingenious applications—and the people behind them.

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Long before applications hit the marketplace, researchers in university laboratories develop innovations that will change our world. Across the globe university research and development is paramount to the future of composites. Here, are six projects conducted on three continents that could one day affect billions of people. By Susan Keen Flynn

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Scouts Lead the Way

Although the economy has slowed in recent years, companies continue to invest in education and training to ensure an ample workforce when the economy rebounds. However, despite the current state of employment it remains difficult to find qualified composites technicians.

ACMA has been proactive in addressing the skills gap issue by implementing the Certified Composite Technician (CCT) course as well as other hands-on training courses offered around the country. The CCT program continues to grow as new certification programs are added. People who are now unemployed or underemployed will seek opportunities to learn new skills to prepare for new careers, creating demand for training programs provided by private suppliers and community colleges. These types of training programs are being recognized at the state and federal levels because these programs produce opportunities for employment.

The number of universities and community colleges implementing composite courses and composite research programs has grown in the last several years. As an industry, we must continue to drive the demand and increase awareness of composites. One way of doing that is to communicate with educators at the high school or even grade school level. The Composites Boy Scouts merit badge (SMB) is a great way to reach the younger generation.

SMB was developed by ACMA member company M.C. Gill with the help of other industry leaders approximately seven years ago. This was a very large monetary investment by M.C. Gill and his company, but they did it because of their commitment to Boys Scouts and composites. Since then there have been less than 1,000 badges awarded. It is a challenge because a lot of Boy Scout leaders do not have the knowledge or access to materials to complete the tasks required to award this badge.

ACMA’s Western Chapter and the Society of Manufacturer Engineers (SME) have come together to help sponsor an event at Camp Witheycombe, Ore., on December 1, 2012. Camp Witheycombe is a National Guard base camp where 500 Boys Scouts will gather to complete a variety of merit badges and we hope to award the 1,000th Composite Merit Badge. Lou Dorworth from Abaris Training Resources and other Western Chapter members will provide onsite support for the Scouts. I am thankful for all the effort Bruce MacKender, a member of SME, and the Western Chapter members have put into this event. This will be a fun day and we hope to build a model that can be easily replicated by other professionals who would like to conduct similar events with their local Scouts.

To participate or help sponsor please email me, we welcome your input and help. We hope to show Scouts the wonderful world of composites so when it comes time to choose a career path they will have a positive experience to motivate them.

Lori Luchak
Miles Fiberglass & Composites, ACMA President
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2 Composites Manufacturing
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Old Money in New Cars

Money doesn’t grow on trees, but it can make great car accessories. At least that’s what researchers at the Plastics Research Group at Ford Motor Company were thinking when they started investigating the use of recycled dollar bills as a natural fiber replacement in non-structural automotive applications. Ford is beginning their exploration by developing money-reinforced composite coin trays to help reduce the amount of shredded U.S. dollar bills in local landfills.

According to Deborah Mielewski, technology leader of the Plastics Research Group at Ford, her team first started working with a small bag of shredded dollar bills as a joke. News of the notorious tongue-and-cheek research project quickly circulated the company. “We made key chains out of it,” says Mielewski. “Afterwards there was strong interest from management to start utilizing the recycled money material in future car designs. So, we scaled up and started investigating part molding and testing.”

U.S. cash-reinforcement is successful for nonstructural composite parts because recycled dollar bills are much stronger than ordinary paper products. Dollar bills are composed of a special cotton paper that is one-fourth linen and three-fourths cotton with a mix of tiny synthetic proprietary red and blue fibers. This special recipe helps lengthen the average circulation time of the bill and reduce counterfeiting. When bills are considered unusable they are removed from circulation, shredded at Federal Reserve cash facilities and packaged into shrink-wrapped bags of long-fiber cotton material.

Did You Know?
The U.S. shreds over $6 billion in printed cash every year. Currently thousands of pounds are packaged and shipped to landfills. Reducing money waste is a long-standing global problem and Ford isn’t alone in its endeavor to reduce printed waste. Several centralized banks around the world are starting to use retired bank notes in interesting ways to limit landfill waste. The Australian Federal Reserve replaced all of its paper bank notes with polymer substrates, which can be granulated and recycled into new plastic products like trash bins. The Reserve Bank of India is promoting a new handmade paper industry that uses recycled money to make products like manila file folders.
The Ford Motor Company is researching the use of retired currency in cash-reinforced plastic components.

of time as the traditional coin tray – approximately 45 seconds to one minute.

**The quest for sustainable production**

Currently Ford is looking for a sustainable source of recycled money to produce enough material for 200,000 new Ford vehicles. “Although we are getting our money samples for free, actually putting this tray into our production lines is a different story,” says Mielewski. “We will need to find a sustainable source of material to use for our production vehicles.” Mielewski’s focus this year is to develop more “green,” natural fiber reinforcements that won’t compromise part durability. “Even though we’re focused on bio products,” says Mielewski, “light-weighting is a critical issue facing auto industry. We’re going to see a lot of steel component replacement with plastic components, and it’s likely going to be with carbon fiber reinforcement.”

Angie McPherson is the communications coordinator at ACMA. Email comments to amcpherson@acmanet.org.

For more stories like this, visit compositesmanufacturingblog.com and search keyword “auto research.”
FRP Reaches Record Heights

In modern building designs, fiber reinforced polymer (FRP) composite reinforcement is being used to strengthen buildings and towers to reach even taller heights. For example, composite retrofitting is being incorporated by more and more architects to protect them from earthquakes and to repair damaged architectural columns. Here is a sampling of the tallest buildings that have been built in the past two years and how they are using FRP to reach new heights.

Tokyo Skytree
Tokyo, Japan
The Tokyo Skytree was completed in May 2012. It is the second tallest structure in the world at 2,080 feet. Tokyo Skytree is a telecommunications tower and observation deck that is currently using reinforced concrete for seismic protection. This is especially important in earthquake-prone Tokyo.

Burj Khalifa
Dubai, United Arab Emirates
Completed in 2012, the Burj Khalifa is the tallest building in the world standing at 2,712 feet. It uses a double reinforced concrete system in its primary structure. The concrete material uses fiberglass reinforcement, which was pumped to the upper sections of the building. According to building engineers, the reinforced concrete is the reason the Burj Khalifa could reach nearly 3,000 feet.

The Makkah Royal Hotel Clock Tower
Makkah, Saudi Arabia
Also known as Abraj Al-Bait Towers, was completed in 2011 and opened in 2012. At 1,972 feet, it is the tallest clock tower and fourth largest structure in the world. The exterior structure includes over 40,000 square-meters of FRP panels and cladding. The clock hands are also composite laminated structures.
In addition to some of the current tallest structures in the world, here are some interesting future buildings that are planning to use composites to reach new records in the next five years.

**Jeddah’s Kingdom Tower**
Jeddah, Saudi Arabia
Known as Mile-High Tower, the Kingdom Tower is next-up to become the tallest building in the world. It is expected to reach higher than 3,280 feet when it is completed in 2017. Although the specifics of the project have not been announced, it is anticipated that the building will use similar advanced reinforced concrete and tools to those used in the making of the Burj Khalifa.

**One World Trade Center**
New York, United States
A new building and tribute to the Twin Towers site, the One World Trade Center will be the tallest building in the U.S. upon completion in 2013 – if you include the 408-foot antenna. The total height will reach 1,776 feet, which is taller than the Willis Tower (previously known as the Sears Tower) in Chicago at 1,729 feet. One World Trade Center will include composite columns manufactured by ACMA member Molded Fiber Glass Construction Products, Independence, Kan.

**Wood Innovation and Design Centre**
Prince George, British Columbia
This may soon become the tallest building in the world made out of engineered wood. Architects around the world are starting to use wood as primary structures to reduce the carbon footprint of buildings by reducing the amount of steel and concrete used in construction. The 10-story center for wood designers is currently collecting bids for design components. It is expected to be complete by the 2015 Canada Winter Games.

Angie McPherson is the communications coordinator at ACMA. Email comments to amcpherson@acmanet.org.

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How are composites used in the One World Trade Center construction? Find out this and other architectural facts at CM Online, search keyword “new heights.”
The Kayak that Crossed the Pacific

When most people around the world were packing for summer vacation, world explorer Wave Vidmar was customizing a durable composite kayak to endure a 70-day solo expedition from San Francisco to Maui, Hawaii. Vidmar, a professional explorer, is the second person in the world to attempt such a massive feat. And no, he’s not just following Google’s pedestrian directions to Hawaii; he’s collecting data for science foundations and demonstrating the material strength of composite products.

Vidmar was ready to face the 3,100-mile journey and 100-foot waves in May 2012; however, he wanted to be confident that his boat could complete the journey too. To increase his chances of safely crossing the ocean, Vidmar selected renowned composite manufacturer Seaward Kayaks to make a customized multi-layer version of its two-seat expedition craft, the Seaward Passat G3.

Seaward is currently manufacturing two-thirds of its products using thermoforming plastic and one-third traditional fiberglass hand lay-up. However, to build a heavy-duty expedition craft like the ocean-bound Passat G3, the company’s hand lay-up process was the only way to go, explains Nick Horscroft, director of communications at Seaward. “Although it’s debatable whether or not thermoform and fiberglass are of the same quality, fiberglass has proven to be more dependable in the long term.”

“The tendency in the marketplace currently is to use vacuum bagging to save money on materials. We’ve looked into the process, but we know we have a system that works. One thing that makes Seward unique is our craftsmanship. We have key people in the manufacturing process who have been with us for many years,” says Horscroft.

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nicians is Cliff Tromp, head kayak builder. Tromp said the boat was completed in good time and with most of the manufacturing time focused on the explorer’s many customizations. “Our normal production process takes about five days, but with all the modifications needed it took 10 days,” says Tromp. “He obviously had a specific kayak in mind when he came here, and it helped that he has previous experience building with composites, too.” Tromp and his team had to design the Passat G3 with many long-journey solutions. For example, Vidmar is transporting several pieces of electronic equipment, including gyroscopes, a waterproof military grade lap top, PLB and emergency transponder, six cameras, a bodily function monitor and a satellite phone in addition to traditional supplies. Seaward designers needed to build a kayak light enough to navigate heavy equipment and food, but strong enough to withstand ocean debris. Therefore, the most important customization to the Seaward Passat G3 was the addition of a thick, multi-layer Kevlar and carbon fiber hull, which gave the kayak increased rigidity from the fiber roving and impact resistance from the hull.

“We used a lot of carbon fiber and Kevlar that we typically use for racing boats because we didn’t want the boat to get too heavy,” says Tromp. The layers of lightweight carbon fiber and Kevlar layers did add an additional 25 pounds; however, Vidmar and his team feel more confident that the extra Kevlar will protect him from floating ocean debris and other dangers. For additional protection Seaward packed a few epoxy patches that can adhere to wet surfaces so Vidmar can repair the kayak in the event of a collision.

Vidmar believes that composites are important and very powerful products and his intention is to spread the word about his confidence in the growing technology to other markets. He especially wants manufacturers to see composite technology being used to push the boundaries of human exploration. “When people start asking, ‘how did you build that kayak?’ The world will be interested to know,” remarks Horscroft, “that it’s from quality composite manufacturing.”

Angie McPherson is the communications coordinator at ACMA. Email comments to amcpherson@acmanet.org.
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Flat-Pack Turbine Targets Urban Landscape

A new wind turbine by renewable energy firm McCamley UK in Staffordshire, England, may soon be changing the sound and shape of the urban landscape. The firm’s new flat-pack wind turbine requires no supporting mast and can be retrofitted to any roof, making it a useful and reliable energy source in urban areas. The turbine incorporates composite materials to overcome issues like size and noise that have long made wind turbines in urban areas a bane instead of a boon.

In the late 1980s Andrew McCamley, chief engineer of McCamley Ltd, met Tony Mewburn-Crook, when Mewburn-Crook was performing wind tunnel testing at a local university as part of his PhD on a unique wind turbine design. McCamley was fascinated by the quiet, reliable and efficient wind turbine and the two agreed to work together to make Mewburn-Crook’s concept a reality.

Finally, in late 2009 McCamley began development of his first design using his own money, a proof of concept machine known as the Mk1. This machine had its first “flight” in 2010 and flew for a year. A second machine then followed using a different structural philosophy than the Mk1. “The initial design utilized composites for the main (vertical) blades and the rotor (horizontal) blades,” says McCamley. However, there were further improvements needed to make the design work the way the team had imagined. “After the Mk1 first flew, I sat down with a blank piece of paper and completely redesigned the structure of the machine,” he says. “I was determined to create something that was beautiful to look at, structurally stable and aerodynamically clean. Our first machine struggled in all three categories.” The result was the Mk2.

McCamley drew heavily from his
aerospace design and structural load path knowledge to create the next generation flat-pack. The end result was a lightweight, stiff, multiple load path, curvaceous design. “I went back to some of Tony’s earlier work where the aerodynamic form was important and gave it performance advantages as well,” he explains.

Unlike horizontal-axis turbines, which rely on steady wind speed, the flat-pack model is able to cope with turbulent and variable wind speeds often found in urban environments. In fact, its self-starting technology means it doesn’t require power from the grid to restart if wind speed drops below a certain level. And the absence of down-force from sweeping blades significantly decreases noise and ground vibrations making it less likely to impact wildlife.

The redesign of the Mk1 also took a significant turn towards composites, albeit with some hesitance at first. “The adoption of composites had a significant financial impact to my pocket, not to mention that I alone had composite experience,” says McCamley. “I always intended to use composites but I expected it to take longer to get here. However, I wanted composite parts for my smaller machines because I knew the weight savings would help in shipping costs, assembly requirements and roof structural issues.”

The newly designed Mk2 utilizes a proportionally large, double curvature stator, which McCamley explains is most easily accommodated using composite materials. “Having designed the shape of the Mk2 machine to have a lot of curve, it became quickly apparent that the stator blades, like the rotor and main blades, should be made of composites,” he says. “The rotor shaft is still currently made of metal but could also be made of composites. However, for strength and stiffness reasons we might use carbon rather than glass composites.”

Currently a full-scale prototype of the turbine is being tested at Keele University Science Business Park in North Staffordshire, England. During the next six months, McCamley UK CEO Scott Elliott says the company will finish plans for a 12kW model. “Wind energy has huge potential, but the traditional wind farm models are just not effective and are certainly not suitable for urban environments. This leaves a huge gap in the market where businesses, residential blocks and other organizations could be benefiting from clean energy,” he says.

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Game-Changing Research
University R&D shapes the composites industry and the world in which we live

By Susan Keen Flynn

Composites touch all our lives, from the young boy swinging a baseball bat in the local park to the businesswomen driving over a bridge each day to work. But long before applications hit the marketplace, researchers in university laboratories develop innovations that will change our world. The ingenuity and dedication of researchers studying composites have shaped industries — transportation, aerospace, automotive, wind, infrastructure, marine and more.

Worldwide university research and development is paramount to the future of composites. Composites Manufacturing scanned the globe to find breakthrough projects from the fundamental materials science level to commercialization. Here we present six projects conducted on three continents that could one day affect billions of people.
Composites Enable Icy Flights

Project: Aircraft for cryospheric remote sensing
School: University of Kansas
Location: Lawrence, Kan.
Director: R.D. Hale

The earth’s average temperature has risen by 1.4 F over the past century and is expected to increase another 2 to 11.5 F over the next 100 years, according to the U.S. Environmental Protection Agency. That may not sound like a lot, but subtle changes in the average temperature translate into potentially dangerous shifts in climate that can ultimately affect our economy, health and communities.

Aerospace engineers at the University of Kansas are at the forefront of global climate change research, building portable composite aircraft to help collect data on polar ice sheets. They work alongside faculty and students from a variety of disciplines at the Center for Remote Sensing of Ice Sheets (CReSIS), established on campus in 2005 by the National Science Foundation. The mission of CReSIS is to develop new technologies and computer models to measure and predict the response of sea level change to the mass balance of ice sheets in polar regions.

“The leading science lacks data on the fundamental physics behind the motion of glacial ice,” says R.D. Hale, associate professor of aerospace engineering at the University of Kansas and associate director of technology for CReSIS. “We provide better data so scientists can come up with better predictive models for the rate at which things are changing.”

Hale and his students have built both unmanned and manned aircraft used for remote sensing surveys in isolated areas. The Meridian unmanned aircraft system (UAS) flew several missions in Antarctica and Greenland between 2009 and 2011. The 1,100-pound, 26-foot span aircraft is a rugged, modular plane with removable wings that can be assembled in a short amount of time on the field. Rigidity constraints for the wing-mounted sensors and takeoff weight versus range performance led to an aircraft of predominantly bonded carbon and epoxy composites.

“Every ounce we can save on the aircraft is another mile we can fly,” says Hale. “We’re trying to fly 1,000-plus mile missions, so light weight is important. It gives us more payload potential.” In addition, scientists in the field take the wings on and off so light weight wings make their job easier.

Hale’s team is currently installing avionics and ground testing a second Meridian UAS and building the airframe for a third Meridian UAS. The fuselage has a machined aluminum substructure and carbon prepreg monocoque shell. The wings feature a box beam carbon main spar, a c-channel carbon aft spar and carbon ribs. The carbon upper and lower skins are core-reinforced. Flaps and ailerons have a c-channel carbon forward spar, carbon ribs and monocoque carbon skins. The fully-actuated tails have aluminum primary tube spars, aluminum ribs and carbon skins. The cowling is constructed of fiberglass, and the antenna array is composed of layers of glass, carbon and copper.

CReSIS uses a collection of wet lay-up — mostly tooling — and prepreg for all composite parts.

“We have small autoclaves, but by and large all parts are vacuum cured in ovens,” says Hale. “Tooling ranges from high-density foam to aluminum to carbon, depending on the number of parts to be produced on that tooling and the geometric tolerance required on cured parts.”

While Hale is proud of the work done in the field, he is equally enthusiastic about the learning opportunities the CReSIS program provides for engineering students. “Every year, students get hands-on experience building a real aircraft,” he says. Seventeen courses at the University of Kansas have incorporated parts of the manned and unmanned aircraft into their curriculum. Students have compared aluminum to composites and developed landing gear, cowling and antenna concepts.

Prior to a flight to Greenland last year, the Meridian UAS switched to landing skis rather than wheels. After the summer mission, a fall manufacturing class was charged with redesigning the skis in a more aerodynamic shape to create lower drag. “Within a semester, the students redesigned the ski, retooled it and remanufactured some fairly complex carbon skis,” says Hale. “They are now characterizing those in a wind tunnel through structural testing.”
Putting a Spin on Bio-composites

Project: Bio-based carbon fibers for wind turbine blades
School: Iowa State University
Location: Ames, Iowa
Director: Michael Kessler

Longer, lighter, less expensive wind turbine blades. That winning trifecta would catch anyone’s attention in the wind energy industry. And it’s the ultimate aim of a fundamental research project being conducted by the Iowa State University Biopolymers and Biocomposites Research Team.

“Our goal is to provide a low-cost, bio-based carbon fiber that significantly outperforms glass fiber in composites for wind turbine blades,” says Michael Kessler, project leader and associate professor of materials science and engineering. In 2009 his team received a $100,000 grant from the Iowa Alliance for Wind Innovation and Novel Development to investigate the production of carbon fibers from low-cost, lignin-based polymer blends. Derived from plants, lignin is a by-product of the wood pulping process.

“We’re not the first people to come up with this idea,” says Kessler, citing research done at Oak Ridge National Laboratory in Tennessee. “But we had some ideas on improving the way that lignin could be modified so it could be spun into fiber.” His team relies on a manufacturing process called melt spinning.

First, the polymer is heated to a melted state and then extruded through a spinneret, a die with numerous holes. The polymer fibers are then wound and stretched into thinner fibers for further processing. They are placed in a fiber conditioning system to be stretched at different draw ratios and at a heat zone above the glass transition temperature of a polymer. “That’s where fibers get their strength,” says Kessler. “Pulling them through this heat zone, you get high alignment of the polymer molecules.”

Because lignin polymers are brittle and cannot be spun and spooled into fibers without modification, Kessler’s research group tested ways to overcome this barrier. They are chemically modifying and blending the lignin with biopolymers to enhance polymer flexibility and improve the melt spinning process.

Today, most turbine blades are made from fiberglass reinforced epoxy resins. These glass fibers are dense and weaken over time under repeated stress, which limits turbine blade length and performance, says Kessler. The need for lightweight, low-cost blades led Kessler to begin investigating carbon fibers that could replace the glass fibers currently used in wind turbine blade manufacturing. “It’s hard to beat carbon fiber as a reinforcement material for making materials very strong and very stiff,” he says. “If we could make a wind turbine blade from carbon fiber, it could be much lighter and longer and have better fatigue resistance than glass.”

However, carbon fiber is more expensive than glass fiber. So instead of using expensive petroleum-based carbon fiber, his research group is exploring ways to use lignin, a renewable resource. Kessler believes there is a lot of potential for making the carbon fiber production greener and renewable by blending lignin with biopolymers, such as the starch-based polymer polylactic acid (PLA), rather than using petroleum-based polymers such as polyethylene terephthalate (PET).

“The expected benefits are three-fold,” said Kessler. “It uses renewable resources, it optimizes energy and materials costs for producing carbon fibers, and the fibers themselves will be used for wind turbine blades to produce renewable energy.” He estimates that using lignin will result in a 37 to 49 percent savings in the final production cost of carbon fibers.

While the research team focuses on wind energy applications, Kessler envisions other applications for the lignin-based carbon fibers. For instance, replacing steel structures in the automotive industry with lighter carbon fiber reinforced composites could lead to significant vehicle weight reduction. That, in turn, would improve fuel efficiency. “By bringing down the cost of carbon fiber, we can take high-performance materials and put them into more large-scale, low-cost applications,” says Kessler.
Race cars have long employed composite brake rotors, both because of their light weight and their ability to perform under the extreme heat caused by the friction of braking from high speeds. But until now, cost has been prohibitive for mass market cars. Researchers at the Polytechnic Institute of New York University (NYU-Poly) and REL, Inc., in Calumet, Mich., have developed a next-generation aluminum composite brake rotor weighing 60 percent less than cast iron rotors with three times the life expectancy.

Earlier this year, REL, a developer of advanced material products and automated manufacturing processes for transportation and aerospace, received a $150,000 Phase I Small Business Innovation Research Grant from the National Science Foundation to develop the initial product design, material and manufacturing process. The company partnered with NYU-Poly Mechanical and Aerospace Engineering Associate Professor Nikhil Gupta and his Composites Materials and Mechanics Lab to develop the application for automotive applications.

"Traditional brake rotors are made of cast iron, which is very heavy," says Gupta. "Reducing vehicle weight has become increasingly important in order to improve fuel economy and reduce emissions. Heavy parts such as brake rotors provide a great opportunity for replacement with lighter materials."

A brake rotor has three functional zones, each of which requires a distinct strain and thermal properties to function optimally. Temperature and pressure changes across the rotor surface are a major cause of wear, warp and brake failure.

Some lightweight aluminum alloy and composite brake rotors are currently available, but their high price has been a significant barrier to mass-market adoption. "Our new product is designed to have a low cost while it improves the performance over traditional metals," says Gupta. He expects the brake rotor to shave approximately 30 pounds from a mid-size sedan — a noteworthy achievement in an industry facing a fuel economy requirement of 54.5 miles per gallon by 2025.

The new one-piece brake rotor is made of aluminum alloy and reinforced with glass fibers and silicon carbide particles. The glass fibers are expected to provide dimensional stability even though temperatures can exceed 1,000 F on hard braking from high speeds. The silicon carbide particles provide wear resistance for long life. The ratio of aluminum to ceramic reinforcements will vary throughout the rotor, based on the forces exerted on particular areas. For example, the interface where the brake pad clamps down on the rotor becomes very hot from friction. Since ceramics can better withstand heat, the composite will contain more ceramic in that area compared to a less-taxed area, such as the rotor's center.

"The hybrid materials allow us to provide reinforcement where additional strength is needed, increase high-temperature performance and minimize stress at the interfaces between zones," says Gupta. "Together, this should boost rotor life significantly, reducing warranty and replacement costs." Another factor in lowering costs is development of a low-cost mass manufacturing process.

REL and NYU-Poly have cast prototype rotors, which are now being tested for performance and properties such as high-temperature strength and stiffness, vibration damping capabilities and wear resistance. In addition, life cycle evaluation is under way. While the current project is focused solely on the automotive sector, Gupta believes the technology development and experience gained along the way will aid in expanding the product line to heavier vehicles, such as military fleets.
Researchers are accustomed to working on projects that don’t work out as planned, ending in disappointment. But for three researchers at the University of Wollongong, unexpected results in the development of nanocomposite fibers based on carbon nanotubes were met with delight.

Professor Geoff Spinks, Dr. Sanjeev Gambhir and Professor Gordon Wallace of the University’s ARC Centre of Excellence for Electromaterials Science tested whether there are advantages to replacing expensive carbon nanotubes with cheaper graphene flakes. “We were surprised to find that at the magic mixture of a one-to-one ratio of graphene flakes to carbon nanotubes, the toughness of the fibers increased dramatically,” says Spinks. “This was a totally unexpected result, and we spent some time figuring out why.”

Microscopy studies and other analysis showed that carbon nanotubes and graphene flakes formed an interconnected network within the poly vinyl alcohol (PVA) matrix. This carbon network is very effective at stopping cracks growing through the fiber, so the fiber became very strong. Tensile tests indicate that it appears to exceed all other tough fibers, such as spider silk and Kevlar.

Spinks and his team have produced monofilament fibers several meters in length made of graphene flakes, carbon nanotubes and a PVA binder. The graphene flakes are very thin sheets approximately 400 nanometers in diameter, and the carbon nanotubes are bundles approximately 20 nanometers in diameter and several microns long.

The fibers are made by wet spinning: A dispersion of the graphene flakes and carbon nanotubes in water is injected into a coagulation bath containing the PVA dissolved in an aqueous salt solution. The PVA wraps around the carbon nanotubes and graphene flakes producing a fibrous gel. The fiber is removed from the bath and dried.

Researchers at the University of Wollongong worked in conjunction with Professor Seon Jeong Kim at Hanyang University in Korea on the project. Spinks and his associates produced the graphene flake dispersion, while Hanyang University made the fibers by wet spinning.

Spinks says the toughness of the graphene material lends itself to applications where the ability to absorb damage is critical. He speculates that bullet-proof vests might be a good application, though researchers need to make more fiber to produce fabrics for ballistic testing. “Toughness is important in many composite structures, so our fibers could be useful as a reinforcing fiber in composites,” adds Spinks.

Another possibility is electronic textiles, which integrate electronic components such as sensors and batteries into conventional textiles. “The fibers we have produced so far are very good mechanically, but we are looking at their electronic properties now,” says Spinks. “There are many applications in wearable electronics.”

While the researchers remain excited about the “surprise discovery” of the tough new graphene composite material, Spinks and his colleagues have a lot of work ahead of them before they bring it to market. They are currently working to scale up production of the fibers so they can move on to producing woven or knitted fabrics for textile prototypes. In addition, the researchers are considering replacing the PVA with other binders that are less sensitive to water. Finally, they are continuing with materials development to optimize both the electronic and mechanical properties of the nanocomposite fibers.
Researchers at Imperial College London describe the automobile as a technological miracle on four wheels. “The underlying concept of the modern car is very much the same as that of 100 years ago — a comfortable box to take you from point A to B as quickly and/or as cheaply as possible,” says the StorAGE research program’s website. “However, increasing environmental awareness and ever-inflating fuel costs are leading to a change in the public perception of the car.” Consumers demand cars that minimize environmental impact.

That’s the focus of the StorAGE Project: It aims to develop revolutionary concepts for lightweight structural energy storage components, including composite structural capacitors, batteries, super capacitors and hybrid capacitors. These multi-functional materials will allow for full integration of the energy storage systems into the structural load paths in the vehicle. Emile Greenhalgh, a leader in composites materials at Imperial College London, a group of professors, students and six corporate partners, including end-user Volvo, are involved in the program.

The research has been ongoing for seven years, during which time several prototype materials have been built. “Our first systems had very poor performance, but proved the concept,” says Greenhalgh. “We now have materials which have good levels of energy density (~2Wh/kg) but the power density is still a challenge (about 100W/kg).”

The researchers believe that the versatility and constituent architecture of polymer composite materials make them well-suited for development of novel multi-functional materials that can store the electrical energy required to power systems while meeting the demands of mechanical loading. In particular, carbon fibers are attractive because they are commonly used as both electrodes and structural reinforcements. While the nature of the carbons used for these applications is usually different, there’s an opportunity to unify the roles with appropriate manipulation and nanostructuring of both matrix and reinforcement, says Greenhalgh.

The StorAGE team has created polymer composite materials consisting of two carbon fiber woven electrodes, which are separated by a glass fiber woven layer. This is all embedded within a multi-functional matrix — an optimized blend of electrical component (an ionic liquid) and epoxy. “It looks like a normal composite,” says Greenhalgh.

The composite material enhances battery performance and life, reducing the need for such a large battery in a car. That, in turn, helps lower the total weight of the car, minimizing its environmental impact. “By using a super capacitor, the electrical load on the battery is reduced, which reduces the sudden surges in power that damage the battery,” says Greenhalgh. “Imbuing multi-functionality also means there is a space savings. Volvo has demonstrated huge savings can be achieved with this concept.”

The challenge, though, is to improve power density by at least a factor of 10, says Greenhalgh. He adds that the research team has strategies in place to enhance power density. “The research is going very well,” says Greenhalgh, “and we are about to start on another program in collaboration with the Ministry of Defense, BAE Systems and Umeco.”
Parts Made of Powder

Project: 3-D aluminum composite parts
School: University of Exeter
Location: Exeter, United Kingdom
Directors: Sasan Dadbakhsh and Liang Hao

Producing strong, lightweight and complex parts for the aerospace and automotive industries could become cheaper and more accurate thanks to a new technique developed by engineers at the University of Exeter. A team of researchers led by Dr. Sasan Dadbakhsh and Dr. Liang Hao has created a method for making 3-D aluminum composite parts by mixing a combination of relatively inexpensive powders.

The process is based on the emerging technique of selective laser melting. Researchers use a laser to build successive layers of 3-D parts by melting a mixture of powders composed of aluminum and a reactive additive, such as iron oxide. The laser triggers a reaction between the powders, resulting in the formation of new particles. Those particles act as reinforcements, distributed evenly throughout the composite material.

“This method facilitates the production of composite parts with complex shapes,” says Liang Hao, project supervisor and senior lecturer in advanced materials and manufacturing. “The products embed very fine particles, making them more robust compared to conventionally manufactured composites with larger reinforcements.”

The particles — around 100 nanometers in size — are distributed evenly through the material, making it very strong. The properties of the produced composites also benefit from rapid solidification which is in nature of selective laser melting, adds Hao.

The research team cites several advantages of this new technique. First, it triggers an exothermic reaction within production of metal matrix composites, which facilitates the laser manufacturing process and enhances the overall processability of the material. This allows the operator to use a lower laser power (translating to energy savings) or a higher laser speed (leading to higher production rates). “The high production rate is a real concern in this industry,” says Hao. “Any technique that improves it will significantly reduce the cost.”

In addition, Hao says this technique uses considerably cheaper powders, especially in comparison with the price of nano-size and ultrafine particles. Finally, the method enables the manufacture of aluminum composites with extremely fine and well-distributed reinforcements in complex shape parts.

Parts from cars and planes are widely made from aluminum with reinforcement particles to make them stronger. Traditional production methods, typically involving casting and mechanical alloying, can be inaccurate and expensive — especially when the part has a complex shape. The new SLM technique can be used to manufacture aluminum composite parts such as pistons, drive shafts, suspension components, brake discs and almost any structural components of cars or planes. Hao adds that it also enables the replacement of old simple designs with new, complex and lighter designs, which can lead to new applications for this method in future.

The university is pursuing partnerships with a few companies that have shown interest in commercializing the technology. Hao says future research might be dedicated to using advanced laser manufacturing machines to fabricate high-performance aluminum matrix composites for aerospace and automotive applications. The team may also explore new material systems in production of novel advanced composites.

Susan Keen Flynn is a freelance writer based in Cleveland. Email comments to sflynn@keenconcepts.net.

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Light Car, Heavy Research
The rise of composite-to-metal research in automotive applications
By Angie McPherson

The main focus of modern automotive lightweighting research is to develop hybrid material automobiles – where different material components are selected on a functional basis to exploit the best characteristics of each material. In order to develop the next generation of multi-material automobiles, research laboratories like the Laboratory for Materials and Joining Technology (LWF) at the University of Paderborn in Germany are working with the auto industry to solve the technical barriers in joining dissimilar lightweight materials in high-volume, cost-effective ways for future automotive production.

“This is the first time composites are being used as structural automotive structures, previously only seen in motorsport or mainly for use in the outer skin or non-structural components,” says Dr. Gerson Meschut, PhD, director of the LWF. “Now with composites moving into serial production cars, automotive suppliers need to think about suitable joining technologies. Our main challenge is there are no technologies available to join these materials as easily as sheet metal.” Composites will be a key material moving forward and advance hybrid-joining techniques just might be the key to address the technical challenge of joining large composite structures to other lightweight metals.

Dr. Meschut has been researching joining methods in automotive applications for more than 15 years and has worked for and with various automotive companies around the world to develop efficient joining methods. Meschut predicts hybrid joining - a combination of adhesive bonding, mechanical joining and welding - and similar technologies will lead the way for faster and cheaper methods. Several laboratories around the world, including his lab in Germany, have recently started the practice of investigating new hybrid techniques for faster production times.

Addressing technical barriers
Kim Hamner, engineering director at Continental Structural Plastics, has been involved with the automotive composites industry since exterior sheet-molded compound (SMC) body components were becoming viable options on cars other than the Corvette over 40 years ago. She has been developing applications

“Our main challenge is there are no technologies available to join these materials as easily as sheet metal.”
for composites to reduce vehicle weight ever since. “Basic joining methods have not changed significantly since the architecture of vehicles has not changed over the last 20 years,” says the composite manufacturer. “To connect to the structural parts of the vehicle, we will need to develop structural adhesives and as well as assembly techniques to take advantage of the lighter weight composites.”

Hamner is referring to the techniques most automotive manufacturers are using today – typically mechanical joining, adhesive bonding or a combination of the two – to join composites to other materials. Each method is selected depending on the application of the part and has a unique set of benefits and limitations. For example, mechanical joining is historically used to join steel parts, which requires drilling or cutting holes into the composite piece effectively limiting stress redistribution in composite components.

Adhesive bonding is the most common method of composite-to-composite joining, but the technology takes time to cure. “Slow processing time is the main reason automotive companies prefer mechanical joining,” says Dr. Meschut. “Additionally, some manufacturers trust adhesive joining, while others feel more comfortable with mechanical joining.” To be absolutely safe, automotive companies have been adding additional mechanical bonds to the adhesive joint – which is why a new method, known as hybrid or fusion joining, is a popular research topic. The theory is that even if the adhesive fails, the joint will work.

**New developments in European hybrid research**

Metal joining techniques, like spot welding and self-piercing riveting, have cycle-times of approximately 3-5 seconds from spot to spot. LWF researchers would like to reduce the time it takes to join composite structures to be competitive with traditional sheet metal assembly times. Addressing the problem of composite joining for production vehicles, Merschut will present his findings at the 2012 International AVK Conference, taking place October 8-9, 2012, in Düsseldorf, Germany. His presentation will cover the development of the material and design in the automotive industry as well as the future challenges for joining technologies.

“Besides self-piercing or self-drilling joining elements, we have at least three interesting new technologies being introduced at the lab. One new development is with ONSERT technology,” says Meschut. ONSERT is a joining method developed by one of his previous employers; Böllhoff GmbH & Co. KG in Bielefeld, Germany. ONSERT is a fast joining method that uses a light curing adhesive to adhere a threaded bolt to the surface of a carbon fiber structure within a few seconds. Another hybrid method being researched at the lab involves a new thermal mechanical joining technology, which is a combination of resistance spot welding with a rivet. A similar joining method is also being explored by the U.S. Council for Automotive Research, LLC (USCAR).

Researchers at the LWF are also investigating the use of a high-speed joining technology using nailing technology. “This method called RIVTAC, also developed with Böllhoff, inserts a kind of nail with a pistol, similar to the technology people have seen in automobiles.”
The Structural Composite Underbody Project

In the U.S., Oak Ridge National Laboratory (ORNL), the Automotive Composites Consortium (ACC) of the United States Council for Automotive Research (USCAR), whose members include Chrysler Group, Ford Motor Company and GM, and Multimatic Engineering, LLC, recently developed testing and modeling methodologies to predict the effects of mechanical loadings and environmental exposures on the durability of an automotive composite-to-steel joint. This project was conducted in support of the ACC’s Composite Underbody project. According to ACC researchers, the focus of the project was the joining of a structural composite underbody to the vehicle structure.

“Another objective was to generate an experimental database of the multi-material joint’s performance and durability under various load and environmental conditions to support and validate the modeling approach,” says Barbara Frame, a research staff member at ORNL. “This effort was an iterative process between analysis-and-test. Both weld-bonded and adhesively bonded joint specimens were used in this study.”

Weld-bonding, a hybrid-joining technique that uses a combination of spot welding and adhesive bonding, was selected for ACC’s Focal Project 4 because it met the needs of the existing high-volume automotive manufacturing environment where welding is the most commonly used joining technique. The automotive industry has previously used weld-bonding to join steel-to-steel, but not for joining composite-to-steel. “Prior investigations conducted by the ACC and Multimatic Engineering, LLC, suggested that the concept of using a steel doubler to enable spot welding to the surrounding steel structure would mitigate peel stresses in the joint during loading, while the adhesive would enhance the joint’s fatigue life, improving joint durability,” says Frame.

The researchers created custom specimens and conducted quasi-static and cyclic fatigue tests over a range of temperature and load conditions in order to validate the models developed and evaluate the joints’ durability. In a number of cases, the weld-bonded joints out-performed the adhesive-only specimens, and met the automotive industry’s objectives for non-joint failures. The physical tests confirmed that the spot welds delay separation after the adherent and/or adhesive has failed. “This suggests there may be potential for further optimization of this type of joint design in future efforts in order to achieve greater weight savings,” says Frame.

Composite underbody structure developed by the ACC.
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This summer, physicists at the European Organization for Nuclear Research (CERN) announced a discovery that could answer fundamental questions about the universe, and they couldn’t have done it without composites.

The Higgs boson, a subatomic particle that could explain the origin of mass, was discovered at the Large Hadron Collider (LHC), the world’s largest particle accelerator, with help from the ATLAS Experiment, a particle detector used to measure the collisions made by the LHC.

When protons slam into each other, they create hundreds of other types of particles. The ATLAS Experiment uses layers of sensors to measure properties such as the trajectory and momentum of the particles. As the particles pass through the sensors, which are generally made of silicon, they create a charge, allowing the sensors to take snapshots of what’s happening at a precision of about 10 microns, or about one-half of one-thousandth of an inch, at intervals of 25-billionths of a second.

“The data is filtered and then eventually recorded and analyzed by computers all over the world,” says Murdock Gilchriese, a senior scientist at the Lawrence Berkeley National Laboratory (LBNL), one of many labs around the world that collaborate with CERN. He is part of a team that works to create carbon fiber composite structures to support the sensors inside the ATLAS Experiment.

Carbon fiber composites were chosen for this important task in part because they have high strength but low mass and low weight, which helps reduce interference between particles and matter inside the detector.

“The particles that go through matter don’t just go through matter; they interact or scatter,” Gilchriese says. “The lighter the material, the less they do that.”

Carbon fiber also has high thermal conductivity, which comes in handy because the sensors inside the detector function best at low temperatures, around –10 to –15 C. The composite structures help to channel heat generated by the collisions away from the electronics to a thin-walled metal tube filled with coolant. New types of carbon fiber structures are needed for the next generation of upgraded tracking detectors planned for the CERN experiments.

The structures themselves are like sandwiches of carbon foam and carbon fiber to which sensors are glued. They begin with low-density glassy carbon foam, which has thermal conductivity that is not much better than that of air. California-based Allcomp Inc. then processes the foam with a chemical vapor deposition heat treatment to add layers of carbon to the native carbon foam. This process increases the foam’s density to around 0.2 grams per cubic centimeter, improving its thermal conductivity by more than 200 times. The foam is made in blocks that are then sliced into sheets and machined to the lab’s specifications.

Gilchriese’s team uses a three-ply lay-up of carbon fiber, with two plies along the length, in a 0/90/0 layer. They then stack...
These carbon fiber composite structures made at the Lawrence Berkeley National Laboratory will support sensors inside the ATLAS Experiment, a particle detector at CERN.

three sheets of the pre-impregnated carbon followed by the foam inside an autoclave and elevate the temperature. This all-in-one process forms the layers of carbon fiber and attaches them to the foam. It also turns out the lowest weight.

Most of the composite structures are made at LBNL due to the one-off nature and exacting standards required by the project, Gilchriese says. The biggest challenge in designing these structures is reducing their weight while maintaining their thermal performance and reliability, Gilchriese says. His team also has to contend with high levels of radiation inside the detectors and extreme temperatures fluctuations, ranging from room temperature to as low as −40°C.

But after years of work, they have proven that composites can stand up to the test.

“The development of using composites in these big experiments has really grown over the past decade,” Gilchriese says. “These experiments at CERN have demonstrated that it works and that it works very well. The next generation of upgrades will feature more and more exotic techniques.”

Jamie Hartford is a freelance writer based in Los Angeles. Email comments to jhartford@gmail.com

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At the Core of Change

Core materials offer a wide range of properties and benefits for composite manufacturers. However, research labs, universities and supplier companies are continually expanding, adapting and answering the demands of new composite applications.

Greener, Quieter Sandwich Composites

Three composite manufacturing researchers from the University of Delaware investigated the material properties of cork-sandwich composites and concluded that cork shows significant promise for use in aerospace, commuter rail and wind-energy technology. Dr. Jong-hwan Suhr, an assistant professor in the university’s Department of Mechanical Engineering and affiliated faculty member of the Center for Composite Materials (CCM), said the most important discovery was finding just how well natural cork reduces sound transmission and vibration when used in cork-sandwich composites.

During the research project, Suhr served as an advisor to the lead researcher, Arthur James Sargianis, who completed his master’s degree in mechanical engineering at the University of Delaware in May 2012. Sargianis took first-place honors at the 2012 Society for the Advancement of Material and Process Engineering’s National Student Research Symposium for his paper, “Natural Material Based Sandwich Composites with Enhanced Noise Mitigation.” Published in 2012, the paper detailed Sargianis’ findings as he researched the potential benefits of using cork as a core material.

Sargianis’ research with cork was selected from a group of six finalists in the U.S. in the master’s degree category, according to the university. A third team member, Hyung-ick Kim, is also a postdoctoral researcher at the CCM and an expert in mechanical characterization of advanced materials.

“After researching with natural materials, we found that cork had interesting properties that we need to improve the acoustics,” Suhr says. Traditional composite beams radiate noise at a very small frequency range — around 2.5 kilohertz whereas aluminum beams begin radiating noise at five kilohertz. “We tested the cork core material in a sandwich-composite configuration and found that it virtually doesn’t generate any noise.”

The team had several goals in mind for the research project, says Suhr. One was improving the acoustical properties of sandwich composites so that less noise is transmitted. A secondary goal was reducing vibration and a third priority was to incorporate “greener” materials that lessen the environmental impact.

The academic team also explored the underlying mechanical properties that contribute to poor acoustical performance in sandwich composites. “If the wave speed is faster than the air, then it radiates all noise from the sandwich composite structure,” Suhr says. In order to slow down the wave speed in a structure, the team surmised that a certain set of physical properties must be in place for solving the problem, and cork possessed those properties, he says.

“We think the cork has a nice green story because it is renewable, but it also has very good fire and smoke toxicity properties, which is Mother Nature working for us once again,” says Richard O’Meara, president of Core Composites, Inc., a division of ROM Development
Corporation, in Newport, R.I., which provided the team with the cork materials.

Suhr says the lighter material fits the bill for aerospace engineering because the current strategy of insulating the fuselage with fiberglass increases weight. There is also less vibration with cork, he says, which makes it a good candidate for wind-turbines. As it’s a natural insulator, applying cork material to the manufacture of wind turbines would also reduce the build-up of ice on turbine blades, thereby reducing the risk of injury or property damage, should a turbine blade spin off sharp pieces of ice, Suhr says.

Core Composites is the exclusive North American agent for Amorin, a Portuguese-based company with a whole division solely devoted to developing acoustical applications for cork. The team’s cork composite research had never been that well documented, especially on carbon-skin composites, says O’Meara. “To have that kind of acoustic reduction is something that we would expect, but it was never really quantified.” The team also explored the impact resistance of cork composites.

Suhr is now investigating ways to make efficient use of the particles of cork left over from processing cork for other applications. Cork processing produces cork granules and those granules contain a natural resin, he says. The waste from cork processing can be recycled into manufacturing a 100 percent bio-friendly particulate composite material bonded together with natural resins, instead of polyurethane, he says.

Cork is a big focus for them now, says O’Meara. His company is integrating cork into a plywood-type product, which will reduce the weight of the composite material by almost 40 percent. “We have so many programs going with so many diverse types of composite applications—from residential homes, all the way through to aircraft interiors. It’s kind of a fun product.”

Jan Fletcher is a freelance writer based in Spokane, Wash. Email comments to Jan.fletcher@me.com.

New Advantage for Polyester Cores

3A Composites, a material supplier based in Cham, Switzerland, launched a new surface sealant for polyethylene terephthalate (PET or polyester) foam cores called AIREX SealX at the 2012 JEC Show in Paris. SealX reduces the amount of resin absorbed by the foam, thus significantly lowering the weight and cost of manufacturing composite sandwich parts in resin infusion processes.

“We can now reduce the resin taken up by the core’s surfaces during infusion processes by about 50 percent, relative to our uncoated AIREX T92,” says Marc Anderson, director of sales and marketing at Baltek Inc., a subsidiary of 3A Composites. “The reduction in resin will reduce overall weight and fabrication costs of the end product, two targets that are very high priorities for our customers.”

The new technology was recently demonstrated by 3A Composites customer Pauger Yachts. In early July 2012, AIREX T92 SealX was used to reduce the weight of its winning Balaton Blue Ribbon Regatta 50-foot catamaran. The carbon fiber and epoxy sandwich composite hull infused with AIREX T92 SealX technology helped the team reduce the weight of the boat and complete the course in record-breaking time. Several other composite products including wind turbine rotor blades have been built using the sealed foam. According to Anderson, many other projects are in the pipeline. “We expect that over time this product will result in a change in the marketplace in favor of PET core materials.”

Angie McPherson is the communications coordinator at ACMA. Email comments to amcpherson@acmanet.org.

To read more about the core material advances at 3A Composites, visit CM Online at www.compositesmanufacturingblog.com.

Fraunhofer Institute Develops GFRP Sandwich Material

The Fraunhofer Institute for Chemical Technology (ICT) in Pfinztal, Germany, has developed a glass fiber reinforced polyurethane (GFRP) sandwich material that can reduce the weight of train and automobile components. The resilient material can withstand extreme stresses and makes components 35 percent lighter than their steel and aluminum counterparts, according to the research organization.

In order to test the material strengths of GFRP, Fraunhofer ICT worked with Bombardier Transportation Corporation, in Newport, R.I., which provided the team with the cork materials.

Suhr says the lighter material fits the bill for aerospace engineering because the current strategy of insulating the fuselage with fiberglass increases weight. There is also less vibration with cork, he says, which makes it a good candidate for wind-turbines. As it’s a natural insulator, applying cork material to the manufacture of wind turbines would also reduce the build-up of ice on turbine blades, thereby reducing the risk of injury or property damage, should a turbine blade spin off sharp pieces of ice, Suhr says.

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30 Composites Manufacturing

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GmbH, KraussMaffei Kunststofftechnik GmbH, Bayer MaterialScience AG, DECS GmbH, the DLR’s Institute for Vehicle Concepts, the University of Stuttgart and the Karlsruhe Institute for Technology to manufacture a diesel engine housing for passenger trains. The composite diesel engine housing demonstrator is located beneath the passenger compartment, between the car and the tracks. It shields the engine from flying stones and prevents oil from escaping. In the event of a fire, it also stops the flames from spreading, thus meeting the flame retardant and fire safety standards for railway vehicles.

The diesel engine housing developed by the Fraunhofer Institute and its partners features a sandwich structure with GFRP in the outer layer and honeycombs as a core structure. It was manufactured using an automated polyurethane fiber spraying process.

Before the involved researchers started manufacturing the engine housing, they first altered the composite material properties to ensure the engine house would meet safety standards to the same capacity or better than the current metal counterparts. They started incorporating various additives to the polyurethane resin to maximize strength and fire retardant properties.

Next, the team optimized the standard manufacturing process — fiber spraying — by developing a new mixing head that allows manufacturing more complex structures. Additionally, they determined the precise thickness of the face sheets of polyurethane-based sandwich structures. Therefore, the researchers opted to use computer topography to inspect manufactured layers, then apply a specially-adapted evaluation routine to establish their exact thickness. This allowed the team to gain information on the strength of the component and its ability to withstand stresses.

Finally, the team was ready to manufacture a strong composite diesel housing. After nearly four years the team produced the first diesel engine housing demonstrator as part of the PURtrain project, which is funded by the German Federal Ministry of Education and Research. The diesel engine housing they produced is approximately 15 x 6.5 feet and passed its first strength test of the components in late 2011. “The project was a success,” says Professor Frank Henning, Head of the Fraunhofer Project Centre for Composite Research (FPC) at Western University in London, Ontario, “quite a transfer of lab know-how into industrial application.”

The demonstrator needs to pass a field test, which is currently on hold awaiting for a response from the Railway Supervisory Authority, says Tobias Potyra, researcher at the FPC. If that’s successful, the GFRP sandwich material could be used to make roof segments, side flaps and wind deflectors for the car and commercial vehicle industry.

Susan Keen Flynn is a freelance writer based in Cleveland. Email comments to sflynn@keenconcepts.net.

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Marketing Tips for Your Business

By Todd Hockenberry

Inbound marketing is the art of being found by the people who are already interested in and trying to learn about your industry. In a series of articles I will discuss how you can best use social media, blogs, search engines, and your website to direct prospects to your products and services.

To give you an idea of what I’ll discuss, did you know there are three big reasons to consider inbound marketing? It has a lower cost per lead, improved lead generation and improved close rates. These trends are becoming more important with the fact 44 percent of direct mail marketing is never opened. An inbound marketing campaign yields visitors and leads 24/7 so your costs are spread out over a much longer time frame. In fact, according to a study by FOCUS, a market research firm based in Louisiana, it is only in the last third of the sales process that prospects actually want to engage with a sales representative.

How can you overcome that barrier? Go to CM Online’s Online Exclusive page for tips that will benefit your company.

Todd Hockenberry is the president and CEO of Top Line Results. Visit www.top-line-results.com/acma.

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Building the Future America

The new highway funding bill paves the way to increased composites usage

By John Busel and John Schweitzer

Moving Ahead for Progress in the 21st Century (MAP-21), a highway funding bill signed into law by President Obama on July 6, 2012, should result in a significant increase in market opportunities for composite highway components such as bridge deck panels, girders and reinforcing bar for concrete bridge decks. This new $118 billion, 27-month piece of legislation comes 1,010 days after the last surface transportation bill, SAFETEA-LU, expired and will fund programs until September 2014.

The importance of MAP-21 to the industry is that it includes a provision for state and federal Department of Transportation (DOT) officials to assess overall lifecycle cost analysis — but it doesn’t specify the use of composites, which has the potential of being either beneficial or ineffectual for the composites industry. For example, the legislation will require states to establish goals and measures for highway system safety, condition and reliability. Left intact, the bill could result in additional contracts for composites; however if competitive materials should influence the writing of the new standards to eliminate the use of composite components, it could have no effect on future contracts.

States will also work toward goals for freight movement and economic viability, environmental sustainability, eliminating delays in project development and delivery, reducing regulatory burdens and improving state agency work practices. Overall, the bill makes significant programmatic reforms by consolidating federal programs in an attempt to make them more competitive and streamlines the environmental review process to speed project delivery. The bill also provides $400 million for transportation research and authorizes 35 competitive grants provided annually for University Transportation Centers.

ACMA and its member companies, organized under the Composites Growth Initiative (CGI) Transportation Structures Council (TSC) and the FRP Rebar Manufacturers Council (FRP-RMC), worked for several years to promote the use of composites as a solution to unreliable and expensive to maintain highway bridges for program decision makers. This included promulgation of standards by national organizations, education of state and federal DOT officials and education of Congressional offices through dedicated fly-ins on the need to include the lifecycle cost performance of highway structures. Since members of Congress are
comfortable with using modern cost-effective technology in highway systems, ACMA must now work with the Federal Highway Administration (FHWA) as they set standards for lifecycle cost assessment (LCCA) and with state DOTs as they implement those standards.

Under MAP-21, the FHWA, in consultation with states and other stakeholders, will establish performance measures for pavement conditions and performance for the Interstate and National Highway Systems (NHS), bridge conditions, injuries and fatalities, traffic congestion, on-road mobile source emissions and freight movement. States will set performance targets in support of those measures, and state and metropolitan plans will describe how program and project selection will help achieve the targets.

States will report to FHWA on progress in achieving targets. If a state’s report shows inadequate progress in some areas, the state must undertake corrective actions. In addition, due to the critical focus on infrastructure condition, MAP-21 requires that each state maintain minimum standards for interstate pavement and bridge condition. If it falls below either standard, it must spend a specified portion of its funds for that purpose until the minimum standard is exceeded.

One of the challenges of this bill will be to further communicate the LCCA benefits that composites offer large infrastructure projects. Currently there is not one standard approach that all DOTs use. Before the inclusion of the LCCA provision, highway project managers were accustomed to reviewing the budget by individual line item costs. Understanding and characterizing the extra costs that competitive materials add to a project, such as work zone delays, will be a challenge for the DOTs. However, the MAP-21 bill puts provisions in place to standardize LCCA, putting the onus on DOTs to learn and apply the system.

ACMA’s TSC and FRP-RMC member companies are expected to participate in FHWA activities to develop standards, measures and goals for asset management and lifecycle analysis, and to continue promotion of composites as a solution for highway sustainability. To get involved in this important process, contact ACMA at 703-525-0511.

John Busel is the ACMA’s director of Composites Growth Initiative. Email comments to jbusel@acmanet.org.

John Schweitzer is ACMA’s director of Government Affairs. Email comments to jschweitzer@acmanet.org.

The MAP-21 Establishes Performance Basis:

- States are required to develop a risk- and performance-based asset management plan for the National Highway System (NHS) to improve or preserve asset condition and system performance. Plan development processes must be reviewed and recertified at least every four years. The penalty for failure to implement this requirement is a reduced Federal share for NHPP projects in that year from 80 percent to 60 percent.
- FHWA will establish performance measures for Interstate and NHS pavements, NHS bridge conditions and Interstate and NHS system performance. States will establish targets for these measures which will be periodically updated.
- MAP-21 also requires minimum standards for conditions of Interstate pavements and NHS bridges by requiring a state to devote resources to improve the conditions until the established minimum is exceeded. FHWA will establish the minimum standard for Interstate pavement conditions, which may vary by geographic region. If Interstate conditions in a state fall below the minimum set by FHWA, the state must devote resources (a specified portion of NHPP and STP funds) to improve those conditions. MAP-21 also establishes the minimum standard for NHS bridge conditions – if more than 10 percent of the total deck area of NHS bridges in a state is on structurally deficient bridges, the state must devote a portion of NHPP funds to improve conditions.
**Your Association Supporting Your Business**

**Government Affairs:** No company could come up with the hundreds of thousands of dollars that are needed annually to have a Washington presence. ACMA uses its resources to educate Members of Congress, their staffs and federal agency officials about manufacturing safely with styrene. A key component of our success has been the numerous ACMA companies that have weighed in with their Members of Congress — no company can have a presence in every Congressional district.

**Market Growth:** How much of your resources are you spending on educating customers about why they should choose composites over another material? With a robust industry marketing campaign the answer should be “zero.” ACMA is working to create standards that will level the playing field when you compete with other materials. Segments of ACMA’s membership are working on and have completed industry standards as well as building and other codes that ease barriers to using composite products.

Education and Information: Can your company put together two days of educational programs with top technical and corporate industry leaders? That’s what ACMA presents annually at COMPOSITES: THE premier conference and convention. In addition, you have the opportunity to meet with all the major suppliers in the industry at one time ACMA also provides a cost effective way for companies to train their employees through its Certified Composites Technician (CCT) programs, which brings you best practices from across the industry.

Industry Insight: ACMA’s communications platforms connect you to the latest news affecting your business and connect you with innovators (and their products) throughout the industry. You get all of these insights from **CM magazine**, its associated e-newsletters CM Interviews and Industry Digest, CM Online blog and social media sites – plus our members-only e-newsletter, Insider.

I’d say that’s not bad for your contribution in dues! In addition, if you contribute your time, you get the benefit of building a network of peers who will give you insights into your business and connections to the latest trends. So get involved today, contact member services at 703-525-0511.

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  - Stephenville, Texas
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  - Mitchell, S.D.
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### The deadline for the 2013 COMPOSITES Call for Presentations.

Submit your Technical Paper abstracts and Education Session descriptions online at acmashow.org.

### Representives of 12 ACMA member companies and association staff met with senior OSHA officials July 18 to discuss the agency’s policy allowing weight-of-evidence assessment to formally classify the cancer potential of workplace chemicals. Read more about this important issue at acma-regulatory.wikispaces.com.

### September 7, 2012

- **John Carpenter**
  - gave a presentation on FRP composites used in infrastructure to over 70 DOT engineers from 11 states in the northeast.

### September 14, 2012

- **CGI Director John Busel**
  - gave a presentation on FRP composites used in infrastructure to over 70 DOT engineers from 11 states in the northeast.
Industry Digest

800x Stronger.
Tidal energy gains momentum after study proves water is 800 times more energy dense than wind.

75 pounds.
Human-powered helicopter at the University of Maryland employed carbon fiber trusses to reduce weight to 75 pounds.

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22 miles.
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Q&A
John Hennessey builds the fastest cars in the world. His company manufactures the Hennessey Venom GT, the fastest American composite supercar and is recognized as one of the most important innovators in the American automotive marketplace. Find out his view on composites.

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