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I am excited about this issue of Composites Manufacturing focused on green composites and manufacturing plants. I am not talking about the color, of course, but how our products affect the environment around us. This is an important issue for us to tackle collectively.

We have always had to overcome arguments about how environmentally “unfriendly” composites are because they last so long, don’t bio-degrade and so on. In this issue, you will read about several ways that our products are, in fact, becoming more green. This includes alternative energy applications, environmentally friendly manufacturing plants and composites recycling.

Before you turn to those articles, I want to comment on several eco-friendly efforts being spearheaded by ACMA. One of our Composites Growth Initiative (CGI) committees is the Green Composites Council (GCC). One of the projects completed by the GCC is compilation of Life Cycle Inventory (LCI) data on materials and composite production processes. This information can be used to generate Life Cycle Assessments (LCAs) of composite materials. And LCAs can demonstrate that composites may be less expensive to manufacture, install and use over a lifetime: They provide a great way to take what some folks see as a strike against composites – their longevity – and turn it into a positive attribute. For more information on the LCI, visit acmanet.org/resources-tools/lci-comparison-tool.

The GCC also has a Recycling Committee that aims to find novel ways for us to reduce, reuse and recycle all aspects of our composite manufacturing process. This committee is looking for solutions for everything from finished parts at the end of their lives to leftover raw materials.

Volunteers are at the heart of the Green Composites Committee. Your association cannot function without strong participation from our member companies, from the largest suppliers to small manufacturers. We need volunteers from both ends of the spectrum. I respectfully ask that you look at the list of committees for the CGI – or other areas of ACMA operations. Find one that interests you, then just jump in. You will get as much out of it as you put in.

Jay Merrell
Norplex-Micarta
ACMA Chairman of the Board
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Clean Greener

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Controlled Spray and NARA

New This Year:
Composites Manufacturing debuted a new “Best Practices” column in 2015. Each issue, an industry expert will serve as guest columnist, presenting manufacturing techniques and methods you can apply to help achieve optimal results.

Controlled spray and non-atomized resin application (NARA) are best practices that apply to open molding processes, including gel coat application. These practices were developed by ACMA to reduce emissions during the open molding process and should be viewed as “lean” or “green” initiatives in a manufacturing operation.

The benefits of controlled spray are described in ACMA’s Certified Composites Technician (CCT) Open Molding program as follows: “While emissions can be reduced with lower styrene content resins, shorter gel times and the use of suppressants, the single greatest effect in reducing emissions is controlled spraying.” Controlled spraying is a method of increasing material transfer efficiency and reducing styrene emissions through minimization of atomization and overspray loss. This is accomplished by three means:

• Operation of the spray gun at the lowest applicable fluid tip pressure,
• The use of proper spray gun handling techniques, and
• The use of close capture mold configurations that minimize overspray surface area.

While reducing styrene emissions is important in any composites operation, controlled spray has the additional benefit of reducing waste and other non-value activities associated with overspray. The work area will require less frequent cleanup, and personal protective equipment will stay cleaner and can be

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used longer before it needs to be replaced.

While controlled spray focuses on the open molding process, NARA is based on the equipment design and proper operation of the equipment. NARA is referenced in the Composites Maximum Achievable Control Technology (MACT) Standard with the following requirements:

   Equipment must have documentation provided by its manufacturer or user that the design of the application tool will qualify as non-atomizing resin application (NARA).

The equipment must be operated according to the manufacturer’s direction, including instructions to prevent the operation of the device at excessive spray pressure.

When selecting NARA equipment, it is important to know the flow rate requirements – or amount of material that will be sprayed in a given period. The flow rate is primarily controlled by the size of the spray tip along with pump pressure, resin viscosity and resin temperature. The flow rate requirements are determined by the part size and geometry.

Smaller parts with detailed shapes may be easier to spray with lower flow rates using smaller orifice spray tips. Large parts with simple planer surfaces can be most effectively made with larger orifice spray tips on spray systems that deliver higher volumes of resin at lower spray pressures and utilize high-volume glass choppers.

The proper fluid pressure at the spray tip is impacted by many variables including, but not limited to: equipment design, resin or gel coat properties, operating conditions and equipment setup. It is important to remember that the objective of NARA is to set up the spray gun to operate at the lowest effective pressure. Training your operator to follow the equipment manufacturer’s directions is the best way to meet this Composites MACT requirement.

The best practices of controlled spray and NARA were developed by ACMA to meet regulatory requirements. The benefits of these practices have been substantiated in stack tests and employee monitoring for styrene exposure. These best practices have the additional benefit of being lean and green.
Few would expect to see a camel, the workhorse of the desert, floating in water.

A different sort of camel will do just that as the workhorse berthing the fleet of naval submarines. The Navy’s Universal Composite Submarine Camels, made by Kenway Corporation, are structures that maintain separation between a submarine and a waterfront facility, preventing damage and absorbing energy as tides, currents, winds, waves or other ships pass by.

Traditional camels (wood, steel, concrete) have had to contend with environmental and weathering concerns, leading to significant maintenance and replacement issues. Kenway’s composite camels, made with CCP’s EPOVIA® Vinyl Ester resins, benefit from outstanding resistance to water, acids, alkalis, solvents and other corrosive materials, even at temperature extremes.

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FRP Filters Pass the Smell Test

People living near wastewater and sewer treatment plants often complain about the odors that emanate from them. Now some of those plants are becoming better, less odiferous neighbors. The FRP biotrickling filters (BTFs) supplied by California-based Daniel Company are helping to eliminate noxious odors in an environmentally friendly way by capturing fugitive emissions and putting them through biological air scrubbers.

The wastewater treatment process releases hydrogen sulfide and other volatile organic compounds that can be poisonous in high concentrations and that have a very distinct, unpleasant smell. Treatment plants in Europe have been using BTF-type technology for many years, but it’s only during the last five to 10 years that it’s been embraced by U.S. facilities.

“In the past, wastewater treatment facilities in the U.S. have used reagents – a combination of sodium hydroxide and sodium hypochlorite – in what is called a wet pack tower,” says Tim Malki, Daniel Company president. These chemicals break down the odorous compound hydrogen sulfide in the emission into free hydrogen and free sulfur elements. Wastewater treatment plants may also use carbon to absorb volatile organic compounds (VOCs). Both processes require the storage and use of large quantities of chemicals and activated carbon.

“These systems are not necessarily eco-friendly,” says Malki. “So what’s been developed in Europe is a means of using a bio-organism called Thiobacillus bacterium that’s found in great proliferation throughout the wastewater treatment plant. The strain feeds on hydrogen sulfide and some other long-chain reduced sulfuric compound, breaking them down with very little byproducts.” Daniel Company’s BTF system creates a small ecosystem inside an FRP vessel filled with a special media in which the Thiobacillus bacterium thrives. Europe was an early adopter of the micro-organism treatment system because it made economic sense; the chemicals required for treatment plants are very expensive there. In the United States, however, plants did not use this type of filter in a vapor phase application because they could obtain chemicals at a lower cost.

But things have changed in recent years. “People have become more and more cognizant and sensitive to minimizing their environmental footprint, and the price of chemicals has gone up,” says Malki. “Plus, the storage of chemicals has become more of an ordeal.” Environmental regulations and community perceptions also have altered the way that odiferous discharges are handled. In remote parts of the country, treatment plants previously would vent emissions into the atmosphere with minimal treatment. That is no longer acceptable. So the biotrickling filter provides a way that plants can treat the discharge in a cost-effective, environmentally responsible way.

Daniel Company engineers, designs and manufactures a custom BTF system for each plant based on the volume of cubic feet of air per minute (cfm) that the facility needs to process. In a small facility, where the demand is only 2,000 cfm, the system tank could be smaller than an 8 x 8-foot container and skid mounted. One of the largest biological odor control systems in the country is for the Orange County Sanitation District, Plant 2 in Huntington Beach, Calif. It handles almost 185,000 cfm. That facility consists of 16 biotrickling filters, each 10 feet in diameter and 42 feet tall. “You can see it when you fly over John Wayne airport or on Google Earth,” says Malki. “It’s huge; the whole footprint is larger than a football field.”

Orange County is the Daniel Company’s biggest BTF installation. The BTF serves as the initial filter at this site, sending the emissions it treats into chemical scrubbers for the final cleaning. Use of the BTF filter has reduced the use of chemicals by 90 percent. At another installation in Lubbock, Texas, the BTF has shown a 99 percent efficiency in removing hydrogen sulfide from the emissions. The company has installed BTF systems throughout the United States, most recently in Virginia and Florida.

Each BTF includes tanks, ductwork and dampers engineered to specific sizes, shapes and wall thicknesses. Daniel Company manufactures them from Derakane epoxy vinyl ester resins supplied by Ashland Chemicals. “Ashland is one of...
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our four strategic allies in developing this technology,” Malki says.

The BTF is very labor intensive to construct. “This is not something machine-made,” says Malki. “It’s done by craftsmen who are knowledgeable and who have a lot of experience in the art of fiberglass manufacturing.” For cylinders, the FRP is applied using filament winding techniques; for rectangular structures, they use random chop or hand layup methods.

“There is a 100-mil, resin-rich, highly corrosive resistant inner liner, followed by a glass-rich structural layer,” Malki says. For the final stage, the craftsmen apply a pigmented gel coat with UV inhibitors for aesthetics and for defense against sunlight over time.

Malki says that high-tech composite structures are replacing traditional concrete and metal systems because of the corrosive nature of the wastewater treatment process. Unlike concrete structures, which often require relining within 10 years, the BTF will last 50 years or more with little required maintenance except an occasional coat of paint. It’s also easy to modify FRP systems when a plant needs to make changes.

The bio-organism filter is a good solution for wastewater and sewer treatment facilities looking for a green method of odor control, adds Malki.

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

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The more than 150-year-old London Underground is going green. Part of that transformation involves updating the materials used in its train doors, with a recent award-winning demonstration project showing that lightweight thermoplastics can replace heavy metal in doors.

Passengers likely give doors little thought as they board or exit a train. But using thermoplastics could produce a host of benefits in the “rolling stock” – engines and cars that move on the railway. “Lightweighting the doors has a cascade effect on lightweighting all of the rolling stock,” says Jeff Ive, engineering capability lead at the Bristol, U.K.-based National Composites Centre. The NCC is an independent center that works with companies and universities to develop new technologies for the design and manufacture of composite products.

Improved sustainability benefits begin with the lesser weight of the doors themselves. Then, Ive adds, lighter doors mean less closing force is required, and so the machinery to accomplish that task can be smaller and lighter. In addition, less overall weight of the subway car means that lighter brakes and smaller motors can be used.

What’s more, a lighter train means less track wear and, therefore, fewer closures for maintenance, lowering operating expenses. A lighter door also reduces the time needed to open and close it, leading to a reduction in wait time. Along with fewer closures for maintenance, this increases the number of passengers the subway system can handle by reducing the time the subway train is idle.

Even small improvements could have a significant environmental impact. The London Underground serves more than 1.2 billion passengers annually. Its subway trains log more than 47 million miles a year. Hence, environmental improvements of only a few percent could pay off substantially.

With the goal of lightweighting in mind, a consortium, which included the National Composites Centre, evaluated new door materials. In order to meet safety and regulatory requirements, any door had to overcome some challenging conditions. In particular, the material had to be strong enough to withstand rough handling. The material also had to be flame and smoke resistant, as well as meet toxicity requirements.

One composite that meets such specifications would be a thermoset phenolic resin system, Ive notes. However, a thermoplastic can offer greater resistance to impact while still offering acceptable fire resistance. A thermoplastic is better suited to high-volume manufacturing – greater than 40,000 units a year – than a thermoset, according to Ive. One reason for this is that the processing cycle time of thermoplastics is less than most thermoset polymer resins.

There’s also another reason to go the thermoplastic route – an environmental one. “The thermoforming nature of thermoplastics also makes them more highly recyclable than their thermoset counterparts,” Ive says.
The NCC built prototype doors using polyetherimide (PEI) glass thermoplastic for the skins and internal structure. The doors also feature a lightweight thermoplastic-based glazing. The NCC used a 10-meter high-temperature autoclave for the larger parts.

Ive notes that the high processing temperature required by the PEI composite was a challenge. Standard vacuum bagging consumables can't handle the 300°C temperatures required for part of the processing, while those vacuum bag consumables that could take the heat were not suitable for handling vacuum at lower temperatures. The NCC, therefore, explored using several different techniques and products.

“The design of tooling and use of appropriate materials throughout is of great importance when cycling a material through such a large temperature range,” says Ive. “In the work done around press forming, we found a more robust process through eliminating the requirement for these consumables.”

Some of the intricate internal elements were made using thermoset phenolic composites, but Ive anticipates the door could be completely thermoplastic in full production.

Once the prototype was built, it was static load tested and subjected to fatigue testing. This had two purposes. One was to prove that the door could meet the subway system's requirements. The second was to validate the finite element analysis of the demonstration door done by consortium member Atkins, a London-based design, engineering and project management consultancy. Finally, the prototype was tested to destruction.

A second iteration of the door is planned and may include some design improvements. This next version will be tested as before, minus the destructive aspect. Once complete, the door will go into use on a train to gauge the response of the composite to the subway environment.

As for the all-important goal of reducing the weight, the thermoplastic door is about half the weight of existing metallic ones. Each subway car has multiple double doors, so these reductions in mass add up, particularly when lighter motors, brakes and other follow-on factors are considered.

The thermoplastic subway door demonstration has garnered attention – and prizes. The design won the U.K.'s National Rail Awards Stephenson Award for Engineering Innovation.

“The design has proven that is worth continuing with,” Ive says. “Following further verification of proof of concept it will be worth investing in the tooling and ancillary equipment to mass produce these doors.”

Hank Hogan is a freelance writer based in Albuquerque, N.M. Email comments to hank@hankhogan.com.

For more stories like this, visit CompositesManufacturingMagazine.com and check out the Automotive articles under the “Market Segments” tab.
Many in the composites industry are aware that making use of carbon fiber can greatly decrease one’s carbon footprint, such as through the manufacture of lighter automobiles. But when it comes to green energy, composites are ideal for more than just conserving energy – they also can enable the generation of energy through alternative sources, such as wind and solar.

Major population growth and urbanization are increasing the world’s energy demands. According to the U.S. Energy Information Administration, International Energy Outlook 2013, without action, energy demand is expected to continue to grow at an average rate of 2.2 percent annually until 2020. That may not sound like a lot, but at that pace the world could increase its oil use per year by 20 percent, using more than 300 sextillion barrels of oil per day by 2020. The U.S. alone used approximately 48.7 million barrels of oil per day in 2013, according to Lawrence Livermore National Laboratory.

Rising greenhouse gas emissions from fossil fuel energy are linked to escalating surface temperatures, creating a great need for a range of sustainable energy sources. Composites may not be ideal for every application — for instance, geothermal energy, which uses heat from the Earth to generate energy, requires materials to withstand extremely high temperatures. But for other applications that require moving parts and high corrosion resistance, composites enhance efficiency.

**Towerin Wind Turbines**

People have harnessed wind power for thousands of years to
Airborne Marine’s composite blades, shown here attached to a Nautricity Ltd. turbine, are made without adhesives to reduce maintenance requirements. Tidal turbines can use smaller rotors to generate equal amounts of energy as wind turbines.

Pump water and grind grain. Since the 1980s, the wind industry has grown very rapidly. With today’s technology, wind energy has the potential to generate 20 percent of America’s electricity with turbines installed on less than 1 percent of the country’s land area. “What you’ve seen over the past years is 15, 20, even 25 percent GDP growth a year,” says Chris Skinner, director of product platforms at Owens Corning in Toledo, Ohio. Now that wind is an established technology, the era of hyper growth is ending, says Skinner. But the industry still grows 5 to 9 percent per year.

The movement of turbine blades and their requisite to withstand various weather conditions is what makes GFRP and CFRP composites made with epoxy resins preferred choices for wind energy applications. “They offer the highest level of stiffness to the lowest weight,” Skinner explains. “Composites really fit into environments where you see a requirement for stiffness or corrosion resistance where typically the material is moving.”

These stiffness-to-weight advantages are particularly important as designers create even larger blades. Samsung Heavy Industries has commissioned the first prototype of the world’s largest wind turbine with 83.5-meter blades, currently being tested at the Fraunhofer Institute in Germany. Each blade skin was produced in a female mold using a combination of vacuum assisted resin transfer molding (VARTM), prepreg and hand lamination with DIAB’s ProBalsa150 end grain balsa wood and Divinycell H80 polyurea and polyvinyl chloride for the core materials.

Each turbine can generate 6.2 MW of energy, says Flemming Sørensen, director and general manager of SSP Technology, designer and manufacturer of the blade. The new design will be used in South Korea’s first offshore wind energy project, a construction of 12 units in an 84 MW offshore installation in the Korea Strait.

From Wind to Water

Turbine blades can turn out energy high in the sky or below the ocean’s surface with tidal turbines, a hydrokinetic energy application. Hydrokinetic energy relies on marine currents to generate power, and unlike wind or solar, marine currents hold the advantage of being a constant source of kinetic energy.

Tidal turbines are installed on the seabed at locations with high tidal current velocities. These turbines function similarly to windmills and are made with the same materials, except the rotors can be much smaller than wind turbine rotors to account for water’s being 832 times as dense as air. Smaller rotors and blades can be set much closer together on the tidal turbines and still generate equivalent amounts of electricity to a wind turbine. Still a new market, its focal point is currently in the United Kingdom, France and Canada with worldwide potential.

Installing and maintaining a large underwater device presents its own set of considerations; most tidal turbines sit at least 65 feet below sea level and must withstand intense water pressure. To account for some of these variables, Airborne Marine from The Netherlands chose to design its tidal turbine blades without adhesives.

Most current tidal turbine blade designs are based on two shells bonded together, similar to wind turbine blade design, but Airborne’s engineers think foregoing adhesives will maximize the reliability of the blades. Instead, using double-sided tooling for thick-walled structures, Airborne manufactures its tidal blades as a single, integrated composite part.

“The idea behind ‘one-shot-VARTM’ composite blades is to eliminate the adhesive bonding, as this is an additional risk to the already challenging structural design of tidal blades,” says Peter Coppens, business development manager at Airborne Marine. “Adhesives do not have a track record that currently accommodates the lifetime expectancy requirements of tidal blades – up to 25 years. It is about risk control, thus reliability and robustness.” Airborne engineers also design the blades as slender as possible, as this accommodates the best hydrodynamic performance and energy capture, Coppens says.

In terms of maintenance, the application is still new enough that engineers don’t know the exact needs to consider. “If correctly developed, we currently do not expect issues,” Coppens says. “Re-coating the blades at some point during their lifetime could be required, but even that is to be determined.”

Solar Solutions Shine

While wind is king for alternative energy applications, composites can be applied to more than just turbines. For solar power applications, in which sunlight is converted into electricity, composites are most often used as frames for solar panels. But some companies have found new ways of incorporating composites into the panel itself.

5D Composites in Sarasota, Fla., has created a unique
A round the world, governments are looking to enforce stricter laws on energy use and decrease the population’s carbon footprint. For their part in the effort for a greener planet, the U.S. Department of Energy’s Advanced Manufacturing Office (AMO) focuses on bolstering manufacturing competitiveness for specific energy-intensive industries and making manufacturing practices more energy efficient. The AMO hosts a variety of DOE-sponsored clean energy programs, including two that specifically benefit the composites industry.

One program, the Institute for Advanced Composites Manufacturing Innovation, led by the University of Tennessee, Knoxville, aims to develop technologies within a decade that will allow advanced FRP composites to be manufactured at relevant production speeds and performance for clean energy products at lower costs with less energy used and more recycled materials. The details of specific activities are to be determined, says Mark Shuart, program manager for R&D facilities at the U.S. Department of Energy’s Advanced Manufacturing Office. The institute is currently calling for projects amongst its members. “We’re looking for a strong energy overlay in the development of composites in this institute,” he says.

Shuart notes that composites have clear performance advantages, but driving down cost is another important factor for the institute. “From our perspective, people will not use [composites] technology unless it hits the price point,” he says.

A second program with the Bioenergy Technologies Office recently selected two projects to advance production of cost-competitive, high-performance carbon fiber material from renewable, non-food-based feedstock. Specifically, the projects will research new biomass conversion technologies that enable the manufacturing of acrylonitrile – an essential feedstock for high-performance carbon fiber – for less than $1 per pound.

Using carbon fiber in alternative energy and lightweighting applications can keep down energy usage in the end product, but these renewable carbon fiber projects aim to keep the process of creating carbon fiber green as well. Carbon fiber’s product development process currently requires significant energy and heat, so the researchers hope to discover a method that can produce materials with the properties of carbon fiber in an energy-efficient way. Researchers have also considered other biomaterials, such as lignin, for this purpose.

“People have ideas. We want to give them a forum where topics bubble up, and then we see what we can do to drive the cost down and get those ideas to applications where they make a difference,” says Shuart.

DOE Focuses on Manufacturing Opportunities

ACMA is a supporting member of the Institute for Advanced Composites Manufacturing Innovation. For more information about how to get involved with the Institute, please contact Dan Coughlin, ACMA’s Vice President of Composites Market Development, at dcoughlin@acmanet.org.

composite solar roof tile. The tiles can deliver insulation and waterproofing properties in addition to providing power and are sturdier than traditional clay tiles. The molded composite materials have photovoltaic solar cells attached to the materials’ surface to absorb sunlight.

The tiles are an anomaly for the alternative energy market. While composites are typically found in the frames of solar panels, these tiles do not require frames at all. Plus, the stationary tiles don’t have any moving parts that would call for composites’ non-corrosive properties.

On the ground, fiberglass-reinforced polymers can be found on products such as the “Rocket Dome,” an FRP solar hot water heater manufactured by K-Cor Inc. The system uses an in-ground 200-gallon hot water storage tank made with general-purpose polyester and vinyl ester resins in companion with a variety of fiberglass fabrics. The Rocket Dome uses solar thermal energy, a method of capturing energy from the sun and converting it to thermal energy. “The quadaxial weave of the Saertex fiberglass cloth we use gives us the strength required to store the hot water under pressure for extended periods of time,” says Michael Rock, president of K-Cor. The dome can reduce a household’s water heating bill up to 30 percent and requires no maintenance, says Rock.

Though solar is a smaller market for composites, Rock feels proud of his relatively unique stake in the industry. “[Composites’] relative inexpensive cost has given me a marketplace advantage,” he says. “I find myself looking at everything I see as if it might be made of fiberglass instead of how it is [currently] made.”

Energizing the Industry

When it comes to boosting composites in the alternative energy market, the needs are not much different than other segments. Skinner notes the importance of driving down costs, particularly through technologies that will allow for a more consistent product. “You end up using significantly more composites than you actually need to because of current standards and codes, he says. Innovation would be needed at multiple levels of the composites process – including layer, forming, processing and resin technologies – in order to produce composite parts more
Samsung Heavy Industries has commissioned the first prototype of the world’s largest wind turbine, shown here during construction. Its 83.5-meter blades can turn to produce 6.2 MW of energy.

Consistently and reliably, and therefore with less scrap and costs. “If composite producers and manufacturers can demonstrate consistency of their product, the requirement to overspecify and overdesign the composite part will be reduced,” says Skinner. “That’s really the key driving factor to enable [composites] to grow to a bigger mass market, be it renewable energy or automotive or anything.”

Mark Shuart, R&D facilities program manager at the U.S. Department of Energy’s Advanced Manufacturing Office, agrees. “I would encourage everyone to think about innovative ways of manufacturing composites,” he says. “We have to come up with new processing techniques, new ways of how we get quality composite parts manufactured quickly and consistently.”

Even with plenty of room to grow in the alternative energy market, the already advantageous properties of composite parts will help secure their place in market’s future. Sørensen is confident: “Composites are getting designed into more and more components worldwide.”

Mary Beck is the communications coordinator at ACMA. Email comments to mbeck@acmanet.org.
If someone offered your company a way to triple impact the bottom line of your composites business, you’d likely jump at the chance. Evidence shows that sustainable manufacturing could be that opportunity for composites manufacturers. Many companies undertake green manufacturing because they are pressured to do so by regulators, consumers and shareholders who want them to reduce their impact on the environment. And as the availability and cost of materials and energy fluctuate, operational costs demand more efficient use of resources.

But why should composites manufacturers want to go green rather than feel pressured to do so? There are many benefits coming their way— including sound economic, social and environmental performance. What makes green manufacturing a win all the way around is that it can help composites suppliers and fabricators reduce costs and increase profits. The triple bottom line—financial profitability, environmental integrity and social equity— are business objectives anyone can get behind.

It takes initiative to go green, but the National Association of Manufacturers believes that by encouraging sustainability within their organizations, manufacturers can benefit from innovative, cost-effective technologies and operational improvements. The National Council for Advanced Manufacturing (NACFAM) takes the same line and seeks to guide manufacturers toward sustainable manufacturing that reduces and eliminates negative environmental impacts while at the same time creating economic, revenue-generating opportunities through decreased costs.

What Constitutes Green Manufacturing?
Green manufacturing is a broad initiative that touches on every aspect of a manufacturing business. Building systems,
product design, production systems, office systems and more offer opportunities for sustainable improvement. NACFAM defines it this way: “Sustainable manufacturing is the creation of manufactured products that use processes that are non-polluting, conserve energy and natural resources, and are economically sound and safe for employees, communities and consumers.”

For Brock Elliott, president of Campion Marine in Kelowna, British Columbia, a series of “aha” moments got him headed in a green direction. “Our resin and gel coat supplier approached us in 2009 about testing a bioresin for a fiberglass boat application,” says Elliott. “It was our first experience working with a more sustainable composite. The biorein composite provided better elastic and elongation properties and higher Barcol hardness for our curing process — added benefits to its sustainable characteristics. It had all the properties we were looking for.”

At around the same time, the company was asked to manufacture a biocomposite fiberglass boat equipped with a biodiesel engine so Campion partnered with engine supplier Volvo Penta and delivered the craft in May 2010. Flying back from the client meeting in Ontario, Elliott had an epiphany. What if Campion became the world’s first and foremost green boat builder? What would that mean? How would they do it? That’s when the company’s commitment took shape.

**Developing a Strategy**

Once companies decide to embed green thinking into their culture, it helps to have a framework to analyze current processes and identify new sources of environmental, revenue and cost reduction opportunities: In short, a strategy that helps them to adopt sustainable business practices.

For Kohler Co. in Kohler, Wis., whose kitchen and bath division uses composites to manufacture tubs, whirlpools, shower enclosures and more, the initiative began when senior management made the decision to take social responsibility for its environmental footprint, including its worldwide manufacturing facilities. “We chose to be environmental stewards across all of our business groups,” says Tony Biddle, environment health and safety specialist – beneficial reuse. Kohler Co. focused its efforts in three main areas — waste diversion, energy savings and water usage.

“Each division was charged with looking at their processes and identifying where they produced the largest waste and consumed the most energy and water to identify where they could be more efficient,” says Biddle. Plant operations managers then developed site-specific plans and goals to reduce environmental impacts and achieve corporate sustainability targets.

Kohler Co. established a corporate environmental leadership team to provide guidance and serve as a resource. While external to each division, team members such as Biddle are available to consult and facilitate the sharing of best practices. “If it works in one location, it may work in another, or a new procedure can be developed based on a version of the best practice,” says Biddle.

Biddle secures projects to divert the company’s manufacturing waste from disposal through recycling or reuse. “We are involved with ACMA and the Green Composites Council to collaborate in identifying ways to divert composite-based scrap, trim flash or defective product from reaching landfills,” he says. “Finding ways to reuse or recycle materials such as composites is essential, especially given that competitive materials such as concrete, steel and wood have more established reuse markets.”

Elliott notes that Campion Marine already had practices and procedures in place for lean manufacturing. “We decided to use that as our structure to help us go green,” he says. “We already evaluated everything we did by asking, ‘Is this lean?’ Now we ask, ‘and is it green?’”

A typical sustainability plan starts with evaluation of every aspect of a business to identify and prioritize where the most significant benefits lie. The National Association of Manufacturers suggests that the categories to be evaluated by the plan include:

- Minimizing environmental impacts through the selection of less harmful raw material input.
- Improving the environmental, health and safety profile of operations.
- Improving performance processes to increase efficiency and reduce waste.
- Managing use of materials to provide economic benefits while protecting biodiversity.
- Collaborating and interacting with supply chain members to manage your total environmental impact.
- Building sustainable practices to help support, attract, develop and retain a highly skilled, diverse workforce.

ISO 14000 provides one such framework for reference. A family of standards related to environmental management, ISO 14000 helps organizations minimize how their operations negatively affect the environment and comply with applicable laws, regulations and other environmentally-oriented requirements. It relates more closely to how the product is produced than the product itself.

By setting out the criteria for an environmental management system, ISO 14000 can be used by any organization that wants to improve resource efficiency, reduce waste and drive down costs. It is segmented into an easily understandable framework - Plan/Do/Check/Act/Improve – to make implementation manageable. (For more details about the basic principles and methodology for the ISO 14000 standard, visit iso.org/iso14000.)

Bob Moffit, product manager and LEED green associate at Ashland Performance Materials in Dublin, Ohio, steers composites manufacturers in the direction of the U.S. Environmental Protection Agency’s easy-to-read Bulletin 180/B-09/001, “Smart Steps to Sustainability: A Guide to Greening Your Small Business.” Based on a five-step process, the guide tackles the topics of waste, purchasing, water, energy and transportation. (Access the bulletin at epa.gov/osbp/pdfs/smart_steps_greening_guide_042101.pdf.)

**Materials Are a Good Place to Start**

Materials used by composites manufacturers are one of the highest priority factors to assess. The evaluation should range from any raw materials entering the building for production all the way to the cleaning supplies used by the maintenance
Composites manufacturers can benefit by asking themselves what technologies will help them reduce air emissions and improve efficiencies. One environmental concern in a composites manufacturing process is the emissions resulting from the use of resins and gel coats. Many composites manufacturers are minimizing the use of traditional resins, replacing them with low volatile organic compounds or low hazardous air pollutant (HAP) products.

Kalwall took another path to reduce the VOC emissions from its FRP continual lamination process. The company acquired a regenerative thermal oxidizer from the CMM Group in DePere, Wis., to destroy the air pollutants emitted by their process exhaust stream. The VOC abatement technology uses ceramic-packed vertical canisters as a high-efficiency heat exchanger, holding emissions at elevated temperatures in a combustion chamber. The chemical reaction when the VOC pollutants mix with oxygen destroys the VOC emission by converting it to carbon dioxide, water and heat. The heat is reabsorbed by the heat exchanger and clean, cool air is routed to the atmosphere.

Processes that avoid spray-up and the atomization of coatings and resins such as prepregs, infusion, compression molding, resin transfer molding and other closed molding techniques, not only minimize atmospheric pollution but also reduce waste as there is no overspray and very little waste trimming required.

Where spray-up is necessary, controlled spraying is the goal. Airless spray equipment or high-volume low pressure (HVLP) sprayers operate at about 10 psi to apply gel coat or to wet out dry fiberglass while conventional air spray equipment operates at 60 psi. The use of airless or HVLP sprayers reduces overspray, fogging and bounce-back, thereby reducing material waste and air pollutant exposure to workers. High material delivery rates and high-quality atomization are added benefits.

“Moving from our lamination building to the production floor, we looked at every manufacturing step,” says Campion’s Elliott.

“We manufacture a fiberglass stringer system (the support members bonded into boat hulls) filled with a polyurethane marine flotation foam that is sprayed by one of our workers. He was required to wear a safety suit with a hose-fitted helmet. On the days he was applying the flotation foam to the hull of a boat, we had to shut down that plant area because the foam was so toxic.”

Campion approached its foam supplier with the goal of becoming more green and was introduced to Ecomate®, an environmentally-friendly polyurethane foam blowing agent. “It has no global warming potential, no ozone depletion potential and no volatile organic compounds,” says Elliott. The switch provided a green solution that netted bottom-line benefits and increased productivity. The employee no longer requires a hazmat suit, and the facility doesn’t empty out on the days foam spraying is scheduled.

Mike DiPietro of Kalwall displays the old 1.5-inch diameter light bulbs the company previously used and the new 5/8-inch diameter, high-efficiency T5 fluorescent ones it now uses. T5s use less energy and can save companies as much as 79 percent on lighting costs.
buildings pose such as raw material acquisition; energy use and efficiency; emissions to air, soil and water; and waste generation.

During a presentation at the CAMX 2014 conference, Matt Gindlesparger, chief technical officer of Fresh Air Building Systems LLC, noted the direct relationship between air quality and worker productivity. Fresh Air Building Systems offers its customers an active modular photo remediation system – a green plant-based air filtration system constructed from FRP materials – to improve indoor air quality without the expenditure of energy that mechanical filtration systems require. According to Gindlesparger, plant-based systems can remove 80 percent of VOCs from the air stream and reduce HVAC energy loads by 30 percent.

Suppliers are Part of the Equation
Campion's examination of its supplier base turned up further opportunities for reducing its environmental footprint. “I was pleased to learn that our wire harness supplier was already collecting scrap generated in its process. That scrap is supplied to a manufacturer of industrial hose, keeping it out of the local landfill,” Elliott notes.

Having read about Ford Motor Company’s move to a soy-based foam for upholstery, Campion approached its supplier to see if the material was viable for the marine environment. “Absolutely, was their reply,” says Elliott. “So we made that switch. We continued asking the same kinds of questions of all of our suppliers until we reached the end of our production line.”

The opportunities to execute sustainable initiatives are growing. The end results, a healthy triple bottom line that takes into consideration the financial, environmental and social well-being of the company, provide more than just business success. They also offer a way for owners, customers, shareholders and employees to live healthier lives and gain greater satisfaction in the results.

“We must strive to be good environmental stewards,” says Biddle. “We owe this to the communities we live and work in.”

Patrice Aylward is a communications consultant based in Cleveland. Email comments to paylward@aol.com.
Recycling composites is more than just a good idea. It’s the law – or it may well soon be. In Europe, the Waste Management Regulations of 2006 required cars, which are increasingly composite-laden, to be 95 percent reused and recycled by average weight per vehicle starting in January 2015. In the United States, more communities are pursuing zero-waste-to-landfill policies: San Francisco has set an ambitious goal of zero waste by 2020.

Such moves toward sustainability – of which recycling is just one component – shouldn’t be perceived as all doom and gloom: Composites do, indeed, provide sustainable attributes. “Everything can be recycled,” says Mathieu Robert, an engineering professor at the University of Sherbrooke in Canada. “Any type of thermoset resin can be recycled. Any type of fiber can be recycled.”

The operative word here is can – meaning it is possible. That does not mean, though, that the reuse of material is profitable. Having the technical means to divert material from the waste stream and create recycled material – a recyclate – is only part of the battle. “Finding an end user or product for the recyclate is key to closing the loop on composite recycling,” says Andrea Kraj, an applications engineer at the Composites Innovation Centre Manitoba in Winnipeg, Canada.

A Concrete Demonstration

The University of Sherbrooke and René Composite Materials, a Sainte-Clotilde-de-Beauce, Quebec, manufacturer of unsaturated polyester resin-based composites for the automotive and transportation industries, have partnered to develop and demonstrate a viable recycling process. They began with truck parts after molding. Using a 75-minute cycle in a ball mill grinder, they pulverized these parts into a mixture of small particles and fine powder. Some 80 percent by weight of the recyclate was less than 80 microns in size, roughly the diameter of a human hair.

Tests of the mixture showed that its incorporation into other materials could improve mechanical properties. For instance, completely replacing the calcium carbonate in a composite material with the recyclate increased the tensile strength from 80 to 115 megapascals.

The demonstration showed that use of the recycled powder as filler in composite materials was feasible at a high rate of production. However, the best use of recyclate is not likely to be as a replacement for existing materials, Robert says. Rather, what is likely to make the most economic sense is when the recyclate can be incorporated into, and provide beneficial properties to, a new material.

Robert is working on just such an application by putting
recyclate in a concrete that could show up in bridges and buildings across the globe. The product is in high demand, he notes: “Everybody uses concrete all over the world.”

Robert and his civil engineering colleagues are targeting high-performance concrete. A niche market, it still represents a substantial demand. With concrete facing its own growing drive to improve sustainability, the market for high-performance concrete is likely to expand and could do so significantly.

Recycling Methods

Brian Pillay, an associate professor of materials engineering at the University of Alabama, Birmingham, is the academic lead for ACMA’s Green Composites Council (GCC) Recycling Committee. He notes that recycling can be done by mechanical means, through grinding and maceration. A second approach is through the application of heat to burn or break down a complex substance into something simpler. Finally, there are chemical methods.

Connora Technologies of Hayward, Calif., is developing a new chemical recycling approach. It uses a reversible amine hardener in a thermoset product. In the right solvent, all of the hardener crosslinks break. The fiber and matrix then separate, and the recovered material is a thermoplastic. It’s a case of designing-in the ability for reuse.

Of the available methods, the mechanical approach often uses the least energy. It also does not require disposal of a solvent, which can happen with chemical methods. Finally, heating to break down or burn material can mean that the exhaust has to be scrubbed.

No matter the method, one of the most fertile areas for recycling may be before any material reaches the consumer or even leaves the factory. Manufacturing generates waste. ACMA’s GCC Recycling Committee estimates the overall scrap cost for the composites industry is between $500 and $750 million a year. The total amount of pre-consumer scrap runs anywhere between 5 and 50 percent of a product, depending on the company and application. This means that an airplane manufacturer that uses carbon fiber, for example, could be a prime source of material to recycle.

“There’s a continuous stream of carbon fiber that comes out of their scrap from producing those planes,” says Pillay. “[Airplane OEMs] could guarantee a certain amount of scrap per month.”

The use of manufacturing scrap also minimizes the problem of gathering and transporting material to be recycled. What’s more, the material itself is homogenous, at least as compared to what shows up at a landfill. Thus, manufacturing scrap can be a steady supply of known material that can be collected and processed efficiently. All of these factors make recycling more economical.

This approach also reduces landfill costs, which Pillay says averaged $44 a ton in 2008 in the United States. By 2013, the cost had grown to $50 a ton, a 12 percent increase. Additionally, in order to reduce landfill demands, California and Washington are mandating composite recycling and reuse programs, a trend likely to be joined by other states. Europe also is headed down the same landfill-restricting path.

For his part, Pillay thinks that any commercially successful recycling program that deals with post-consumer or end-of-life products will have to take the incoming stream as it is, with minimal processing. That is, if the material comes in painted, the recycling process will have to deal with this without resorting to stripping the paint.

One approach is to grind up or otherwise mechanically rend incoming scrap and then use it as a reinforcing agent. Pillay has successfully done this in pilot projects for different manufacturers. The key is to adjust the mechanical process so that it produces particles of the right size and properties. These can then be added to another material to create an end product with the right characteristics so as to make the whole process viable.

Grinding Out a Solution

Kraj of the Composites Innovation Centre Manitoba was part of a team that looked at how to economically recycle FRP. The group examined everything from burning to crushing the material, opting to go with the latter because it allowed fiber recovery. Estimates are that this approach salvaged more than 90 percent of the scrap in the form of a mix of fiber, resin, filler and other materials. The recyclate could be used in concrete as a fiber or filler replacement, or in other products. The savings of the recycled product as compared to the cost of the material it replaces were as high as 85 percent.

However, not everything was positive in this case study and
evaluation. For one thing, the usable recyclate was only a small portion of the total. The rest, amounting to three out of every four pounds produced, is currently unusable, although there could be applications in insulation, drywall, ceiling tiles or elsewhere. For ultimate success, this recycling approach will have to find ways to incorporate a greater percentage of the recyclate into the manufacture of more products, Kraj says.

She adds that the case study only looked at part of the total problem. “Both the dry and the cured composites are of interest for recycling; however, our method only looked at the cured scrap from manufacturing,” she says.

### Help Plan the Future of Composite Recycling

ACMA’s Recycling Committee, part of the Green Composites Council (GCC), conducts research on the state of recycling and waste in the industry. It’s currently preparing a pilot project to effectively utilize composite waste streams and drafting a White Paper entitled “Plan for Recycling, Sustainability and Growth of the Composites Industry.” For more information or to join the Recycling Committee, contact John Busel, ACMA’s vice president of the Composites Growth Initiative, at jbusel@acmanet.org.

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An Eco-Wolf grinder can render any rigid composite into a powder with a grain size set by filters, according to the company.

**Get the Whole Picture with an LCA**

For those who think recycling is always the way to go to minimize environmental waste impact, Mike Levy says to consider tuna. It can be packaged in steel cans or flexible pouches. A study that compared cans to pouches found the total solid waste of the steel can system was nearly four times higher than that of the flexible pouch, even though 62 percent of the steel was recycled.

“The flexible pouch, which wasn’t recycled at all because it had multilayers of materials, turned out to have a much lower footprint for solid waste, energy and air,” says Levy, a senior director with the American Chemistry Council and lifecycle issues coordinator with the industry trade group.

Behind such results is the reality that making something takes material and energy. The output includes the product, airborne emissions, waterborne effluent and solid waste. Once manufactured, a product’s use phase begins and that could have a big effect on sustainability. Some products need fuel or require utilities. An example is laundry detergent.

Manufacturers found that most of the environmental burden happened when clothes were washed, which meant that developing cold water detergent significantly lessened the product’s overall footprint.

Even those products that don’t require fuel or utilities can present an in-use environmental load. “How many times do you have to repair or replace that product during its defined use phase? Those burdens add to the overall lifecycle impact of that product,” says Gary Jakubcin, president of sustainability consultants B&G Jakubcin & Associates, Pickerington, Ohio.

A lifecycle assessment (LCA) takes all factors into consideration. Once expensive affairs, such studies are starting to become more affordable because relatively low-cost databases are available. This information can be combined with local data, such as the cost of energy or pollution requirements, to yield a highly accurate lifecycle assessment. ACMA offers several life cycle assessments and environmental reviews on its website at acmanet.org/resources-tools/life-cycle-assessments that provide insight into the impact of composite materials versus traditional materials.

Armed with these results, manufacturers can then decide which route is more environmentally friendly. Jakubcin and Levy note that data accuracy is important, software and consultants are available to make the job easier, and a third-party critical or peer review is vital. They also say that a lifecycle assessment is a key part of any product environmental declaration, increasingly a required part of product documentation.

Consider joining ACMA’s Life Cycle Inventory Committee, which educates and facilitates the development of LCAs of composite materials and maintains a list of publicly available LCAs. Contact John Busel, ACMA’s vice president of the Composites Growth Initiative, at jbusel@acmanet.org.
For the demonstration, the researchers used a machine from Eco-Wolf Inc. of Edgewater, Fla. According to President Sabine Corinna Unger, the company's machines can process virtually any composite material. Through the use of different sized filters, the resulting harvested fibers have characteristic lengths that range from an inch down to a micron. In general, the longer the fibers incorporated into a product, the stronger it is.

Not only is the fiber length important, but so too is the amount of recycled material included in product. “Depending on the manufacturing method used, we can recommend the correct ratio of virgin material versus recycled, which can range from 10 to 100 percent,” Unger says.

She adds that the company’s machines are designed to run for extended periods of time with minimal maintenance and upkeep. For instance, the hammers used are reversible, meaning they have four working surfaces and a longer usable life.

Interest in the company’s technique and recycling in general is growing worldwide, according to Bruce Ogilvy, Eco-Wolf sales and marketing manager. He says an example of this can be seen in a composite recycling center now being set up a customer in San Diego County in California. This effort is driven by the local government’s desire to deal with environmental issues caused by composites going into area landfills, he says. “The amount of waste being generated by composites manufacturers in that area is overwhelming the landfills, and it is imperative they get it under control,” says Ogilvy.

Hank Hogan is a freelance writer based in Albuquerque, N.M. Email comments to hank@hankhogan.com.
With the high-performance composites market, ceramic matrix composites (CMCs) are garnering a lot of attention. CMCs combine a ceramic fiber embedded in a ceramic matrix to produce a finished CMC part. They are sought after for applications with demanding thermostructural requirements.

While your company may focus on more traditional CFRP and GFRP applications, it’s still important to understand and keep an eye on ceramic matrix composites. According to the Freedonia Group, an industry research firm, demand for advanced ceramics in the United States will increase 5.1 percent annually to $13.6 billion in 2017.

Applications for CMCs

Ceramic matrix composites are key enabling technologies for efficient gas turbines for aerospace and maritime propulsion as well as land-based electric power generation, hypersonic, nuclear power and industrial processing applications. The technology for manufacturing CMCs is maturing to the point where domestic and international companies, as well as the federal government, are making large investments to scale up production in the United States and abroad.

Demand for CMCs for commercial aerospace gas turbine engines is one of the principal drivers for these investments. CMCs have the potential to enable a step change in the fuel efficiency of gas turbine engines. In general, the hotter the
engine runs, the better the fuel efficiency. Increases in engine temperature capability have historically been enabled by advances in metal technologies and through thermal barrier coatings. Those advances are rapidly approaching their theoretical limits. CMCs have emerged as the material of choice for many future engines, in large part because their operating temperatures are around 1300°C.

Industry leaders have announced significant investments—construction of new manufacturing facilities, expanded employment and capital equipment purchases—to transition CMCs into commercial gas turbine engines. For example, General Electric is adding jobs at a retooled facility in North Carolina to produce CMC components for its new LEAP gas turbine engine. The company currently has orders for more than 6,000 units. Rolls Royce and Boeing/ATK-COIC anticipate similar investments in the U.S. to produce CMC components for gas turbine engines. These companies consider CMCs critical to meeting demand for greater fuel efficiency in aviation propulsion.

CMC cladding of fuel rods in light water nuclear reactors is another potential large-volume CMC application. Using CMCs in place of, or possibly in combination with, zirconium alloy metal for fuel rods improves accident tolerance because CMC rods can survive longer without active cooling, and CMCs do not generate explosive gasses when they break down. The U.S. Department of Energy is working with industry and academia to validate performance of CMC cladding; however, this is considered a long-term market opportunity because certification for new fuel rod materials will take years.

**CMC Manufacturing Steps**

Much like organic matrix composites, CMCs can be processed in multiple ways and provide material properties that can be tailored by using various fibers and matrix materials, using particular fiber coatings and other processing materials, varying the fiber-to-matrix volume ratio and adjusting manufacturing process parameters. Important material properties for CMCs include maximum use temperature, thermal conductivity, thermal stability, toughness and typical mechanical properties such as strength and stiffness. Qualification of CMCs is no different than that of other materials, requiring significant testing of constituent materials and testing of the CMC under a range of environmental conditions.

The ceramic fibers used in CMCs account for much of their mechanical strength and fracture toughness. Thermal stability for commercially available ceramic fibers ranges from 650°C to 1400°C, leading to operating temperatures for CMC parts in the range of 1300°C for gas turbine engine applications. Fiber characteristics like diameter and mono- or multi-filament yarns are important for handling in the CMC manufacturing processes and are crucial factors for the geometry of the finished part (e.g., maximum bend radius). Ceramic fibers are commonly surface-coated and then spooled for further intermediate processing into fabrics, aligned tapes, 3-D preforms or windings.

Typical matrix materials include silicon carbide and alumina. Matrix material is formed by heat treating multiple layers of prepreg or by infiltrating into a fiber preform at high temperatures using batch processes such as melt infiltration, vapor infiltration and a chemical reaction process that involves infiltration with a precursor polymer or other material and subsequent pyrolysis. Melt infiltration is similar to the chemical reaction process in that a molten metal reacts with a precursor material in the preform to create the ceramic matrix. Selection of infiltration process depends on the choice of materials for the CMC and desired porosity.

Following infiltration, CMC parts are machined to final configuration and then may require coating for additional environmental protection. Fully-densified CMC parts are designed to be as close to final net shape as possible to minimize post machining.

**Manufacturing Challenges**

The market growth of CMCs is currently limited by several factors, including the following:

- High cost
- Challenges with producibility
- Availability of design data
- Lack of modeling and simulation tools
- Lack of trained personnel
- An immature supply chain

Significant investments have been made over the last decade to overcome many of these challenges, with industry leaders having developed proprietary databases to support product development and processes, and material formulations (e.g., surface treatments) to reduce cycle time and increase yield. In 2007, CMC industry leaders generated a technology roadmap focused on producibility and affordability challenges. This updated roadmap ultimately became the Ceramic Composites Affordability and Producibility (CCAP) Initiative.
An Evolving Supply Chain

Ceramic matrix composites are an emerging material with a still-evolving supply chain. Major segments of the supply chain are shown below. Specific supply chains are organized according to the manufacturing process being considered. To reduce risk, system integrators such as GE and Rolls Royce have recently made investments and acquisitions to vertically integrate along parts of the supply chain.

To ensure continued growth and access to a technology considered by the U.S. Department of Defense to be critical for future platforms, a call for proposals was released in 2014 from the Defense Production Act Title III program to establish domestic production of silicon carbide fibers, which are currently imported from Japan. An award was expected in early 2015 so that a U.S. silicon carbide fiber might be available by 2017.

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### Manufacturing Challenges for CMCs Operating Below 1300 C

#### Technical Domains

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started with input from three leading manufacturers: ATK/COI Ceramics, Goodrich (now United Technologies Aerospace Systems) and General Electric Aviation. This led to input from the entire supply chain and government subject matter experts as well as endorsements from the National Defense Industries Association, Aerospace Industries Association and the Gas Turbine Association.

The CCAP initiative considered two temperature regimes – nearer-term CMCs operating below 1300 C and advanced CMCs operating above 1300 C. (A summary of the domains and key technical challenges identified for near-term CMCs is shown in the sidebar below.) Industry and government are continuing to invest in these areas to lower the cost of CMCs.

The U.S. Advanced Ceramics Association (USACA) recently submitted a proposal to the National Institute of Standards and Technology Advanced Manufacturing Technology Consortia
The technology for manufacturing CMCs is maturing to the point where domestic and international companies, as well as the federal government, are making large investments to scale up production in the United States and abroad.

program to update producibility and affordability roadmaps for CMCs and advanced ceramics. If selected for award in 2015, USACA will lead an industry effort to review technical challenges and chart a path forward, potentially creating opportunities in fiscal 2016 and 2017 for new federal and private funding for CMCs.

Glen Mandigo is executive director of the U.S. Advanced Ceramics Association (USACA). Email comments to glen@strategicmi.com. Doug Freitag is technical director of USACA. Email comments to dfreitag@baysidematerials.com.

For More Information on CMCs
To learn more about CMCs and to network with leaders in the supply chain, consider attending the American Ceramic Society Ceramics Expo April 28-30, 2015, in Cleveland. For details, visit ceramicsexpousa.com. The American Ceramic Society also holds its International Conference and Expo each January in Daytona Beach, Fla., and the U.S. Advanced Ceramics Association (USACA) hosts the Composite Materials and Structures Conference each January in Cocoa Beach, Fla. Visit the USACA website at advancedceramics.org.

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CompositesManufacturing 29
John D. Tickle Celebrates 50 Years of Composites Excellence

John D. Tickle, chairman of the Strongwell Corporation, is celebrating his 50th year in the composites industry. After graduating from the University of Tennessee in March 1965, Tickle accepted his first job as an engineer with Owens Corning. He later became general manager of Justin Enterprises in Cincinnati and then plant manager with Krueger Metal Products in Green Bay, Wis. In 1972, he accepted the position of president of Morrison Molded Fiber Glass Company (MMFG, now Strongwell) in Bristol, Va. Thus began his career in pultrusion.

When Tickle took the helm at MMFG in 1972, the company’s annual sales were approximately $1 million. He focused MMFG’s manufacturing efforts on the pultrusion process, and the company has been profitable every year since. Under his leadership, Strongwell has grown to become a world leader in pultrusion. Tickle is known as an ambassador for the process of pultrusion and has been a champion for its value in the composites marketplace.

Throughout the decades, Tickle has received multiple industry awards, including the Pultrusion Industry Council’s Award of Excellence, the University of Tennessee’s College of Engineering’s Nathan Dougherty Award and ACMA’s Lifetime Achievement Award.

For the past 50 years, Tickle’s successes have been driven by his continued visionary commitment to innovation, quality, growth and his community. His goal has always been to make composites an important segment of the construction materials industry, and his efforts have directly impacted how composites are used today.

ACMA congratulates John Tickle on 50 years of excellence in the composites industry!

Join ACMA’s LinkedIn Group!

ACMA is excited to announce that we have launched our LinkedIn group! This group will serve as a forum where individuals at all levels of the composites industry can come together to share ideas, ask questions, find business leads and engage with association members.

If you are already a member of LinkedIn, you can join the ACMA group right now! Once you have joined the group, you can post questions or join an existing conversation. If you are not yet a member of LinkedIn, we encourage you to join this free professional network at http://linkd.in/1CZgf2i. Or, go to linkedin.com and search for “American Composites Manufacturers Association” to access the group.

ACMA Helps Members Communicate About Styrene

A new customizable PowerPoint presentation will help business owners and plant managers address
JOHN D. TICKLE
CONGRATULATIONS ON
50 YEARS
IN COMPOSITES!
Your leadership has been instrumental in making composites manufacturing what it is today. Thank you for your contributions as a leader, a visionary and an ambassador for the entire FRP composites industry.
--your friends at Strongwell

John D. Tickle
Chairman of the Board of Directors
Strongwell Corporation

1965

2015
styrene health concerns that may be raised by plant neighbors or other community members. In a simple, easy-to-follow manner, the presentation explains that recent findings of a potential link between styrene and cancer, for example by the National Toxicology Program, are based on partial reviews of the data and are not intended to indicate the actual risk to people who may be exposed to styrene as a result of living near a composites manufacturing operation. The presentation further explains that careful scientific reviews of all the data consistently find that the scientific studies do not support a concern that styrene exposure may lead to cancer. ACMA members can download the PowerPoint presentation from the “Member Resources” section of the ACMA website. For more information, contact John Schweitzer at jschweitzer@acmanet.org.

New Members

Advantic LLC
Beavercreek, Ohio

Cloud County Community College
Concordia, Kan.

Omya Inc.
Blue Ash, Ohio

Solvay Specialty Polymers
Alpharetta, Ga.

For more information on becoming a member of ACMA, email membership@acmanet.org or call 703-682-1665.

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