ALTERNATIVE FUELS

JMU's research and programs are cross-curricular, cooperative and clearly taking the lead BY MARTHA BELL GRAHAM

Chris Bachmann, integrated science and technology professor, directs the JMU Alternative Fuel Program, one of many programs on campus working toward sustainability. In the lab, professors help students tackle transportation issues through education, research, outreach and hands-on learning.

THINK OF ALL 250 MILLION CARS on American highways right now. Next, think how to get every driver to stop, park and mount a bike, get into a small electric car or take a bus. You now have an idea of the task undertaken by professors and students in the College of Integrated Science and Technology's Alternative Fuel Program. It's a critical problem with complex solutions — and tough hurdles to overcome.

Part of the university's Center for Energy and Environmental Sustainability, the Alternative Fuel Program is one of many dynamic programs on campus working toward sustainability. The AFP provides a framework of research in the area of transportation, says director and ISAT professor Chris Bachmann. The program merges applied research with education and outreach, attacking the problem three ways: fuels, technology and the elusive human factor — perhaps the greatest challenge.

The program's exploration of alternative fuels springs from many academic disciplines: biology, chemistry, engineering, geology, physics and technology. The cross-curricular and cooperative nature of the program makes it dynamic and fluid — and impossible to tell the story of one research project without touching on multiple academic departments or JMU divisions. Using surveys, simulation modeling, statistical analysis, along with hands-on research that emphasizes student participation, the program twines varied disciplines with many campus, community and government agencies — and students in all levels of education.

Students from a variety of disciplines – biology, chemistry, engineering, geology, physics and technology – work side by side on projects in the Alternative Fuel Program lab.

The Alternative Fuel Program began in 1997 when then-ISAT professor Jamie Winebrake initiated the assembly of JMU's first fleet of alternative fuel vehicles, which eventually included electric, natural gas, biofuel and propane vehicles. Since then, JMU students and professors have worked together to explore the potential of harvested *macrocystic pyrifera* (giant sea kelp) and *trichoderma reesei* (a fungus) to produce biofuels. They have evaluated the efficacy of converting cooking oils left over from the dining hall into biofuels and converting campus vehicles to run on it. They have investigated compressed natural gas as an alternative fuel and fuel cell auxiliary power units. JMU now has two CNG refueling stations on campus and a fleet of vehicles using alternative fuels.

They also have explored electric and wind energy. Students are converting a truck donated by Shenandoah National Park, using a $20,000 grant, to an electric vehicle the park service will use. It is one of several electric vehicles successfully developed in the university's Alternative Vehicle Lab.

In fact, the Alternative Vehicle Lab is one of the most exciting places at JMU. Located in a former machine shop, the space is shared by facilities management, along with tools and people. Roger Monger, a facilities management staff member, oversees the lab and provides technical expertise to students constructing the designs they've created. The contribution of the facilities management people can't be minimized, Bachmann says. "It's been humongous." Through the work of Bachmann and Towana Moore, associate vice president for business services, the entire lab was made available to students. Here they take their ideas and build them. It is rare on college campuses for so many students to have access to a complete and professional machine shop, Bachmann adds. It's even more uncommon — indeed exceptional — to have the collaboration on lab space.

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"Everything works on paper," Bachmann says. But when students get in the lab, when they start building a design, they have a new appreciation for the difficulty of bringing a plan to life. On paper, nothing is moving, he says, and then with movement, suddenly this piece of metal is hitting that one or this screw can't be accessed. Students often have to drill through their projects to make an adjustment. These things never show up until they get into the lab. "When they get it, it's a little bit of an epiphany."

The lab is of special benefit to students enrolled in the new JMU School of Engineering. Unlike almost every other school where engineering students never build their designs — and if they do, not until their junior or senior years — JMU engineering students use it from day one, as ISAT students have done for a decade.

One of the first projects to come out of the Alternative Vehicle Lab, Bachmann says, was the Super Beetle. Then-ISAT-student Randall Morrison's ('06) uncle donated an old Yamaha motorcycle. "The students scoured the town and found an old VW Beetle," Bachmann says. "We saw potential in the old Bug. I bought it for $50." John Miller ('70, '83M) at Massanutten Technical Center donated an engine. To make floorboards, they cannibalized an old picnic table they hauled out of a dumpster. With the materials, students designed and built the Super Beetle. "$50, free and free. Pretty good," Bachmann says.

"A lot of times our students have no concept of money. ... They can propose pretty outlandish ideas," he says. "So, along with fuel economy, they are learning real lessons in how economic factors influence research, development and the implementation of new ideas."

The economic perspective is a significant part of the entire alternative fuels question and requires creative approaches. One such approach, Bachmann says, might be grid-to-grid power. He explains it this way: Suppose you charge your electric car through a wind-generated power plant (at a price) and drive to work. As it sits all day, the power dissipates — it's lost. What if you could plug it in at work and sell that power back to the grid while you're at work?

This kind of innovative thinking, Bachmann says, is why JMU's creative approach to the entire alternative fuels paradigm is so important. Anyone can build electric cars. The technology is there. But how do you get a majority of drivers to buy and drive them? "In 20 years, we'll run out of easy oil," Bachmann says.

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It's a complex problem with solutions that demand the best of science. But the best science — like a brilliant mind — is useless without the discipline of individuals to embrace it. Changing human behavior is the missing piece and perhaps the biggest challenge AFP faces is changing the culture *outside* the university. Take NASCAR, for instance. It's the most popular spectator sport in the country — drivers going fast in a circle. They're not concerned with fuel economy or environmental impact. They're interested in speed. Much of the same mentality exists for American drivers. They want to get from point A to point B quickly and comfortably. Only a fraction are more concerned with the environmental impact of their gas-powered cars.

This point of interface is where AFP hopes to have an impact. Bachmann puts it this way: "We're doing a different kind of research. … How society interacts with technology. What are the hurdles to overcome to get them (environmentally smart vehicles) into the mainstream?"

One approach they are taking is through alternative vehicle competitions, and the most important is the Society of Automotive Engineers, the most prestigious of the collegiate-adjunctive engineering societies. Two years ago, JMU petitioned SAE to allow the university to start a campus chapter. Without an engineering school, JMU's request required "flexibility" in SAE's decision. The allowance was granted and the chapter established. Now through SAE, JMU plans to make its mark on the entire collegiate engineering world.

Each year, SAE holds Baja SAE, an off-road vehicle competition that draws some 100 colleges and universities to each of three events. The competition challenges student teams to design, build, test, promote, race and market a vehicle that will handle challenging terrain and, sometimes, water. But there is no element in the current competition that addresses environmental impact, Bachmann says. So the JMU chapter is

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ural world, which is the second part of the institute's name. Do you see that at JMU?

HARTMAN: We do see that a lot of young people today are not spending as much time outdoors as children have historically. When I surveyed students in one of my ISAT 321 classes, they indicated that they spend a great deal of time indoors. Maintaining that connection with the outdoors is especially important for our students who will work in outdoor environments. There are also an increasing number of studies that indicate health is closely tied to interaction with nature. We have tremendous resources at JMU in terms of the natural world – for example, the arboretum, where a lot of professors take their classes. The JMU Farm is another and, of course, our surroundings like the Shenandoah National Park.

THOMAS: I love the arboretum and go through there as often as possible. At the right spots it's possible to get lost and pretend you're not in the middle of Harrisonburg.

BOLGIANO: Recycling may be the most immediate way that most people connect with the environment on a daily basis, and recently JMU competed in the National RecycleMania Waste Minimization Competition. How is the recycling program going?

HARTMAN: JMU recycling started about 20 years ago and employs 10 people. Most JMU employees have desk-side bins for common recyclables such as paper, bubble wrap, soda cans; and we have community bins that people use in the common areas. We have about a 35 percent recycling rate, and that's one of the highest university rankings in Virginia. Now it's time to take the next steps, to reduce and to reuse.

RecycleMania is a way to promote waste minimization. The idea is simple: Carry your reusable mug and also save 40 cents at the dining hall instead of using disposable or even biodegradable cups. But it's a cultural change, which is challenging. We'll have our incoming class at orientation get a reusable bag as opposed to a plastic bag. Next, they will get their mug. Hopefully, they will see everybody use these. We'll be reaching out to make our citizens aware that this is campus culture, and it is what's expected. My hope is that our citizens reuse for so many years that when they leave it would seem wasteful to practice a different behavior.

Last fall we did a trash sort where three buildings dumped their trash on the CISAT lawn, and 40 of us sorted through it to see how many recyclables were there. Recycling was anywhere from 10 percent of the trash in one building to 50 percent in the other. Later, we surveyed our 40 volunteers who bravely did this; it was a cold, cold day and it was not a pleasant aroma ...

THOMAS: It was not pleasant.

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CHRIS BACHMANN, *director of the Alternative Fuel Program*

petitioning SAE to change the parameters of the competition to include an environmental plank.

If they succeed, JMU will have substantially shifted the entire nation's collegiate emphasis on alternative transportation to environmental sustainability and changed the dialogue to include environmental impact in vehicle construction.

Still, the greatest challenge looms — changing the behavior of the American consumer. Much of the technology research done on campus is done in light of this dilemma. No matter how successful a program is, Bachmann says, "none can meet current consumption. We have to use less energy. We have to shift our thinking." And that is perhaps the most challenging aspect of alternative fuel research — and the one where JMU is clearly taking a leading role.

"We're not like R1 schools," Bachmann says. Plenty of schools and companies can create the technology, but JMU is working hard to change the perception and the acceptability of environmentally responsible vehicles. "It doesn't matter if you can create the most efficient vehicle on the road if people won't drive it." That's JMU's challenge and where AFP is making its mark.

"We need to reach a new audience," Bachmann says, and education and outreach are huge components of AFP. Engineering professor Rob Prins agrees. He is developing a bicycle competition for high school students. While most high-school students don't have the funds to re-engineer cars, they can attack the problem of creating an electric bicycle. Prins hopes that students will build their bikes and bring them to JMU to compete with other high-school students. (See Page 64.)

Strictly separating one program from the next, one department from another, is impossible at JMU because of the dynamic exchange and generation of innovative ideas. There are no ivory towers here, no sanctuaries of knowledge untouched by students. It is an unfettered and unmatched collaboration of professors, students, staff members, alumni and community members — all working toward a sustainable world. M

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HARTMAN: The institute is coordinating that effort with strong support from facilities management. We have brought in external expertise, that of O'Brien and Gere consultants, to help guide us through the process of measuring our baseline greenhouse gas emissions. We anticipate a report this summer. The point of the emissions inventory is benchmarking – we will have quantitative data, so we will know where to focus our energies.

BOLGIANO: What kind of measurements will the institute use to mark progress toward sustainability?

HARTMAN: Benchmarking, which includes measurement, involves all natural systems, not just emissions. Benchmarking campus water consumption, water quality, materials use, waste minimization and attitudes of citizens is something the ISNW committee members are working on.

THOMAS: Our campus accessibility committee is looking at a bicycle compatibility index, because to ride a bicycle safely you have to have bike paths, locks and easy access to buildings.

BOLGIANO: "Sustainability" is a complex issue, and determining what is truly green can be a challenge in itself – witness the current controversy over corn ethanol versus nonfood biofuel. How will the institute approach conflicts over what is or isn't truly "sustainable?"

HARTMAN: First, through dialogue. We purposefully recruited people for our committees who may be on the end of the spectrum that says, "Global warming is highly exaggerated," because we want everybody's voice included. Of the 100 people on the five committees there are professors, students and staff members from a variety of jobs. In terms of the ethanol, these are complex problems that require analysis to understand the environmental economic-social repercussions. One of the common tools is cradle-to-grave analysis, where the full product cycle is accounted for. We try to put together scientific, peer-reviewed research papers that use such techniques and represent different ends of the spectrum.

JMU also has rich course offerings related to sustainability across a variety of majors, minors and graduate programs. Students can immerse themselves in these issues in the Madison Eco-Community in Hoffman Hall. Students living there focus on the environment, and the residence hall itself is a model of green living. *[See Page 34]*

BOLGIANO: Reaching sustainability is so challenging that it surely will take many years. What is your long-term vision for the institute?

HARTMAN: I want JMU to be Virginia's model of community metamorphosis into a healthy human-ecological system. JMU citizens will be environmentally literate, and an ethic of conservation will be a JMU community member's hallmark. The campus will be a low-impact, living laboratory developed through cross-divisional collaboration.

Environmental stewardship will be integrated into the institutional and individual decision-making process as a core value.

JMU will offer environmental courses and programs to underserved groups, and the campus' environmental stewardship efforts will grow together with other JMU initiatives to address the two other dimensions of the triple-bottom line of sustainability: economics and equity.

BOLGIANO: Emily, you'll soon be entering the world of work. What do you hope to do?

THOMAS: I'd like to work with alternative fuels, either in research and development or in education and outreach. I'd really like to work with a city government and do a lot of the same outreach efforts that we've done here. And I'd like to go to graduate school. JMU has set me on the right path toward what I want to do. It's taught me how to learn, and I've been exposed to a bunch of ideas I didn't know about and experienced a lot of things, not just going to conferences or classes, but also working with a group. It's made me see the cradle to grave, or cradle-to-cradle way of thinking, and that's very much how I think about things now. M

About the Interviewer Chris Bolgiano, faculty member emerita, worked for 31 years at Carrier Library while homesteading in the Appalachian Mountains and learning to write about it. As a freelance writer she has written travel and nature articles for the *New York Times, Washington Post, Sierra Magazine, Wilderness, Audubon, American Forests,* and many other publications. Three of her five books have won awards, and she describes a sixth book as "a community service project that documents a short history of a small place, namely my own rural neighborhood." Her occasional op-eds are syndicated by the Bay Journal News Service, and she appeared as a talking head in all four episodes of the recent PBS documentary special, *Appalachia, A History of Mountains and People*. Learn more about Bolgiano at www.chrisbolgiano.com.

About the Experts Christie-Joy "C.J." Brodrick Hartman is executive director of JMU's Institute for Stewardship of the Natural World. Since coming to JMU in 2002, the integrated science and technology professor has helped write grants which landed some $2 million for transportation and air pollution research. Read more about her in the Bright Lights section on Page 20.

Emily Thomas ('09) is the student representative to the ISNW Campus Accessibility Committee. The integrated science and technology major has helped further campus environmental efforts. She coordinated JMU's first No Drive Day during her freshman year, and the event has become an annual effort. An Earth Club member, Thomas also attended Yale University's climate conference. Read more on Page 30.