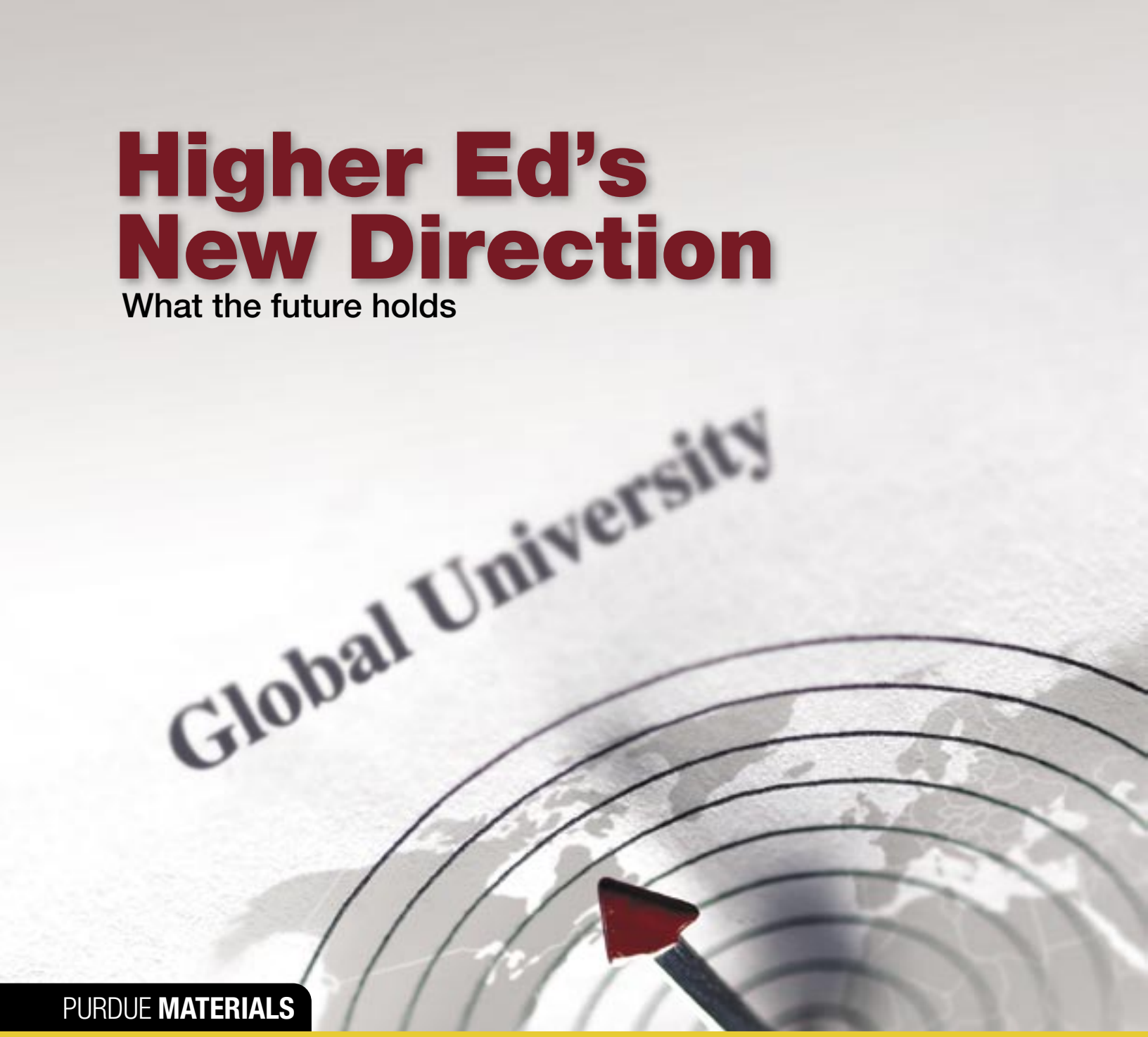
Higher Ed's New Direction

What the future holds



PURDUE **MATERIALS**

ENGINEERING IMPACT

SUMMER 2007

Culture Shock
How international students view Purdue

Globe Trotter
Life as a global engineer

In My View
The case for global education


John Underwood

On My Mind

Globalization: is it a threat or an opportunity?

It has elements of both. Highly skilled, high-paying jobs are increasingly moving from the United States to countries that we once regarded as "developing," but that is not an entirely new phenomenon. Sector by sector, U.S. jobs have been offshored in all sorts of industries and replaced with jobs that rely more on brainpower—and less on muscle power—than the ones that went overseas. Even the "brainpower" jobs are now moving outside the country, hopefully to be replaced by jobs where the next level is creative innovation.

At the same time, markets are moving overseas, too. Where the U.S. used to be the market for the vast majority of the world's high-tech products, it now represents only a small fraction of the total market. Japan once struggled to make products that would sell in the U.S., and now we all have to figure out what it takes to sell there and in China, India, Africa, or anywhere else.

Innovativeness and global knowledge are the keys to success in the new global economy. Here in Materials Engineering, we encourage both through open-ended, real-life project work in our capstone senior projects and our Materials Engineering Study Abroad (MESA) program. One of every six Materials Engineering graduates now has some kind of study abroad experience, and we have set a goal of turning that into one out of every three by 2012.

We are educating our students to grasp the exciting opportunity to be leaders within the global economy.

Alex King
Head, School of Materials Engineering

We're Moving!

We're excited to announce our big move at the end of this summer to the Neil Armstrong Hall of Engineering—what is the new academic gateway to Purdue Engineering. Visit or write to us at:

School of Materials Engineering
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Our phone numbers and e-mail address will remain the same.

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COLLEGE OF ENGINEERING

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contents

Vincent Walter

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around mse

Emerging Areas of Research

Thin-film Multiferroic Composites

Professor John Blendell and his students are focusing on another new area of research involving physical properties of thin-film multiferroic nanocomposites. They are examining composite materials containing both ferroelectric and ferromagnetic phases by atomic force microscopy. The coupling between the two phases is through a strain mediated coupling through the epitaxial interfaces. Such composites form by phase decomposition during thin-film deposition and result in self-assembled nanostructures. The local response of the domains to applied magnetic or electric field, the switching speed of both phases, and the geometry of the domains as a function of the substrate induced strains are all being studied. ■

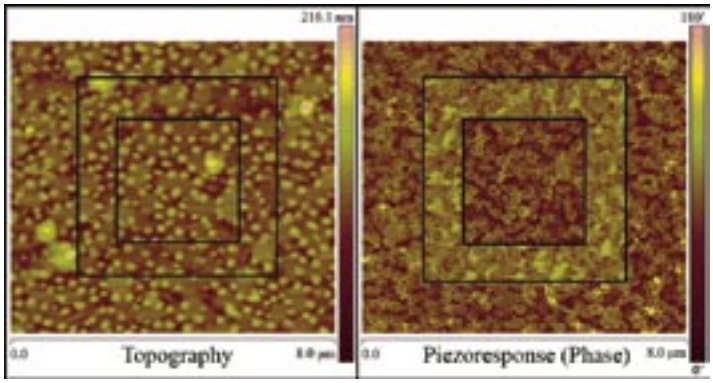

Figure: A set of "nested squares" is apparent after applying ±5 V at 900 G in the PFM phase plot on the right. The outer square shows polarization after applying -5 V, while the inner square shows polarization after applying +5 V. The accompanying topography is shown on the left.

Passion Fuels Bowman's Pursuits

An explorer of life.

Vincent Walter

Bowman at home with his dog, Gus.

Teaching, pushing through to new discoveries, traveling the globe, and advocating for every individual's rights—whatever his pursuit, passion reigns for Keith Bowman, professor of materials engineering. And it's infectious.

As he gobbles up life, ever exploring new ideas, interests, and places, he makes apostles of students, peers, and international collaborators. No wonder the recognitions, renown, and respect keep rolling in—the latest being the 2007 College of Engineering Mentoring Excellence Award.

In the classroom, he transforms abstract to interesting with Silly Putty, a Slinky, or pillow foam. "My goal is to make it worthwhile for the student to be there, and for me, too," Bowman says. "I definitely engage students a lot in class."

As a pioneering researcher in areas such as property anisotropy in ceramics and texture and microstructure effects on properties, "I look to do things where people haven't worked." Currently, that's in applications for ultrasound, speakers, microphones, sensors, and similar items.

As a mentor to nearly 40 graduate students so far, Bowman is known as guide, not dictator, hosting weekly student presentations and discussions. "He gives us a lot of freedom, allows us to make mistakes, and is very patient and supportive," says graduate student Hsin-Yu Li.

And as chair of the College of Engineering Diversity Action Committee and co-investigator on a National Science Foundation-funded project on gender equity, Bowman champions the full meaning of the term "diversity."

Growing up in the suburbs of Cleveland, Ohio, Bowman's childhood was like a village in Europe, he says, with cousins frequently dropping by.

He headed to Case Western Reserve University for undergraduate and master's degrees, then the University of Michigan for his doctorate, earned in 1987.

He said "yes" to Purdue in 1988, but that didn't keep him stateside. He's given talks in 16 countries, maintains long-standing collaborations with researchers outside the United States, and has been a visiting professor three times, twice at Germany's Technical University of Darmstadt and once at Australia's University of New South Wales.

"Directional property of materials is a topic where there's more activity outside the U.S., so I travel a lot," Bowman says. "Because of the topics I work in, I'm probably better known in Europe than the U.S."

Of all Bowman's personal interests, which over the years have included tennis, radio station music programming, mountain biking, canoeing, camping, and garden design, today's favorites are travel and photography.

He loves cities—Chicago, where he owns a condo on Lake Shore Drive—and Sydney, Berlin, Montreal, London, Beijing, Seoul, and Bangkok, among others. "They're amazing. I've had great experiences."

For remote natural beauty, one that took his breath away was Foz do Iguacu, also known as Iguassu Falls, on the Paraguay, Argentina, and Brazil border. "It makes Niagara Falls look very insignificant," he says. Another was an underground coal mine near Kebnekaise, the tallest mountain in Sweden.

"I'm pretty comfortable away from home," he says. "I have a lot of friends elsewhere in the world. I try to meet up with people whenever I can."

■ **Kathy Mayer**

Globe Trotter

For alumnus Peter Tortorici, travel abroad means business.


Tortorici at Medtronic.

Globalization is the new world order. We hear it as Americans all the time: to compete professionally, one must have proficient knowledge of overseas culture. But what does this mean for the practicing engineer? How are engineers adapting their careers to fit this new mold of operating in multi-continent corporations?

Peter Tortorici (BSMSE '90, MSMSE '93, PhD '97) is today's quintessential globe-trotting engineer. As a manager of advanced packaging development for Medtronic—a leading manufacturer of implantable devices—Tortorici takes frequent trips abroad. "As I'm writing this e-mail, I'm in Switzerland at a device facility working on a manufacturing issue," he explains.

Tortorici attributes technology such as e-mail and worldwide cellular service as agents of change in a shrinking world. "When I lived overseas 11 years ago, I made a weekly call home to my parents from a local telephone booth in a small village," he recalls. "Hardly anyone then had a laptop. Even six years ago, the only Internet access was dialup in hotels."

For Tortorici, a one-week business trip meant sorting through 300 to 500 e-mails when he returned home. "Today, I have a five-band phone that works anywhere in the world. With my laptop, wifi access, and my phone, I can do business throughout the world without missing a beat," he says.

Over the past five years, his work has taken him primarily to Stuttgart, Germany, and Tokyo, Japan, where his two main suppliers are located. However, some additional support trips for other Medtronic divisions have resulted in business trips to the Netherlands, Italy, Switzerland, France, China, Taiwan, and Korea.

Because his suppliers span the globe, Tortorici cites one of his biggest challenges as maintaining face-to-face communication and getting to know his business associates on a personal level. "One can easily conduct business by telephone, but there is the personal aspect of the relationship that is missing. Over time, mutual trust and credibility need to be developed," he says.

He goes on to explain: "Face-to-face interaction is extremely important because it communicates the importance of the business relationship between my company and our suppliers. With all of the advanced technologies such as video, Web conferences and teleconferences, sometimes people lose perspective on the need for personal meetings."

However, it is this same advanced technology that Tortorici attributes to helping him overcome some of the other challenges his traveling elicits. He estimates that over the past few years he has spent about two and a half to three months of each year away from home. "My main hobby is my family. It can be taxing at times to spend so much time away from them," he says.

He and his wife of 10 years met at Purdue and were married a week after his graduation. They have four children: Whitney (21), Ashley (19), Olivia (8), and Nolan (4). "Having the Internet all over the world and global cellular service makes it seem like I'm not gone too much from home. With today's technology my family can reach me any time of day."

Asked if he has advice for engineering students preparing for a career in the modern, global market, he has this to say: "Look into a study abroad or work assignment overseas. It helps make you more marketable and broadens your perspective. But, more importantly, learn continuously. Always assess your talents and skills and learn new ones as your careers evolve." ■ **Kristen Senior**

While at Purdue

Although traveling is a way of life for Tortorici, he started collecting stamps in his passport long before he began work at Medtronic. While pursuing his bachelor's degree in materials engineering from Purdue University, Tortorici participated in an overseas exchange program with Argonne National Labs. He lived and worked in Germany for four months, while spending his weekends traveling to other European locations. "That was a fantastic experience," he says. "It was complete immersion into German culture and everyday life, the benefits of which are tremendous."

Participating in the program provided Tortorici with international business and cultural experience. "The biggest thing is that one isn't as wide-eyed and naïve on business trips. You become a knowledgeable resource within your company for traveling abroad and conducting business overseas," he explains.

According to Tortorici, "It was this experience coupled with the basic engineering principles and critical thinking skills I acquired at Purdue that have helped prepare me for my career at Medtronic."

New Direction

THE GLOBAL UNIVERSITY

Change taking place within industry prompts the question, What role will universities play in the emerging global economy? As industry adapts to a new paradigm, will universities follow suit? By Lee Lamb

> "Every pair of hands has to be a pair of thinking hands. Globalization will force nations to reallocate resources, restructure their economies, and reorient their societies for the future." —*Singapore Prime Minister Lee Hsien Loon*

A Call to Act

Experts within academia and industry suggest that the American university has operated within a regional vacuum of research and teaching for too long. Corporate America has gone multinational and is requiring its research, workforce, and innovation to do the same. As a supplier of knowledge and high technology, universities are looked upon by industry to provide a product, and today that educational product must be supplied at the global scale.

But is the United States higher education system ready?

"American universities are not responsive enough to industry needs and have failed to evolve to keep pace with changing economic realities," says Nicholas Donofrio, an IBM executive vice president. "The last place I go to find out about an economic trend is the university. The sea changes don't happen there."

According to R. Byron Pipes, Purdue's John L. Bray Distinguished Professor of Materials Engineering, the university must change. "The geographic monopoly universities like Purdue enjoy today will be lost in the future," he says. "Universities will have to change, and the need of the educational customer will come first."

Carol Handwerker, professor of materials engineering, adds, "As the model for U.S. industrial research, development, and manufacturing has changed, the university goal must change from developing the discipline-focused engineer to developing a diverse, globally engaged workforce able to work remotely in teams on complex design and manufacturing projects."

Predictions Circa 1997

The global university isn't a new topic of conversation for Pipes—it's been on his mind for over a decade. Before coming to Purdue, he served as president of Rensselaer Polytechnic Institute. During his tenure, Rensselaer received the Theodore M. Hessburg Award (1995), Pew Leadership Award (1996), and Boeing Educator Award (1996) for innovations in undergraduate education.

"I traveled to Seattle in 1996 to meet with Phil Condit, the CEO of Boeing, and to receive their prize," explains Pipes. "He and I started talking about how the university has to change as the global corporation changes. And we started working together on this."

That year, Condit and Pipes convened a conference in the Seattle area and brought together corporate vice presidents of research from companies like GE, Lucent, IBM, and Boeing and deans of engineering from various colleges throughout the U.S. "This was 10 years ago, before people really began talking about the role of the global university," Pipes says.

continued on next page

From the conference's final report, Condit and Pipes co-authored an article titled "Straight Talk" for publication in *Issues in Science and Technology* in 1997. Here are some of the article's findings and predictions:

- Centralized, monolithic engineering operations will give way to integrated project teams that will incorporate workers from across the globe.
- Work will be handed off "down-sun"—across time zones— in sequence to team members around the world.
- As global skill levels rise, Americans will comprise a smaller percentage of the global engineering workforce.
- In the global environment, academe and industry will converge.
- The academic organization will reconfigure itself to the educational needs of students with a particular focus on practicing engineers and scientists.

They predicted then that the university will reshape itself structurally to resemble its primary client: industry. The central core campus is responsible for basic education of entry-level students. But much of the actual delivery of the educational product will occur at branch campuses and remote sites around the world that are located in close proximity to industrial centers.

Pipes says that many of these predictions came directly from Condit and what he was doing at Boeing. Ten years ago, the company was in the midst of taking its operations worldwide and needed a coherent approach and quality in its workforce. "Condit's idea then was that the only way he can assure this quality is to work through a single provider of talent, rather than multiple providers. To me, this is a good illustrative example of what's happening in the global practice of engineering today," he says.

The Tide Changes

> **"Our economic future is inextricably linked to our ability to come up with more technological breakthroughs that equal the internet in magnitude. Such large-scale innovations drive growth, create new jobs and industries, push up living standards for both rich and poor, and open up whole new vistas of possibilities."**
> ***—Michael Mandel, chief economist of BusinessWeek***

The number of engineering degrees, including those in materials engineering, awarded in the U.S. peaked in 1985 and has steadily declined by more than 20 percent since then. And according to the American Electronics Association, one out of five U.S. scientists and engineers are foreign-born, and the number of skilled workers immigrating to the U.S. declined by 27 percent between 2001 and 2003.

"When I was in China recently, I saw a university the size of Purdue built in five years," says Pipes. "And the students were mostly engineers. They had 3,000 electrical engineers in one building. China is outproducing us almost 4-to-1."

Competition for engineers also comes from India, where 300,000 young Indians compete for no more than 3,500 freshman class positions in one of seven Indian Institutes of Technology (ITT).

"For a corporation, if you can get engineering talent anywhere in the world and at any time, what would make you choose from one university or another? The answer is quality and cost," asserts Pipes. "In other words, if the university supplying the talent is unique, corporations will flock to the institution for talent. If the university is not unique, the corporation will go to the low-cost provider with the same quality."

According to Pipes, the implications for the university and programs like Purdue's School of Materials Engineering are straightforward: You must become a steeple of excellence.

The Global University

What will the global university look like in the future, and how will materials engineering teach future students?

Anil Sachdev (MSMSE `72), a research fellow and group manager for a General Motors research and development lab, points out that the American education system remains predominantly local and does not train students for the new global operations paradigm (see "In My View," p. 8).

"The engineer we educate has to learn how to work in the global environment and has to know enough that global corporations will come to Purdue to hire them," suggests Pipes. "Our students have to be better than the global average."

The best bet for universities might just be the international branch campus concept—go where the corporations operate and provide engineering talent locally. Bill Showalter, a professor of chemical engineering at Princeton and a colleague of Pipes, uses a pharmaceutical company that opened a research laboratory in Singapore to illustrate the global model.

R. Byron Pipes thinks globally.

"One of the executives associated with the decision said, 'Why should we bring people from Asia to the United States, train them, and then go through the requirements necessary to keep them here? We should provide jobs for them near their homeland so they do not have to leave it,'" says Showalter. "If this seems obvious to the corporate sector, should it be any less so for academe? The customers of a research university are, on the one hand, students; on the other, they are the corporations. Should we not serve both of these customer bases by being in close proximity to them?"

Pipes adds, "In terms of global education, Purdue thinks of itself as competing just in the Big Ten. Imagine our basketball team—to use a metaphor—not just going to the NCAA championships, but going to the Olympics. That's how we need to think about Purdue."

Examples of global partnership locations include the Middle East, where Qatar, the United Arab Emirates, and Abu Dhabi are asking universities to go there and start branch campuses. Tsinghua University in China has established science parks—where the university is co-located—in five provinces.

"I don't think the global university model has finished evolving," suggests Pipes. "But the right model ultimately provides the flow of human talent and wealth between the branch campus and the main campus.

"One of the benefits of the branch campus is that it's a cash cow. You can resell all the educational products you've already developed. It's more than that, though. The human talent you can provide, the global reach, and the ability to build excellence on your main campus—those are all related to what will happen in the global university," says Pipes.

Look Into the Crystal Ball

Simon Lehto, project manager for the development of engineering education at Helsinki Polytechnic in Finland, says, "During the past decade, it has become clear that the discrepancy between the education organizations and their corporate customers can no longer be solved by means of partial solutions with the present operating mode: adding subjects, courses, projects, and work practices. This situation can only be remedied by changing to incorporate a new structure.

"Meeting the needs of societies in the global competition of the 21st century emphasizes the role of engineering and increases the requirements for engineers."

For the university, its educational and research duty takes it to the global customer. American engineering students will have to adapt to new cultures, learn new languages, and live overseas in multiple cities throughout their careers.

"To survive, Purdue's School of Materials Engineering has to be the best program in the world. That's essential," Pipes asserts. "I'm just projecting what I think is happening and why. Then it's up to my faculty colleagues to think about what the implications are to us and to our students."

As the global university model evolves, one thing is for sure: materials engineering, being a pervasive enterprise, will be at the forefront of change. ■

The Case for Global Education

Anil Sachdev started his GM career in 1977 with the GM Research Labs after receiving his doctorate in materials science and engineering from the Massachusetts Institute of Technology, master's in metallurgical engineering from Purdue University, and bachelor's in metallurgical engineering from Banaras Hindu University in India. He is currently a research fellow and lab group manager in the Materials and Processes Lab at the GM R&D Center, and leads advanced materials-related projects for next-generation lightweight body and power trains.

Globalization is common to business. In only the last 10 years, markets have become global. Durable goods, personal mobility, improved healthcare, and high-quality housing are within reach to a larger world population. As a sign of the times, General Motors is forecasting that roughly 70 percent of future automotive growth will come from 10 emerging markets.

In response, multinational companies like GM have initiated technology development that occurs seamlessly around the globe. This makes it possible for companies to increase productivity and reduce costs by sharing technology solutions across multiple products and applications. Since the cost for technology development for individual markets is prohibitively expensive, the future rests in creating unique technology backbones with sufficient embedded flexibility to create local variants with equivalent functionality.

Innovation will be managed globally and will utilize the best minds, regardless of location, to provide customers a greater variety of products with higher quality and lower costs. This will require local engineers to understand and respond to local preferences and support local manufacturing operations within an overall global framework. And the global diversity of an organization will become its competitive advantage.

Although the digital age has removed boundaries for technology and information flow—and has enabled the fast-to-market phenomenon—the education system remains predominantly local and does not train students for this new operational paradigm. This is especially true for science and engineering. The educational model needs to change to prepare students for expanding career opportunities, since it is highly unlikely that a person's work career will occur only in the United States. Simply put, why should educational standards in the U.S. and at Purdue differ from those at equivalent universities located elsewhere?

A push to globalize education provides an opportunity to promote skills such as creative thinking and innovation. Just mastering textbook knowledge will not be sufficient for global employment. Students across the world will need to develop the ability to be innovative and creative.

Global education will also lead to an efficient delivery of the total educational experience, including knowledge about international safety standards and environmental issues, and will foster best practices in teaching. The concepts of being a student anywhere, being a teacher anywhere, and accessing classes that are always available are likely to become more pervasive in the near future.

Global education will also alleviate current corporate recruiting challenges and shorten the time for companies to grow industry-specific competencies within engineers who work around the world. Being exposed to diverse cultural skills, developing a global network of peers, and gaining a new perspective on differences and similarities in customers will become an indispensable part of a well-rounded education. With this opportunity, students will gain invaluable international experience: a must-have for a successful career.

Our work now is to break down boundaries and embrace global collaboration, whether it is in education, research, technology, or social development. The goal is to leverage the best minds with the best solutions to drive the highest quality of life—globally! ■ **Anil K. Sachdev**

The World Is Their Classroom

Vicki Cline sends students to far-off, majestic lands. And they call this studying?

Vicki Cline wears many hats in Materials Engineering: from undergraduate and graduate advisor to coordinator of the study abroad program. Here, she answers a few of our questions.

Has the school hitched on to the globalization bandwagon?

Yes, definitely. I started in Materials Engineering in 1989. Prior to the time I arrived, I can't find any evidence of our school's undergraduate students studying abroad. Since then, the profile and nature of our students has changed a great deal. The college has put a priority on developing the global engineer, and that's caused us to really push global experience with students.

The school initiated the concept of study abroad in 1997 through an agreement with Tohoku University in Sendai, Japan. When Alex King joined the school as head, he continued our strong interest in study abroad. And professors Keith Bowman, Matthew Krane, and Kevin Trumble developed a global studies proposal that got the ball rolling with our Materials Engineering Study Abroad (MESA) program.

Today, we're gaining momentum. Every time a student goes abroad, they give a presentation to our undergraduate seminar—which builds enthusiasm among students. We're averaging three or four presentations each semester.

So, it's not hard to sell study abroad to students?

Not at all. When it comes to students who express an interest, there are two types. For some, there's no need for a sales pitch. They come in with a plan, and it's just a matter of deciding where to go.

For others, they haven't really considered traveling abroad before. However, once they hear one of their fellow classmates talk about their experiences and show incredible photos, they are bitten by the travel bug. The program sells itself.

For future engineers, it is crucial to have an understanding of different cultures and approaches to engineering. The best way to accomplish this, obviously, is to actually be a part of other cultures for a period of time.

Our current ratio of students participating in study abroad is 1-in-6. Right now, I believe that's the highest in the college. We've set a goal of 1-in-3 students.

What are the obstacles to growing such a large program?

One of the biggest challenges involved is making sure students don't lose time toward completing their degrees. We don't want students to feel that studying abroad hinders their graduating on time. With the variety of programs worldwide, this can be a time-consuming effort. However, the university's Study Abroad Office is excellent with assisting departments to resolve issues. Also, our faculty are encouraging and flexible toward study abroad, which helps a lot.

Last summer, I went to China as part of Purdue's Global Partners Program. We visited four universities. The backgrounds of those selected to go varied from history, psychology, and sports to engineering. I was the only engineering representative.

I visited Tsinghua University, which is very similar to Purdue and to our materials engineering program. However, since their class structure is different—and there is still a language barrier in most courses—we couldn't find a match in coursework. Tsinghua teaches 41 courses in English; but only one such course in the spring semester. Also, there's not a large selection of courses our students can pick in any one semester for their major. So, we got creative and came up with a model that we could use: We established a research arrangement.

This arrangement is very similar to how our students pursue independent research with our own faculty. Students are allowed to count the independent research credit towards the technical elective requirement of our plan of study.

We currently have one sophomore in China involved in two research projects and a class on China's culture. Tsinghua is now talking about some of their students expressing an interest to come to Purdue. That's exactly what the program was targeted to do.

We're focusing now on study abroad internships. We're looking at arranging partnerships with industries that'll extend our students' stay after their academic session. Some of our partner schools have developed models where a student can attend class for part of the day and then go to their internship. We'd like to start growing these relationships. ■ **As told to Lee Lamb**

Where They've Studied Abroad

Sydney, Australia
Shanghai, China
London, England
Grenoble, France
Darmstadt, Germany
Crete, Greece
Sendai, Japan
Zurich, Switzerland
Florence, Italy
Madrid, Spain
Beijing, China
Galway, Ireland

Culture Shock?

International students find Purdue to be a welcoming place.

Why Not?!?

Jonny Lavery came to Purdue from Ireland by way of the College's Summer Undergraduate Research Fellowship (SURF) program.

"The thought of studying in the United States dazzled me for two weeks," Lavery recalls. "I was working in a bar back home, asking customers what I should do. The majority said to do what I wanted to do. But I didn't know!"

Lavery eventually found his way across the pond, figuring that, as long as Purdue had a coffee shop and a newsstand, he'd be fine. (Purdue has plenty of both.) Fears of being lost, or not having others to talk to, subsided when he arrived at his campus apartment and found other international students who gave Lavery the friendship he needed. "I still consider them good friends of mine today," he says.

Lavery was on campus for just a short time when materials engineering professor R. Byron Pipes brought a dose of academic reality to him. "I got an e-mail from the professor asking me to come to his office to help his group understand multi-walled carbon nanotubes," says Lavery. "My knowledge of materials science was Polymers 101. Professor Pipes suggested at the end of his e-mail that I Google carbon nanotubes for a little background reading!

"During my first few weeks, I was really thinking about why I was at Purdue. I was really worried. Now, as I look back, the experience really pushed me in a very positive way."

Lavery says that his stay in the U.S. was both personal and professional. "Professionally, I learned a new area that I can later apply. Personally, I learned about myself and my ability to cope with new situations."

A Hope for Selflessness

Alfred Okello is originally from Kenya and went to France at the age of 19 to study medicine. But after a struggle with medicine, he changed to engineering. "Going to France definitely let me know my possibilities," Okello says. "It was in France and at the Ecole Superieure d'Ingenieurs de Luminy in Marseille that I finalized my plans to come to the United States and study in Indianapolis."

Upon arriving in the U.S., he had to immediately shed any preconceptions of what life might be like. "I first noticed that almost everyone had a personal vehicle. And I questioned my level of English—I realized the difference in my diction compared to Americans," says Okello.

He left Indianapolis in 2006 for Purdue through the SURF program. "It was time for me to learn again, and this time in materials engineering," he says. "I had three months to perform experiments and arrive at conclusions. This made me realize that research needs perseverance and hard work."

His experience at Purdue allowed him to compare life in West Lafayette to his home in Kenya.

"There's this mentality that, in more developed countries like the U.S., there are no problems," Okello explains. "In Kenya, you think that outside of the country, things are better. But when I came here, I saw normal people with their own way of life. And they have problems, too." He adds that people in the U.S. have more opportunities, and if they want to make it, they can.

During his time in the states, Okello also saw clear social differences between Kenya and the U.S. "I think Africa is less individualistic," he reflects. "People tend to do things in groups. When you make a decision, you first consider what your group is also thinking about it."

The spirit of progress in Kenya is different, too. As a Kenyan, Okello hopes that as the world grows, like his home country, "everyone becomes selfless." He adds, "Stop asking, 'What's in it for me?' The approach should be trying to understand other cultures, not about gaining."

A Better Future

Françoise Angoua came to the U.S. to improve her English and has plans to stay through 2010 to complete her PhD in materials science. "I'm from the Ivory Coast—a very small country not even as big as Indiana. This is my second year here, and I'll graduate soon with my master's," she says.

When Angoua arrived in the U.S., after spending four years in France, she was a bit scared and didn't know anyone. But she was put at ease through the many resources Purdue has for international students. Angoua, whose mother tongue is French, recalls her struggle to learn English: "My language was horrible, but my roommate helped me a lot. She was very helpful, and we still keep in touch."

Although Angoua doesn't care much for American food, she does like going to school at Purdue. "People here pay more attention to your work. They don't pay attention to where you come from; it's by your work that people judge you. If you're a good worker, you'll be fine."

Angoua speaks affectionately about her family and home in the Ivory Coast. "I have one brother. My father is in the army, and my mother is the head of a high school. I miss them and my country. There's been a crisis there since 2002, and it's very bad for the country.

"I'd like to go back there when I'm done. Maybe I'll be a teacher if I can finish my PhD." ■ **L.L.**

Vincent Walter

Okello, Lavery, and Angova share their experiences.

This image of Earth's city lights was created with data from the Defense Meteorological Satellite program Operational Linescan System, which NASA uses to map urbanization. The brightest spots are the most urbanized but not necessarily the most populated. (Compare Western Europe to China and India, for example.) See "Prime Numbers" on page 10 (college side) for a numerical quick look at our world.