MAKING IDEAS

PURDUE **MATERIALS**

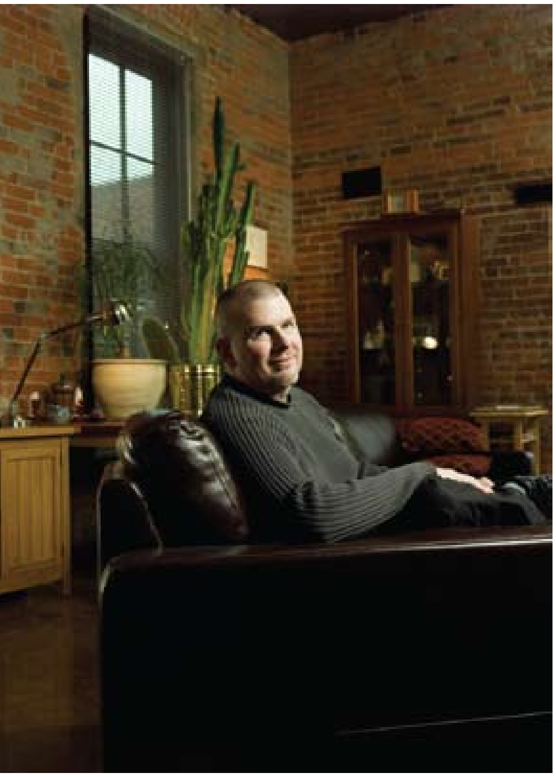
ENGINEERING**IMPACT**

Summer 2008

Looking Ahead
MSE gears up for 50th anniversary

Up Close: faculty
New uses for scrap metal

In My View
A personal take on innovation



On My Mind

Six months into any new job can serve up a mixture of surprises at what has and has not happened compared to expectations. My new responsibilities as head of the School of Materials Engineering still come with a strong enough dose of good will and support from faculty, staff, students, and alumni that some of the more challenging days are easy to put in perspective. I am regularly reminded of the tremendous opportunity afforded by being head of this school at this time.

This spring we graduated one of the best classes of seniors and graduate students in our history, including a number of student organization leaders. They have set a high standard for the classes that follow. Some other notable events include: The 2008 class of seniors conducted undergraduate research that will result in more research publications with faculty than for any prior class. Awards for funding of research have already reached a record level with several weeks to go in the fiscal year. This year, our school produced more doctoral students than at any time in its history. And, speaking of history, we are gearing up for a 50th anniversary celebration of the School of Metallurgical Engineering, which was founded in 1959. Please be ready for upcoming announcements of some special events and initiatives to kick off the second half-century of our school. All indications are that we will attain even greater success.

Keith J. Bowman
Head, School of Materials Engineering

If you have pictures or memorabilia from 1950-1965, we have gaps in our collection and would greatly appreciate contributions.

Tell Us What You Think

Share your Purdue memories, react to a story, or let us know your thoughts about a particular issue. Write to us at peimpact@purdue.edu. In doing so, you grant us permission to publish your letter in part or in whole in an upcoming issue. We reserve the right to edit letters for length and/or clarity.

PURDUE UNIVERSITY™
COLLEGE OF ENGINEERING

Ryan R. Elias

Director of Development
MSE

It is a great pleasure to announce that Ryan Elias has joined us as our new director of development. I would find it difficult to imagine a person better suited to serve in this pioneering capacity as our first full time fundraiser. Aligning our strategic plan with flexible support for operating the school is critical to further advancing our success. Ryan's head start on knowing our program, our program's values and even our program finances should serve him well in relating the further potential of our program to alumni, friends, and other stakeholders. Ryan's stellar two years as our business manager have made following in his footsteps in that capacity a challenge for his successor. ■ **Keith J. Bowman**

If you would like to discuss giving to Purdue MSE feel free to contact Ryan (relias@purdue.edu, or (765) 494-4094.

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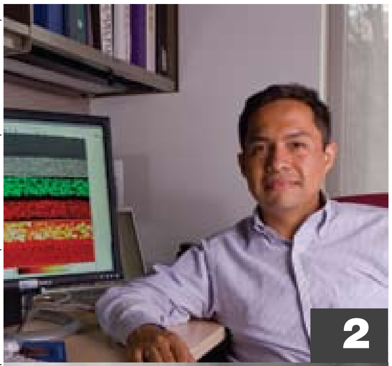

Cover photography by Vincent Walters

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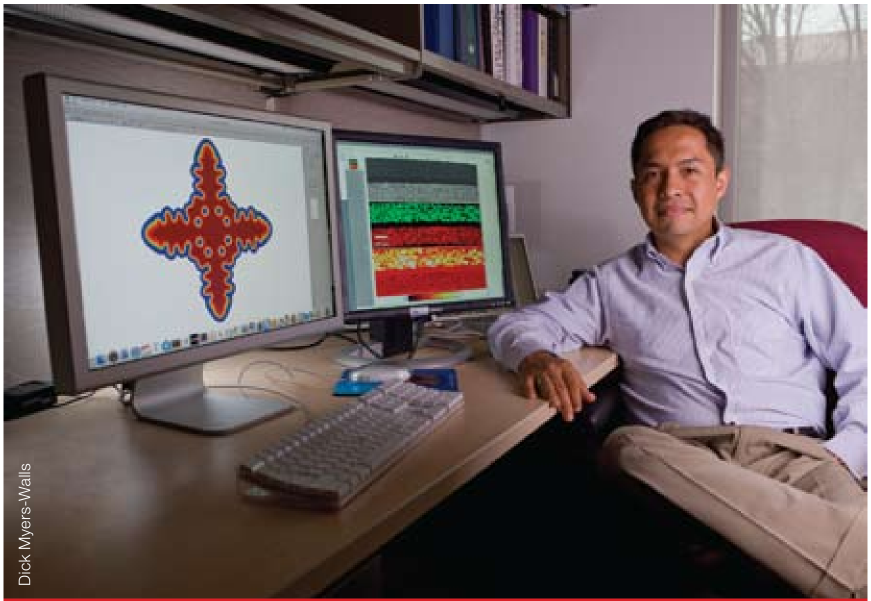
Q&A With R. Edwin Garcia

Considering computational materials engineering

R. Edwin Garcia, assistant professor of materials engineering, has been at Purdue since 2005. He has a BS in physics from the University of Mexico (1996), and an MS in Materials Science and Engineering (2000) and a PhD in Materials Science (2002) with a minor in applied mathematics, both from the Massachusetts Institute of Technology. He was a postdoctoral researcher at the National Institute of Standards and Technology in the Center for Theoretical and Computational Materials Science between 2003 and 2005. He and his wife, Lindsay Haugland, have four children.


Dick Myers-Walls

R. Edwin Garcia

Q: Were you born to engineer?

A: I was strongly influenced in choosing engineering by my father, who was a physics professor at the University of Mexico. He studied the atomic aspects of matter. I was in middle school during the Mexico City earthquake of 1985, which closed down our schools for seven months. My father made me and my brother keep studying. He took us to the library, bought a book on Euclidian geometry and asked us to explain a theorem a day. This daily exercise taught us how to think systematically and critically. I studied physics at the baccalaureate level, but, partially because I grew up in an underdeveloped country, I felt there was a greater need for people with technical knowledge, that it was important for me to study something more applied than physics. I became interested in looking at the ways in which materials organize themselves, understanding how materials and devices work, optimizing, and engineering them.

Our research group at Purdue, the Laboratory for the Computation of Materials and Devices, applies theoretical and computational methods to understand the relations between material properties and microstructures in order to tailor their properties and to optimize their associated reliability. I am a computational materials engineer. Modeling provides guidelines and is a very powerful tool in combination with experiments to shorten materials and devices design. At the end of the day, the combination is very powerful, inexpensive, and results in a better product.

Q: Describe your current work with rechargeable lithium ion batteries?

A: I am focusing now on the design of energy-related materials and devices by starting from the most fundamental thermodynamic principles. I began working on this during my doctoral studies at MIT by accident when a very good friend challenged me to engineer a battery. I am now looking at engineering batteries for better efficiency by removing the diffusion barrier between the cathode and anode. I am looking at the best particle size distributions and spatial configurations and eliminating or harnessing defects to optimize power and energy density. The uniqueness of my approach relies on the possibility of resolving the topological defects of the device by using both real and computer-generated materials. We are also applying similar approaches to engineer solid oxide fuel cells, thermoelectric generators, and phosphor-free light emitting devices. In all these cases, we start from the laws of thermodynamics, we incorporate the relevant transport mechanisms, and after understanding the processes that control their response and efficiencies, we propose new designs and guidelines to optimize them.

Q: Can thermodynamics be fun?

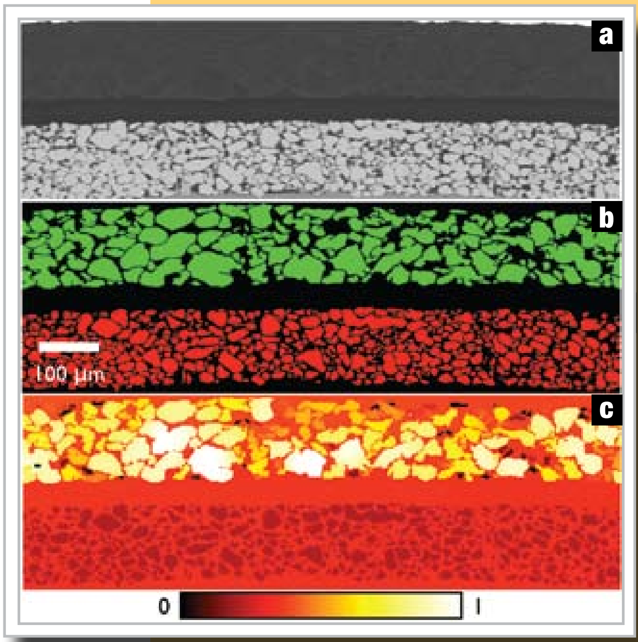
A: I am always very excited about discovering new things and sharing that excitement with students. I teach undergraduate thermodynamics, which is often thought of as a dry topic. My personal goal is to remove that prejudgment from the subject and have students appreciate that you can do exciting, applicable things by starting from well-rounded fundamental principles. I give them assignments—make a spinodally decomposing tomato soup, engineer a raincoat with a fabric that breathes, propose the conditions to heterogeneously grow a Si-Ge film, or to cast the iron of your choice. The class is oriented to describe real-life situations, and the textbook, *Introduction to the Thermodynamics of Materials* by Purdue Materials Engineering Professor David Gaskell, is the ideal starting point. Thermodynamics prepares students for a technology-oriented world but it can also be used in everyday situations, because thermodynamics is universal.

Q: Describe your work in one sentence.

A: I consider myself an explorer, discovering new things every day, something useful that the industrial and scientific community can use.

Linda Thomas Terhune

Inside Garcia's Work



Above is a simulation of lithium-ion distribution in a rechargeable battery. The top section (a) corresponds to "as-received" cross-section of portable power source. The middle section (b) embodies the digitized cross-section. The green phase corresponds to particles of graphite (anode) material, the red phase to lithium cobalt oxide (cathode), and the background black material to polymer-based electrolyte. The bottom section (c) illustrates the lithium-ion distribution at the end of a single discharge cycle over a period of one hour. Particle-particle electrochemical interactions are readily observed and impact on the delivered macroscopic power density. Calculation performed by Madeliene Smith (BSMSE 2008).

Waste Not, Want Not

Professor develops new uses for scrap metal

Materials Sciences Professor Kevin Trumble knows that the little things in machining are infinitely the most important. In his case, it's very little things—specifically, nanoscale structured particle production.

Trumble has collaborated for the past six years with Industrial Engineering Professor Srinivasan Chandrasekar and several students on a new kind of nanoscale structured particle production—taking strengthened machining chips and finding new uses for them.

Kevin Trumble

"Millions and millions of pounds of machining chips are produced every day around the world and most of these have unique internal structures on account of the machining process," says Trumble. "When you forge a metal or cause it to bend or stretch, it not only changes the shape but becomes stronger in the process. Cutting processes likewise induce severe deformation in the metal chips, which refines the internal grain structure down into the nanometers (billionths of a meter) size scale and thereby greatly increases strength and hardness."

These tiny pieces of scrap metal, formerly part of the waste stream, are being re-examined by the IE/MSE team. "Something that was formerly just a byproduct could be upcycled and put back into the use-stream at a much higher value than before," says Trumble, adding that controlling the properties of the chip particles would benefit his other research focus—infiltration processing.

Currently, the standard process for obtaining metal alloy particles is to melt the metal and atomize into small liquid droplets. The process is expensive and the resulting particles lack the work-hardened properties that Trumble studies. The team's milled chips, on the other hand, can go directly into reinforcements in composite materials and have better properties than the particles made by atomization.

"By infiltrating a compact of chip particles with another metal, composite components that have complex shapes can be produced. It's like packing marbles in a beaker; they don't fill space, so you've got to infiltrate a liquid into the pores and then solidify the liquid," Trumble says. The finished product is reinforced and contains the additional properties of the metal chips.

Research in this area will eventually affect industry. Trumble and Chandrasekar, along with co-inventors Dale Compton of Industrial Engineering and Tom Farris of Aeronautics and Astronautics, have three patents issued on producing nanostructured materials by machining, with another pending. A "products to process" patent was issued in November 2007, which covers products made from machining chips.

Despite having several patents under his belt and a wealth of grants, Trumble is true to the basics. He loves working in the lab with his students most of all.

"I probably spend too much time in the lab, but that's when I feel like I'm having the most fun and doing the best job of teaching," he says. "I have a philosophy to provide opportunities in lab classes so that students have a chance to make mistakes and figure out what's going on, rework it again, and see how it can be different from their expectations about the way things behave. I'm most proud of all the students' work." ■ **Rebecca Goldenberg**

Student Research Translates to Success

Industrial engineering student James Mann always planned to start his own company. He spent several years working on nanostructured materials production in a joint research program with Industrial Engineering professors Srinivasan Chandrasekar and W. Dale Compton and Materials Engineering Professor Kevin Trumble. Working closely with this team gave Mann the opportunity to take the research a step further in 2006 and form a company called M4 Sciences. Short for "Micro/Meso Mechanical Manufacturing Sciences," the company is devoted to improving precision machining at the micro-scale level.

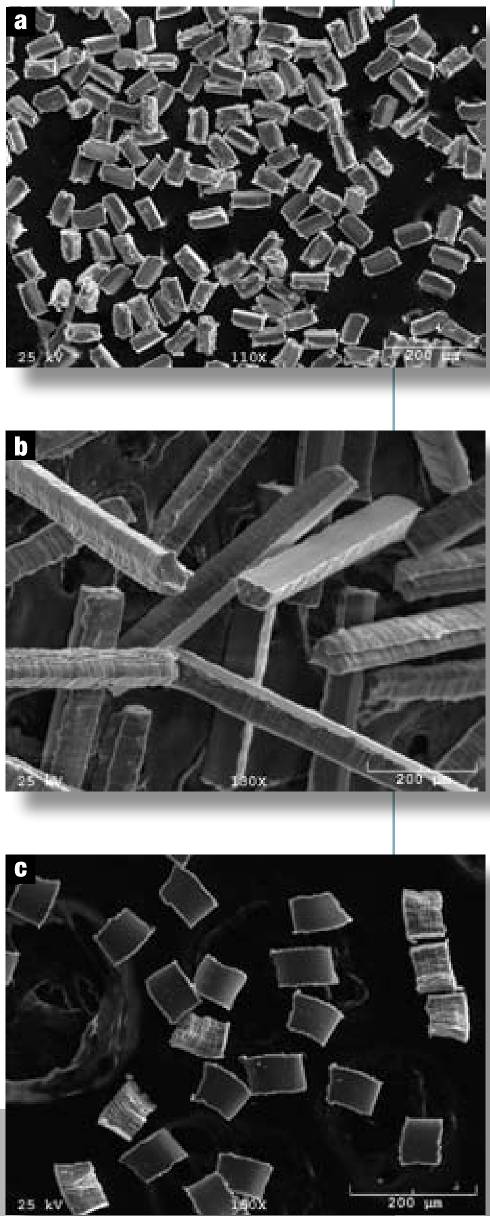
The company utilizes the technology from Mann's research at Purdue called Modulation-Assisted machining to improve the machining of precision components by oscillating [modulating] the cutting tool. It developed a special device that increases productivity in manufacturing precision components like orthopedic implants or fuel injectors. In a unique materials processing application, the technology can produce particulate metals and alloys directly by a controlled machining process. The oscillating process can produce micron-sized metal fibers, platelets, and particles with unique microstructures.

Shortly after its formation, M4 Sciences won the university's 2007 Burton D. Morgan Competition in which students work in multidisciplinary teams to formulate a business startup idea, prepare a business plan, and compete for money to help commercialize the idea.

The experience proved to be invaluable for Mann. The team won $40,000 in prize money and a springboard for M4 Sciences. "It gave us contacts with many other types of investment, access to other source of capital, leads, contacts, networking, and visibility," Mann says. "The competition honed our perspective on how to move forward as a company by giving us critical feedback from a panel of experienced business professionals."

M4 Sciences, located in the Purdue Research Park, is currently in its third year and has received funding from private investment and grants from both the National Science Foundation and Indiana's 21st Century Research and Technology Fund.

Rebecca Goldenberg



Images: Scanning electron micrographs of Al 6061-T6 particulate produced by MAM: (a) Equiaxed, (b) needle and (c) platelet shapes. Note the uniformity in size and shape of the particles.

Reference: J.B. Mann, C. Saldana, S. Chandrasekar, W.D. Compton and K.P. Trumble. Scripta Materialia 57 (2007) 909–912.

Making Ideas CLEAR

by Gina Vozenilek

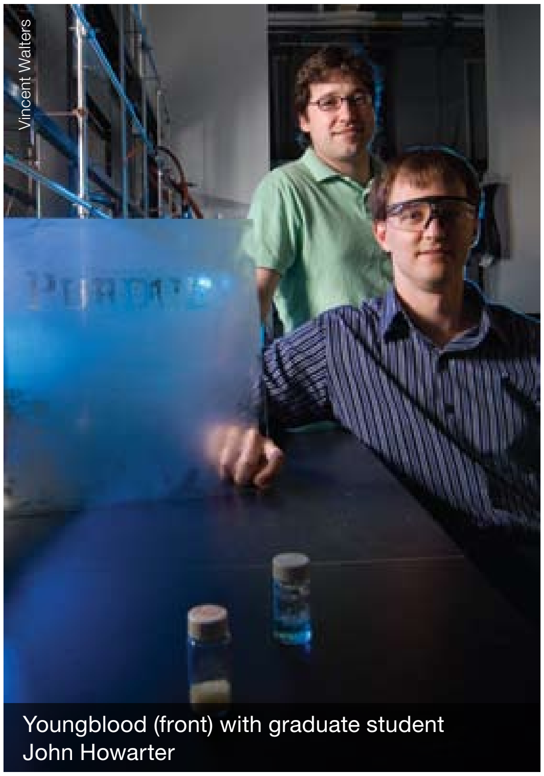
Can research engineers be in sales? Should they? And what are they selling? These are questions MSE Professor Jeffrey Youngblood wants his students to consider. He wants to teach them to think in what he terms an "entrepreneurial mind set," making their ideas clear and learning to sell them, whether through papers, grant applications, or, quite literally, by translating research into enterprise. The importance of entrepreneurship is a growing emphasis at universities around the world and across the School of Materials Engineering. Here's a look at how MSE nurtures entrepreneurship—from the laboratory to the classroom.

Setting Goals

Jeffrey Youngblood was on the ski slopes trying to enjoy the powder when his goggles fogged up—a common problem—and his attempt to clear the lens left an annoying fingerprint in his line of vision. So Youngblood, assistant professor of materials engineering, set his mind to fixing this mundane but irksome problem. He relates that real-world scenarios like the fingerprint in his face help him "find out where the limitations are and design around them."

Youngblood puzzled over how to make an anti-fog surface that repels oil—like the kind that comes off your fingertips—but that also simultaneously allows water to wet it. Working with the low surface energy of oil and the high surface energetics of glass, Youngblood and his team were able to develop a class of self-cleaning materials "strange enough" to file for a patent. For Youngblood, engineering ingenuity is vitalized by practical application, a tangible end result that solves a problem or improves a process. "For a polymer chemist," he says, "I'm very much an applied science guy."

At Purdue, Youngblood works with undergraduate and graduate students. He throws his cadre of undergraduates into the "pie-in-the-sky" projects to see if they can vet a new idea, and then his graduate students take the workable concepts and move them forward. In both instances, practical applicability of the ideas they study is essential.



Youngblood (front) with graduate student John Howarter

"It's not just pure scientific exploration we're doing," says Youngblood. "If students have an endpoint product in mind, if they understand its usefulness, they will better understand what you [the professor] are talking about."

Appreciating the salability of a scientific concept is obviously valuable for students heading for jobs in industry, but it also serves those who eventually find themselves working in academia. Youngblood recognizes how important it is for engineers to be able to sell their ideas in the papers they write, the presentations they give, and the grants for which they compete. The ability to communicate ideas effectively is paramount to academic success. "Having an entrepreneurial mindset helps one succeed in the marketplace of ideas," Youngblood says.

Getting Down to Business

To ensure that his work is successful, Eric Stach, associate professor of materials engineering, is focused on the little details—exceedingly little. Stach teaches a graduate course in electron microscopy and also owns a company called Hummingbird Scientific, which makes the sample holders that fit into transmission electron microscopes [see sidebar page 8].

These two sides of his professional identity—academician and businessman—fit together in a complementary fashion. "My entrepreneurial activity forces me to be more broadly aware of the state of my field," he says. Scientists from a broad spectrum of industrial and academic settings bring their problems and ideas to him at Hummingbird. From three-dimensional imaging of a virus' structure to examining the behavior of magnetic tunnel junctions for advanced hard drives, Stach keeps his finger on the tiny pulse of the world of electron microscopy. "I don't know much about biology," says Stach (just like the song), "but I get to use my skill set to build what the biologists need."

Stach is particularly proud to see evidence of his work out in the world. At the recent Frontiers in Electron Microscopy meeting, four of the invited presentations were given by clients who had used Hummingbird's services. "I go to conferences and see people from industry present their results and know that my company had a hand in their success," says Stach. "That gives me great satisfaction."

Straddling the world of business and education does require some delicacy, however. Purdue professors are entitled to consulting time to use on their own outside projects, and Stach is quick to point out that the university implements well-defined measures to make sure all is on the up and up. "I have my own conflict of interest manager, my external work is continuously reviewed, and there are clear procedures in place." But the university is supportive of such ventures, Stach reports. He finds the process administered through the Vice Provost of Research always to be "clean and well-handled."

Eric Stach and a transmission electron microscope

IP in the Classroom

Keith J. Bowman, professor and head of the School of Materials Engineering, sees the inherent business side of the work he and his colleagues do. "In addition to writing research papers we also develop intellectual property that may be of interest to companies," he says. Securing a patent, particularly one that results in licensing and eventual products, should be regarded as an important recognition of accomplishment, Bowman says.

As leader of the school, Bowman sets a positive tone in his department. He cultivates a culture of support for an entrepreneurial approach to science, enabling faculty to flourish. Youngblood concurs: "The patent and intellectual property development process is a core component of my research." And he says the school has encouraged his pursuit of multiple patents.

Bowman also advocates the importance of patents in the classroom. He teaches MSE 250, "Physical Properties in Engineering Systems," a foundational engineering course for sophomores. "Foundation courses have historically lacked context, leaving students to ask 'why would I care?'" Bowman says.

In response to this trend, he assigns students a patent to read, chosen to relate to particular course content. An example is patent number 7,108,826, "High compliance, high strength catheter balloons useful for treatment," which puts a practical spin on the fundamental science of thermoplastic polymers. Students then write a brief paper about the patent, discussing how foundational engineering concepts can be related to the technology in the patent. They talk about intellectual property and what makes something patentable. Best of all, says Bowman, "patents give context and relevance to classic examples in engineering. Students learn that patents are not just about making money."

Bowman notes that two-thirds of undergraduate engineering students will take their degree into the business world. Learning about patents "increases the potential of students to be more successful once they are in industry. It gives them an advantage compared to their peers who may not have learned about patents and intellectual property," he says. ■

Handling a Business Load

HUMMINGBIRD SCIENTIFIC

Before coming to Purdue as an associate professor of materials science engineering in 2005, Eric Stach started a company called Hummingbird Scientific. The company's core specialty is building equipment and accessories that enable researchers to handle samples for Transmission Electron Microscopes (TEM). Their work fixes materials on the head of a pin—a 3mm disc, actually—so that they can be precisely oriented, heated, electrified, or otherwise manipulated. TEMs allow researchers to observe the internal structure of materials that end up in all sorts of applications: jet engines, car pistons, ceramics, and semiconductor devices, to name a few.

Hummingbird Scientific has nine employees. Stach's partner, an engineer whose background is in manufacturing, is "brilliant at making really, really small stuff." As a businessman-scientist, Stach enjoys providing help to other researchers as they write grants and develop new products. He likes the synergy that exists between doing research and being an entrepreneur. "My job," he says, "is to leverage my material science expertise to target new areas of development and industrial need." ■ **G.V.**

California Dreaming

Materials Science grad joins software development startup

Mark McCormick took a calculated risk in April. He packed up his belongings and three years as a business development manager with Motorola in Chicago and headed into the unknown—life as the business manager for a software development startup in Santa Cruz, California. Like any fine pioneer, he was ready for the challenge.

McCormick (PhD 2002) had a clear education and employment plan from the moment he chose materials engineering, drawn by a fascination with the ability of engineers to influence the properties of materials and create structures not found in nature. As a doctoral student at Purdue, he focused on materials used in the microelectronics and semiconductor industries and targeted the leader in that industry—Intel—as his career goal. For nearly two years after graduation he worked as a process engineer for Intel in Portland, Oregon. But his life plan needed tending. He left the Northwest and enrolled in the MBA program at the University of Chicago.

"As an engineer you have a chance to do research and development, but you don't have the opportunity to influence a company's bottom line and make decisions on strategy. The people who do that have both technical and business backgrounds so they can make business decisions that are fundamentally sound," McCormick says.

The engineer's introduction to real-world business development came through an internship during business school at Motorola, where he married his training in materials engineering with the management side of the telecommunications and wireless industry. He stayed on at Motorola after his MBA, analyzing emerging technology potential and developing business case analyses for emerging device and wireless-related technology applications.

Then an opportunity came along. FullPower Technologies, a startup in mobile sensing technology founded in 2003 by Phillipe Kahn, father of the camera phone, needed a business development specialist. The company develops software applications for mobile devices, including motion-based applications that are just beginning to make an impact in the consumer device industry. A simple example of how motion is used to create interesting applications can be demonstrated with the iPhone, which uses an accelerometer to rotate picture orientation when the phone rotates. McCormick predicts that sensor-based applications will increase exponentially over the next few years as more and more sensors are built into mobile devices and accompanying software becomes more sophisticated. The calculated risk-taker saw the chance to get on board as the industry takes off.

Mark McCormick at home in Santa Cruz

"I have the tools necessary to understand the technology at the hardware and software level, and I have the business skills that will allow me to do business case development," he says. He also has enthusiasm, which is an essential ingredient in his own recipe for entrepreneurial success.

"You have to be outgoing and like to work with people with lots of different backgrounds and think globally. The one single factor that sets entrepreneurs apart from others is that you really have to enjoy what you're doing. If you like it, you will work all the time and wake up excited. If you are doing something you don't really enjoy, it's not going to be successful," he says.

McCormick also has a fallback. For the last four years he has worked in Chicago's Lincoln Park as a bartender on Saturday nights for fun and a bit of extra cash. "If I get wealthy enough," he jokes, "I'll probably open a bar." If not, he can always tend one. ■ **Linda Thomas Terhune**

Vincent Walters

A Well-Rounded Education

PhD student Kalapi Biswas takes learning beyond the classroom

Although it is a long way from Mumbai to West Lafayette, a deep passion for engineering helped India native Kalapi Biswas bridge that distance. With a bachelor's degree in civil engineering from Veeramata Jijabai Technological Institute, she enrolled at Purdue to earn her master's degree in the same field. She then stayed on to pursue a PhD in materials engineering.

A rich affinity for science and analytical problem solving makes engineering a perfect fit for Biswas' PhD work. "After finishing my MS, I got interested in the area of nanotechnology and its applications, and moved on to materials engineering to work in that field," she says. Her doctoral work is geared toward developing novel materials that use nanotechnology to efficiently convert thermal energy to electrical energy. Her research seeks to fabricate cost-effective, high-performance thermoelectric nanowire arrays by hybrid nanostructuing. Through her efforts she hopes to demonstrate efficiencies that will make these devices commercially viable.

Industrious by heart, Biswas participated in an entrepreneurship competition at Purdue where she pitched a device based on her research. She has also filed an invention disclosure for her PhD research and one day may launch a business based on those efforts. Biswas received the Bilsland Dissertation Fellowship, which is awarded to outstanding PhD candidates.

For Biswas, the Boilermaker experience extends far beyond research and studies as she shares her vast and diverse talents across campus. "Purdue has been a learning ground for me not just academically, and it has helped me hone my talent in different non-academic areas," she says.

Biswas developed her leadership skills by serving as vice president for the Materials Science and Engineering Graduate Student Association (MSEGSA) in 2005-06, helping MSEGSA gain recognition as an official university organization. Among its initiatives, the group has planned outreach events to spread awareness about materials engineering to first-year students.

MSEGSA barely scratches the surface of Biswas' contributions. "I have served on various university boards and committees, and served as an official student blogger at the Materials Research Society fall 2007 meeting," she states. She is also an official blogger for the College of Engineering, enjoys painting and dancing, and has displayed her theatrical talents by acting in multiple plays both on and off campus.

Whether through extracurricular experiences or her academic pursuits, Purdue has afforded Biswas great freedom to explore her interests and has opened doors to exciting opportunities.

"The research facilities at Purdue have helped me in doing cutting-edge research. The research work that I have done at Purdue has provided me with an opportunity to give invited talks at international conferences," she says. "I owe my success to my professors and colleagues at Purdue University and unconditional support from my family in India."

■ **Matt Schnepf**

As this magazine went to press, Biswas was getting ready to participate in the Summer Commencement Ceremonies and has accepted a job with Intel Corporation, ATD Division in Chandler, Arizona, where she will become a process TD engineer.

What is an Entrepreneur?

John M. Storm

In 1986, I left my comfortable job with a Fortune 500 company and ventured into the great unknown of running my own business. Now, 23 years later, I am glad to offer my views from outside the box.

Look around for inefficient and wasteful systems. Engineers are educated to change the physical world and we have a responsibility to change it for the better. Improvements that can be characterized in fundamental engineering terms—kinetic vs. potential energy, first law of thermo dynamics—produce long-lasting successes.

Someone may tell you, "We have been doing it this way for 30 years." Statistically, this system is ready for an engineering improvement. Large companies work on small, incremental improvements in technology. Entrepreneurs work on big, radical improvements because they are less constrained by historical capital and because large-scale improvements provide entry into sustainable markets for small organizations.

Start with hypothesis, organization, and data collection. Nothing beats a written account of something you feel is grossly inefficient or if you believe something can be done significantly better. Take your time and observe the events in question multiple times.

Test your theories against your engineering education. Purdue alumni are well-equipped to analyze and compare observed "state of the art" conditions against theoretical improvements.

Be on the lookout for and collect all factual, printed information about your area of interest. Proceed with caution as you evaluate this form of media and apply engineering principles as a test of legitimacy.

If, after withstanding the test of time and data-gathering, all of the indicators are still positive, it is time to prepare an analytical business model focused on fully developing and marketing your unique innovation. Treat this study as another engineering problem; focus on what makes your offering unique and why a customer would select your product, method or service over others on the market. If you are looking to pitch a significant change to established businesses or markets, be prepared to first educate your target audience. It is very important to have identified your niche; unique products tend to grow unique markets and you should not expect to be everything to everyone.

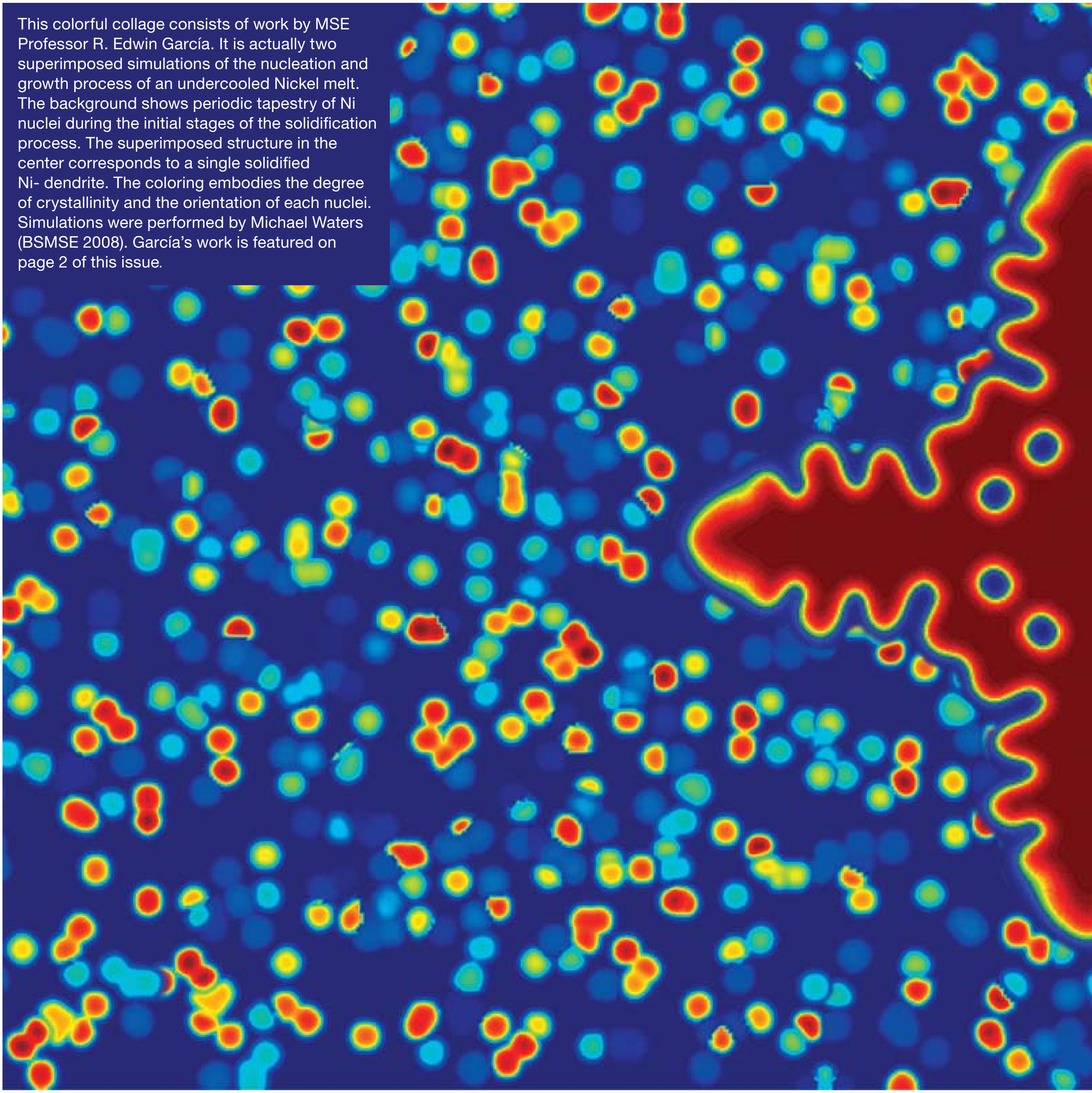
Prior to seeking the necessary capital and arranging for the financial, legal, and technical support necessary for opening the doors to my business, I spent two years gathering data, developing a business plan, and evaluating the market.

What advice can I offer to you? Take advantage of your engineering education. Purdue offers a superior education that is also practical. Seek out post-graduate educational opportunities including seminars and conferences. People with years of real-world experience are an invaluable resource. Read everything you can get your hands on—professional periodicals, Web articles, science and technology magazines—and think about the big picture implications of other people's research and innovations.

Make sure you select an area for which you have a passion, because you may end up living it for 30 years. When someone asks me what it is like to be a successful entrepreneur, I answer that for me it is like being an engineer blessed with the opportunity to run my own, successful company. ■ **John M. Storm** *(BSMetE '77)*

is from a rural, central Indiana farming community. His early career took him to US Steel and General Motors. In 1981, while working at GM, Storm conceived, developed and put into production a unique multi-frequency heating system that rapidly and uniformly heats gears and other finished components to levels at or above 1600° F. This technology is the basis upon which Contour Hardening, Inc. was founded in 1986. In 1996, Storm was selected as the Indiana Entrepreneur of the Year (Advanced Manufacturing). Today, Contour has systems and products in eight countries on four continents.

aperture



This colorful collage consists of work by MSE Professor R. Edwin García. It is actually two superimposed simulations of the nucleation and growth process of an undercooled Nickel melt. The background shows periodic tapestry of Ni nuclei during the initial stages of the solidification process. The superimposed structure in the center corresponds to a single solidified Ni- dendrite. The coloring embodies the degree of crystallinity and the orientation of each nuclei. Simulations were performed by Michael Waters (BSMSE 2008). García's work is featured on page 2 of this issue.