PCSA enters fifth year with enthusiasm and ambition

(Credit: Bradley Williams.)

Iowa State materials science students leap with joy in front of the Lincoln Memorial. Read the story of why they were there, "Good science needs good policy." From left, Bradley Williams, Daniel Voss and Robert Holec.

Student special issue – Table of contents

Chair's report on programming, outreach, fundraising and growth

By Troy Ansell

The President's Council of Student Advisors, or PCSA, was formed in 2008 to increase student involvement in ACerS and the broader ceramics community. The leadership of ACerS found a growing gap between the established professionals and scientists and the new generation of ceramists. It established PCSA to focus on student participation and education. PCSA has accomplished much in the four years since its inception.

The PCSA is responsible for the content in the June/July issue of *the Bulletin*, one student article in every other *Bulletin*, organizing student tours of research facilities, raising funds for student travel and lodging at technical conferences, and most importantly, promoting the scientific and creative impacts of the ceramics industry on the world.

This year, the primary goal of the PCSA is to finish ceramic demonstration kits, a project that began last year. It is hoped that the demo kits will be used by universities to showcase the ceramics industry and foster an interest in engineered ceramic materials to secondary school students. The kits include examples of experiments involving ceramic materials directly linked to real world applications. Other important goals for this year include continued work on student-focused *Bulletin* articles, continued fund raising for PCSA activities, increasing the number of student delegates as well as increasing the number of schools represented, and improving student access to professional information.

The PCSA is organized into four committees: programming; finance and grants; communication; and recruiting.

The programming committee is in charge of assembling the demo kits, and this committee has its work cut out. The demo kits are at the top of the priority list for PCSA because these kits will advertise to the outside world what it means to be a ceramic scientist or engineer. The committee's delegates — Kelsey Meyer (chair), Alex Wilmot, Elizabeth Reidmeyer, Aaron Lichtner and Kevin Strong — have been hard at work. To date, they have worked out discrepancies in the demo kit instructions and Kelsey Meyer wrote up an excellent student symposium for EMA 2013, where demo kits may be showcased. The committee's goal is to complete the kits by June.

Communications is fun, but the communication committee also knows the meaning of hard work. In charge of providing student content for the *Bulletin*, members have completed articles for three issues as well as provided content for this issue. They have the added goal of expanding the PCSA website. The committee's delegates are Samara Levine (chair), Michael McLeod, John Soloman and Seth Berbano.

The delegates on the finance and grants committee — Sam Miller, Tim Pruyn, Michelle Gervasio (chair) and Chris Hoo — are hard at work raising funds for the PCSA next year. They have established a goal of raising $20,000 before EMA 2013. This is a tall order. However, with their energy and experience, they will come through. Their accomplishments so far include writing a grant letter to submit to funding agencies, expanding a list of potential donors and working on a new flyer to advertise the needs of the PCSA.

The recruitment committee (Mona Emrich (chair), Chris Turner, Ryan Wilkerson and Dharam Persaud) is charged with expanding the number of delegates and schools represented in the PCSA. Its goal is to have at least 18 schools represented by next year (over the 14 schools represented this year). Adding four schools is a reasonable and attainable goal. Committee activities this year include completing a recruiting brochure and completing PCSA applications for teachers and students. Members have started "cold" emailing schools to expand participation in PCSA.

Finally, the PCSA is trying to expand its presence at technical conferences such as MS&T. PCSA will have a presence at the 4th International Congress on Ceramics this summer as well as MS&T'12 and EMA 2013, and hopes to lead student symposia at the latter two.

Despite the large amount of work, the PSCA is full of bright and hard-working student delegates, all working hard to promote our ceramics industry.

About the author

Troy Ansell is a PhD candidate at Oregon State University and chair of PCSA. He served seven years in the US Marine Corp Reserve. ■

Laboratory safety perspectives and best practices

By Seth Berbano

When I started laboratory research as an undergrad, one of the first things I learned was the acronym MSDS — Material Safety Data Sheet. Fortunately, I joined a group that valued safety, making employees aware of potential hazards and ensuring proper training before working in the lab. Thinking about safety does not stop after the initial training. Instead, safety should be an attitude or culture of continual improvement. Good safety culture is essential to responsible, high-quality research.

Perspectives

What happens when somebody in your group does not wear the proper personal protective equipment (PPE)? The answer depends on the safety culture of the group. Some will have the attitude, "If this person is careful, PPE is unnecessary," or "Not wearing PPE affects only the decision maker, and it should not matter if he or she is not directly exposing others to undue hazards," or "If an accident happens, their injury might lower group's productivity and the person might face an administrative reprimand." Safety should be a group, rather than a personal, attitude. Poor individual choices can affect more than the decision maker and may influence safety practices of mentees. It is better to work carefully while using PPE, much like it is better to drive defensively while wearing a seatbelt. When everyone in a group follows safe practices, they take collective responsibility for making the work environment safer for current and future group members.

Can old labs be safe labs? It is possible if the building is up to code with proper equipment, storage and ventilation. New facilities are less important than the safety culture of the people working in them. This includes everyone helping to maintain an up-to-date chemical inventory, proper disposal of hazardous waste and the facilities being appropriate for the type of work being performed. For example, the fume hood face velocity should be rated for the type of chemicals your group uses and the processes performed inside the hood.

Is it OK to work alone in a chemical lab? In addition to being careful, wearing the PPE and easily being able to call for help, deciding whether to work alone depends on the risk involved and what could go wrong.

Here are some important questions to ask prior to working alone: Have you done this work (either processing or characterization) before or is it something new? Does your work use or possibly evolve flammable or toxic gases? What would happen if there was a leak in the gas line? Could you smell the gas if gas sensors fail? What fail-safes are in place for the hazards in your lab?

Does safety affect productivity? Redesigning experiments to be safer may make them less precarious and increase reproducibility. Safe labs are organized, which makes it easier to find supplies and set up experiments. Maintaining a safe work environment attracts students who take pride in their work and will be comfortable spending time to be productive in the lab.

So far, I have focused on experimentalists using chemicals. What about everybody else — should they be required to receive general safety training? Providing appropriate safety information and training to everybody in the building, including support staff, is good. In addition, everybody in the building should be able to recognize common "bad smells" from the labs as well as how to react to natural disasters and fires.

Improving safety culture

In addition to the strong materials research and teaching excellence at Penn State, I am proud to be in a department that values safety.

During our graduate student orientation, we learned how to complete the basic safety training and viewed an educational MatSE Safety Video (http://www.youtube.com/watch?v=AIy6AC9F1Gk). Having a common orientation gives students more confidence to gently remind one another about safety while working in the lab.

The Department's Materials Safety Awareness Organization put together a successful Safety Week that included fire safety training, non-laboratory personnel training and refresher safety training. Granted, safety is more than training sessions and sleek videos. To demonstrate an attitude of continual improvement, the MSAO posts monthly Stall Wall newsletters in the bathrooms, keeping readers up-to-date about events and providing helpful safety tips and reminders. Furthermore, the department's safety webpage is updated regularly and provides a centralized, easy-to-access location for safety-related resources (http://www.matse.psu.edu/safety).

How did Penn State's MatSE Department get to be like this? What prompted the change in safety culture? The safety initiatives began with recommendations from our External Advisory Board several years ago. Our administration has been very supportive of safety efforts and recognizes that educating students encompasses excellence in the classroom and education about safe research in the lab. More information, including the names of the many "safety champions" at Penn State, can be viewed online at http://live.psu.edu/story/56194#nw63.

While numerous safety resources exist, I hope this provides a challenge for you to carefully evaluate what the safety culture is in your workplace. Then, take steps to improve the safety culture within your group and organization as a whole.

About the author

Seth Berbano is a PhD candidate at Penn State University advised by Clive Randall and Michael Lanagan. He was the 2011 recipient of the GOMD Alfred R. Cooper Scholars Award for his work as an undergraduate in Steve Martin's group at Iowa State University. He aspires to research ceramics for clean energy and teach as a faculty member. ■

Quality education: Teaching students to optimize experiments

By Ashley Durrbeck

Virginia Tech's Materials Science and Engineering department is constantly looking for ways to improve its curriculum to prepare its students for what is coming next. One of its more recent additions includes the class, Materials Optimization through Designed Experiments. The department developed this class to better prepare seniors for their design projects by examining ways to refine their experiments as well as to prepare the students for challenges they will face in the work place.

The goal of the class is to understand how to make experimentation more efficient, more powerful and more predictive, according to instructor Gary Pickrell. More efficient experiments require fewer trials to produce meaningful data, saving time and money. The more powerful the experiment, the better the understanding that will be obtained from it. The more predictive an experiment, the easier it is to optimize and improve the performance characteristics. With these goals in mind, Pickrell introduced the students to concepts such as Six Sigma, Statistical Process Control Charts and the Taguchi Method.

Lectures include interactive building of Statistical Process Control Charts, where students gather data over the course of several class periods, and the data were entered into an $\bar{x}$ chart and an R chart. Through examining these charts — $\bar{x}$ chart for analyzing the average and R chart for analyzing the variation — students are able to determine if the data is in an acceptable range for the given experiment. Students also learn how to determine when changes in a system over time are significant and what to do when the system does not behave as expected.

(Credit: Durrbeck; Va. Tech.)

An example of a projectile system created and optimized for this class. The factors that were varied include board angle, elastic pull back position, ball position and peg location.

A real world perspective from prior industry experience often is shared with the students, as concepts that are important, such as the Six Sigma method for quality control. The Taguchi Method was discussed in depth, as it utilizes loss functions, system design, the interaction of data and outcome analysis to improve the quality of the product. The Taguchi Method is heavily used for the group project assigned to each class.

To put the lessons into practice, students work in groups to build a projectile system that has four variables with three levels each. These four variables were peg height, pin location, draw-back position and ball position (the photograph shows an example projectile system). Once this system is built, the groups are given different target distances to achieve, and they have to optimize the system to decrease variance from the target. By creating and analyzing these systems, students are able to better absorb the information presented in their lectures.

The Materials Optimization through Designed Experiments course provides invaluable information to students that is applicable to many real-world situations. By learning about Six Sigma, students will increase their career marketability and will be able to become valuable members in any company because of their ability to design efficient experiments, analyze the results of data and determine when the changes in a process have occurred.

About the author

Ashley Durrbeck is a junior at Virginia Tech. ■

Travel scholarship enables international research collaboration

By Amy White

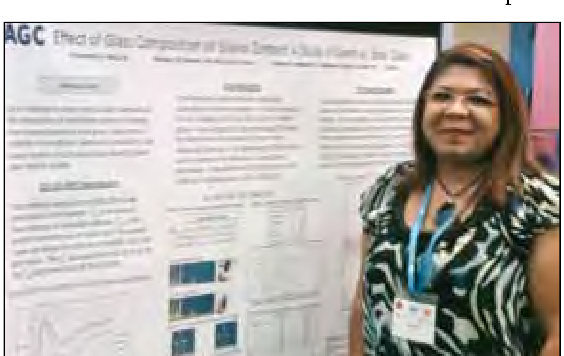
Gaining international exposure for research and building collaborations around the world are among the most important goals for researchers. However, obtaining funding for international travel is a challenge, particularly for students and those early in their careers.

Yet dozens of students and postdoctoral researchers have traveled abroad through the International Conference Travel Scholarship provided by the International Materials Institute for New Functionality in Glass, a National Science Foundation funded virtual research center based at Lehigh University in collaboration with Pennsylvania State University.

Since its creation in 2006, the scholarship has aided 52 US students in traveling to 12 countries to present at international conferences, network and gain valuable feedback on their glass research.

"The goal of this program is to help young scientists—undergraduate and graduate students and postdocs—currently studying at US universities to develop into future leaders of research on glass and other materials. We provide them with the opportunity to gain international experience and draw attention to research results in the US and build new collaborations between international and US teams," says Himanshu Jain, IMI-NFG director and professor of materials science and engineering at Lehigh University.

The year-round program reimburses 50 percent of conference-related travel expenses (up to $1,000) for individuals who have a paper or poster accepted at an international conference. Expenses may include airfare on a US carrier, living expenses and registration fee.



(Credit: Photo provided by Sefina Ali.)

Sefina Ali presents her poster on "Effect of Glass Composition on Silanol Content: A Study of Green vs. Solar Glass" at the International Meeting of Pacific Rim Ceramic Societies (PAC RIM 9) in Cairns, Australia, in 2011.

Opening a door

For most recipients, the scholarship has allowed them to participate in a conference they otherwise would not have been able to attend.

"Costs for attending conferences in the US are already expensive," says Julien Lumeau, who received the scholarship as a postdoc at University of Central Florida. "When it comes to international conferences, costs are 50 percent higher or more, and funding tends to be harder to be found."

Through the scholarship, Lumeau presented posters on his work on photo-thermo-reactive glass at three conferences—in Brazil, Slovakia and France—between 2007 and 2010.

The scholarship allowed Amit Belwalkar, then a graduate student at Lehigh University, to present his work on flow analysis in the extrusion of tellurite glass at a conference in France in 2011.

(Credit: Photo by Zhongzhi Tang.)

Amit Belwalkar in St. Malo, France (Du Petit-Be fort in background), during his trip to the Flow and Fracture of Advanced Glasses (FFAG-5) conference in 2011.

Sefina Ali, then an undergraduate at Washtenaw Community College, used the scholarship to attend a conference in Australia in 2011, where she presented on "Effects of Glass Composition on Silanol Content: Study of Green Glass vs. Solar Glass."

Advisors or senior postdocs often receive preference for international travel, meaning that generally younger researchers may have opportunities to travel only domestically.

"So we are opening up a doorway that otherwise would have been closed," William Heffner, IMI-NFG associate director, explians.

"The scholarships provide younger researchers with funding, which encourages advisors to help them get to international conferences," Jain says. In addition to exposing students to senior researchers, the program introduces younger scientists to others in their age group around the world who also may have difficulty attending conferences in the US.

"They are the ones who are going to lead and really be responding to the international scene," Jain said. Such friendships and professional relationships can result in additional long-term collaborations.

Wider exposure and personal connection

Attending international conferences exposes US students to the breadth of glass research, introducing them formally and informally to the latest research and ideas.


(Credit: Photo provided by Lehigh University.)

Amanda Simens (left) and Jamie Neilson (right), then seniors in materials science and engineering at Lehigh University, outside the Taj Mahal in Agra, India, in 2006. Both attended the 15th International Symposium of Non-Oxide and Optical Glasses (ISNOG) in Bangladore, India, with the assistance of the International Conference Travel Scholarship provided by the IMI-NFG.

"The glass and optical material community is a very small community, and when you attend only conferences in the US, you mostly meet the same people at each conference," says Lumeau, now a research scientist at CREOL—The College of Optics, UCF. "Participating at foreign conferences allows you to socialize with many more people and therefore to create a wider network of collaborations." Lumeau has published several papers with Brazilian and German researchers he met.

"There is exciting glass research being done and quite a large fraction of it is outside the US," Jain says. "There are nitty-gritty details you would pick up only in the corridor, and there's a personal relationship you build, to exchange samples, ideas, when you really want to share an instrument."

James Giammarco, a graduate student at Clemson University in 2011, attended a conference in Greece through the scholarship. It meant gaining a broader perspective of the variety of researchers in the nanotech field. The trip was his first outside the US.

"The conference allowed me to increase the spectrum of those who know of my published work," he says. "This was done by getting a request to read my article based on my poster presentation."

Traveling to conferences with the scholarship was fruitful because it broadened his network, Lumeau says.

"But it also is very enriching because it allowed discovery of a new country, new people and new culture from Eastern Europe and South America," he says. "Moreover, as a French citizen attending the Non-Crystalline Materials conference (NCM11) in Paris allowed me to keep close contact with the French glass community."

IMI-NFG's Heffner believes such international experience is vital.

"Science is a much bigger game than what's happening in your backyard," he says. "International collaboration and awareness are essential to doing the best science. … We need to teach them how to do that and introduce them to that."

The scholarships allow young researchers a short-term international experience that organizers hope gives them the confidence to pursue science abroad and be international global scientists.

Opening opportunities and expanding research

Belwalkar, now a research and development engineer at Strainoptics Inc., which makes stress measurement instruments for glasses and plastics, says the experience he gained presenting his research at an international conference before an audience specialized in glass-related research gave him confidence when he joined his company.

"The experience I got from the conference, such as talking to the researchers from different countries about their culture or even sharing ideas over lunch helped me share my ideas confidently and connect with the people in the glass industry much better," Belwalkar says.

Presenting on their research to worldwide experts also challenges participants to better understand their work, direction and how to integrate with the wider field of knowledge.

"It gave me an idea where my research stood in comparison with overall glass research," says Belwalkar. "It helped me to broaden my outlook [and to] look outside my own area of research."

For Ali, participating in the conference was an accomplishment and a recognition of her research analysis.

"The best part was meeting and networking with colleagues working in the same areas and their feedback on analysis and next-steps work," says Ali, who is continuing her education in the chemistry field. "The next-steps to the research opened ideas for continuing with an interest in adhesion."

Andrei Jitianu, then a postdoc at Rutgers University, used the scholarship to present on his work on melting gels at a conference with 500 attendees in France in 2007. It was the first time he presented on the concept, and he received valuable feedback on his research. After the conference, he published more than five articles based on continuing to develop the concept.

"Any debate of any nature can help your work," says Jitianu, now an assistant professor at Lehman College, City University of New York. "For example, Professor Livage (a well-known international expert from Collège de France), suggested during the conference that the melting gels are thixotropic. Based on this suggestion, we started a series of rheological studies which will be published soon."

A broad definition of glass

To be eligible for the International Conference Travel Scholarship, individuals must pursue research focusing on an aspect of science or engineering of glass or amorphous materials, from applications to theoretical modeling.

The IMI-NFG, which provides the scholarship, is one of five NSF-supported IMIs established to enhance research collaborations between US researchers and their counterparts worldwide in the field of materials science. It is the only institute of its kind to focus on a single class of materials.

Scholarship applications are accepted year round and require submission of an application and an abstract for the paper or poster to be presented. For an application and more information, see www.lehigh.edu/imi/opportunitiesguideICTS.html, email imi@lehigh.edu or call 610-758-1112. ■

Is the textbook right? Supporting a truck on coffee mugs

By John Mayo

"Since cracks and flaws tend to remain closed in compression, brittle materials such as concrete are often incorporated into designs so that only compressive stresses act on the part. Often, we find that brittle materials fail at much higher compressive stresses than tensile stresses. This is why it is possible to support a fire truck on four coffee cups; however, ceramics have very limited mechanical toughness."

When I read this in my materials science and engineering book, *The Science and Engineering of Materials, Sixth Edition*, by Askeland, Pradeep and Wendelin, it captured my attention. My friends will tell you that I am one to test the limits, so this statement sounded like a dare. Because I did not have a fire truck handy, I decided to use my own truck, which weighs just more than 3,000 pounds.

(Credit: John Mayo.)

▲ John Mayo at Texas A&M used his truck to test the compressive strength of ordinary coffee mugs.

Sandwiching the mug between wood scraps helped distribute the load and protected the tires in case of failure.

Having an assortment of ceramic coffee mugs from trade shows, I selected four evenly sized ones for the experiment. I also cut pieces of scrap wood to place above and below the mugs to provide a uniform surface. The wood also would isolate the ceramic from unevenness of the concrete driveway, especially if the truck shifted and put excessive pressure on only one edge of a mug. With a jack, two jack stands and wood blocks to keep the truck from rolling, I began at the front, driver side wheel. After ensuring that the transmission was set to "park" and the parking brake engaged, I jacked up the wheel and gently lowered it back on the mug between two wood pieces. The mug did not break, so I added one under the front, passenger side next. The truck seemed stable, so I jacked the rear end under the differential, lifting both tires simultaneously. As soon as the tires rose from the concrete, the truck rolled forward slightly, so I let it back down and checked on the front mugs. Surprisingly, the coffee mugs had not broken, even though they were both titled with only one point on their rims supporting the truck.

I quickly jacked the front end up, and supported it slightly above the cups with jack stands. Next, I jacked the rear end up again and successfully installed the mug and wood "sandwiches" under each tire. Then I used the jack to remove the jack stands at each front wheel, thus getting all four wheels supported on mugs.

After leaving the truck on the mugs for the entire, windy night and most of the next day, I decided to test them further by jumping up and down in the truck bed. The mugs seemed to be magically strong, so to prove to myself and others that these were ordinary, empty ceramic mugs, I set my phone to record a video clip of me breaking one of them. Wearing safety glasses and using a glass shield for the phone proved to be a wise decision because the weight of the truck helped create an intense "explosion" of ceramic pieces when I tapped a mug with a hammer. The video clearly demonstrates that the mug is indeed ceramic and that the truck's weight is substantial.

To see the video, visit www.ceramics.org/ceramictechtoday and search on coffee mugs.

About the author

John Mayo is a second-year mechanical engineering student at Texas A&M. He is thinking about going to graduate school when he graduates. ■

Conquering the conference

For students attending their first conference, the atmosphere can be intimidating but just as equally rewarding.

By Samara Levine

(Credit: ACerS.)

MS&T organizers planned plenty of activities for students, including this student mixer.

One of my biggest regrets in my academic career was not going to the Materials Science and Technology conference my sophomore year. I thought that because I had just selected Materials Science and Engineering as my major, I would not benefit from going. I immediately knew I was mistaken when a couple of my peers, who had been more adventurous than me, returned from the conference excited by their new contacts and new insights. Not being one to make the same mistake twice, I immediately made plans to go to MS&T the following year.

I went to MS&T with several students from Virginia Tech. We arrived on Sunday morning and registered. Receiving the schedule of presentations was overwhelming. It was a booklet! Who knew there could be so many talks on sintering? Luckily, scheduling on the first afternoon was light so I did not have to make any decisions with my time right away. It was Sunday, and the conference was not in full swing yet. However, there were several programs for students. I spent the afternoon supporting a fellow student in the ACerS speaking contest and attending a forum on graduate schools.

The following morning I perused the schedule over breakfast and figured out what talks I wanted to attend for the day. I was not prepared for how difficult a task it would be. I complained to my friend while frustratingly gesturing with my bagel, "How am I supposed to choose between all these presentations? There are so many that sound interesting!" Eventually, I developed a list of presentations I wanted to attend for the day. However, the same scene would repeat itself each morning of the conference.

Sitting in on presentations filled me nerdish delight. It was as if everything I was learning in class was put into context. Suddenly seeing the applicability of topics like thermodynamics made all the equations I had struggled to learn in class redeeming and worthwhile.

At the same time, it was a humbling experience to see how my knowledge skimmed only the surface of the field of materials science and engineering. As I listened to presenters from various universities and companies, questions I had wondered about during class were being answered and new ones were being formulated. A number of new perspectives were being opened to me.

My experience at MS&T was invaluable. I could argue that I learned more during the few days I spent at the conference than during an entire semester of school. My time at MS&T also connected me to the material science community. After the conference I kept in contact with one of the presenters who spoke on a topic on which was particularly interested. Whether it is MS&T or another material science symposium, I highly recommend the experience. I eagerly look forward to this fall and am excited this time around to join the dialog, presenting on behalf of the ACerS's President's Council of Student Advisors on ceramics education.

About the author

Samara Levine is a junior studying materials science at Virginia Tech. She is the communications chair of PCSA. ■

Industry desires more than an engineer

By John Solomon

As a materials engineering undergraduate student, it is easy to be consumed by the rigors of class work, research and social activities. The undergraduate engineering curriculum is demanding, yet employers are looking for success in and out of the classroom. A graduate desiring to be competitive in the job market needs to have a well-rounded portfolio of experience beyond school work.

Let's do a simple analysis to find out how a "typical student" spends the 168 hours of each week. Let's assume a student is taking 15 credits, working 10 hours per week, and sleeping 8 hours a night—bear with me, it is just an assumption. The rule of thumb I was told before entering college, is that for every one hour spent in class a student should expect to spend two to three hours outside of class working on comprehending the material, completing the homework, writing up labs, etc. Let's again assume the 15 credit hours are technical classes and require an additional two to three hours per credit, which means 30–45 hours spent on schoolwork outside of the classroom. Don't forget the time spent eating, social networking, student organization activities, traveling to classes, exercising, etc. We will assume all of these activities fall into the "other" category and consume 22 hours of the week. Using some simple math, I deduce there are only a measly 20 hours left in the week.

1 week=168 hours

168 – 15(class) – 45(classwork) – 10(research) – 56(sleep) – 2(student org.) – 20(other) =

20 hours remaining

The remaining 20 hours left in the week are the most important to a student's success after graduation. Each student graduating with a materials engineering degree takes roughly the same core classes with a few flexible credits for electives. Although maintaining a quality GPA is important, it is only one piece in the career search puzzle. In an effort to bolster résumé points, students flock to student organizations such as Material Advantage and Keramos. These are excellent organizations that provide many opportunities to students who wish to develop technical and leadership skills. In today's job market just being a member of such an organization is not enough. Here are five fairly simple ideas that can differentiate top notch graduates from their peers.

- Design and participate in an independent study. Universities are a microcosm of knowledge, and all one has to do is ask to learn. The independent study does not have to be within the college of engineering or even technical, at all. Find a mentor outside of the sciences and read a common book (such as *Getting to Yes* by Fisher & Ury, or *7 Habits of Highly Effective People* by Stephen R. Covey).
- Find public speaking opportunities. Many universities have a debate club or a Toastmasters International chapter. Ask a few of your closest professors if they will listen to a 15-minute presentation and offer feedback. There are many competitions around the nation for students and young professionals to practice public speaking.
- Attend a nontechnical conference to broaden your perspectives. Many universities host one- or two-day conferences centered on diversity, leadership development or public service.
- Network, network and network. This can be as simple as asking faculty members to grab some coffee and discuss their career. Once the discussion gets rolling, it is very easy to expand the topic list and receive some guidance for life after college.
- Get involved in an organization outside of your field of study. Individuals studying political science, business, history, agriculture and women's studies all offer a drastically different perspective on a variety of topics. As mentioned earlier, Material Advantage and Keramos are excellent organizations, but members have common educational backgrounds and think similarly.

These five ideas offer unique yet simple experiences that can be used to help land that dream job, get into graduate school, become a well-rounded individual and solve the problems the world will face in the next 50 years.

(Credit: Bob Elbert, ISU.)

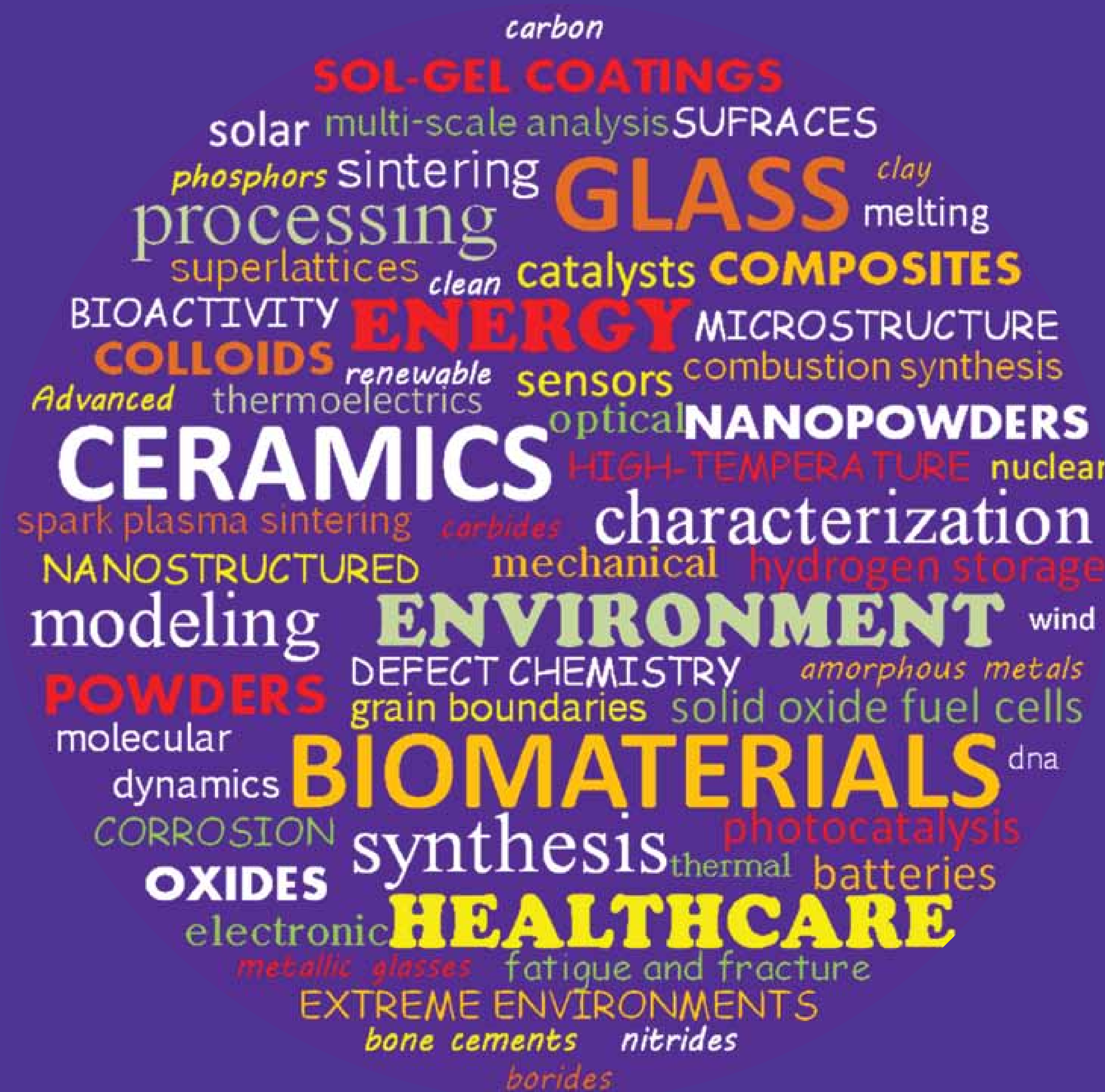
John Solomon used one of his spare hours to introduce Vice President Joe Biden during a visit to Iowa State University in March.

About the author

John Solomon graduated in May with a BS materials engineering degree from Iowa State University. He is joining Caterpillar Inc. in the engine materials group. ■

Kazuo Inamori School of Engineering

Ceramics, Glass & Biomaterials



Alfred University

Individuals. Inspired.

Sampling the work world

Internships provide a view of research outside the university.

By Eleanor A. Gamble

As a PhD student's thesis research approaches completion, it is necessary to determine the next step on the career path. This can be a difficult step in the graduate school experience. Some of my graduate student colleagues at the University of California, Santa Barbara, entered graduate school with the goal of going into teaching, becoming a researcher in industry or at a national lab, or joining a startup company to develop products on the cutting-edge of technology. Others, like myself, were motivated to earn a PhD by a love of research and discovery but were not sure how we wanted to use that passion to earn a living. I have found that research internships are valuable experiences for gaining insight into my career interests and for exploring opportunities.

During my undergraduate studies, I participated in two summer internships at the NASA Glenn Research Center in Ohio. These first experiences with materials research helped shape my career. They solidified my decision to obtain a PhD and allowed me to begin developing the skills necessary to succeed in a graduate program. I hoped an internship in industrial research would prove similarly useful for expanding my skill set and providing experience in research outside the academic community. Professor Levi at UCSB helped put me in contact with the Engineered Ceramics lab at the GE Global Research Center, and I spent February–May 2011 working there.

My research activities at GE Global Research focused on high-temperature ceramic coatings for turbine compo-

***Charles Forman** and **Patrick Sinko** are junior materials science and engineering majors at Virginia Tech and had interesting summer work experiences, albeit very different. Their stories show how government and industry internships differ.*

Government Sector

By Charles Forman

I participated in a Department of Energy sponsored Science Undergraduate Laboratory Internship at the Thomas Jefferson National Accelerator Facility in Newport News, Va., last summer. Jefferson Lab is a world-class nuclear physics research facility that houses a 7/8-mile continuous electron beam accelerator for studying subatomic particles.

I was assigned a mentor, Michael Kelley, who gave me a unique materials research project. My project was the very first to dissect and analyze a high-performing superconducting radio-frequency niobium accelerator cavity.

Many Jefferson Lab engineers are relaxed in terms of attire, but they are all very involved in their work. My research experience was more formal, because my mentor treated me as a graduate student.

I am still impressed by the quality of equipment present at Jefferson Lab. I needed only to sign up online, and I had access to top of the line optical, scanning and atomic force microscopes. In addition to my mentor, I reported to the supervisor of the internship program.

All interns are expected to write a formal research paper and present their work in a poster session at the end of the summer. The DOE annually chooses the top 14 papers from about 500 national lab interns nationwide to be published in the agency's *Journal of Undergraduate Research*. They selected my paper and arranged for me to compete in a national conference in Washington, D.C.

Overall, they treated me very well, and I had a great research experience.

Private Sector

By Patrick D. Sinko

For the past two years I have been working in the pharmaceutical industry as a materials scientist and engineer at Bristol-Myers Squibb. Although the company is global, I worked at the original site in New Brunswick, N.J. I spent my first summer at BMS characterizing pharmaceutical excipients and active pharmaceutical ingredients. I had the opportunity to work with experienced materials engineers from all over the world as well as world-class pharmacists. This was beneficial because I was using traditional methods and cutting edge technologies to generate a central database of pharmaceutical materials properties. I had the opportunity to develop a platform formulation.

The working atmosphere at BMS is relaxed, but you are expected to deliver results on time or early. The dress code was relaxed, business causal in the office and appropriate lab safety gear while in the lab.

My job resided in the Drug Product Science and Technology Department, but I actually belonged to two smaller groups within that department that deal with materials characterization and development. My team was five people ranging from 25 years of experience to myself with only a years of experience.

BMS holds an internal symposium, which the upper management and most of the top level scientists attend, and this is where you present the findings from your research. The amount of learning that I experienced over my two years at BMS was not limited to material systems and pharmaceutical knowledge, but extended to professional development and learning how to work in industry as an engineer. ■

nents. I investigated how the deposition and processing of environmental barrier coatings for ceramic-matrix composites influenced the coating microstructure and reliability. This research differed significantly from my thesis work on predicting dynamic fracture and deformation of ceramics. Nevertheless, the mentoring I received and the skilled technical staff in the labs allowed me to make significant progress in just a few months. My work was one part of a large team effort to develop robust and effective coatings to protect the composites from the harsh environment in the turbine. Team members working on all aspects of the problem collaborated to design experiments, share results and offer advice.

The team structure at GE was different from what I had experienced in academic research. There were individuals on my team and in my lab only a few years out of grad school, ceramic engineering experts with decades of experience and people everywhere in between. I was able to interact with and learn from scientists at all stages of their careers, offering snapshots of how my career could develop in this type of organization. This allowed me to thoroughly assess and confirm my interest in pursuing a career in industrial research.

I was able to begin developing more industry-specific skill sets during my last month at GE. I presented the results of my research at a progress meeting with design engineers at GE Energy's Engineering Headquarters in Greenville, S.C. In contrast with the experimental focus of team meetings, the GE Energy engineers were concerned with the reliability of results, cost minimization and timelines for improvements. Constructing a timeline for developing a material or solving a problem—before the form of the solution is even known—is a complex process. It was eye-opening to look a different approach to research and development.

Overall, my internship at GE was very beneficial to me. Obtaining work experience in an industrial research lab helped me to confidently determine that industrial research was the right career path for me. I developed skills and made professional contacts that will serve me well regardless of what career path I choose, but are particularly useful in accelerating my entry into a permanent position.

About the author

Eleanor Gamble is a PhD candidate in materials at the University of California, Santa Barbara, working with Frank Zok on dynamic fracture and deformation of armor ceramics. She earned a BS in materials science and engineering from Purdue University. She is supported by an NSF fellowship. ■



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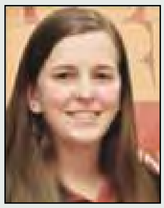
Keramos and Material Advantage

Like cousins, these two student organizations look alike, but are very different up close.

By Ellen Sitzmann and Laura Van Steenhuyse



Universities emphasize the importance of learning beyond the classroom to better prepare students for the workforce. This includes student participation in campus clubs and organizations. In the Materials Science and Engineering Department at Iowa State University, this involvement often occurs with two international organizations, Keramos and Material Advantage. From the outside, they seem to be very similar, but in actuality, there are major distinctions between them. In this article, the leaders of both organizations reflect on the differences and similarities by looking at the practices of the Iowa State chapters.

General

The most obvious distinction between Keramos and MA is their origins. Keramos was founded a century ago as a fraternity for ceramic engineering students and professionals, and began at Iowa State in 1941. Material Advantage was founded in the past decade by four supporting organizations: ACerS, AIST, ASM and TMS as an exclusively student group. The ISU chapter was established in 2003.

Both chapters are very independent groups, exclusively run by students. The executive board of Keramos consists of six officer positions, while MA has twice that number. This gives an indication of the number of members in the two groups. Keramos has 31 members, half of which are active. Material Advantage has around 100 members, also with 50 percent participation on average.

Membership

The aspect in which the two organizations diverge most is in the requirements for membership. Keramos is considered a professional fraternity, and all members must meet and maintain a minimum grade point average to qualify for membership. MA also is a professional organization, but requires that only its executive officers to maintain a certain GPA.

At ISU, Keramos requires that students are enrolled or have been enrolled in ceramic engineering specialized courses. This is not the same for Material Advantage, because the club encourages membership for all MSE students and welcomes students from outside of the department, too.

Membership fees are an absolute requirement and are paid annually or semiannually depending on national or local membership status for both organizations. To become a member of Material Advantage, a student simply signs up online and pays a fee. To become a member of Keramos, the student must pay a fee, but also goes through an initiation ceremony that is rich in tradition.

(Credit: MA, ISU.)

MA members demonstrating the properties of the non-Newtonian fluid, oobleck.

(Credit: Keramos, ISU.)

Keramos members throwing pots on the potter's wheel for a semester activity.

Activities

Keramos and MA members have similar interests and backgrounds. Therefore, the groups try to collaborate on activities to avoid overlapping schedules. MA and Keramos have regular general and executive meetings held on consecutive weeks once a month. The meetings are similarly structured, with dinner and club announcements followed by a speaker from industry or academia.

Although activities in both organizations are meant to enhance student involvement in their chosen profession, the groups take different approaches. Material Advantage focuses on developing professional networking by attending conferences, touring manufacturing facilities and holding informational sessions about life after graduation. The club also devotes much of its effort to engaging K–12 students in materials engineering through interactive demonstrations. Keramos, on the other hand, is geared toward providing hands-on activities in which students can design and process different ceramic materials and exposing members to ceramic research and technology.

Finances

In order to provide these activities to its members, the organizations need financial assistance beyond what their member fees can sustain. Once a semester, the College of Engineering allows any engineering club to submit a financial requisition to the board and allocates the money based on each club's financial need. Both MA and Keramos take advantage of this opportunity and participate in allocations.

Because MA sponsors more activities and has a larger member base, it holds several fundraisers throughout the year. The most lucrative is selling pizza in a campus building once a week to students, faculty and staff. Keramos began a similar fundraiser strategy, but discontinued when most of the materials needed for its events were generously donated.

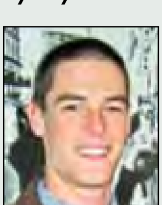
Although they are similarly structured, the organizations have different methods of attracting and maintaining student involvement in materials (or specifically ceramic) engineering. By bringing students closer together and exposing them to the future of materials science, both clubs play a major role in materials science and engineering undergraduate education and professional development at Iowa State.

About the authors

Ellen Sitzmann and Laura Van Steenhuyse are graduating seniors in materials engineering from Iowa State University. Sitzmann will attend graduate school at the University of Michigan in the fall. Van Steenhuyse hopes to work in the recycling industry on graduation. ■

Managing information flow in the current age of science

By Taylor Shoulders



The portrait Hollywood paints of mad scientists, working away in their top secret laboratories, completely shut off from the rest of the world, is a far cry from the modern scientist. We are now more connected to our research communities than ever before. Communication across oceans and borders is lightning fast. Conferences and meetings no longer need a physical location. Journals are published online for anyone in the world to read before they are available in print form. We can use all of this to our advantage to work more efficiently and solve more complex problems, but only if we are able to manage the flow of information.

As a first-year graduate student, I have found myself overwhelmed with the amount of information accessible to me. Even though I belong to one of the first generations to grow up with the computer, I still find it difficult to manage the constant flow of information from emails, social media, online databases, textbooks, etc. This overflow of information extends to research and coursework.

Here are a few tips that have helped me to manage my information flow:

- Keep your email inbox free of clutter. Consider separate inboxes or even separate accounts for school and personal use.
- Every scientist needs a good reference library. Use the many sources on the web for used books to help build your library. Many books also are available in digital format at little or no cost.
- Some top universities offer free online lectures or even entire courses. Do some independent study to give yourself additional background on a course you are taking or to help you with your research.
- Learn to use all the features embedded in the literature databases. Most allow you to track citations to find related papers. Some also allow you easily to share articles with your peers and your advisor over email or social media.
- Use a citation manager to keep track of the papers you read. There are so many on the market, it is worth reading online reviews to find the best fit for you.
- Download an RSS feed reader and subscribe to feeds from the journals you most often read. This takes some of the work out of finding the newest articles.
- Use social media to connect with others in your field. Professional organizations often use these platforms to announce seminars, meetings or social gatherings.
- Remember, you also have peers and professors that are human beings. Engage their help with coursework and research.

If you use the right tools to find, organize and review information, you can access the information efficiently without wasting time and brain cells wading through the large volume of information available. Time and brain cells spent processing and using information to increase your knowledge base and advance your research are time and brain cells better spent.

About the author

Taylor Shoulders is a first-year PhD candidate in materials science and optics at the University of Central Florida, where he is working in the transparent ceramics group of Romain Gaume. He earned a BS in ceramic and materials engineering from Clemson University. ■

Art, science and engineering: Lessons given, lessons received

By Maxwell Marple

The offerings of art to engineers

Many engineers balk at the notion of taking an art class, because they see no value from such an endeavor. Ironically, most engineers strive to be creative and inspire others with their work, and art classes are intended to inspire and push the bounds of creativity.

So, why do engineers choose not dabble in art? The answer may be simply that engineers generally do not see the potential in art and design. This can be a problem because engineering is the art of manipulating nature and using science to solve problems.

Engineering requires a solid understanding of the fundamentals of nature to creatively manipulate them to serve a purpose through the process of design. Interestingly, if you substitute the word "art" for "engineering" in the previous sentence, it still holds true. An art course can offer valuable skills to an engineer, including more effective communication, enhancing nonlinear thinking and reinforcing theory. By taking art classes, engineers expose themselves to a different perspective on thinking, allowing them to improve themselves in a variety of ways.

Changing your communication

Taking an artistic perspective is a great way to develop communication skills. Everyone notices and observes information differently, and by expanding your repertoire of communication techniques you will be able to reach a broader audience. When constructing an art project, the constraints are those of the medium being manipulated. Each medium has its own unique methods and procedures, along with standards of design criteria. Working within the constraints of a particular medium forces you to analyze and determine the optimal way of presenting your ideas to your audience.

The hands-on nature of art is one aspect. A unique facet of art that is absent from engineering is the infamous critique. The critique is an opportunity for peers or instructors to provide feedback on work-in-progress or the finished work. It is communication at its finest—

the feedback given must be justified and often forces individuals to give precise statements with concrete explanations of the problems of a particular art piece.

By participating in an art class you will be exposed to receiving and giving criticism. And, by consistently receiving criticism, you can understand better how to deal with negative comments and how to properly modify your project to make it better. By consistently giving feedback to others, you spend more time considering the precise phrasing that will direct others to rectify their mistakes without obliterating their motivation. Thus, participation in art offers an engineer a whole palate of techniques to communicate more effectively.

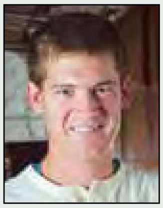
Improve nonlinear thinking

Many engineering courses teach methods of tackling problems. Typically this involves understanding the fundamental mechanisms behind problems and ways of testing a design. Although these methods serve their practical purposes, there can be a lack of focus on the visualization or ideation of multiple solutions. How can ideation be taught? Or more aptly put, how can you teach people to think "outside the box"?

There is no simple solution other than to broaden your perspective and develop nonlinear thinking skills. Engineers pride themselves on the ability to think in a linear fashion but

Ceramics: The intersection of art and engineering

By Samuel Miller



(Credit: William Carty, Alfred University.)

Artists and engineers usually try to avoid crawling of glazes (left), but an intentionally crawled glaze can enhance aesthetic appeal.

While it may seem obvious, artists and engineers think differently. Take for example crazing and crawling: While engineers strive to eliminate both, artists sometimes use these "defects" as decoration.

At Alfred University, there is much collaboration and interaction that benefits both groups, but usually not in the form of dual majors in art and engineering. Both disciplines have a long history and are deeply embedded in society, and students at Alfred are finding new ways to interact.

Artists and engineers come from different backgrounds and bring different perspectives and skill sets to their work. Engineers are strong in math and science, and are often good problem solvers, but because they are inclined to think "inside the box," sometimes they can miss the overall goal.

Artists, however, think more abstractly and bring different ideas into their work. They tend to be goal oriented, although they sometimes overlook the process steps. Artists have a very good physical "feel" for the material they work with—engineers think and understand materials more conceptually.

Having acknowledged their differences, let us consider what they can do for each other. This is something that Professors William Carty and John Gill have been doing at Alfred for the past 18 years. When artists and engineers interact, exchange ideas and work together to solve them, great things can happen.

Take cracking, for example. In one case an artist wanted to create a special clay body that would intentionally crack. Working with an engineering student, the artist developed a body in which cracking could be controlled and used as an aesthetically appealing aspect of the artwork.

Crawling is another good example. Engineers see glaze pulling away from the body and beading as a problem. So do artists, unless it is understood and can be controlled and reproduced to create art. The image above shows how crawling can be "engineered" to control the size of the beads that form as well as their orientation as they follow the underlying texture of the body.

Alfred is a unique place where barriers tumble, allowing students from the two disciplines to interact with each other. Artists often know what happens and can control certain effects, and engineers can help them understand why the effects happen so that better results can be obtained and replicated. In return, artists can help engineers "think outside the box," see problems from a different angle and even see that they might not be problems at all.

The lesson is that ceramics have so many more uses than just electrical insulators, dinnerware, electronic components, armor or synthetic bones. Ceramics are versatile because slight modifications in their formulation or processing can turn something that has been used for thousands of years for its aesthetic appeal to a material that can help solve, for example, the modern world's energy problems. Not only are ceramics versatile in their applications, but so are the people who work with them, and they can learn a lot from each other.

About the author

Samuel Miller is a junior MSE major at Alfred University. After graduation, Sam plans to pursue a PhD in materials engineering.

often miss the opportunities that come from nonlinear thinking. Art provides an opportunity to practice nonlinear thinking as the environment is more conducive to taking an off-beat approach and considering novel solutions. An art project typically has only a few constraints stemming from the limitations of the medium and desired message trying to be expressed.

The process of thinking with limited constraints and a vague idea in mind for the end goal is practice for nonlinear thinking. The physical limitation of the medium being used will make you really break down the message you are trying to get across. Physically reorganizing the message to be represented can lead to interesting ways of interpreting the medium and the message. With practice, this thinking process can become second nature when a problem is presented and a logical path yields no fruitful results.

Supplement to theory

Artistic manipulation can reinforce theoretical learning, too. Although knowing physics does not make one a craftsman, working with a physical medium (especially if it is one of scientific interest, i.e. pottery and glass) can provide a deeper appreciation of the subtleties that engineering often exploits. Observing these subtleties and gaining experience working with a material can further the understanding of its properties.

For example, consider glassblowing. You may learn the theory behind thermal shock, but when working with glass, you begin to see how vital it is to think about temperature gradients and the thickness of glass during every step of the process to prevent your work from ending in ruins.

The experience of working with a medium can provide a more physical picture for the theory the next time it comes up in the classroom, and as you may find out, there is an inherent satisfaction from creating something that all engineers can relate to.

Engineering is a discipline that values structure and empirical methods. This often blinds us to the fact that really good engineering needs a high degree of creativity and innovation. Can we learn to be more creative or innovative? With practice, creative thinking becomes easier. You may not get this type of practice from many classes that involve mathematics, but art courses can certainly promote the creative process and expand your mind to being a better engineer.

About the author

Maxwell Marple is a senior in materials engineering with a minor in physics at Iowa State University. He intends to pursue a MS in nanoscience after graduation. ■

Good science comes from good policy

Students travel to the US Capitol for Congressional Visits Day.

By Tricia L. Freshour

Congressional Visits Day, organized this year by the Material Advantage Program, was held on April 17–18, 2012, in Washington, D.C. The CVD is an annual event that brings students to Washington to raise visibility and support for science, engineering and technology.

(Credit: Office of Congressman Van Hollen.)

Some of the student delegation visited Rep. Chris Van Hollen, D-Maryland, who is holding the Nobel Prize medal awarded to the father of Bob Shull from NIST (immediately right of Van Hollen). Pictured from left are Hang Li, George Washington University; Justin Wilkerson, Johns Hopkins University; Richard Suchoski, University of Maryland; Van Hollen; Shull; Cynthia Byer, Johns Hopkins University; Paul Rottmann, Johns Hopkins University; Ziang Ji, North Carolina State University; and Zhi Tang, University of Tennessee, Knoxville.

Thirty-three students and faculty from 13 universities attended this year's event. It was an exciting time for the students because they occurred when the space shuttle Discovery flew over Capitol Hill on its way to Smithsonian's National Air and Space Museum, and because it was a unique opportunity for materials science and engineering students to advocate for long-term funding for science, engineering and technology through meetings with Congressional decision-makers.

The CVD experience began on Tuesday, April 17, with a talk by Kei Koizumi, Assistant Director for Federal R&D at the White House Office of

Science & Technology Policy, titled, "The 2013 Budget: Investing in Our Future."

A reception, which included a fun and interactive role play session led by Dave Bahr from Washington State University and Bob Shull from NIST followed the budget talk. This warm-up event was a valuable time for students and professors from across the country to meet and share their perspectives and motivations for making the effort to meet with their elected officials.

Organizers set the schedule so that most of the students' appointments with legislators would be held the second day, April 18.

Prior to CVD, organizers gave the student participants the task of contacting the offices of their representatives and senators to arrange these visits for their groups. Students reported that setting up their own appointments is an important part of the experience because it allowed them to take ownership of their trip to Washington. An optional event was available to the students that evening at a local restaurant where they had a great time sharing their CVD experiences.

The 2012 CVD was a great success and a very rewarding and eye-opening experience for the students. Colin Gore, graduate researcher at University of Maryland, commented, "Getting a chance to offer anecdotal support for scientific research to congressmen and women, and hearing their feedback on how we can further help them, was very enlightening. After all, great science can only gain traction under good policy".

"Overall I was very surprised at how well received we were when meeting with the congressmen and their staffers. Everyone was polite, well-informed and seemed genuinely interested in our story and how materials engineering impacts the nation," said Bradley Williams, undergraduate student at Iowa State University.

The universities that participated in CVD 2012 included Colorado School of Mines, Drexel University, George Washington University, Iowa State University, Johns Hopkins University, Michigan Technological University, Missouri University of Science and Technology, North Carolina State University, Rensselaer Polytechnic Institute, University of Maryland, Washington State University, Virginia Tech and University of Tennessee, Knoxville

The partner societies in the Material Advantage Student Program are The American Ceramic Society, The Association for Iron & Steel Technology, ASM International and The Minerals, Metals and Materials Society.

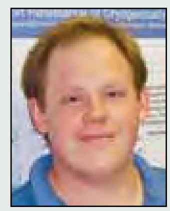
About the author

Tricia Freshour is ACerS Liaison to the Material Advantage student program. ■

The Wreckers

New Mex Tech undergrads answer a call to wreck and rebuild lab space in the department.

By Michael McLeod and George Edgert



In the past two years, the faculty of the Materials Department at the New Mexico Institute of Mining and Technology experienced several painful losses involving professors. Osman Inal passed away, Gillian Bond retired and Deidre Hirschfeld moved on to the greener pastures of Sandia Labs. These losses created a pressing need to reorganize, inventory, update and restructure labs, offices and equipment.

Some type of organized phoenix needed to rise from the ashes of these losses. Thus began "The Wreckers," an informal group of students, faculty and staff committed to meeting the challenges presented by this "new" department. As usual, most of these challenges involved hard, dirty, labor-intensive efforts. The group, as of summer 2011, consisted of students Alex Thayer, George Egert, Kiichi Harada, Nathan Compton and Michael McLeod, and faculty members T.D. Burleigh and Gary Chandler supervised the group with the help of staff member Prescott Thompson.

Some initial projects included an upgrade of safety and first-aid equipment in all the department labs, and an intense effort to clean and organize all fume hoods in the department. Several storage rooms had become repositories for outdated and unused equipment, which was inventoried, cleaned and repaired or refurbished when possible. One particularly laborious effort involved the relocation of a Charpy impact tester, known as the "1,800-pound Gorilla," to a more spacious location. Now, a class of 20 can comfortably observe the mighty hammer munching metal.

All of these projects, and many others that are continuing, have been made far easier and more pleasant with the camaraderie developed by The Wreckers. This little group has tried to establish a contagious collegiate atmosphere and a reputation for ability, reliability and responsibility. As "veterans" graduate and move on, new underclass students take their places, and skilled individuals move through the group as their expertise is required.

The talents and work ethic of Tech students never ceases to amaze. It is hoped that The Wreckers will continue to provide a safer, more pleasant environment for the process of education.

About the authors

Michael McLeod recently graduated with a BS in materials engineering from New Mexico Institute of Mining and Technology and plans to pursue a MS in materials engineering at NMT. George Edgert earned his BS in materials engineering from the New Mexico Institute of Mining and Technology and is working on his MS. Both intend to continue their wrecking ways. ■