

# THE PRE-ENGINEERING *TIMES*

A publication of JETS



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## Explore...Assess...Experience Engineering

JETS provides programs and resources that help students explore, assess, and experience engineering first-hand. From exciting student competitions to assessment tools and career exploration materials, JETS helps students plan for rewarding futures by showing them how engineering can help them pursue their dreams.

### EXPLORE...

Find your dream job, meet extreme engineers, watch videos

## Feature Story

### Homeland Security Engineering

Bet you hadn't thought about how much engineering goes into keeping our nation safe. Many different types of engineers contribute to this critical task. With the attacks of September 11, 2001 and the creation of the U.S. Department of Homeland Security, dozens of universities across the nation, some in partnership with corporations, are being funded to help develop the tools needed to keep our country safe and secure.

Projects under way by engineers affiliated with the [University of California at San Diego](http://www.ucsd.edu) include:

- Structural engineers are investigating effective ways to retrofit U.S. embassies around the world and other critical structures against blast load. One approach is composite overlays made up of carbon threads precisely woven to increase the strength and flexibility of buildings. These overlays allow the buildings to absorb horizontal forces and keep key structural components from failing.
- Electrical and computer engineers are working on developing a video camera network system that would allow first responders and other emergency personnel to customize their views

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JETS Affiliates help increase awareness of and interest in engineering and technology-based careers to pre-college students, parents, teachers, and school counselors.

To fit your organization's needs, JETS has created several ways to become a JETS Affiliate. To learn more about how your organization can participate as a JETS Affiliate and help JETS inform and excite young people about engineering careers [click here](#).



SAINT LOUIS  
UNIVERSITY



### \*Pass it On!\*

Please encourage your students and their parents to subscribe to the Pre-Engineering Times! It's not only a great resource for the classroom, but also for students and their parents as they make career choices and learn about the world of engineering.

To sign up to receive the monthly Pre-Engineering Times, please go to <http://www.jets.org/programs/newssignup.cfm>. If you wish to unsubscribe, [click here](#) and include "REMOVE" in the subject line.

of a remote incident scene in real-time from a handheld computer. These devices could be installed at airports and other critical sites for counter-terrorism and threat prevention, allowing multiple federal, state, and local authorities to monitor vulnerable sites simultaneously.

- Mechanical and aerospace engineers are working on developing mobile robots, such as those used for search and rescue at the World Trade Center. These robots, however, will use a new approach to legged locomotion to navigate uneven terrain. Today's models are wheeled and tracked and have difficulties navigating uneven terrain. Electrical and computer engineers are working on real-time face detection to isolate and recognize faces in a crowd instantly and accurately without human intervention or supervision. These new systems will be able to work even when lighting conditions aren't optimal and be able to scan larger areas covered by video surveillance systems. These adaptive feature detection algorithms will allow the system to keep track of environmental changes, such as sunlight, and equalize the extracted features. This would allow officials to scan people in line at the INS or Customs as well as monitoring public spaces such as airports and embassies.
- Structural engineers are also working on developing a versatile, efficient, and practical health monitoring strategy for structures. These networks of sensors would report in real time the structural integrity of key structures such as bridges.

Other gems of security under development include:

- Expandable large-span composite assault bridges that can be easily transported via truck;
- Computer chips with built in tiny explosives that would self destruct if they fell into the wrong hands;
- Lasers for anti-missile defense using beam plasma discharge technology;
- Self-healing material polymers for use in bridges and aircraft and such. When cracks appear in the material, the capsules break open, allowing the monomer to come into contact with a catalyst that turns the monomer into a polymer, filling and repairing its own cracks;
- And many, many more.

A researcher at the University of Wisconsin-Madison is taking a novel approach. Professor Vicki Bier, in the Department of Industrial and Systems Engineering

there, has been doing ongoing research on terrorism under funding from CREATE, the Center for Risk and Economic Analysis of Terrorism Events (based at the University of Southern California), which is the first university center of excellence funded by the U.S. Department of Homeland Security (DHS) (<http://www.usc.edu/dept/create/>). In particular, she has been using the tools and techniques of industrial engineering to help DHS determine how to best allocate its resources to provide the best, most-cost effective security. This involves lots of mathematical modeling. Some of the specific topics she and her students have tackled include how to keep aircraft safe from surface-to-air missiles, and the vulnerability of our electrical systems, to name just two.

More generally, however, Prof. Bier is using game theory to help DHS protect against intelligent adversaries, which can adapt their tactics to our efforts and strategies. (See the profile on Jun Zhuang, Extreme Engineer, for more on this topic.) What they are learning is that traditional safety thinking may be no longer be effective under these circumstances. For example, if an airport has 10 safety risks, Prof. Bier notes that we will usually do the eight items that will provide 80 percent of the benefit at 20 percent of the cost. However, if the other side can figure out that there are still two areas of vulnerability, the eight items that were fixed might not provide any security at all. To take another example, consider the anthrax scare from 2001. If all post offices in the country had spent the money to buy anthrax sterilization equipment, terrorists could adapt to that just by spending \$10 for Federal Express, versus 40 cents for a postage stamp.

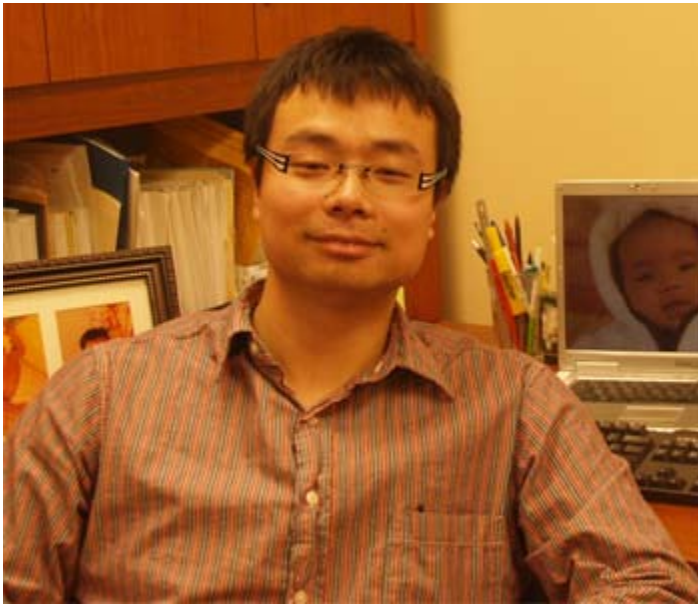
Because the U.S. has so many targets, it's hard to defend them all. As a result, Prof. Bier is starting to look at overarching protections that protect multiple targets. These include border security, intelligence, emergency response (where you don't have to guess right about targets in order for your investments to pay off), and public health. The intent is to use game theory to help make decisions not only on which targets to defend, but also how much to spend on these kinds of overarching protections, taking into account what terrorists might attempt to do.

Because increased national security has become a high priority in this country, substantial funding is being devoted to advances in this area. As a result, there may be many exciting engineering opportunities well into the future in this field.

"Making the world a safer place is a priority to every engineer," said [Linda P.B. Katehi of Purdue University](#). Purdue focuses its celebration of Engineer's Week as an opportunity to talk about "what's important to citizens and professionals alike and to highlight the role engineering plays in making us all more secure."

## Extreme Engineer of the Month

**Profile:** Jun Zhuang, Ph.D. Candidate, Research Assistant and Instructor, Department of Industrial and Systems Engineering, University of Wisconsin-Madison



### Education:

- B.Eng. Industrial Engineering, Southeast University, China, July 2002
- M.S. Agricultural Economics, University of Kentucky, August 2004
- M.S. Industrial Engineering, University of Wisconsin-Madison, December 2006
- Ph.D. Industrial Engineering, University Wisconsin-Madison, summer 2008 (expected)
  - Major/Minor: Decision Science & Operations Research/Mathematics
  - Dissertation: *Modeling Secrecy and Deception in Homeland Security Resource Allocation*

**Favorite Class:** Math modeling; decision analysis; game theory; stochastic process.

**Best Skills:** Modeling real-world problems.

**Hobbies:** Travel, swimming, and spending time with family.

**Role Models:** Prof. Vicki M. Bier, professor of University of Wisconsin-Madison, his advisor and co-author for the last four years, who helped teach him how to learn, teach, research, and mentor students.

**Advice:** There are really no limits to engineering (except your imagination). Carefully plan the milestones of your education and life as soon as possible, and then relax to enjoy the details. Time flies so fast.

Jun was born and raised in Nanjing, China. In school he enjoyed math, physics, and chemistry. He found these subjects stimulating, and won a few national awards in high school competitions. When it came time to pick a major for college, he decided on industrial engineering, because he didn't want to be fixed on a specialized technology. Jun describes industrial engineering as "the most flexible engineering." He says he chose it because you don't need to focus on just one area of engineering, and you get to work with many different engineering specialists. As a senior in college at Southeast University in China, Jun was contacted by a U.S. professor who wanted him to conduct a Chinese consumer survey, and provided him a research assistant position at the University of Kentucky. There, Jun received a full scholarship to get a masters degree in agricultural economics.

While this may seem like a big departure from his industrial engineering degree, it's not. Jun's research was building economic models to analyze different agricultural engineering problems, and conducting a cost-benefit analysis of new technologies being developed. He worked with specialists in biochemistry, animal science, and plant mycology, and published three papers on those subjects.



Jun Zhuang presented his work "Game Theory and Homeland Security Resource Allocation," at the U.S. Department of Homeland Security's Annual University Network Summit on Research and Education in Washington, DC, in March of 2007.

He enjoyed this work, and decided he needed a Ph.D. to continue. His next step was to pursue a master's degree in Industrial Engineering at the University of Wisconsin-Madison, a top 10 program in the field. Here he met Professor Vicki M. Bier, who had just started an exciting project of applying industrial engineering and mathematical modeling to homeland security—a new area of research. Professor Bier is a principal of CREATE, the Center for Risk and Economic Analysis of Terrorism Events, the first university center of excellence funded by the U.S. Department of Homeland Security. Professor Bier was interested in adding Jun to her research team to build mathematical models for how best to use resources to maximize

homeland security in the United States. This work requires researchers to go beyond optimization models to apply game theory because terrorists, unlike hurricanes and earthquakes, change their strategies in response to security and defense measures. Thus, Jun's game-theoretical models can be applied to security issues in areas such as:

- computers and the Internet;
- airports; and
- supply chains (the supply networks that move products and services from suppliers to customers).

This approach—applying game theory, essentially games between an attacker and a defender—to security considerations is relatively new. Both natural disasters and terrorists kill people and cause economic loss. The difference is that terrorists are intelligent and adaptive. In homeland security, “if you protect DC, the terrorist could simply switch to New York or LA,” Jun says. Terrorists adapt their strategies. To create a cost-effective defense, you must take their likely responses into account. You need to ask, “If we do this, what would they do?” In this part of his research, Jun lets the hypothetical attackers and defenders make certain decisions such as how many resources to spend on each target, with the defender moving first. “We let the attackers know what is being defended,” he says. “Then the attackers pick their best response.”

Another component of his research deals with determining to what extent information should be disclosed to the public and, therefore, to attackers. For example, should the allocation of Department of Homeland Security money be completely disclosed? “There could be both positive and negative effects. Disclosure might help to deter attacks, but may reveal our vulnerability as well.” Jun is working to understand under which conditions it is most appropriate to disclose the truth, and when secrecy or deception is more appropriate. This is a novel area of research, which he finds exciting.

Jun is scheduled to receive his Ph.D. this summer. After that, he hopes to work as a professor, and will seek funding from organizations such as the National Science Foundation and the Department of Homeland Security to continue his research in this area.

“There is no limit to what you can do with a degree in industrial engineering,” Jun says. Best of all, Jun likes the creativity, and knowing that his work could provide insights into decision-making on topics of critical importance. Eventually, Jun believes, this type of work will change how decisions are made and affect policy. In addition to continuing his research as a professor, Jun also looks forward to teaching operations research, optimization, and simulation.



Jun Zhuang and Prof. Vicki Bier presented their work on risk analysis for Homeland Security and Defense in New Mexico, in 2007.

## Feature Product



### NEDC Water Bottle

This 24oz. polycarbonate plastic water bottle is shatterproof, break resistant, odorless, tasteless, and stain resistant. Great for camping, hiking, beach, and other outdoor sports activities, this water bottle includes a finger clip ring for easy carrying, and a unique flip top spill resistance lid with locking tab closure for safe travel use.

Transparent blue in color with the small NEDC logo in black featuring the text: Design That Matters.

Dishwasher safe!

### ASSESS...

Find your strengths, prepare for the future



ASSESS is a comprehensive toolkit for students in grades 9-12 who are on the path to discovering a future career in engineering. ASSESS provides guidance about engineering careers by allowing them to gauge academic preparedness in subject matter important for the profession.

## EXPERIENCE...

Get active and unlock the mysteries of engineering

DESIGN THAT MATTERS  
jets.org/nedc



Sponsored by the  
AbilityOne Program

## Congratulations to the Six NEDC Finalist Teams

The results are in and the design review board has selected six national finalist teams and twelve runners-up! **Thank you all for making the NEDC such a success this year!**

### Finalists

- Edcouch Elsa High School, Edcouch, TX — *Arthrisissors*
- Flowery Branch High School, Flowery Branch, GA — *The High Roller*
- Gardner Edgerton High School, Gardner, KS — *Bag Attachment Replacement Technology (BART)*
- Garfield — Palouse High School Engineering Team, Palouse, WA — *Parapalegic Agricultural Lift (PAL)*
- Texas Academy of Mathematics and Science Engineering Team, Denton, TX — *Ergonomic Spool Assembly System (eSAS)*
- The Upper St. Clair High School Engineering Team, Pittsburg, PA — *The SinkAble*

For more information about our finalists, click here.

The best overall design from a national finalist team will win \$3,000 for their school's sponsoring department. Two additional finalist awards will be given and the school's sponsoring department will be awarded \$1,500.

Please join us for the 2008 NEDC Finals Competition

Friday, February 15, 2008  
9:00 am - 12:00 noon

**Westin Arlington Gateway**  
F. Scott Fitzgerald Ballroom  
801 North Glebe Road  
Arlington, Virginia 22203

Design Showcase 12:00 - 1:00 pm

### **What is the NEDC?**

Teams of students will design an Assistive Technology (AT) device to help a person with a disability to

perform or increase productivity in his or her job. Students will choose a scenario from two options and work with a person with a disability.

Winning students have an opportunity to travel and win recognition for their creativity. The five top teams win an all-expense-paid trip to Washington, DC to present their designs and compete for prizes at the annual NEDC Finals Competition on February 15-16, 2008. The winning team receives \$3,000 for their school's sponsoring department. Two additional winning teams will be awarded \$1,500 for their school's sponsoring department.

## TEAMS

## Win \$5,000... it's not the same as a gold medal, it's better!

TEAMS, the flagship program of JETS, kicks off at the end of January, challenging students across the country to go *behind the scenes* and solve real-world engineering challenges related to large scale sporting events such as the Super Bowl, World Series, or Olympic Games. The grand prize team will walk away with \$5,000 cash!

It's not too late to get in the competitive spirit: Competitions kick off January 29th and go through March 17th ....visit the TEAMS website to find the host site nearest you!

TEAMS is hosted at nearly 100 locations across the United States, but if there is no host in your area or the host date conflicts with your school's schedule, you can still participate as a remote site and compete right from your high school!

Find a Competition Site: <http://www.jets.org/TEAMS/siteSearch.cfm>

Learn more about Remote Participation: [mheaphy@jets.org](mailto:mheaphy@jets.org)

## POWER Engineering & JETS

### **Applications are NOW being accepted for the Next Generation Scholarship Fund!**

**Students:** Thinking about a career in engineering? Maybe you're thinking about getting a degree in **chemical, electrical, mechanical, materials, or nuclear** engineering. Did you know that with any of those degrees you can pursue a career in the power industry?

Now is a great time to consider a career that helps run

the world! Power generation is the backbone of what makes our economy and society function. Electricity, in some way, impacts nearly every aspect of our lives. From our homes, our businesses, our cars, to our health and safety, our critical infrastructure requires a dependable and economic supply of electricity.

#### Quick Facts:

- Over the next 15 years, it is estimated that more than 300,000 people will retire from the power industry.
- The International Energy Agency estimates world electricity demand will double by 2030—only 23 years from now!
- The US Department of Energy projects national demand will increase 45% in twenty years.

JETS and *Power Engineering Magazine* are offering a scholarship to help make your pursuit of a power engineering career possible. The Next Generation Scholarship is now taking applications! This \$5,000 academic scholarship is open to all currently enrolled 12th grade students in the United States. Students expressing an engineering career interest in the power industry and planning to enroll in a four-year engineering program should apply.

**Click here** to download the application guidelines and essay requirements. Entries must be received by JETS no later than March 3, 2008. Contact JETS for more information.



What's your idea of a dream job? Check out [www.engineeryourlife.org](http://www.engineeryourlife.org) and find out about cool jobs and different kinds of engineering, meet inspiring women who love their careers, learn from students about what engineering programs are like, and get information on how to get started toward an engineering career.

## Host Highlight: Stanford University



#### Background

Stanford University's School of Engineering was founded by Theodore Jesse Hoover, an alumnus of the University and brother of the 31st President of the United States, Herbert Hoover, an engineer himself. With an enrollment of 1,970 undergraduate students, nearly 30% of which are female, Stanford is an academic powerhouse and a leader in pre-college outreach.

One of the more active engineering groups on campus in Stanford's chapter of SWE, the Society of Women Engineers, and it is this student-lead group that serves as the Stanford TEAMS host year after year.

#### Meet the Hostesses

This year's TEAMS co-chairs at Stanford are **Serena Yueng** and **Jessa Lee**. Serena, a sophomore at Stanford majoring in Electrical Engineering, has been active in the SWE student chapter since her freshman year when she attended a chapter event and was "really impressed by the support they showed both within the chapter and toward other women and girls interested in engineering." Jessa is a junior at Stanford majoring in physics, and as such takes a "wide smattering of engineering classes, especially in Computer Science and Electrical Engineering." She too has been involved in the SWE chapter at Stanford since her freshman year and says serving as the co-chair of high school outreach and becoming the TEAMS Coordinator was "a natural role I'm very excited about."

#### The Competition

"The Stanford SWE-sponsored TEAMS competition is a half day event in which approximately 150 students spend a Saturday morning competing in TEAMS after an early breakfast on the Stanford campus," explain Serena. "During lunch we try and plan an activity," she continues, "in the past we've invited speakers or organized informal chats with college students, and after lunch we present the awards for each division."

#### The Benefits

"My favorite part of working with TEAMS is seeing the teams get really excited during the competition, as they come up with and discuss some pretty creative ideas," says Serena. Both she and Jessa hope their event stimulates an interest in engineering amongst the student participants, and eventually one day maybe even have some of those students follow in their own footsteps. "I chose to study electrical engineering because I've always been fascinated by how our understanding of fundamental concepts in math and physics can be applied to develop the

seemingly magical technology we have today," says Serena. "It's been incredible (and fun!) to learn how everything fits together," she adds, hoping others also see the benefit of an engineering degree and encouraging high school students to consider that path.



## New this Year: Engineers Without Borders Activities!

### "Building a Better World One Community at Time"



Did you know that 1.2 billion people (out of 6.4 billion) do not have access to clean water. A basic human need? JETS is pleased to announce a new collaboration with Engineers without Borders - USA (EWB-USA) that will help you and your students

explore how engineering is essential in bringing basic human needs to developing countries.

Visit [www.jets.org/experience](http://www.jets.org/experience) to learn about the EWB/JETS Classroom Activity and the EWB/JETS Annual Design Challenge.



This month's newsletter topic is robotics and homeland security. Robots can play various important roles in homeland security. For instance, if a robot can be used to search for and disarm bombs, then a person does not have to do this dangerous job. Before examining all of the many ways in which robots can be used in homeland security, it is first helpful to build one.

This month's activity, Beginners: How to Build Your First Robot Tutorial, shows high school students how to build a robot from scratch. Sponsored by the Society of Robots, this website has information on hardware and software. It provides an outline of instructions for building a basic robot and tips for obtaining parts and information. It says, "Robotics can teach you so much. You will learn skills ranging from electronics, mechanics, controls, programming, and even as broad as understanding animal behavior and human psychology."

This activities is brought to you by the new Engineering Pathway, a part of the National Science Digital Library. The portal provides high-quality teaching and learning resources in applied science and math, engineering, computer science/information technology and engineering technology — for use by K-12 and university educators. The Engineering Pathway brings together quality engineering education materials from all over the internet, including those from the TeachEngineering Collection, allowing teachers to search all of these documents in a single location.



## The JETS Challenge

The JETS Challenge is a weekly word problem posted each Friday during the academic year. Correct submissions are entered into a monthly drawing where five winners are selected and announced each month. This month's Challenge winners are:

- **Eugene Wu**
- **Jennifer Huffman**
- **Felicia Yau**
- **Casey McDonald**
- **Foster L. Grant**

Winners will be receiving a complimentary copy of the new JETS ASSESS and Explore pieces. Take the JETS Challenge, submit your answers and get featured in next month's *PE Times*! To learn more and to see this week's Challenge, click here: **JETS Challenge**.



## University Spotlight:

### SAINT LOUIS UNIVERSITY

**PARKS COLLEGE OF ENGINEERING, AVIATION AND TECHNOLOGY**

**DESIGN • BUILD • EXPERIMENT**



Aerospace



Electrical



Mechanical



At Parks, you will enjoy advanced facilities and equipment, a hands-on approach to study and opportunities to collaborate with faculty on their research. Parks provides a solid foundation for your upcoming endeavors through rigorous preparation in technical knowledge and skills, research, application of professional ethics and sensitivity to global needs. We prepare you for a responsible and ethical life because every degree program includes classes that make a Jesuit education unique — like philosophy, theology, ethics, humanities, and social sciences.

**Parks College of Engineering, Aviation, and Technology...where leaders are formed.**

**For more information, visit <http://parks.slu.edu> or call 314-977-8203.**

#### Engineering Programs:

- **Aerospace**
- **Biomedical**
- **Computer**
- **Electrical**
- **Interdisciplinary**
- **Mechanical**
- **Engineering Physics**

## Society Spotlight:

### IEEE-USA

The IEEE-USA Precollege Education Committee (PEC) announces their new Precollege Web Site for teachers, students and engineers. The web site includes resources such as funding for teachers to implement engineering related programs in or out of the classroom. The PEC website is located at: [www.ieeeusa.org/volunteers/committees/pec](http://www.ieeeusa.org/volunteers/committees/pec).



Flip on a light switch. Move your mouse cursor across the computer screen. Shuffle the tracks on your iPod. Every day, everywhere we go, in everything we do, we are immersed in technologies that would have seemed miraculous for the great majority of human history. These devices and inventions have transformed our material relationship with the world-and the future promises only more life-changing innovation.

Saint Louis University's Parks College of Engineering, Aviation and Technology aims to create the next generation of global innovators in engineering for the good of humanity.