



# JETS

THE PRE-ENGINEERING TIMES

November 2006, Issue #52

## Letter from JETS

With the winter solstice—the darkest day of the year—just a little over a month away, it's fitting to explore illuminating engineering for the November issue of the Pre-Engineering Times. It's often said that you don't really notice lighting unless it isn't working. This month we'll go behind the scenes to learn about the many ways lighting enriches our lives—increasing productivity in the workplace, making streets and public places safer and more inviting places to gather and recreate, enhancing our health, helping us celebrate the holidays, and creating dramatic moods in entertainment venues—and what's involved to make it all happen. Our feature article presents an overview of illuminating engineering—an exciting mix of art and science—and the many venues in which illuminating engineers work. For those who have an equal passion for math and science as well as the world of design and architecture, illuminating engineering may be a great fit. Our Extreme Engineer for November, Mitul Parekh, shares his dual passion for architecture and physics as he talks about an exciting project he worked on: creating the spectacular and technically challenging lighting effects for 7 World Trade Center—the first building to rise out of the ashes of the 9/11 attacks. Working with architects, his team at Cline Bettridge Bernstein Lighting Design, Inc. used a cutting-edge application of LED technology on the building's exterior and an interior lighting system programmed to change color throughout the day.

This month's Engineering Pathway explores light phenomenon—including polarized light, prisms, and lenses. In addition, the November Hot Topics provides insight into the LEDs Mitul and his teammates used so effectively at 7 World Trade Center.

It's an exciting time of year for JETS as well. JETS Clubs, which launched November 1, has already signed up nearly 800 members. Visit the Coaches' Corner to learn about the many benefits of the free membership and how to join. In addition, the JETS

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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 learn more about two of JETS Affiliates, click on the logos below.



The  
LIGHTING  
AUTHORITY



SAINT LOUIS  
UNIVERSITY

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](#).

**This newsletter is a publication of JETS.** JETS opens the world of engineering and technology to students, parents, and educators by providing career guidance and through programs and resources that illustrate real-life teamwork and problem solving skills.

### \*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/ewsssignup.cfm>. If you wish to unsubscribe, [click here](#) and include "REMOVE" in the subject line.

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## Letter from JETS

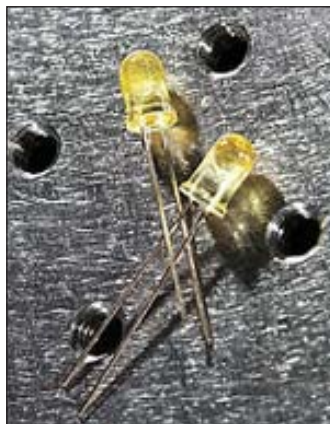
*Continued from page 1.*

TEAMS Competition is off to its best start ever with more than 300 teams already registered and nine new universities—Atlanta University Center, Auburn University, Greenville Technical College, Harvard University, Norfolk State University, North Dakota State University, Triton College, University of Kentucky, and University of Alaska, Fairbanks—joining the roster of TEAMS hosts! NEDC—the National Engineering Design Challenge—also kicked off this month, with 35 teams around the country advancing to Round II. Visit the Coaches' Corner to learn more.

We at JETS wish you an illuminating start to the holiday season! May it be filled with good cheer, math and science fun, and light!

## Hot Topic

LIGHT BULBS ARE old-school energy hogs. Adoption of light-emitting diodes (LEDs) might be able to halve lighting energy consumption and cut CO<sub>2</sub> emissions by 258 million metric tons a year. Today, LEDs are found in accent lighting and flashlights, but they're not white enough for general use. That may change, thanks to a chance discovery by Vanderbilt University chemists led by Sandra Rosenthal. The key ingredient: quantum dots—tiny semiconductor crystals (in this case, cadmium selenide) that absorb light and generate a charge. Lab members James McBride and Michael Bowers had made nanocrystals so small they verged on the molecular. When Bowers pointed a laser at these "nano-nano" crystals, he anticipated violet or UV light but saw white. "He knew something was up," Rosenthal says, "so he mixed the batch with Minwax floor polyurethane and coated a violet LED. It glowed white!" Now the team hopes to make the LEDs brighter. "It's too early to tell whether it will be a quantum dot LED or some other approach," Rosenthal says. "But I do believe solid-state lighting will revolutionize the way we light our homes."



### **BULB SLAYER**

#### **Innovators:**

Michael Bowers, James McBride, Sandra Rosenthal

## Coaches' Corner— Resources for Educators



**JETS Clubs launched November 1st! To date we have 775 registered members!**

JETS Clubs makes all of JETS resources and benefits available to students, parents, teachers and club leaders in a new package. JETS Clubs members received their first monthly club only email. The first month's theme was SPORTS ENGINEERING. It included three JETS Challenge problems, a TEAMS problem, two activities courtesy of The Engineering Pathway Portal, and several discussion topics. Members were also sent a preformatted lesson plan. In addition, JETS Clubs members also receive a subscription to the Pre-Engineering Times, special discounts at the JETS Store, TEAMS and NEDC updates and registration fee promotions, and much more. Best of all it's free! There is no fee to participate during the inaugural year. For more information click here, contact us at [clubs@jets.org](mailto:clubs@jets.org) or (703) 548-5387 x 104.

Don't wait! Sign up today and start receiving your JETS Club Benefits.

**POWER  
Engineering  
& JETS**

**STUDENTS: "POWER"  
YOUR FUTURE!**

**The Next Generation  
Scholarship Fund is NOW accepting applica-  
tions.**

The Next Generation Scholarship Fund was established by JETS and Power Engineering Magazine to create a scholarship that will be awarded annually to one or more students who plan to pursue a career in a field related to electric power generation (for example, chemical engineering, electrical engineering, nuclear engineering, mechanical engineering, materials engineering). This academic scholarship is open to all currently enrolled United States 12th grade students who are active participants in one or more of JETS' programs - such as TEAMS, NEDC, or JETS Clubs. 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 submitted to JETS by March 2, 2007. Contact JETS for more information.



## National Engineering Design Challenge

Thirty-five Teams Nationwide Advance to Round II!

Teachers and students from twenty states around the country have been busy preparing their entries for the deadline of Round I. The votes are in and thirty-five teams have been chosen to advance to Round II of the JWOD/JETS National Engineering Design Challenge.

All teams have completed the research phase of the competition. The first step was to complete an Internet scavenger hunt that helped students gain a stronger understanding of individuals with a disability.

Teams then selected one problem from a choice of eight scenarios of different people with disabilities. They researched the problem, proposed a solution, and drafted a sketch to illustrate their prototype.

The panel of judges selected teams to advance to Round II based on the quality of their research, proposed solution, and design sketch.

In addition, ten teams were granted scholarships to help cover the cost of materials to participate in Round II and build their prototype.

The next challenge for participants is to build, test, and evaluate their prototype design. Round II submissions are due on December 18, 2006.

JETS would like to wish all of these talented teams good luck in the next phase of the competition!

## TEAMS

With more than 300 teams already registered, representing more than 150 schools, the 2007 TEAMS competition is set to be the biggest and best to date!

In just the first month of registration, 157 high schools around the country, from Alaska to Alabama, have registered for the 2007 TEAMS competition, totaling 337 teams altogether. TEAMS, the flagship program of JETS, has been challenging students to unlock the mysteries of engineering for over 30 years.

Host sites across the country welcome participants each year during February and March to their cam-

pus for a one-day competition event, emphasizing team work and challenging students to apply knowledge learned in the classroom to real world engineering scenarios. This year, Fairview High School in Fairview, PA is celebrating its 25th year as a TEAMS participant, and Atlanta University Center, Auburn University, Greenville Technical College, Harvard University, Norfolk State University, North Dakota State University, Triton College, University of Kentucky, and University of Alaska, Fairbanks join us for their inaugural year as TEAMS hosts.

Registration continues until mid-January — check the host site nearest you for an exact date as they vary from location to location — so sign up your team now and begin practicing for the 2007 TEAMS competition! To find the competition site nearest you, click here. Good luck and have fun!



This month's lesson and activity provide students with the opportunity to explore light phenomenon including polarized light, prisms, and lenses. Specifically, The Energy of Light lesson and associated Stations of Light activity provide students with the opportunity to explore light phenomenon. Engineers apply their knowledge of the properties of light and light energy to the creation of many useful products and tools. Engineers also use their knowledge of light energy, lenses and prisms as they design eye glasses, binoculars, cameras, medical equipment, satellites, optics and lasers. By understanding polarized light, engineers have created laser applications, electron microscope imaging and medical imaging techniques, in addition to sunglasses and camera filters that reduce the glare from the sun.

This lesson is designed for grades 3 through 5, but an important part of many documents in the TeachEngineering Digital Library is the activity extensions heading near the bottom of the activity, providing teachers with ways to make the activity harder or easier for different grade levels. In this case, optics equations could be introduced and quantitative measurements could be required to make the assignment more challenging for high school students. An online physics applet also from the Engineering Pathway created by Davidson College provides students the opportunity to explore optics quantitatively through a web-based activity.

This lesson is brought to you by the new Engineering Pathway, a part of the National Science Digital Library. The Engineering Pathway Portal to the National Science Digital Library (NSDL) launched last

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month. 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 allowing teachers to search all of these documents in a single location. The lesson and activity are from the TeachEngineering Digital Library for K-12 engineering curricula.

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## Illuminating Engineering

*It's not about just having the proper number of foot candles. It's understanding architecture, understanding brightness relationships, understanding how people feel in a space.... It's all about people ultimately. You're honoring the architecture, but you have to be sure the human component is forward in your decisions.*

—Stephen Bernstein, IALD, IESNA, Principal, Cline, Bettridge, Bernstein Lighting Design

Illuminating engineers design and engineer systems that provide lighting in the built environment—the structures we visit every day—such as schools, offices, theaters, sports facilities, stores, and even bridges and roadways. Illuminating engineering brings new meaning to the term “state of the art.” They combine the best of design aesthetics with state-of-the-art technology.

Comprehensive lighting design considers the amount of light required to perform tasks effectively, the energy consumed, and the aesthetic impact of the lights on the setting—whether interior or exterior. Lighting projects in some work environments such as hospitals or sporting facilities place appropriate lighting to accomplish the tasks as the top priority. For buildings, such as warehouses and offices, the most important consideration is often energy efficiency. Other buildings like museums, monuments, and hotels often place aesthetics and creating a mood through dramatic lighting that has an emotional appeal, as their top priority.

While most lighting projects involve electrical lighting systems, daylighting is also an important area within the field. Lighting designers and engineers can work to use effective daylighting within a building, supplementing it where necessary with electrical lighting. Complex lighting design often requires mathematical modeling to check for uniformity and quantity of illumination from all sources including available day light and light reflected off walls, ceilings, and floors.

Illuminating engineers require knowledge of physics, engineering, electrical wiring, architecture, and design as well as installation, maintenance, and operation of lighting systems. They strive for excellence in all forms of lighting:

- Interiors
- Exteriors
- Sports facilities
- Roads, tunnels, bridges, and other transportation structures
- Festival lighting
- Theaters and other entertainment venues

### Energy Consumption

Buildings use up to 50 percent of energy consumed in the United States, and artificial lighting consumes between 20 and 50 percent of that. That means that between 10 and 25 percent of energy used in the United States is expended to light buildings. In large office buildings, effective strategies can sometimes reduce lighting costs 90 percent by selecting the right lighting for each area of use, integrating lighting design into space planning and architecture, selecting the best available technology to conserve energy, ensuring proper maintenance, and training personnel to minimize energy waste.

### Light for Health and Productivity

Selecting the right light intensity and color spectrum for tasks has another important benefit. It contributes to the productivity and health of occupants, reducing stress and associated effects such as headaches or increased blood pressure. Latest studies reveal that only 80 percent of neural fibers connected to the eye are used for sight. The remaining 20 percent send their signals to other areas of the body and brain including those that control the body's timeclock and endocrine glands, thus helping to regulate many aspects of our hormones, health, and emotions.

### Light for Safety, Community, and Commerce

Good lighting also makes an important contribution to road safety, crime prevention, and the environment. It promotes a feeling of security and well-being within a community. Bad lighting creates unsafe conditions. This can dramatically affect the economy of an area. For a relatively small expense, housing developments, town centers, and industrial areas can be transformed producing a positive effect on quality of life for all.

## State of the Art: Where Art Meets Science

Illuminating engineering is both an art and a science. For students who are interested in both architecture and engineering, illuminating engineering can be a great fit.

Lighting is becoming more technically challenging with many new light sources to consider. According to Stephen Bernstein, one of the most promising new mediums is LED. Those tiny red dots that once were only used to tell you appliances are on, actually come in a full rainbow of colors and offer an exciting new type of lighting with very low energy usage. Their small size allows lighting designers to integrate light into architecture in new ways.

*What's exciting about the field is that we are working with architects and interior designers, allowing their work to be viewed. Lighting is not only technical, there's a big artistic element to it as well. It reveals form. It shapes structures. It can reveal materials so you can see things in a different way. It also has an emotional component to it. You can make something look friendly, dramatic, or reverential. Manipulating light in response to the architecture allows you to create a new composition with the architect.*

—Stephen Bernstein, CBBLD

Architectural, Electrical, or Mechanical Engineering—Many Paths to Take

Most illuminating engineers enter the field from one of three engineering disciplines: architectural engineering, electrical engineering, or mechanical engineering.

Graduates are typically hired by lighting, engineering, and architectural or architectural engineering design firms as well as manufacturers of lighting equipment.

### Related Links:

- The Illuminating Engineering Society of North America
- The Lighting Society (Australia & New Zealand)
- Lighting/Electrical Option in Architectural Engineering at Penn State
- Illuminating Engineering Society Lumen Awards

## Extreme Engineer of the Month

**Profile:** Mitul Parekh, Illuminating Engineer, Cline Bettridge Bernstein Lighting Design, Inc. (CBBLD)



### Education:

- B.Tech in Architectural Engineering, National Institute of Technology, Calicut, India
- M.E. in Architectural Engineering with a specialty in Illuminating Engineering, Penn State

### Favorite Classes:

- Daylighting
- Fixture Design

**Best Skills:** Analytical thinking—coming up with options then determining what works best

**Hobbies:** Independent music and movies

**Role Model:** No particular role models, but have always admired my parents for being very supportive of education.

**Advice:** Study hard. There's no easy way around it. Competition today is global. You have to prepare yourself to the fullest.

### Art and Science—Bringing Things to Light

Growing up in India, Mitul was always interested in architecture, but he was also good in science and math. Based on the reputation of schools, he enrolled in the National Institute of Technology in Calicut, which offered architectural engineering. He was drawn to the program as an interesting mix of architecture and engineering but wasn't certain if it was the right fit. It's hard at that age to know what

the right pick is. "Sometimes you just have to follow your gut," he says.

He liked all the architectural aspects of the program, yet recognized that the structural engineering component wasn't for him. He started reading about the specialties within the field, and by his senior year knew he was drawn to the lighting aspect. Daylighting was particularly interesting to Mitul. It intrigued him that you could design a building to bring more daylight into the space and enhance energy efficiency.

After deciding to study lighting, he found there were no programs for that specialty in India. In fact, there are just a few schools in the world that focus on lighting. Prominent in the United States are Penn State, Colorado State, Rensselaer Polytechnic Institute (RPI), and Parsons, which is more design oriented than engineering. Mitul selected Penn State and immediately loved the program because lighting has both the aesthetic/design side as well as technical aspects.

"You need to quantify how much light you need in a space, which involves physics and mathematics," Mitul says. "It's the perfect balance for anyone who has aptitudes in design and is interested in the physics of it." In addition, he notes that there is a psychological aspect, which made it all the more interesting for him. "Lighting affects your mood, so you can create a mood with light. You can change the mood in any space by changing the lighting," he added. The program was more technical with less emphasis on design, but he says it was a really enjoyable two years.

Among the courses Mitul liked best was fundamentals of lighting. "It's very important to understand the fundamentals and to have them firmly rooted," he says. Two of his other favorite classes were daylighting, which he says was exceptional, and a class on fixture optics design. Mitul explained that fixtures have a light source/bulb and housing, which controls the throw or distribution of the light. "It's purely physics," he says. "Most fixtures have a reflector or lens, which reflects light or refracts light and achieves the right control and distribution of that light source."

The daylighting class covered how different sky conditions (sunny, cloudy, overcast), longitude and latitude (the angle of the sun's rays coming in the windows), and time of day all affect the amount of light coming in a window at any given time. The course teaches you to quantify available light based on all these factors. Today software programs help you do this. You build a 3D model of the space in software and designate sky conditions, geographic location, and time of day. The program then calcu-

lates the amount of available daylight. Another way to do it is to build a model of the building. For one of his classes, Mitul built a model of a building on campus and compared the actual readings from the model to those generated by a computer program.

Most of the projects Mitul works on are based on artificial light, but for projects that have atriums with large glass exposure, he calculates the amount of daylight to know how much supplemental artificial light is needed. Some projects, he noted, have hardly any daylight coming in at all.

After graduation Mitul applied to several lighting design firms and received multiple job offers. He selected Cline Bettridge Bernstein Lighting Design, Inc. (CBBLD) because of "the amazing work they've done" and because of their philosophy to integrate light into architecture rather than doing light as a separate element. "Light shows architecture," he says. "It doesn't show itself."

## 7 World Trade Center

One of Mitul's favorite projects is the new 7 World Trade Center building, the first building to rise out of the ashes of the 9/11 attacks. His firm worked on the lighting for the base building—the building's lobby, the exterior base, the plaza and the tower top of the building. He was the associate on his firm's project team, which included principal designer Francesca Bettridge and senior associate Michael Hennes. The building was designed by Skidmore, Owings & Merrill LLP (SOM).

The building's architecture and lighting scheme had several significant challenges to overcome. A smaller than usual building footprint was a tradeoff to providing 115-feet of setback from the street for security reasons. This meant that the first four floors—or 80 vertical feet—could not have windows because all of that space was required for the building's electrical transformers. To compensate and create a blended look between the concrete wall of



the base and the windows of the tower above, the building was clad with stainless steel panels embedded with screens of LED lights. During the day, the panels reflect sunlight in much the same way as low-E window glass. At night the screen layer comes alive and illuminates the building base with a peaceful blue glow. In a significant engineering feat, small blue and white LED lights were integrated into the screen in a pattern that diffuses light evenly across the surface avoiding hot spots. Quick connects at the panel seams provide for maintenance access.

“The project was quite challenging,” says Mitul. Incorporating lighting in the stainless steel screen wall was quite an engineering feat. While LEDs themselves are not new, the use of LEDs in architectural lighting is. “To integrate LEDs into the screen wall was a major challenge. To integrate the light fixtures within the screen walls and to preinstall them at the fabricator and detail it in a way that the wiring connection is made on site required tremendous coordination between various consultants and detailing.”

The building’s lobby has an L-shaped translucent glass ceiling that goes up, wraps around, and creates an artificial glowing skylight. It’s backlit with fluorescent lighting. In addition to the white light, the CBBLD team added colored light—blue and red fluorescents. The lights are connected to a control system so they can be programmed to change color

through the day. During daytime, only white fluorescent lamps are turned on. At dusk, the red and the blue lamps turn on and are all dimmed appropriately to provide a blue-white color with a red tinge suggesting the sunset hue. Then, as it gets dark outside, the red lamps turn off and the intensity of blue increases and the lobby glows with a nice blue-white color creating the feeling of moonlight.

The top of the building was lit to provide a signature iconic look. A back-louvered wall conceals the mechanical equipment and cooling tower located there. Light fixtures on the structure that supports the outer curtain wall shine light on to the back wall, creating a softly glowing tower top and a new addition to the NYC night skyline.

The project has been written up in a number of magazines, including a four-page, full-color spread in the September-October 2006 issue of *Architectural Lighting* magazine. Click here for a link to the magazine. The website currently features the July-August issue of the magazine, but it should be changing to feature the September-October issue soon.





JETS Spotlight — Illuminating Engineering Society of North America

Need An Answer To Just About Every Lighting Question?



The LIGHTING AUTHORITY

What do you want to know about lighting? Design criteria for sports lighting? Classification definitions for roadway

lighting? Minimum requirements for energy efficient design? Light and color issues?

What do you expect from an association? Timely materials? Responsiveness? Technologically innovative programs?

Answer yes to all of the above and you have the Illuminating Engineering Society of North America. The IESNA recently celebrated its 100th birthday, but there is nothing old or old-fashioned about it.

The IESNA seeks to improve the lighted environment by bringing together those with lighting knowledge and by translating that knowledge into actions that benefit the public.

The IESNA is a not-for-profit membership organization of 9,000 lighting professionals (engineers, architects, lighting designers, electrical contractors, students, utility personnel, etc.), and almost 400 corporations.

The IESNA produces world-renowned publications: The IESNA Lighting Handbook is the definitive text on the science of lighting, lighting engineering, the elements of design, lighting applications, and other special topics, and Lighting Design + Application magazine (LD+A), the industry's most authoritative and informative monthly publication.

IESNA also develops technical documents: recommended practices (many of which are ANSI standards); design guides; lighting measurement documents; technical memorandums; energy measurement documents. IESNA co-sponsors ASHRAE/IESNA 90.1 — Energy Standard for Buildings Except Low-Rise Residential Buildings, and publishes the LEUKOS, the Journal of the IESNA, an on-line technical journal.

Check out [www.iesna.org](http://www.iesna.org). Take a free course "Discover Lighting" or view "The Power of Lighting" (both under Educational Opportunities). "The Power

of Lighting" focuses on the importance of light in our everyday lives - from shopping to dining, from security needs in an urban society to psychological needs. You'll enjoy it.



JETS Spotlight — St. Louis University

Engineering Programs

- Aerospace
- Biomedical
- Electrical
- Mechanical

Engineering Technology Programs

- Electronics
- Mechanical

Parks College of Engineering, Aviation and Technology

Design Build Experiment

<http://parks.slu.edu> 314-977-8203

WHERE KNOWLEDGE TOUCHES LIVES

You were the kid who took apart your toys to see what made them tick, talk, and move. Now, you're the one who likes to know what makes a computer faster, a rocket more fuel-efficient, or an artificial knee joint more functional. Maybe you look up every time airplane flies over or you dream of going into outer space.

It's a good thing. Because in a world increasingly reliant on technology, computer specialists, and engineers lead the list of professionals who will be most in demand during this new century.

Why? Because these professions mold the future—some in ways we can't even imagine. That's where SLU comes in. Parks College of Engineering, Aviation and Technology is known for graduating talented engineers, skilled communicators, independent thinkers and innovative problem-solvers—with very high personal and professional standards. These men and women are known for getting the job done, taking theory—whether aerodynamics or circuit design—and putting it into practice.

At Parks, you'll enjoy advanced facilities and equipment, a hands-on approach to study and opportunities to collaborate on faculty research. We also prepare you for a responsible and ethical life because every degree program includes classes that make a Jesuit education unique.

Prepared for life. That's what you will be at Parks College of Engineering, Aviation and Technology.