

### Thin-Film Photovoltaics Modeling and Manufacturing

Imagine being able to provide the electrical needs for your home or business using solar cells at a cost comparable to buying your electricity from the local power utility company. Mechanical engineering Professors W. Sampath, V. Manivannan, and Hiroshi Sakurai are engaged in doing exactly that. They are working with four graduate students and seven undergraduate interns to develop a high-speed fabrication process that will make cadmium-telluride solar cells on a substrate of ordinary window glass. This work is based upon the work Sampath has been doing since 1991, and through that effort, cells are being produced at high rates that have efficiencies in the range of 10 percent to 13 percent. This is about the same efficiency as

that achieved by the more expensive solar cell technology that is based upon silicon.

Over the past 16 years or so, Sampath, his students, and research associates have developed a continuous through-put machine that fabricates 3-inch square Cd-Te solar cells at a rate of about 1 device every two minutes, which is about 10 times faster than the rate at which silicon solar cells can be made. Now, in a team effort with Professors Mani Manivannan and Hiroshi Sakurai, a continuous fabrication machine that makes 16-inch square solar cells is in the testing phase, and a new continuous fabrication machine that will make solar cells that are 2 feet x 4 feet is in the design phase. Each of these newer machines will still make



Millions in the developing world read or cook with light from a kerosene lantern. Observe the differences if an LED light powered by a solar cell were used instead.

devices at the rate of about one device every two minutes. For the 16-inch machine, this is equivalent to about 3 MW of generation capacity that can be fabricated in a year. The large machine is projected to produce cells at a rate of about 13.5 MW per year



From left: Professors Manivannan, Sampath, and Sakurai discuss PV fabrication projects in the ME department lab at CSU's Engineering Research Center.

at about one-third the cost of silicon cells in large production runs. Solar cells from the 16-inch machine are targeted to go to the commercial market in winter 2007, while the 2-by-4-foot machine is targeted to  
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### ME Faculty Lead New School of Biomedical Engineering

Colorado State University is accepting applications for a master's and doctoral program in bioengineering via the new School of Biomedical Engineering – the first of its kind in the state. The program began in Fall 2007.

The new school involves more than 50 faculty members in four colleges: the College of Applied Human Sciences, the College of Engineering, the College of Natural Sciences, and the College of Veterinary Medicine and Biomedical Sciences.

The program trains students in the development of innovative products for the prevention, diagnosis,

and treatment of disease and also helps improve overall human health and patient rehabilitation.

Graduates are expected to work in industry, the government, and academia. Students in this program would, for example, create new orthopedic implants, develop new therapies and imaging modalities for fighting cancer, improve the design of medical equipment such as the blood oxygenators used in open heart surgery, and work on the next generation of gene therapies or engineered tissues and organs.

“The field of bioengineering is one of the fastest emerging areas of

scientific discovery and represents an enormous opportunity for economic growth within Colorado,” said Sandra Woods, dean of the College of Engineering.

The school, based in the College of Engineering and directed by ME faculty members, offers master's and doctoral degrees. The school also houses the Master of Engineering degree and Interdisciplinary Studies Certificate in Biomedical Engineering.

Colorado State is uniquely positioned to offer this program because it has both an engineering college and a college of biomedical and



Professors Christian Puttlitz and Sue James with CSU students in the lab.

clinical life sciences – including the only veterinary medical center and professional veterinary medicine program in Colorado and one of the top veterinary schools in the nation.  
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## ME Hosts International Students



ISF Students T.N. Karthik, Sandeep Makam, and Siva Theja.

In its pilot year, Colorado State's International Summer 2007 Fellowship program provided seven students from the India Institute of Technology (IIT) with a chance to gain research experience through a 10-week internship. In the collaborative program, students had the opportunity to work in several departments within the Engineering and Natural Sciences colleges.

From implementing anonymous electronic voting protocol for the Internet to designing and developing robotic marmots for capturing golden eagles, students from a wide variety of engineering and computer science backgrounds were busy working on practical engineering applications while learning about a new country and culture.

"It is a nice thing to come to a different country and know how things go on here," said electrical engineering student Siva Theja. "We see how the academic environment

works and how it's different from India and IIT. We also get research experience."

Organized by Professors V. Manivannan of mechanical engineering and V. Chandrasekhar of electrical and computer engineering, the program allows students the opportunity to gain real-world experience and prepare for continued studies in engineering fields. At the end of the 10 weeks, the student research projects culminated in a presentation for department heads and organizing professors.

"The very aim of this internship is to get the feel of the real world," said Nagarjuna Duvvuru. "I didn't expect I would get experience working with a team of professors and an M.S. scholar. It is a marvelous experience!"

While at CSU, students had the opportunity to not only interact with department faculty and staff, but also spend time with students participating in the Research Experiences for Undergraduates program, as well as others living and working on campus. To give them a chance to explore the United States, organizers arranged trips around Colorado, visiting Horsetooth State Park, Old Town, and Rocky Mountain National Park, where many saw snow for the first time.

## From the Department Head



Dr. Allan T. Kirkpatrick

Welcome to the Fall 2007 issue of *The Mechanical Engineer*. The fall term has just started here at CSU, and the campus is now populated with students again. We have the largest freshmen class ever – 150 new freshmen students! We continue to be an attractive program to mechanical engineering students from Colorado and around the nation. One of the new educational features is the Academic Village, which opened this fall. The Academic Village is a living/learning residence hall that has classrooms, meeting rooms, and computer

laboratories, as well as residential facilities. All of our new freshmen are being taught in small seminar-type classes by Professor Fitzhorn in the Academic Village. At the senior level, we have about 130 students enrolled in our Senior Design Practicum, another record level of enrollment. The seniors have chosen their projects, and in a future issue of the newsletter, we will write about their work.

In this newsletter, there are articles detailing some of the current activities in the department. The thin film photovoltaic cell research of Professor W. Sampath and his research group has been commercialized and is now going into the manufacturing phase through his CSU spin off company, AVA Solar. We now have a School of Biomedical Engineering, led by Professors Sue James and Christian Puttlitz, which offers graduate degrees in biomedical engineering, a focus area of the department. Please read the Class Notes section for more information about the achievements of your fellow classmates. Our graduates continue to make an impact in the engineering profession.

Have a great fall, and please feel free to stop by and say hello if you are in the Fort Collins area.

Dr. Allan T. Kirkpatrick



International Summer Internship (ISF) Program Students (from left) Siva Theja, Sandeep Makam, and T.N. Karthik.

## Calendar of Events



Human Powered Vehicle Team

### Student Competitions (dates/locations to be announced)

- SAE Aero Design West
- ASME Human Powered Vehicle
- Formula SAE Race Car Competition
- U.S. and World Open RoboCup Rescue Robot League

### Department, College, and University Events

- |        |   |
|--------|---|
| Oct. 4 | Annual 50th and Prior Reunion Dinner; Fort Collins Hilton                 |
| Oct. 5 | COE 50th and Prior Reunion Breakfast; Internet Café, Engineering Building |
| Oct. 5 | MEAP Board Meeting; Lory Student Center 214-216                           |

- |         |  |
|---------|--|
| Oct. 6  | Academic Village Grand Opening Luncheon; Academic Village      |
| Oct. 27 | EECL 15th Anniversary Celebration; EECL                        |
| Dec. 15 | Undergraduate Commencement; Lory Student Center Main Ballroom  |
| Apr. 18 | Engineering Days/ME Senior Design Practicum and Project Demos  |
| Apr. 18 | MEAP Board Meeting; Lory Student Center 214-216                |
| Apr. 19 | Alumni and Friends Awards Dinner; Lory Student Center Ballroom |

## Vincent Leone Receives Distinguished Alumni Award

Vincent D. Leone Sr. (B.S.M.E. 1949) was presented the Mechanical Engineering Distinguished Alumnus award at the College of Engineering Annual Distinguished Alumni Awards Dinner in April 2007. The College of Engineering alumni awards recognize former students whose accomplishments in their careers, their service to industry and the public, and/or their volunteer efforts have brought honor to that individual, to the College of Engineering, and to Colorado State University.

Mr. Leone is a retired registered petroleum engineer in Texas and Louisiana. He holds several oilfield equipment patents. In 1957, he formed a successful oil well analysis company, which was sold in 1995. Even though retired, Vincent is still seen at the office on a regular basis.

While at CSU, he served as the vice president of the Sigma Phi Epsilon fraternity, and during his career, he

has been an active and contributing member of the American Institute of Mining, Metallurgical and Petroleum Engineers, and Society of Petroleum Engineers.

Vincent fondly remembers Professors Taylor Strate and Harry Scofield from his time at CSU (then Colorado A&M College) and said that all his professors were great and helped him a lot. He came to Colorado because he wanted to be somewhere that was not flat. He hails from Texas, and before coming to study here, he had spent 11 months at sea during World War II in the North Pacific on (mostly) flat water. He also came to Colorado so he could learn to fly fish and hunt, and he did both. He has fond memories of the “flower dances” that were held among the sororities and fraternities at the time, and he said that he had bunked in a basement apartment with three other guys including Roy Romer (later to become governor of Colorado) and



*Dr. Allan T. Kirkpatrick presents the Distinguished Alumni Award to Vincent D. Leone, Sr.*

“Kenny” Monfort (another well-known CSU alumnus, though not in engineering). Roy and Ken were both Sigma Phi Epsilons. Ken was fraternity president at the time, and Mr. Leone was vice president.

The College of Engineering is accepting nominations for the 2008 Distinguished Alumni awards

to be presented to an outstanding alumnus or alumna from each of the five academic departments, one from engineering science, and one college-wide honoree. Submit your nomination for these awards online at: [www.SupportEngineering.colostate.edu](http://www.SupportEngineering.colostate.edu) (click on “Alumni”) by December 14, 2007.

## Thin-Film Photovoltaics

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produce test solar panels about a year from now.

Such cells installed on the roof of a house could reach “grid parity” at the cost of conventional electricity of around 8 cents per KWH. In such an installation, the roof solar cells would produce enough electricity to operate the home and extra electricity would go back to the power grid. In effect, the power grid becomes the energy storage device for periods when the solar cells are not producing power.

How does this technology work? Imagine a conveyor belt moving at a steady speed carrying 3-inch square glass wafers into a vacuum chamber. Impossible you say? Not so in the ME department labs. Sampath and his co-workers developed a system of labyrinth seals through which the belt and the wafer pass. There is a series of vacuum chambers with

each successive one being at a lower pressure.

Much of this development has been supported by the U.S. Department of Energy through numerous grants and contracts over the years. Due to requirements of the new DOE Solar America program, commercializing the technology developed is required to receive continued funding. Several years ago, Sampath formed a company in Fort Collins known as AVA Solar Inc. That company continues to operate today and is receiving funds that include financial support for ongoing research in CSU’s ME department. In addition, the research team will submit proposals for additional basic research to the Solar America University Support program that would provide additional grants for undergraduate and graduate student research in the ME department.

## ME Faculty Lead New School

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Bioengineering is defined by the National Institutes of Health as the integration of physical, chemical, or mathematical sciences and engineering principles for the study of biology, medicine, behavior, or health. The new graduate degree program is expected to attract engineering students interested in doing more biomedical-based research, as well as students with undergraduate degrees in the life sciences, such as biochemistry or molecular biology, interested in engineering-based research.

Susan James, professor of mechanical engineering and director of the School of Biomedical Engineering, said the program aims to have a unified front for students,

faculty, and the industry. “The new school and new research master’s and doctoral degrees will help us attract the best students and faculty in biomedical engineering. The new degrees will greatly enhance our research programs in these areas, which will translate to economic growth for Colorado and improved health and wellness for the citizens of Colorado and the world,” James said. “We’re also excited about what the new school and degrees will do for our efforts to increase diversity among our students and faculty – studies have shown that there are more women and minorities in bioengineering than many of the more traditional engineering fields.”

***For more information about the new School of Biomedical Engineering, go to <http://www.engr.colostate.edu/sbme>.***

## Class Notes

**Roger Lewis ('65)** is a retired pilot having flown for Delta Airlines for 30 years. He resides in Mundelein, Illinois, and has four great children, one in her final year of law school.

**Gary Knapp ('68)** retired from IBM in 2000 after many years as a senior project manager, most recently managing international development contracts for engineering and maintenance systems for airlines. In 2000, he and his wife went to India to teach at the Kodaikanal International School, where he taught physics, computer science, and woodworking. He now lives in Stevensville, Montana, where he is a professional woodworker under the name Cats Eye Craftsman.

**Patrick Albert ('81)** currently resides in Minnetonka, Minnesota, and is the senior vice president of operations at Deltak LLC located in Plymouth, Minnesota.

**Mark Christon ('90)** and his wife live in Albuquerque, New Mexico, with their son A.J. (14). Their daughter Jennifer (19) is pursuing a dual-degree program in international studies/engineering science at CSU. Mark conducts research in computational physics methods at Los Alamos National Laboratory and is an adjunct professor at the University of New Mexico.

**Bradley Williams ('90)** is presently a principal with Edwards & Zuck Consulting Engineers located in New York City, New York. He was the principal engineer for the recent renovation to the Top of the Rock, the re-opening of the rooftop observation deck at Rockefeller Center in New York City.

**Jason Rogers ('93)** serves as a project engineer at Blue Bird Corporation in Ft. Valley, Georgia. Blue Bird designs and manufactures school bus bodies and chasses, as well as commercial transit buses and the Wanderlodge-brand class-A RV. His areas of focus are powertrain cooling and hydraulics systems. He lives with his wife, Liz (Frush, former CSU

engineering science student), and their six children in Warner Robins, Georgia. He is still a car hobbyist and still owns his turquoise '55 Plymouth Belvedere – which, on one night in fall 1988 transported some students and a bewildered, newly hired Dr. Willson to an SAE meeting in Denver.

**Ehren Ehmman ('04)** is currently working in the Aviation Systems Engineering group at the Johns Hopkins Applied Physics Lab, supporting the advancement of military systems for communications/electronic warfare. After leaving CSU, he worked in the Aerospace Systems Design Lab at Georgia Tech, gaining practical experience in systems engineering, particularly in the area of military systems. After he received his M.S. in aerospace engineering at Georgia Tech, he moved to Maryland to work for Johns Hopkins Applied Physics Lab. He plans to receive his M.B.A. soon.

**Sean Johnston ('06)** is an aeronautical engineer with Lockheed Martin in New Orleans, Louisiana, working on the external fuel tank for the Space Shuttle program.

**Ryan Stucky ('06)** currently works for Boeing's Commercial Airplanes Division in Everett, Washington, as a liaison (production support) engineer for the 747 program, working directly with the airplane mechanics, quality assurance, and many other groups to ensure production standards are met. He enjoys working with many skilled people, working with physical parts and seeing so many processes, techniques, and materials applied in airplane production.

**Corey Sullivan ('07)** is an upper-stage structural design engineer at United Launch Alliance located in Denver, Colorado.

**Vijay Surla ('07)** is a postdoctoral scholar at Stanford University, California. His current research involves building a catalytic reactor for converting harmful Volatile Organic Compounds (VOCs) into carbon dioxide and water vapor.

## 2007-2008

## ME Scholarship Recipients

### Scholarship Name

Advanced Energy-Hollis Caswell  
 Advanced Energy-Hollis Caswell  
 Allen Porter Mowry Memorial  
 C. Byron and Donna T. Winn  
 Claude W. Wood  
 Claude W. Wood  
 Claude W. Wood  
 Claude W. Wood  
 Claude W. Wood  
 Claude W. Wood  
 Claude W. Wood  
 Claude W. Wood  
 Claude W. Wood  
 Delano F. Scott  
 Delano F. Scott  
 Douglas D. Dreher Memorial  
 Edward B. House  
 Engineering Freshman  
 Engineering Scholars  
 Engineering Scholars  
 Frank Kimball Memorial  
 George T. Abell  
 Graham W. Howard Memorial  
 Ival V. Goslin  
 Ival V. Goslin  
 Ival V. Goslin  
 J. T. Strate Educational  
 John and Amy Lawton  
 Kirkpatrick Family  
 Lockheed Martin  
 Lockheed Martin  
 Lockheed Martin  
 Lockheed Martin  
 Mechanical Engr. Alumni/Faculty  
 Micro Motion Engineering  
 Micro Motion Engineering  
 Micro Motion Engineering  
 Mr. & Mrs. A. J. Parfet  
 Myron Brown Ludlow  
 Richard F. Walker  
 Robert L. and Bonnie J. Walker  
 Robert L. and Bonnie J. Walker  
 Robert L. and Bonnie J. Walker  
 Robert L. and Bonnie J. Walker  
 Robert L. and Bonnie J. Walker  
 Robert Mock Memorial  
 Robert Mock Memorial  
 Vorhees Family  
 Walery Richard Gawronski Memorial  
 Walter Scott, Jr.  
 Walter Scott, Jr.  
 Walter Scott, Jr.  
 Walter Scott, Jr.  
 Walter Scott, Jr.

### Recipient

Scott R. Domingue  
 Ravi C. Singaraju  
 Ryan J. Kindt  
 Laura M. Ruff  
 Seth L. Davies  
 Laura J. Davis  
 Caleb J. Dean  
 Luke J. Jackson  
 Austin L. Jurgensmeyer  
 Geoffrey M. Lodal  
 Beau M. Moore  
 Rodney A. Pace  
 Daniel J. Woldvedt  
 Bradley M. Carr  
 Richard E. Ortecho  
 Stacy M. Jonett  
 Nicholas R. Gruber  
 Francisco J. Martinez  
 Scott R. Domingue  
 Adam J. Hutchinson  
 Jonathan D. Woodworth  
 Stephen M. Hill  
 Jeffrey H. Gabel  
 Nicholas P. Echter  
 Eric S. Dischinger  
 Zachary J. Gonzalez  
 Janice K. Rainwater  
 Daniel L. Wilson  
 Lucas J. Oehlerking  
 Nicholas R. Gruber  
 Erin J. Dorociak  
 Perry D. Konishita  
 Christian C. L'Orange  
 Richard E. Ortecho  
 Kevin M. Wills  
 Judd C. Nutting  
 Ravi C. Singaraju  
 Daniel J. Woldvedt  
 Kevin E. Walters  
 Bradley L. Walpole  
 Nicholas I. Denning  
 Caleb O. Brown  
 Steven A. DeHerrera  
 Kelly D. Fagerstone  
 Ryan J. Slinger  
 Matthew L. Ellis  
 Eric R. Mowrer  
 Michael B. Peterson  
 Ravi C. Singaraju  
 Gregory J. Broughton  
 Joseph D. Gerdom  
 James W. Howland  
 Jack A. Martin  
 Zachary D. Simson

## Share Your News!

We enjoy hearing from our alumni. Please help us celebrate your personal and professional accomplishments. Send your update to:

E-mail: [SupportEngineering@colostate.edu](mailto:SupportEngineering@colostate.edu)

Fax: (970) 491-3815

Web: [www.SupportEngineering.colostate.edu](http://www.SupportEngineering.colostate.edu) (click on "Alumni")