THE ◆ BRIDGE

The Magazine of Eta Kappa Nu

SPRING 2006

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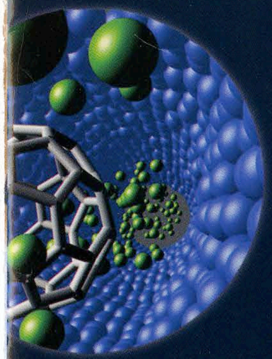
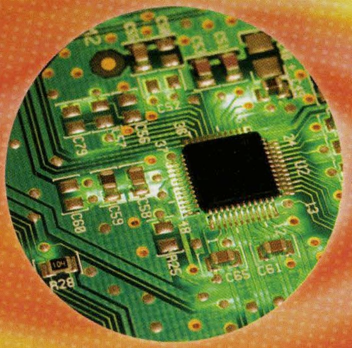
Problem Solving: Engineers as Leaders

Offshoring and the U.S. Electrical Engineering Workforce: Impacts and Trends

Globalization and Its Impact on Electrical and Computer Education: Preparing Engineers for the World of 2025

Creating the World of 2025





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LETTER FROM THE PRESIDENT

Karl E. Martersteck | Eta Chapter Member

Dear fellow HKN members,

Robert M. Janowiak took on the persona of the HKN executive director in autumn 2004, when the International Engineering Consortium (IEC) assumed responsibility for managing HKN. Bob poured a tremendous amount of personal energy and creativity to instill a new vitality into HKN as the society entered its second century. Sadly, Bob passed away January 29. Bob's impact is visibly evident in the new look and fresh content of *THE BRIDGE* and in the new HKN Web site. Less visible, but perhaps more important, Bob worked diligently to improve our operations and governance. He will be greatly missed.

I am pleased to announce that Roger Plummer, executive vice president of the IEC, has been appointed as the executive director of HKN, succeeding Bob Janowiak. Roger will be closely supported by Dr. Barry Sullivan, IEC director of Content Development and a member of HKN, and the entire IEC professional staff.

Roger Plummer graduated from the University of Illinois in 1964 with an engineering degree. He then joined Illinois Bell Telephone Company as a management trainee and continued with Illinois Bell and its successor company, Ameritech, for 30 years. During that period, Roger worked in various engineering, operations, and marketing assignments, rising to level of vice president. He retired from his position as president and chief executive officer of Ameritech Custom Business Services in 1994. Shortly after retiring, he joined the IEC as managing director. In that role, Roger worked very closely with Bob Janowiak in all of the IEC's endeavors. I am confident that Roger will be an enthusiastic leader and diligent manager of the HKN affairs.

Roger can be reached at *executive@hkn.org*.

Warm regards,

Karl Martersteck

LETTER FROM THE EDITOR

Barry J. Sullivan | Beta Omicron Chapter Member

This issue of *THE BRIDGE* marks the second with the new look and format, and my first as the editor. It was my pleasure and privilege to work under the direction of Bob Janowiak on the last issue. In my new role, I will strive to maintain the high standard he set as we continue to evolve *THE BRIDGE* to meet your needs and expectations.

The autumn 2005 issue of *THE BRIDGE* explored "The World of 2025" by presenting visionary articles on the state of technology 20 years into the future. In this issue, we build on that theme by considering some of the challenges engineers will face in "Creating the World of 2025."

Stephen Goodnick provides guideposts for the semiconductor road map as he describes the challenges of engineering at the nanoscale in his article, "Future Nanoelectronic Technologies." Ron Hira offers guidance on where in the world this work will take place as he addresses "Offshoring and the U.S. Electrical Engineering Workforce: Impacts and Trends."

Training the next generation of engineers must take into account changes in the nature of engineering careers as well as the advance of technology. In their article, "Globalization and Its Impact on Electrical and Computer Education," Kenneth Connor and Kenneth Jenkins report on a recent workshop on these issues organized by the Electrical and Computer Engineering Department Heads Association (ECEDHA).

Finally, achieving the visions of technology in 2025 will require visionary leadership. Steven Sample, recently named an HKN Eminent Member, presents the case for engineers assuming leadership roles in his article, "Problem Solving: Engineers as Leaders."

You will find supplemental material for these articles on the Eta Kappa Nu Web site, **www.hkn.org**. While you are there, I encourage you to help us serve you better by sharing your e-mail address if you have not done so already. You can do this by following the "Update Your Information" link on the home page.

I hope you enjoy this issue of *THE BRIDGE*. I welcome your suggestions for new themes and additional improvements as we plan for future issues. I can be reached at *editor@hkn.org*.

Warm regards,

Barry Sullivan

HKN

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Eta Kappa Nu (HKN) was founded by Maurice L. Carr at the University of Illinois on October 28, 1904, to encourage excellence in education for the benefit of the public. HKN fosters excellence by recognizing those students and professionals who have conferred honor upon engineering education through distinguished scholarship, activities, leadership, and exemplary character as students in electrical or computer engineering or by their professional attainments.

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THE•BRIDGE

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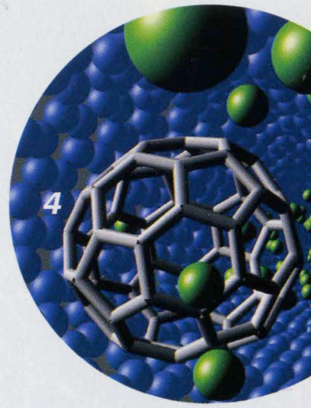
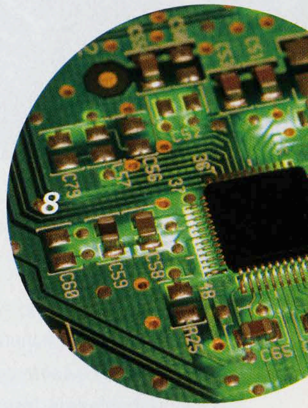
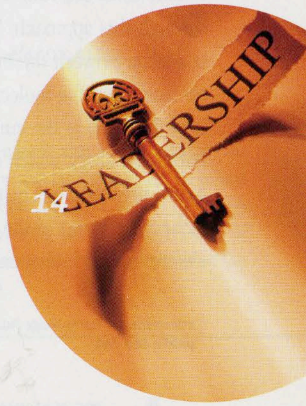
features







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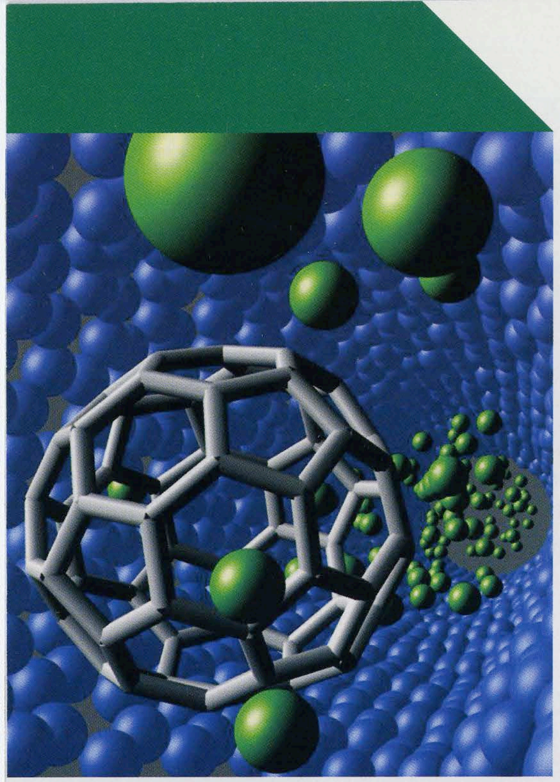


Future Nanoelectronic Technologies
Overcoming Semiconductor Limits

by Stephen M. Goodnick

Nanotechnology by its name implies technology with critical dimensions at the nanometer scale, i.e. 10^{-9} m. The enormous focus today on nanotechnology is driven by the convergence of two quite different approaches to the control of material properties on this scale. One is the "top-down" approach, employed with tremendous success by the semiconductor industry over the past several decades, based on optical lithography and the transfer of patterns using masks, materials growth, and etching.

Advances in lithography allow for the definition of devices with critical features approaching 10 nm and below. The second is the "bottom-up" approach used by chemists and biologists in synthesizing molecular and biomolecular structures at the nanometer scale. Self-assembled structures with unique functionality are routinely being realized through this approach. This convergence in size scale between the inorganic semiconductor world and the molecular biological world is at the heart of the current revolution in nanotechnology, which offers the potential for many advances, not just in new computing technologies, but in the interface between the electronic and biological worlds.

The dominant technology in the semiconductor industry over the past several decades has been the metal oxide semiconductor field-effect transistor (MOSFET). The gate length, which corresponds to the distance between the source and drain, is the critical dimension that affects performance. As this length is reduced, all the corresponding dimensions of the device decrease in size or "scale," according to well-defined scaling rules from the International Technology Roadmap of Semiconductors (ITRS)[1]. *Figure 1* shows scanning electron microscope photographs of Intel's current production transistors at the so-called 65 nm node, and successively shorter gate length devices realized in the research laboratory, down to 15 nm. Clearly, current transistor technology is nanotechnology.

To maintain charge as gate lengths shrink, research and production device structures are becoming increasingly three-dimensional rather than planar, using silicon on insulator technology (where a buried layer of oxide is introduced to isolate the device from the silicon substrate), dual-gate and wrap-around gates (in which the gate is above, below and around the sides of the channel, rather than simply on top), and nanowire (NW)-shaped channels.

Today there is increasing interest in the use of self-assembled, chemically grown wire structures as future FET–type devices using carbon nanotubes (CNTs) and self-assembled semiconductor NWs. CNTs are the focus of considerable attention because of the many remarkable properties of this new structural state of carbon. It is a highly stable state of matter, very similar in concept to fullerenes like C60 (Buckyballs). There is also intense interest in semiconductor NWs because of the demonstration of directed self-assembly of NWs via epitaxial growth. The scalability of arrays of such NWs and NTs to circuits and architectures has also begun to be addressed, although the primary difficulty is in the ability to grow and orient NWs and CNTs with desired location and direction.

Beyond these material and manufacturing issues, there are fundamental limits as device dimensions shrink. One is that quantum mechanics starts to play a role in small dimensions, in terms of the wave-like properties of charge carriers such as electrons.

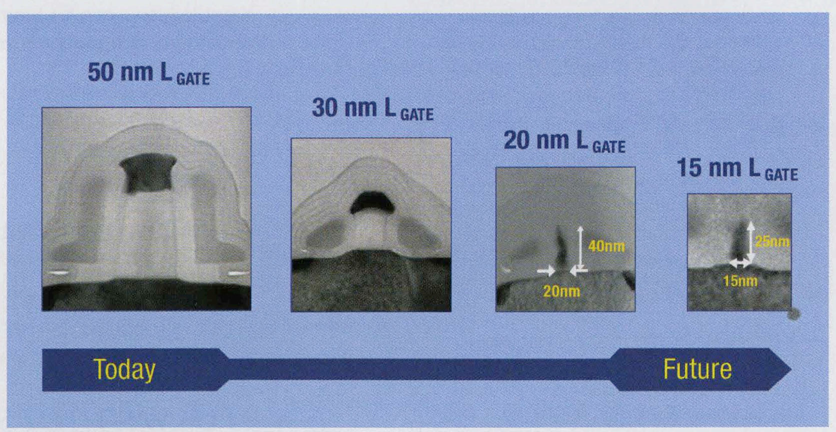
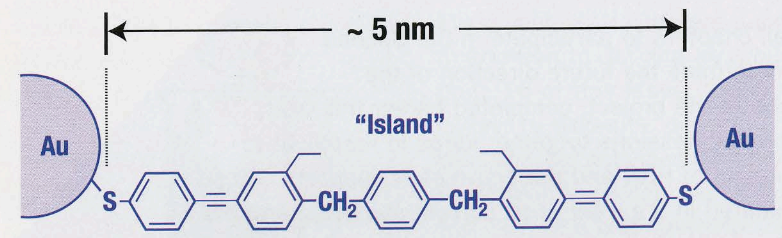


Figure 1 *Scaling of Successive Generations of MOSFETs into the Nanoscale Regime* (from Intel, with permission)

[1] International Technology Roadmap of Semiconductors, **public.itrs.net**



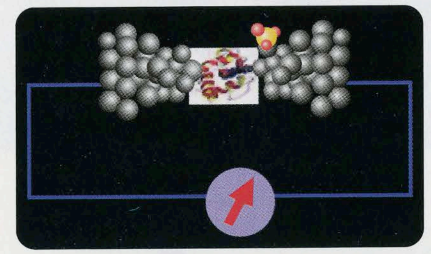


Figure 2

A Molecular "Junction" (Left) and details of the Organic Chain with Metal Contacts (Above)

Effects such as quantization of motion, interference effects, and tunneling are all physical effects that modify the performance of devices at small dimensions. The analogy of the wave nature of particles at this scale to electromagnetic waves has led to a number of proposals for quantum waveguide devices based on using the interference properties for switching. Quantum computing is one paradigm of information processing based on the coherent behavior of electrons at small scales, in which information is encoded in the wave functions of the particles themselves.

Another effect observed in small-dimensional structures is the discrete nature of charge. In small structures, charge can no longer be treated as a continuous fluid; rather, the number of charges is finite and small, which can lead to so-called single-electron-charging effects. For very small structures, the capacitance (the proportionality between charge and voltage, $\Delta Q = C\Delta V$) is a geometrical quantity that shrinks as the structure size shrinks. If C is sufficiently small (10^{-17} F and less), then the change in voltage, ΔV, for a single electron moving from one side to the other ($\Delta Q = 1.6 \times 10^{-19}$C) may be larger than the thermal voltage, 25 mV at room temperature. The fact that a voltage may control the movement of a single charge from one side of a device to another at small scales has led to the development of single-electron transistors (SETs) and memories, where current flow occurs because of the motion of one electron at a time.

Perhaps the ultimate limit of size scaling are devices comprised of a small number of molecules, forming the basis of electronic systems realized with molecular devices, or molecular electronics (moltronics). *Figure 2* shows a schematic diagram of a nanoscale contact to a molecular device, through which current is passed. Here the molecular device is an organic chain, to which different side groups or molecules are attached to realize a desired functionality. Elementary molecular electronic architectures have been demonstrated by HP Research Laboratories using crossbar-type logic. A very attractive feature of molecular systems is the possibility of bottom-up or self-assembly of functional systems. Such templated self-assembly is, of course, the basis of biological systems, which have exquisite complexity and functionality as well as self-replication and self-repair. Such "biomimetic" approaches to molecular circuits would represent an inexpensive alternative to the exponentially increasing cost of top-down nanofabrication, which is driving fabrication costs into the billions of dollars.

Conclusion

In summary, there are many candidate technologies being pursued in the field of nanoelectronics to enable the continued scaling of the density and computational power beyond current limits. However, there is not a clear alternative to conventional MOS technology at present, so much work remains. In the nearer term, many of the applications of nanoelectronics will be found in sensors and/or bio-medical applications using the types of nanodevices discussed in this article.

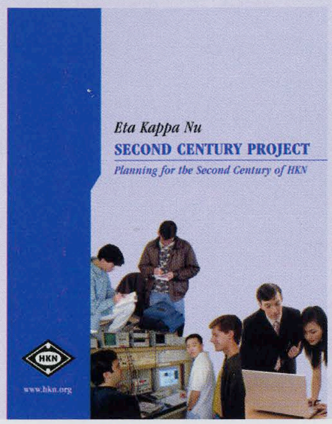
For more on this topic, visit **www.hkn.org/bridge**

ABOUT THE AUTHOR

Stephen M. Goodnick
Interim Deputy Dean of Engineering, Director of Nanoelectronics, Arizona State University
Delta Pi chapter – Oregon State University

A leading researcher in the emerging field of nanoelectronics, Dr. Goodnick also studies transport in semiconductor devices, computational electronics, and high-frequency and optical devices. He joined Arizona State in 1996 as chair of the Department of Electrical Engineering. Prior to that, he was a professor of electrical and computer engineering at Oregon State University. He is a past president of the Electrical and Computer Engineering Department Heads Association and a current member of the HKN Board of Governors. He was named a Fellow of the IEEE in 2004.

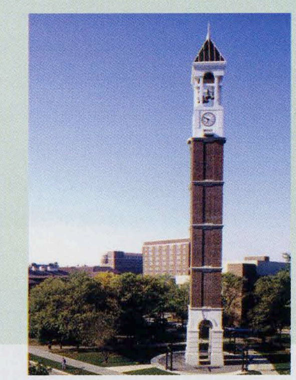
Second Century Project



The HKN Board invited all chapters to participate in the Second Century Project to help determine the future direction of the organization. In phase one of the project, completed earlier this year, chapters met in brainstorming sessions to gather ideas in response to five questions on the purpose of HKN and the activities it supports. These ideas are now being evaluated in a survey of all current student members as phase two of the project.

The results of the Second Century Project will provide structured input to the HKN Board on the future direction of HKN. Participation in the project will help chapters meet the requisite criteria to be considered for the Outstanding Chapter Award.

Regional Leadership Conference



Beta Chapter will host a student leadership conference at Purdue University in November 2006. The conference will feature industry executives and distinguished alumni speaking on the leadership qualities that have contributed to their success. Students attending the conference will also participate in activities to develop their leadership skills. This conference will serve as a model for other regional conferences, providing opportunities for students to meet and network with members from other universities as they gain valuable training.

Faculty Advisor Honor Roll

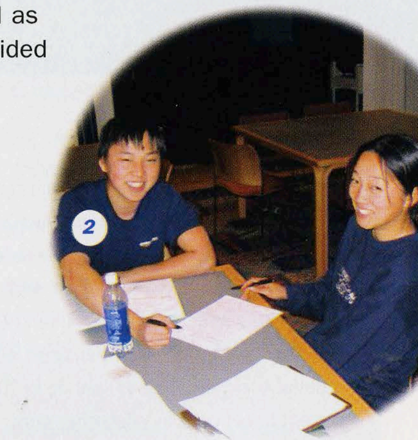
The honor roll recognition is given to advisors who participate in at least four general membership activities and one officer training or planning executive committee activity, who submit an Annual Faculty Advisor Report, and who receive letters of recommendation from the chapter president and the host department chair. Also, the chapters must initiate members during the year and submit all required chapter reports. This program is administered by the Faculty Advisor Support Committee, and the next application through the Annual Faculty Advisors Report is due June 30 for the 2005–2006 academic year.

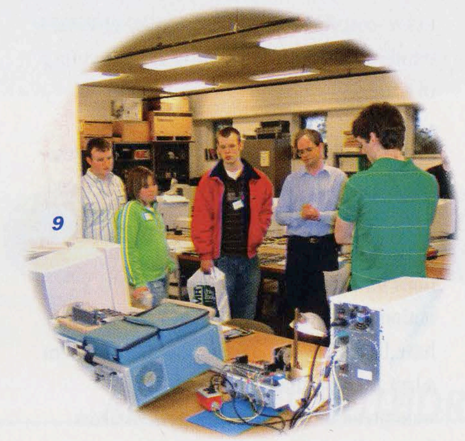
HKN Chapters in Action

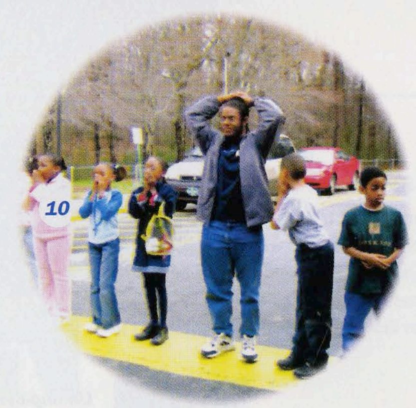
HKN Chapter Activities

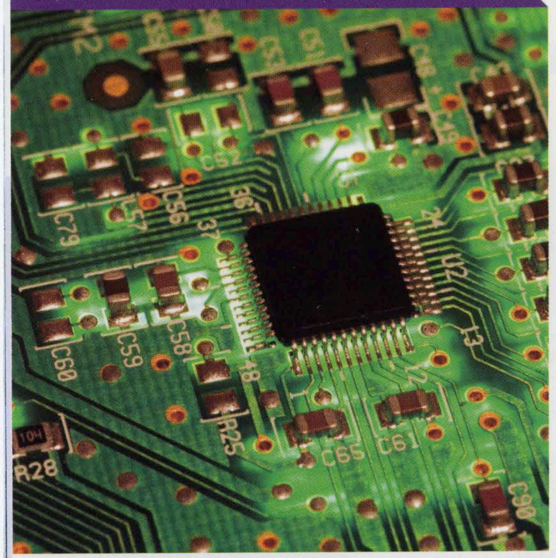
Every year, HKN chapters submit an annual report describing their various activities. In addition to serving as a basis for selecting the Outstanding Chapters listed on page 16 of this issue, these reports catalog the valuable services active chapters deliver to students, departments, universities, and the surrounding communities. HKN chapter activities demonstrate that Eta Kappa Nu is more than an honor society. In addition to recognizing deserving students, it is dedicated to serving the electrical and computer engineering profession as well as society as a whole. Some of the chapter activities that provided important services and instilled personal pride in HKN members over the past year include the following:

1. ***Awards recognizing outstanding professors and students***
2. ***Tutoring services, including peer advising, study sessions, and exam files***
3. ***Fundraising through sponsorship and merchandise sales***
4. ***Scholarships funded and awarded***
5. ***Career planning through information sessions and job databases***
6. ***Engineering open house and career days***
7. ***Faculty and course evaluations***
8. ***Research and industry seminars***
9. ***Department service projects***
10. ***Community service projects***
11. ***Social activities***









Offshoring and the U.S. Electrical Engineering Workforce

Impacts and Trends

*by Ron Hira**

Many companies are transferring tasks and jobs traditionally done by American engineers to lower-cost countries, where engineers earn as little as 10 percent of the salaries Americans earn. Company managers, making rational decisions, hope to save up to 70 percent in net costs by offshoring work. Although no government organization has reliable figures on exactly how many engineering tasks and jobs have been moved to low-cost countries in recent years, observable trends indicate that offshoring is accelerating in scale and scope.

The types of jobs moving offshore are increasingly sophisticated, some requiring advanced degrees and experience in engineering. No doubt these changes have important implications for American engineers and the U.S. national innovation system, but engineers have little objective information to help them adapt to these changes, and, despite widespread media attention, policymakers have so far chosen to do nothing in response to these structural changes in our innovation system. A flurry of legislation has been introduced in 2006, but because of the way it is designed—focusing on increasing basic research spending—its potential impact for American engineers will be limited.

* *This article reflects the personal opinions of the author.*

The net effects of offshoring on the U.S. economy are uncertain, but engineers and the engineering community can begin adapting if they understand the anticipated impacts on the labor market and begin tracking observable trends. This information can also help policymakers explore feasible policy responses.

Impacts of Offshoring on Employment

Most economists believe that offshoring will have little or no long-term impact on the overall number of jobs or the unemployment rates in the United States. According to their models, the total number of jobs in the United States is a function of the size of the labor force (primarily influenced by population and labor force participation), and the unemployment rate is a function of monetary and fiscal policies. They argue that individual jobs may indeed disappear at the microeconomic level as they are moved overseas, but the displaced workers will find jobs elsewhere in the economy as new opportunities arise or are created.

In the short term, offshoring is expected to have the following impacts on employment: job displacement for U.S. workers; a change in the mix of U.S. occupations; and downward pressures on wages for jobs that are newly tradable across borders.

> *Job Displacement*

Some U.S. workers will lose their jobs as their work is shifted to overseas locations. In July 2005, for example, Wachovia Corporation announced plans to move many of its information technology (IT) jobs to India and told its 3,000 U.S. IT workers to prepare for layoffs. The assumption is that these about-to-be displaced workers will be re-employed rapidly, and at substantially the same wages, as they "adjust," as economists say, to structural changes in the economy.

For displaced engineers, the adjustment process depends on the robustness of engineering job creation. As *Figure 1* shows, U.S. electrical and electronics engineers and computer scientists experienced higher levels of unemployment in the past four years than during any other four-year period since 1972.

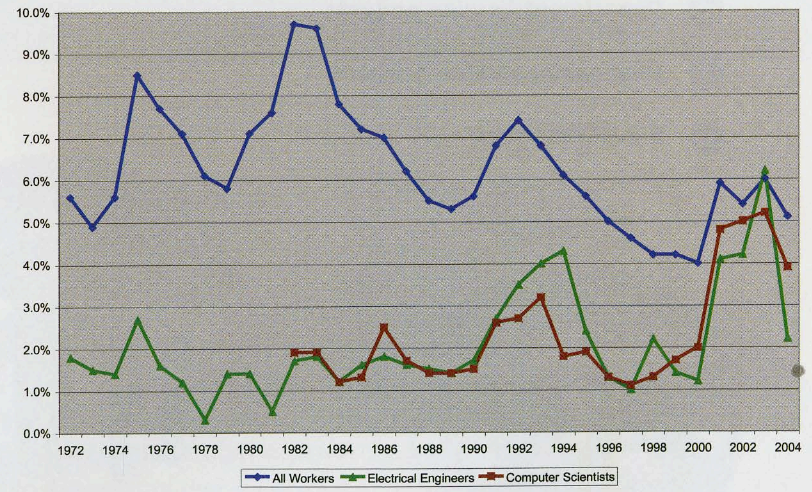


Figure 1 **Unemployment Rates for U.S. Electrical and Electronics Engineers**

Source: IEEE-USA from Bureau of Labor Statistics

In 2003, for the first time, the unemployment rate for electrical and electronics engineers (6.2 percent) exceeded the national unemployment rate (6 percent). To put this in historical perspective, throughout the 1980s, unemployment among electrical and electronics engineering never rose above 2 percent, despite national unemployment rates that peaked at 9.7 percent.

In addition, because of the slack labor market, wages of those who are employed fell slightly. For the first time in the 31 years that the Institute of Electrical and Electronics Engineers-USA has been surveying its members, median compensation declined in 2003. Although unemployment rates improved markedly among electrical and electronics engineering in 2004, this was partly due to increased hiring and partly due to engineers dropping out of the profession and looking for work in other occupations.

> *Mix of U.S. Occupations*

The second effect of offshoring predicted by economists is a change in the mix of U.S. occupations, as some jobs migrate to more efficient (lower-cost) overseas locations. As some sectors are lost, the United States will specialize in sectors in which it has a comparative advantage. However, there is no guarantee that the new mix of U.S. occupations will be better. In fact, economists cannot predict what types of new jobs will be created. This is a key policy question that no one can answer at this point. It is also a practical question. At every IEEE meeting I attend, I am invariably asked, "What new jobs should I be training for? What new skill sets will I need?"

Educators are grappling with the same questions. Engineering educators want to adjust curricula to help immunize their students' careers against offshoring. But because most companies are reluctant to reveal their plans for offshoring, and because the government is not collecting data, we are all left to speculate about what kinds of jobs will go and what kinds will stay.

If the United States relinquishes many engineering and technology jobs, will we be able to replace them with better jobs? If the replacements are non-technology jobs, how will that affect our ability to drive technological innovation? Conventional economic theories do not explicitly account for the impacts of offshoring on technological innovation and national security.

> *Wage Suppression*

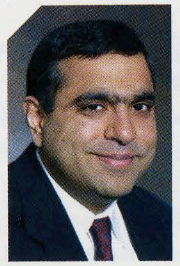
The third predicted effect on employment is wage suppression in jobs that are newly tradable across borders. Workers in these occupations are suddenly facing much more competition, which means they have less bargaining power. As some try to shift into non-tradable tasks in the same or new occupations, competition for these jobs will also increase. Some observers believe that wage suppression, rather than job loss per se, will be the most important effect of offshoring on U.S. employment.

Conclusion

It is clear that offshoring will have a major impact on many engineers and the engineering profession. Engineers need to be diligent about tracking these trends so that they can adapt to them and ensure they have durable careers. It is unlikely the government will help, and some of the proposals promoted by companies, such as doubling the number of American engineering graduates, may actually hurt. For the working engineer, it is ever more important to network with others in your profession and to take charge of managing your career.

For more on this topic, visit **www.hkn.org/bridge**

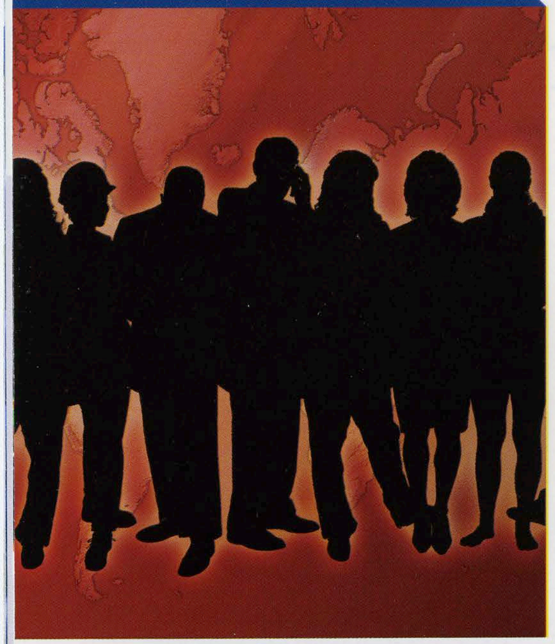
ABOUT THE AUTHOR



Ron Hira

Assistant Professor, Public Policy, Rochester Institute of Technology

Dr. Hira specializes in engineering workforce issues and technology policy. He is the author of *Outsourcing America*, has testified before the U.S. Congress on the implications of offshore outsourcing, and has given more than 70 invited talks on this subject. Dr. Hira is a licensed professional engineer and is vice president of Career Activities of IEEE-USA. In 2004, he was awarded the Citation of Honor from IEEE-USA for his work on behalf of the engineering profession.



Globalization and Its Impact on Electrical and Computer Education

Preparing Engineers for the World of 2025

by Kenneth Connor and Kenneth Jenkins

It is difficult to predict the changing nature of the engineering workplace in the 21st century, but some trends are becoming apparent. In November 2005, The Electrical and Computer Engineering Department Heads Association (ECEDHA) held a workshop on the Impact of Globalization on ECE Programs of the Future, for which we invited several leaders of the industry, government, and academia to address about 50 ECE department heads. We heard certain common themes, especially from the industrial participants.

First, employment for electrical engineers, computer engineers, and computer scientists remains strong. Starting salaries do not suggest either a shortage or excess of engineers, but we continue to attract about 25,000 engineers from foreign countries each year. It is also important to note that more and more jobs are being restricted to U.S. citizens, which clearly affects the graduates of U.S. universities and limits the ability of companies to fill positions from abroad. While engineering students can expect to see a good job market, the nature of the jobs is changing because companies are changing.

For more than a decade, companies have been moving from the multinational model to the global model. Previously, companies tended to create more or less self-contained units at each location, at least in part because it was difficult for their people to work together effectively if separated by significant distance. However, with the revolution in collaboration tools and communication channels made possible by the Internet and ubiquitous computing, it is now possible for a group working together on some project to be scattered throughout several sites in several countries. This means that it is no longer necessary to duplicate capabilities.

Rather, each unit in a company can have unique strengths that can be exploited by all other units. Regardless of whether such unique units are in other countries, they will have many characteristics that differ greatly from unit to unit.

Because of the development of the global rather than multinational company, all participants at the workshop, as well as most industry people we talk to, stress very strongly that engineers now must be able to do their job without ever being in the same room with their collaborators. This puts a very high premium on communication skills, because the cultures at different locations can be very different even if they are not in different countries. To achieve the highest level of success in this new working environment, it is necessary to be able to utilize all new collaboration tools, which are changing at least as fast as any other engineering product.

These changes are occurring, albeit in different ways, in all kinds of companies. Most of us have read stories of how the largest companies such as IBM and GE have units throughout the world. However, nearly all companies now have business units in many states and countries. Even defense contractors such as BAE Systems, Lockheed Martin, and SAIC are in hundreds of cities worldwide. Issues of security and export controls can significantly limit the flow of information, but design teams are still not generally located at one site. Small and even start-up companies are also increasingly spread out.

For example, 1st Playable, a new independent game development studio with a focus on handheld games for kids, has a solid core of people at their home in Troy, New York, but the games they produce also require the contributions of people from countries such as Netherlands and Canada.

How should ECE educators in the United States react to this global situation? An issue that must be addressed is the need to educate engineering students for competitive careers in a global economy characterized by the outsourcing of many jobs that were previously done at home. Students need to be trained with an awareness of global issues, cultural values, global economics, and an increased sense of lifelong learning in addition to being provided with a solid grounding in fundamental science and engineering. To keep engineering jobs in the United States, engineering programs should produce graduates that are so valuable that relative salary differences are not a major discriminator.

One strategy is to properly prepare students to work across hierarchical levels of design. Compartmentalized skills are the easiest to outsource, so training students with the ability to work across many system levels will become increasingly valuable. Coupled with this will be the need for increased emphases on multidisciplinary skills. Engineers who can work effectively with colleagues from several disciplines and respond to a rapidly changing work environment will be most likely to succeed.

In addition, it is still perceived that one of the main assets of the United States' engineering workforce is its entrepreneurial culture. Educational programs should seek to capitalize on and foster entrepreneurship in molding engineers for the future.

To meet the challenges of a quickly changing global marketplace for engineers, ECE programs should feature both breadth and depth via hands-on projects initiated in the first year. A system engineering approach that deals properly with real constraints (e.g., cost, environmental issues, etc.) should be introduced early, and efforts should be made to achieve integration across courses, effective management of project teams, and innovation.

In anticipation of U.S. engineers moving to higher-value-added job functions in global organizations, it is important to emphasize what are often called "soft skills" from areas such as communication, leadership, culture, history, and language of other societies, along with ethics and values. Additional content should be included in ECE curricula that covers topics such as business awareness and skills, an understanding of company organization and management, economics, offshoring versus globalization, and entrepreneurship.

Conclusion

The concepts of "design at a distance" (working in teams across the country and/or world), the ability to quickly expand into non-traditional ECE disciplines (bio, etc.), and adaptability to change (lifelong learning as a mechanism to retain lifelong employment) must all be woven into a successful program. It is also important that U.S. universities develop partnerships with non-U.S. academic, industrial, and government institutions, including for collaborative research and design projects and substantially increased opportunities for study- and work-abroad experiences.

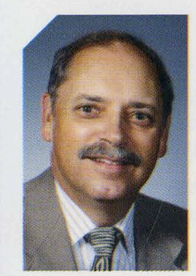
For more on this topic, visit **www.hkn.org/bridge**

The theme of the 2006 ECEDHA Annual Meeting is Globalization Opportunities for ECE. This meeting plays a critical role in our plan to address globalization, since it will actively involve the majority of ECE department heads. Details of the 2006 ECEDHA Annual Meeting can be found on the ECEDHA Web site, www.ecedha.org.

ABOUT THE AUTHORS

Kenneth A. Connor
ECEDHA President; Department Chair, Electrical, Computer, and Systems Engineering, Rensselaer Polytechnic Institute
Theta chapter – University of Wisconsin

Dr. Connor conducts research on plasma diagnostics and electromagnetic phenomena, in addition to technology-enhanced learning. He joined the Rensselaer faculty in 1974. He was named a Fellow of the IEEE in 1998 for his work on the application of heavy particle beam–based diagnostics to plasmas of interest to the thermonuclear fusion community.



W. Kenneth Jenkins
ECEDHA Past President; Department Head, Electrical Engineering, The Pennsylvania State University
Chi chapter – Lehigh University

Dr. Jenkins' research interests include signal processing algorithms, multidimensional array processing, and biologically inspired algorithms for signal processing. He co-authored a book on *Advanced Concepts in Adaptive Signal Processing*. He is a Fellow of the IEEE and the recipient of a Golden Jubilee Medal from the IEEE Circuits and Systems Society and a 2000 Millennium Award from the IEEE.

Three New Eminent Members Inducted

Eta Kappa Nu established the rank of Eminent Member in 1950 as the society's highest membership classification. It is conferred upon those select few whose contributions and attainments in the field of electrical and computer engineering have resulted in significant benefits to humankind.

EMINENT MEMBER — Presented March 2006*

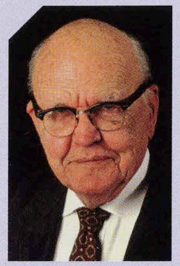


Photo courtesy of TI

Jack St. Clair Kilby

There are few men whose insights and professional accomplishments have changed the world. Jack Kilby is one of these men. During the summer of 1958, working with borrowed and improvised equipment, he conceived and built the first electronic circuit in which all of the components were fabricated in a single piece of semiconductor material. It was this breakthrough that made possible the sophisticated high-speed computers and large-capacity semiconductor memories of today's information age. Mr. Kilby went on to pioneer military, industrial, and commercial applications of microchip technology. He later co-invented both the handheld calculator and the thermal printer that was used in portable data terminals. From Mr. Kilby's first simple circuit has grown a worldwide integrated circuit market whose sales in 2004 totaled $179 billion. These components supported a 2004 worldwide electronic end-equipment market of $1.186 trillion. Such is the power of one idea to change the world.

* *Awarded Posthumously*

Kilby at a Glance

- Invented the integrated circuit at Texas Instruments; rose to assistant vice president and director of engineering and technology, Components group
- Distinguished professor of electrical engineering, Texas A&M University
- National Medal of Science, National Inventors' Hall of Fame, IEEE Medal of Honor, The Charles Stark Draper Prize, National Medal of Technology, Kyoto Prize in Advanced Technology, Nobel Prize in Physics
- B.S. in electrical engineering, University of Illinois, and M.S. in electrical engineering, University of Wisconsin

EMINENT MEMBER — Presented October 2005

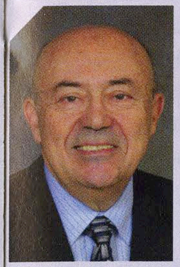
Steven B. Sample

Dr. Sample became the 10th president of USC in March 1991. The university's first holder of the Robert C. Packard President's Chair, Dr. Sample is also an electrical engineer, a musician, an outdoorsman, a best-selling author, and an inventor. Sample is the author of numerous journal articles and published papers in science and engineering and higher education. His patents in digital appliance controls have been licensed to practically every major manufacturer of appliance controls and microwave ovens in the world. More than 300 million home appliances have been built using his inventions. He remains an active member of USC's faculty, co-teaching a popular course for juniors and seniors titled "The Art and Adventure of Leadership." His book, *The Contrarian's Guide to Leadership*, has been a *Los Angeles Times* best-seller and has been translated into five languages. He donates all royalties to a scholarship fund for USC undergraduates.

Sample at a Glance

- President of the University of Southern California
- Former president of the State University of New York at Buffalo
- Elected to the National Academy of Engineering in 1998 and the American Academy of Arts and Sciences in 2003
- Member, Alpha chapter
- B.S., M.S., and Ph.D. from the University of Illinois at Urbana-Champaign

EMINENT MEMBER — Presented January 2006



Andrew J. Viterbi

Anyone using a cell phone today has almost certainly benefited from one of the technologies developed by Andrew Viterbi. He is the inventor of the Viterbi algorithm, an algorithm used for decoding convolutionally encoded data. He also contributed significantly to developing CDMA for wireless communications and evangelizing the technology throughout the world. His inventions are used in the vast majority of digital wireless phones, data terminals, and digital satellite broadcast receivers, as well as in such diverse applications as magnetic recording, speech recognition, and DNA sequence analysis. Viterbi is a co-founder and retired vice chairman and chief technical officer of QUALCOMM. He spent equal portions of his career in industry, having previously co-founded Linkabit Corporation, and in academia, as a professor at UCLA and then at UCSD, where he is now professor emeritus. He is president of the Viterbi Group, a technical advisory and investment company.

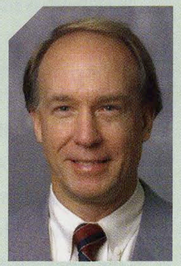
Viterbi at a Glance

- Trustee and presidential chair professor, University of Southern California
- President of the Viterbi Group
- Co-founder of Linkabit and QUALCOMM
- National Academy of Engineering, National Academy of Science, and the American Academy of Arts and Sciences
- Member, Beta Theta chapter
- B.S. and M.S. in electrical engineering from Massachusetts Institute of Technology (MIT), and Ph.D. in digital communications from the University of Southern California

HKN Distinguished Service Award

Awarding esteemed recognition to at most one individual annually, the Distinguished Service Award honors those who have made significant contributions to the HKN society throughout their lifetime.

AWARD WINNER — Presented December 2005

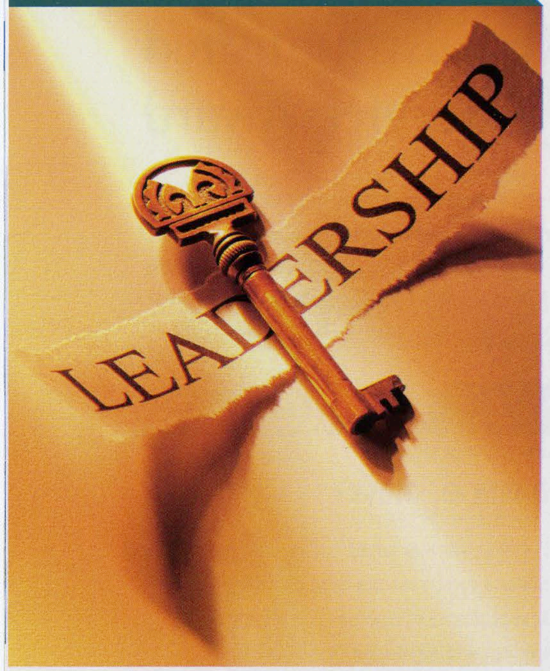


David G. Meyer

David Meyer has served HKN where it matters most—at the local chapter level. As a professor of electrical and computer engineering at Purdue University, he has served as HKN faculty advisor for the Beta Chapter since 1986. During this time, the chapter has received HKN's Outstanding Chapter Award numerous times. Meyer guided the chapter to activities that improved professional development, raised instructional and institutional standards, encouraged scholarship and creativity, provided public service, and furthered the established goals of HKN. In addition to his dedication to his local chapter, in 1989 he was elected to the HKN Board of Governors and later served as vice president and president. As an officer, Dr. Meyer spent considerable time encouraging chapters to become responsive to various HKN efforts, in particular by encouraging comments on proposed changes to the organization's constitution.

Meyer at a Glance

- Professor of electrical and computer engineering, Purdue University
- HKN faculty advisor for the Beta Chapter at Purdue
- HKN Board of Governors, vice president (1992–1993), and president (1993–1994)
- HKN C. Holmes MacDonald Outstanding Teacher Award
- Member, Beta chapter
- B.S., M.S., and Ph.D. from Purdue University



Problem Solving: Engineers as Leaders

The Art of Leadership from the Perspective of an Engineer

by Steven B. Sample

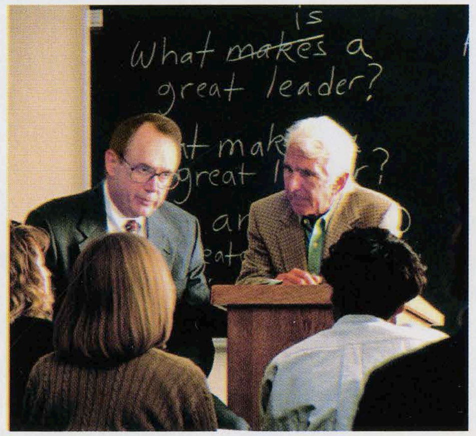
I'm an engineer by education and a leader by experience. Both are problem-solving professions that have dissimilar roots. Engineering employs the application of well-defined and long-lasting mathematical, scientific, and technical principles, while leadership is remarkably fluid, situational, and contingent. Unlike the specificity of math and science, leadership has no set rules. This elusive quality of leadership makes it an art, not a science. Thus it is more like music, painting, and poetry than it is routine endeavors. Nonetheless, aspiring leaders can be taught to develop their own potential for leadership by studying what's worked for others.

As part of my own study of leadership, management expert Warren Bennis and I co-teach a course for juniors and seniors each spring called "The Art and Adventure of Leadership." It is now the most sought-after course at the University of Southern California, attracting more than 300 applications for just 40 slots.

Although most of the students in this leadership class aren't engineering majors, I often tell them how the study of engineering has made me a better leader. It's a way to remind them that leaders come from all types of disciplines and backgrounds. In other words, the path to political leadership is not necessarily through law school, nor is business school the only route to becoming a company president.

In fact, 30 or 40 years ago, the doors were closed to engineers who wanted to be presidents of comprehensive universities. Today, among the 62 members of the Association of American Universities (which comprises America's leading research universities), 10 are led by engineers (including USC).

What lessons can be learned in engineering that can contribute to a person's effectiveness as a leader? At the top of the list would be analytical thinking and judgment—key attributes of the engineering profession. These qualities can help leaders examine problems from various angles and assess situations through qualitative and quantitative means.



USC President Steven B. Sample (left), here co-teaching "The Art and Adventure of Leadership" with renowned USC management expert Warren Bennis

The downside of engineering as preparation for leadership occurs when engineers become so entrenched in a particular technology or methodology that they stop exploring new ideas. They lapse into rigid thinking that can stifle their own creativity and that of others. In addition, engineers—whose work directly affects people—sometimes gloss over the importance of moral considerations in the design and creation of new products or processes.

What I love most about engineering is that it cultivates skillful judgment and analysis—key ingredients in problem solving. Real engineers make judgments based on inadequate information and imperfect designs. They operate under constraints such as time, cost, size, reliability, customer appeal, and what the competition is doing. Sometimes an engineer's judgments are based as much or more on gut feeling than on precise analysis.

One does not need to crank out closed-form analyses of problems that lend themselves to precise solutions to be a professional engineer; such work can be done by computers and technicians. Rather, the exquisite part of engineering involves deciding to move ahead with a solution based on reasonable professional judgment and analysis when you know that that solution is not as good as the one you might develop if you were to keep working on the problem.

In exploring possible solutions to a problem, engineers—just like leaders—must be careful not to fall into the proverbial rut of rigid and narrow thinking.

Often the most important inventions in a particular field are made by people who are new to that field—people who are too naïve to know why something can't be done. These neophytes, unburdened by hidebound perspectives and internal naysaying, are able to think more freely about seemingly intractable problems. They're willing to explore radically new ideas and technologies.

Unfortunately, some engineers feel threatened by new inventions. When I was a practicing engineer, I quickly found out that many of my colleagues, after just a few years in practice at one company and in one technology, become psychologically and emotionally wedded to that technology.

Just consider this: At one time, the leading vacuum tube manufacturer was RCA. Then the transistor was invented. One would think that RCA, as the dominating force in the electronics business, would have latched onto the transistor as a new technology that could take their business to greater heights of success. However, the engineers at RCA hated the concept of the transistor. So Texas Instruments became the rising star of the transistor business. And although an engineer at Texas Instruments later invented the integrated circuit, most of the engineers at TI had spent their whole lives with transistors and didn't want to have anything to do with integrated circuits. Another firm—Intel—became dominant in that field.

Although hidebound thinking can be stultifying, moral laxity can be downright dangerous. Leaders must develop a strong moral compass if they are to be effective leaders. Even the perception that a leader is dishonest, unfair, or unconcerned about the rights of other people can adversely affect the success of a company or organization.

As engineers, many of us would like to think that engineering is somehow morally neutral. But engineering is all about empowering people to manipulate and exploit the natural world for their own purposes. Thus, engineering is inevitably involved in moral as well as technological issues.

Sometimes the outcomes of our work as engineers are morally repugnant. For example, engineers are frequently asked to develop better methods for killing and maiming people.

However, engineers also have developed ways to make people safer, communication faster, infrastructures stronger, and computer systems more secure. Engineers are at the forefront of developing new and better robots, biomedical devices, nanotechnology devices, and multimedia tools that enhance the health, education, and well-being of people around the world.

As an engineer, I'm especially pleased that top research universities such as USC are in the vanguard of pursuing solutions to societal problems. Most of society's major challenges are global in scope. They include sustainability, disease prevention, environmental quality, and fossil-fuel alternatives—all areas in which engineers can and do make important contributions to improving people's lives.

Conclusion

In conclusion, the best advice I can give to those people studying engineering or leadership is to cultivate their natural creativity, intellectual independence, and moral integrity. These are the best tools for guarding against the rigid thinking and moral ambivalence that can drag down or prostitute new ideas.

The goal of my work as an engineer—and as a leader in higher education—has been to expand human potential. I encourage engineers who are inclined toward leadership to exploit the fact that their talents and predilections as engineers will serve them well as leaders.

For more on this topic, visit
www.hkn.org/bridge

ABOUT THE AUTHOR

Steven B. Sample
President, University of Southern California
Alpha chapter – University of Illinois

An electrical engineer, inventor, and author of the best-selling book *The Contrarian's Guide to Leadership*, Sample has been president of the University of Southern California since 1991. A recent publication of the Harvard Business School listed his book as one of six "must-reads" for leaders. In February 1998, he was elected to the National Academy of Engineering for his contributions to consumer electronics and leadership in interdisciplinary research and education. He was named an Eminent Member of Eta Kappa Nu in October 2005.

HKN Awards at ECEDHA Annual Meeting

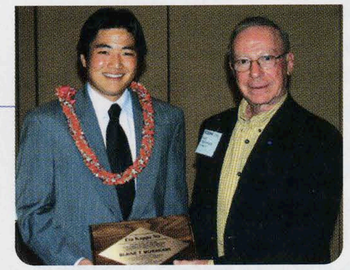
The Outstanding Electrical and Computer Engineering Student Award and the Outstanding Chapter Awards were presented at a banquet during the annual meeting of the Electrical and Computer Engineering Department Heads Association (ECEDHA) at the Turtle Bay Resort on Oahu's beautiful north shore on March 13, 2006.

Outstanding Electrical and Computer Engineering Student Award 2005

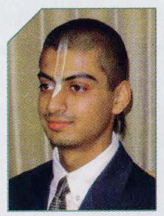
The Alton B. Zerby and Carl T. Koerner Outstanding Electrical and Computer Engineering Student Award recognizes outstanding scholastic excellence and high moral character, coupled with demonstrated exemplary service to classmates, university, community, and country. This program is administered by the Los Angeles Area Alumni Chapter. A jury of distinguished engineers selects the recipient.
For more on the award and a list of past winners, visit **www.hkn.org/awards/oeces.html**.

2005 AWARD RECIPIENT
Blaine Murakami, University of Hawaii

Murakami has co-authored one book chapter and 13 conference papers, in addition to serving as the student principal investigator on a $100,000 grant to design and build two nanosatellites for low Earth orbit. He also co-founded a company to develop self-steering antenna technology, of which he is a co-inventor.



Honorable Mention — Outstanding Electrical and Computer Engineering Student Award 2005



Ayush Goyal
Boise State University

Lai Heung Fan Thriven
University of California Los Angeles

Jacquelyn Kay Stroble
University of Missouri Rolla

Outstanding Chapter Awards 2005

The Outstanding Chapter Award recognizes excellence in college chapters for their activities. Recent changes in the award allow multiple winners and level the playing field for large and small chapters to be recognized for commendable performance.
For more on the award and a list of past winners, visit **www.hkn.org/awards/oca.html**.

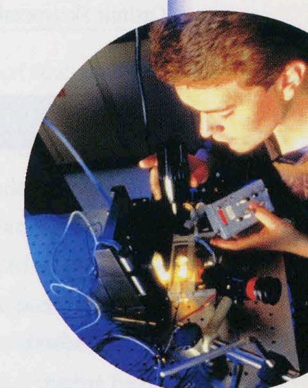
2005 CHAPTER AWARD RECIPIENTS

Department heads from seven of the nine Outstanding Chapters were on hand to accept the award on behalf of their chapters. From left to right,

Robert Trew, North Carolina State University, Beta Eta Chapter
Richard Blahut, University of Illinois at Urbana-Champaign, Alpha Chapter
Mark Smith, Purdue University, Beta Chapter
David Munson, University of Michigan, Beta Epsilon Chapter
Jacquelyn Stroble & Kelvin Erickson, University of Missouri-Rolla, Gamma Theta Chapter
Ali Sayed, University of California, Los Angeles, Iota Gamma Chapter
Gary May, Georgia Institute of Technology, Beta Mu Chapter
Karl Martersteck, HKN President
David Irwin, HKN Vice President

ADDITIONAL CHAPTER AWARD RECIPIENTS (Not Pictured)
University of California, Berkeley, Mu Chapter
Florida International University, Kappa Delta Chapter

ETA KAPPA NU
Electrical and Computer Engineering Honor Society



Dear Eta Kappa Nu Members and Friends,

Our contributions campaign for 2005–06 has produced more than $25,000 thus far, but there is still time for members to support the work of the association. Nearly 400 members have contributed already, enabling progress on new HKN initiatives.

This letter appears in the second issue of a revitalized *THE BRIDGE* magazine, just one example of these initiatives. The format and content of the magazine have received very positive feedback from members. Beta Chapter will host a student leadership conference at Purdue University in November—the first of many such conferences and another important initiative. The new HKN Web site (www.hkn.org) has become a valuable resource for members and for those considering membership.

Your gifts have helped fund implementation and continuation of these very important initiatives.

Please consider joining those listed on the following pages to make the 2005–06 campaign a big success. The greater level of support and additional services that HKN needs to provide can only be accomplished by the support of its loyal members and friends. Please help HKN achieve greater service levels to its students, professional members, and society. Your contribution can be sent to Kathy Ricker, HKN administrative director, at:

HKN Headquarters
300 West Adams, Suite 1210
Chicago, Illinois 60606-5114, USA

In conclusion, I am honored to be executive director of this very special organization whose initial chapter was formed at my alma mater, the University of Illinois at Urbana-Champaign. While your financial support will be very important to the work of HKN, your active involvement in the work of the chapters and HKN as a whole is just as valued. Your ideas on how we can strengthen our programs and grow membership will always be welcome. Send your ideas to me at *executive@hkn.org*.

I look forward to working with you.

Warmest personal regards,

Roger Plummer
Executive Director
Eta Kappa Nu

2005–2006 Annual Fund Contributors

Eta Kappa Nu thanks its many generous donors who have contributed to the 2005–2006 Annual Campaign. As HKN enters its second century of service, it is renewing its important service mission through many notable improvements in university-chapter relations, student member leadership development, broadened volunteer support, working relationships with ECE department chairs, and improved communications including an updated Web site, a newly formatted magazine, and e-mail communication with members.

$1,000 & Higher

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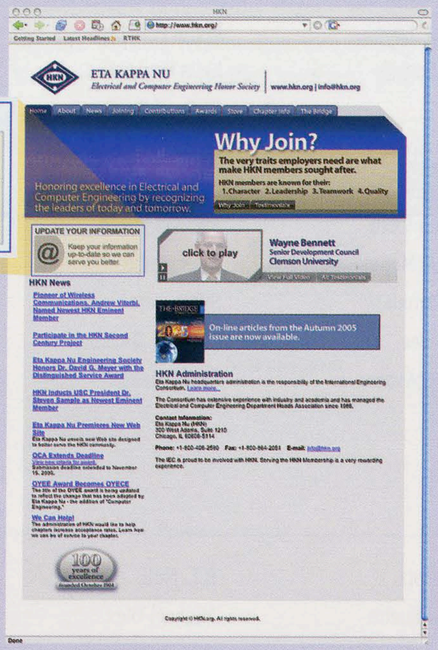
Keep your information up-to-date so we can serve you better.



The HKN Web Site

Professional Look and Feel

The HKN Web site sports an industry-accepted site architecture and layout with a professional design that is easy to navigate and understand.

Better Site and Page Architecture

The site is easier to comprehend with much of the content reworked and regrouped.

Easy-to-Use Navigation and Organization

The HKN site features a pull-down navigation menu, which allows quick, easy, and direct access to all of the site's main sections and pages.

HKN News Features

HKN members can now stay up to date on the latest society activities by visiting the HKN Web site. The site's home page features news headlines that link to articles and press releases.

HKN Video Testimonials

The HKN Web site features video testimonials from HKN alumni exploring the benefits of membership in the society.

Chapter Administration Forms and Information

Everything needed to establish and run an HKN chapter is now available in one spot on the HKN Web site.

Eta Kappa Nu Association
300 West Adams Street, Suite 1210
Chicago, Illinois 60606-5114 USA

CHANGE SERVICE REQUESTED