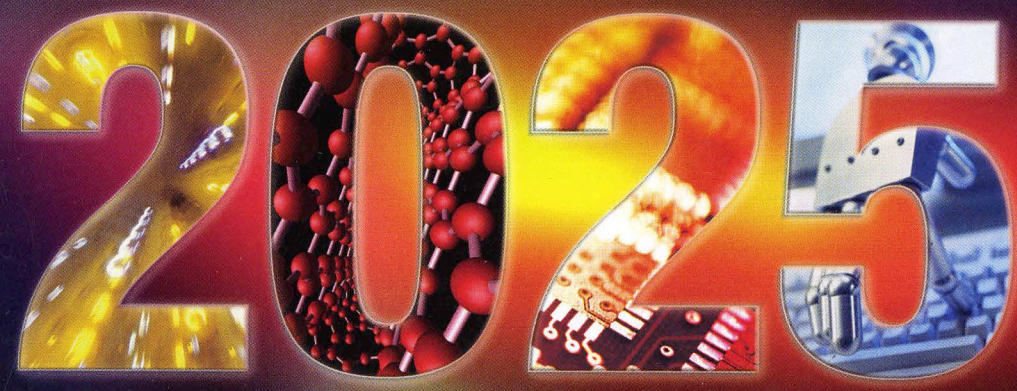
THE·BRIDGE

The Magazine of Eta Kappa Nu

AUTUMN 2005

The World of 2025



FEATURES

HKN

www.hkn.org

LETTER FROM THE EDITOR

Robert M. Janowiak | Executive Director | Alpha Chapter Member

It has been one year since the International Engineering Consortium assumed responsibility for managing HKN. We are continuing to transform our society to meet 21st century needs.

One very important new initiative is improved communications with you and all other HKN members. As *The Bridge* magazine is published only twice per year, we plan to begin issuing an HKN newsletter via e-mail.

To keep you informed, we need your e-mail address, so please go to the new HKN Web site (*www.hkn.org*) to update your personal profile (simply click "Help Us Help You" on the home page).

It is with great pleasure that we publish this issue of *The Bridge*, which features a new look and fresh content. Based on a recent reader feedback survey, it was clear that a new, exciting view of the future was desired.

Whenever I have met Eta Kappa Nu members, I have asked them for their thoughts on *The Bridge*. A very important theme, *The World of 2025*, has emerged from these discussions. And who could be better at providing perspectives on the future than HKN members?

Many of our HKN friends were approached to develop articles for this issue of *The Bridge*, which yielded an intriguing set of forecasts on semiconductors, communications, power, and entrepreneurship. I hope you thoroughly enjoy these forward-looking viewpoints, and I invite you to share your ideas on other interesting subjects and prospective contributors for upcoming issues of *The Bridge*.

A NOTE OF INSIGHT

We have entered a new millennium, and, as Peter F. Drucker, renowned management consultant, professor, and author of *Management Challenges for the 21st Century*, cautions, "much of what we have come to accept as true of business management is about to be challenged. The world is changing at a rapid pace, and only those who understand what those changes mean will be poised to prosper under the new rules. Old paradigms will be replaced by new ones."

Much is happening now to continue to grow HKN as a world-class honor society. Several months ago, we launched HKN's new Web site. Student chapters are being encouraged to develop their own sections for the site to feature their ongoing activities and initiatives.

Further, we have also established a strategic relationship with the Electrical and Computer Engineering Department Heads Association (ECEDHA) and recently held an HKN board retreat co-located with ECEDHA's annual retreat. Additional areas of cooperation are being discussed.

HKN's committees have also been working hard to select award winners and revamp the society's direction. Alan Lefkow, Chair of the OCA Committee, has updated the selection process for the Outstanding Chapter Award. Tom Rothwell, Chair of the Ritual Committee, similarly spearheaded a revision of the Induction Ritual.

HKN chapters are also receiving more support from the society's headquarters. HKN's governance is planning a series of regional leadership conferences that will be an important developmental resource for the society's members. Additionally, a Student Chapter Project, "Planning the Second HKN Century," is now being carried out to gather student ideas on the future of HKN. We expect insightful results from this project that will provide the Board of Governors with much to consider.

Last year, HKN also began a program seeking donations from members. HKN's new set of aggressive and ambitious initiatives requires more resources than we have currently available to be successful. Nearly 600 members responded to our first yearly fundraising appeal, and their names appear in this issue of *The Bridge*. Please consider a contribution to HKN this year.

The 2005–2006 year promises to be very busy. We look forward to hearing from you and other HKN members about the future direction of the society. Renewal is challenging, but most important, it is necessary and rewarding.

Warmest regards,

Autumn 2005

Editor
Robert M. Janowiak

Content Editor
Barry J. Sullivan

Copy Editors
Erin C. Green
Kimberly L. Lewandowski

Art Director
Graphic Design
Joseph T. Man

Advertising Sales
1-800-406-2590

HKN INTERNATIONAL HEADQUARTER OFFICE
Address editorial, subscription, and address change correspondence to:
300 West Adams Street, Suite 1210
Chicago, IL 60606-5114, USA
1-800-406-2590 phone | 1-800-864-2051 fax
www.hkn.org

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.

THE BRIDGE is the official publication of the Eta Kappa Nu Association.

Subscription Price: $15.00 (3 years)
Life Subscription: $60.00

THE•BRIDGE

The Magazine of Eta Kappa Nu

features

departments

award winners

Semiconductor Technologies for 2025

Needs, Challenges, and Opportunities

by Ralph K. Cavin, III and Victor Zhirnov

Needs

We believe that civilization rests on a foundation of knowledge derived from access to and processing of information. The need to develop, process, and communicate information is insatiable, and we believe that the need for increased information processing and communication capability will not abate. The quantitative measure of our ability to handle the information is the number of units of information (e.g., bits), N, we can process per unit time. Similarly, for communication of information, a useful metric is bandwidth, N/t [bit/s]. For computation, the number of the physical information-bearing elements (e.g., logic gates or memory cells) available per unit area, n, [bit/cm^2] is a critical factor. A measure of computational capability on the device level is binary information throughput, n/t [bit/(cm^{2}s)]. Thus the need for increased information processing power relates directly to increased binary information throughput and to communication bandwidth.

The semiconductor industry has responded to this need by scaling feature sizes to make faster and denser monolithic integrated circuits. Remarkably, the industry has been able to scale so that performance-per-dollar increases exponentially with time (about two times every two years—known as a form of Moore's Law, see *Figure 1*). Sustaining an exponential rate of progress into the indefinite future is a daunting task.

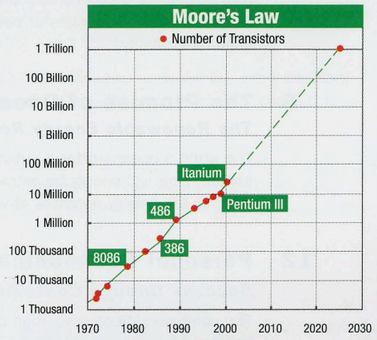


Figure 1

Challenges

The two most difficult technical challenges are the following:

1) Manufacturing of billions of nanoscale devices

Top-down lithography costs are steadily increasing and threatening the performance/cost benefits of scaling. One reason why scaling is becoming more difficult is the direct relation between the feature resolution, λ, and the energy of the information-bearing carrier (e.g., light quanta in photolithography, electrons or ions in particle-beam lithography). For example, for light, Einstein's formula $E=h\upsilon=(hc)/\lambda$ (h is Planck's constant, c is speed of light, and υ is light's frequency) indicates that if the feature size of a nanoscale device is 5 nm, the photon energy required to represent this feature is $E>250$ eV. In addition to driving up overall manufacturing energy costs, the energy to "print" far nanometer regime features far exceeds the bond energy of solids (~3-8 eV), and material defects from printing are inevitable.

2) Power consumption and heat dissipation

Let the energy processing costs for a bit of information be E_b. For a chip with binary information throughput n/t, the power density and the corresponding heat generation is on the order of $P=E_b(n/t)$ [W/cm^2]. We are beginning to see increases in power density for high-performance chips that make it difficult to remove the heat generated by device activity, since both increased device density and increased operating frequency increase n. One way to ease the heat problem is to minimize E_b. However, there is a fundamental limit: $E_{bmin}\sim 3k_BT\ln 2$, beyond which devices do not function properly (k_b is Boltzmann's constant and T is absolute temperature).

The International Technology Roadmap for Semiconductors (ITRS) expects to see scaling continue until around 2018. By then, the transistor gate length will be on the order of 5–10 nm, nearing the ultimate limit for charge-based devices prescribed by fundamental physics. *Figure 2* depicts the device switching energy as a function of feature size and indicates that we are far from physical limits. We don't know how close to fundamental limits devices can be operated. We do know that in order to approach fundamental limits for charge-based devices, the industry must innovate at an unprecedented pace, in device structures and materials, in processes, and in design methods.

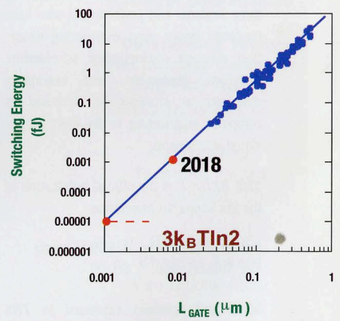


Figure 2 ***Gate length versus switching energy for a MOSFET***

(Courtesy of G. I. Bourinoff/Intel Corp.)

Opportunities

Is 2018 the time at which semiconductor technology will reach maturity? We don't think so, and, in fact, we believe that we are entering an era that will reward technical creativity like no other in the history of the semiconductor industry. We would like to pose a few challenges whose solutions we believe are fundamental to the continuation of the benefits of Moore's Law provided to society for 2025 and beyond.

I. Can we "teach" matter to organize into structures that we desire?

The bottom-up self-assembly of matter in complex structures could replace the top-down lithography and thus solve the manufacturing challenge mentioned earlier. However, we need to understand the fundamental laws of self-organization. Do self-assembling biological systems depend on a non-equilibrium environment to achieve the complex and intricate shapes that provide a desired functionality? Are there lessons that we might learn from inorganic processes such as the formation of a snowflake?

II. What other computational state variable might we utilize in the post-charge era to sustain scaling benefits for the next two to three decades?

Charge has been the workhorse for information technologies, but it faces substantial challenges as scaling continues, primarily driven by the excessive amount of heat that high-performance devices will generate. Might other "state variables" such as spin, phase, polarization, magnetic flux quanta, dipole orientation, etc., overcome the scaling limits for charge-based devices and allow us to continue Moore's Law scaling?

III. What are the fundamental limits to heat transport from semiconductor systems?

Current practice allows us to achieve removal of heat at about 50 W/cm^2 from a silicon chip. We need to improve this capability by one to two orders of magnitude to sustain the benefits of scaling.

IV. What are the "secrets" to the energy-efficient computation of biological systems?

In some applications, such as image processing, the human brain is far superior to any computational system that we can now consider building, and yet it performs these computations with incredible energy efficiency. Might we draw inspiration from the brain to enable us to design sophisticated high-performance processors that are energy efficient? Is brain "computation" digital?

V. How can we build cognitive machines?

A holy grail for information processing is the idea that we might be able to someday construct machines that can reason across several domains to develop hypotheses, to, in fact, create new knowledge. How does one synthesize new concepts, and can we do this in hardware?

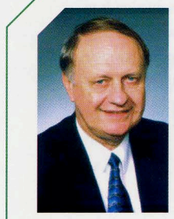
VI. Can we devise a two-way interface between neurons and transistors?

One of the highest callings of humankind is to develop prostheses that improve the quality of life for our fellow human beings who have been disabled. If we could create a knowledge base that would enable us to engineer a two-way interface between neurons and electronic devices, we might be able to systematically attack problems such as blindness, paraplegia, etc.

Conclusion

It is our hope that by offering intriguing questions, we can spur the creativity of future generations of engineers and scientists, much as Einstein was motivated about 100 years ago to answer questions that had been postulated in his era. For example, "Why is the speed of light, c, a fundamental constant?" (one of the implications of the answer is $E=mc^2$) or "Why is the energy of released photoelectrons independent of the intensity of the light?"(answer: $E=h\upsilon$). The answers to these questions helped to create the foundation on which we have constructed much of the information technologies that we use today. We believe that opportunities exist today for profound contributions from this generation of scientists and engineers.

ABOUT THE AUTHORS



Ralph K. Cavin, III

Vice President of Research Operations
Semiconductor Research Corporation
Gamma Omega chapter - Mississippi State University

Cavin designed missile guidance and control systems at the Martin-Marietta Company early in his career. He served on the electrical engineering faculty at Texas A&M University and on the electrical and computer engineering faculty at North Carolina State University, where he also served as department head and dean of engineering.

Victor Zhirnov

Program Manager
Semiconductor Research Corporation

Zhirnov has served as a senior scientist at the Institute of Crystallography of the Russian Academy of Science in Moscow and as a research professor at North Carolina State University. He is currently a program manager at the Semiconductor Research Corporation (SRC), responsible for assessments of emerging nanoelectronic devices.

Eta Kappa Nu Establishes Four New Chapters

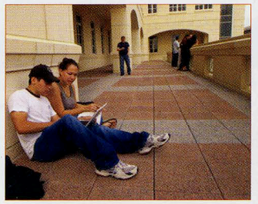
Eta Kappa Nu was happy to establish four new chapters during academic year 2004–2005.

University of Texas at San Antonio

Chapter Name
Kappa Upsilon

Date of Induction
November 19, 2004

Number of Inductees
17



The mission of the Electrical and Computer Engineering Department at The University of Texas at San Antonio is to serve the needs of the south central Texas region, the state, and the nation by providing quality educational and innovative, relevant research programs in computer, control systems, and communication and signal processing engineering. The department strives to offer outstanding design-oriented undergraduate and graduate courses, conduct research, and develop technology in the aforementioned areas and promote supportive areas such as bioengineering for the betterment of the quality of life.

University of North Carolina at Charlotte

Chapter Name
Kappa Phi

Date of Induction
April 29, 2005

Number of Inductees
26

The William States Lee College of Engineering at the University of North Carolina at Charlotte is a community of students, faculty, and industry partners. The role of the College of Engineering is to establish strong research and curriculum concentrations in areas such as power, systems, microelectronics, communications, biomedical engineering, VLSI, and computer engineering. These primary objectives include developing a healthy educational and research environment, improving the capabilities of the school's graduates, providing unique educational opportunities, and furnishing critical information technology to complete its mission.

Virginia Commonwealth University

Chapter Name
Kappa Chi

Date of Induction
May 6, 2005

Number of Inductees
12

The School of Engineering at Virginia Commonwealth University has established itself as a preeminent school in education, research, and technological development for engineering, business, medicine, and the life sciences. The development of the school has been a collaboration between the university and the industrial community, which is reflected in its curriculum, in the industrial experience students have available, in the business courses within the engineering curriculum, and in the recruitment of faculty with industrial experience. This initiative was in response to the workforce and economic development needs of Richmond and Central Virginia.

University of California, San Diego

Chapter Name
Kappa Psi

Date of Induction
June 2, 2005

Number of Inductees
12

The Jacobs School of Engineering at the University of California, San Diego is a premier research school set apart by its entrepreneurial culture and integrative engineering approach. Among its strengths are bioengineering, earthquake and renewal engineering, communications, security and networks, materials, and systems and controls, with a focus on research and education for the information-technology infrastructure. Its mission is to educate tomorrow's technology leaders and to seek discoveries that fuel economic prosperity of the nation and enhance the quality of life for people everywhere.

HKN Chapters in Action

Eta Kappa Nu chapter activities continue to be very strong. This first semester/quarter of the academic year has HKN officers determining the students that will receive invitations to join, organizing their activity calendar, and beginning their planned social and service programs.

The new HKN Web site (www.hkn.org) is a substantial resource to chapters. There are sections detailing officer responsibilities, effective recruitment of new members, potential social and service programs, and current chapter activities.

The Outstanding Chapter Award (OCA) has been changed. As the award is now structured, multiple awards may be conferred each year. This change will allow smaller chapters with exemplary programs to compete on the same scale as large chapters with many resources. Now both large and small chapters will be recognized for their laudable activities.

The HKN Induction Ritual has been reviewed frequently throughout the past several years and is now significantly different from the ritual that was used in the past. The current ritual not only preserves the grace and charm of the old ritual while focusing on "self-improvement and social obligation," but it also addresses the concerns of ethics, honesty, and truth.

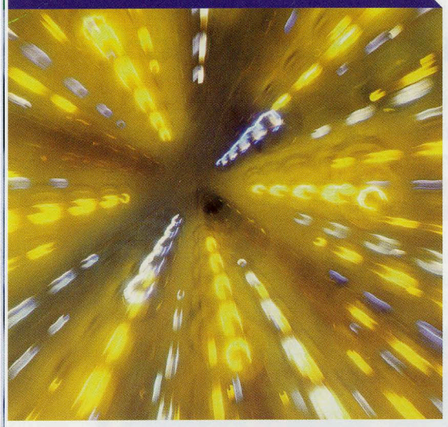
HKN is pleased to introduce its Student Chapter Projects initiative. The HKN Board will define projects of substantial importance for members, chapters, and the overall organization. All chapters are invited to participate in a Student Chapter Project. Exceptional chapter performance in a Student Chapter Project will be recognized and will be a favorable factor when being considered for the Outstanding Chapter Award.

HKN will be organizing Student Leadership Forums where universities in a specific geographic region will gather to share leadership experiences. Each forum will feature presentations by industry executives and leadership experts, as well as discussions of the many key ingredients to successful leadership. These Leadership Forums will provide valuable training for students and an opportunity for them to meet and network with members from other universities.

We certainly expect a very busy year ahead. The HKN headquarters is committed to providing chapters with an unprecedented level of support, and we hope that those universities currently without HKN chapters decide to join our growing HKN family.

ATTENTION ALL MEMBERS

Please be sure to visit the HKN Web site's home page (www.hkn.org, then click on the "Help Us Help You" link) to ensure your personal profile is up-to-date!



The Promise of Ocean Wave Power

The Renewable Energy Resource for 2025

by Annette von Jouanne and Alan Wallace

The solutions to today's energy challenges need to be explored through alternative, renewable, and clean energy sources to enable a diverse national energy resource plan. A significantly untapped renewable energy source exists in the world's oceans: it is estimated that if 0.2% of the oceans' untapped energy could be harnessed, it could provide power sufficient for the entire world.

Ocean energy exists in the forms of wave, tidal, marine current, thermal (temperature gradient), and salinity. Among these forms, significant opportunities and benefits have been identified in the area of wave energy extraction. Waves have several advantages over other forms of renewable energy, such as wind and solar, in that the waves are more available (seasonal, but more constant) and more predictable, thus enabling more straightforward and reliable integration into the electric utility grid to provide reliable power. Wave energy also offers much higher energy densities, enabling devices to extract more power from a smaller volume at consequent lower costs.

Figure 1 *OSU's MSRF*

Wave Energy Extraction Technologies

The world's first wave energy device patent was registered in 1799 by Girard in Paris, France. After more than 200 years' development, there are currently more than 1,500 wave energy device patents.

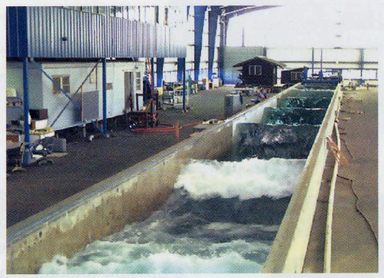


Figure 2 *OSU's O. H. Hinsdale WRL*

Historically, there have been two booms of interest in the research of wave energy, corresponding to the oil crisis and pollution concerns of the 1970s as well as concerns regarding natural resource reserves since the mid-1990s. Depending on the distance between the conversion devices and the shoreline, wave energy systems can be classified as shoreline, near-shore, and offshore extraction systems.

Wave energy devices that are developing around the world include the Ocean Power Delivery (OPD) Pelamis, the Ocean Power Technology (OPT) PowerBuoy, Aqua Energy's AquaBuoy, Wavegen's Limpet, Energetech's Oscillating Water Column (OWC), and others.

Wave Energy Developments at Oregon State University

The authors are the leads of a strategic, multidisciplinary wave energy team at Oregon State University (OSU), investigating novel direct-drive offshore wave energy extraction approaches. OSU's research focuses on a simplification of processes—i.e., replacing systems employing intermediate hydraulics or pneumatics with direct-drive approaches, to allow generators to respond directly to the movement of the ocean by employing magnetic fields for contact-less mechanical energy transmission and power electronics for efficient electrical energy extraction. The Oregon State Wave Energy team's research and development goals are driven by the important issues of survivability, reliability, and maintainability, in addition to efficient and high-quality power take-off systems. OSU is a prime location to conduct ocean wave energy research, noting the following strategic facilities:

- OSU is the home of the nation's highest power university-based energy systems laboratory, the Motor Systems Resource Facility (MSRF), co-directed by the authors, with a 750kVA dedicated power supply and full capabilities to regenerate back onto the grid (see *Figure 1*).
- OSU is the home of the O. H. Hinsdale Wave Research Lab (WRL) with world-class wave tank facilities, including a 342-foot wave flume (see *Figure 2*).

The Oregon State University Wave Energy team is developing several novel direct-drive prototypes, including a Permanent Magnet Linear Generator Buoy, a Permanent Magnet Rack and Pinion Generator Buoy, and a Contact-less Force Transmission Generator Buoy. These buoys are designed to be anchored 1-3 miles offshore in typical water depths of greater than 100 feet, where the buoys will experience gradual, repetitive ocean swells. Inside the Permanent Magnet Linear Generator Buoy, the wave motion causes specially designed electrical coils to move through a magnetic field, inducing voltages and generating electricity. In the Permanent Magnet Rack and Pinion Generator Buoy, linear to rotary conversion is being developed as an extension of the concept of permanent magnet gears. The Contact-less Force Transmission Generator Buoy exhibits linear force transmission using large, high-strength permanent magnets configured in a "piston." The motion of the piston is then transformed to rotation, using a ball screw to drive a permanent magnet rotary generator.

Advanced designs are also being pursued to achieve high-speed, high-efficiency rotary generation without the inherent friction of a ball screw approach. The OSU researchers are also investigating small-scale wave energy generators, which could be integrated into boat anchor systems to power a variety of small-craft electronic devices. These similar small-scale systems could enable ocean data collection and monitoring buoys to become self-powered.

The combination of key facilities at Oregon State University, ongoing successful wave energy research, and the tremendous wave potentials off of the Oregon coast has led the OSU Wave Energy team to pursue the formation of a U.S. Wave Energy Research, Development, and Demonstration Center in Oregon. This center is strategically necessary for the United States to keep pace with the European Marine Energy Center (EMEC) in the development of renewable wave energy resources in what is projected to become a rapidly developing new set of industries.

Ocean wave energy extraction technology is currently in the preliminary stages of development, where wind turbines were approximately 15–20 years ago, with several topologies developing and no clearly superior engineering solutions yet established. The national wave energy center would enable the acceleration of research toward optimal topology standards, similar to the wind turbine research process, which led to the predominant horizontal-axis, three-blade turbine design. Fortunately, several factors, such as advanced technologies and materials, and lessons learned from other renewable industries, offer encouraging predictions that the catch-up time for ocean wave energy can be accelerated.

Figure 3 shows a conceptual wave park illustration, highlighting OSU's first wave energy prototype of their permanent magnet linear generator. Full-scale wave park buoys could be 12 feet tall (fairly neutrally buoyant) and 15 feet in diameter, and they could be capable of producing up to 100 kW of power. An average coastal home consumes 1.2–1.5 kW and, including a capacity factor of 0.5, each buoy would be capable of supplying approximately 35 homes.

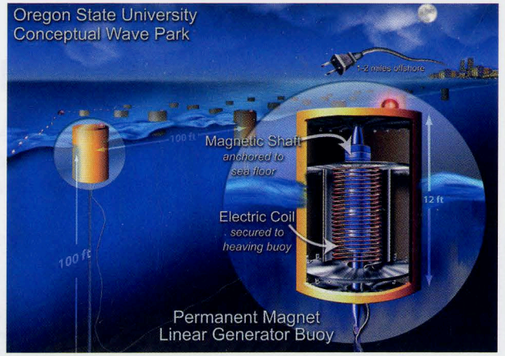


Figure 3 *OSU's Conceptual Wave Park*

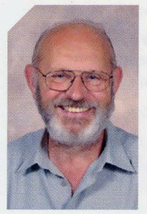
Conclusion

As shown in *Figure 3*, each buoy would have a power cable dropping down along the tether to the anchor, which would then be routed to a central junction box located on the seafloor at the front of the wave park. At the central junction box, the unregulated voltages from all of the buoys would be combined and conditioned as regulated direct current (DC), for delivery to the shore through a single submarine cable. At the shore substation, the DC power provided by the wave park would be inverted to alternating current (AC) and connected to the grid. Recent advances demonstrate that there is reason to hope that ocean wave power may become a new, reliable, and clean source of affordable renewable energy as we approach 2025.

ABOUT THE AUTHORS

Annette von Jouanne
Professor, School of Electrical Engineering and Computer Science
Oregon State University

Von Jouanne is the 2004 recipient of the C. Holmes MacDonald Outstanding Teaching Award from Eta Kappa Nu. Her research interests include power electronic converters, power quality, adjustable-speed drives, hybrid electric vehicles, and renewables.



Alan K. Wallace
Professor, School of Electrical Engineering and Computer Science
Oregon State University

Before joining the faculty at Oregon State University, Wallace worked with Imperial Chemical Industries, Spar Aerospace, Canadair Services, and the Urban Transportation Development Corp. of Kingston, Ontario. He also taught electrical machine design and power system analysis at the University of Nottingham.

Three New Eminent Members Inducted

Eta Kapp 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 April 2005

Joseph Bordogna

Joseph J. Bordogna's career as an engineer and educator has spanned more than 45 years. He began his academic career in the 1960s as a professor of electrical engineering at Pennsylvania State University, where he became dean in 1981. A U.S. Navy veteran, his industrial career includes experience as an engineer at RCA Corp. in design, manufacturing, and R&D activities for product and process development, principally in electro-optics. Bordogna is also the co-author of two books: *Electric Networks* (1966) and *The Man-Made World* (1971). In 1993, Bordogna was elected to the American Society of Engineering Education Hall of Fame and is a recipient of the society's George Westinghouse Award. Additionally, the Society of Manufacturing Engineers awarded Bordogna its Gold Medal in 2001, and the Semiconductor Industry Association honored him with its Leadership Award in 2004.

Bordogna at a Glance

- Alfred Fitler Professor of Engineering, Pennsylvania State University
- Fellow and former President of the Institute for Electrical and Electronics Engineers (IEEE)
- Former Deputy Director and Chief Operating Officer of the National Science Foundation (NSF)
- Member, Lambda chapter
- B.S.E.E. and Ph.D. from University of Pennsylvania, and M.S. from Massachusetts Institute of Technology (MIT)

EMINENT MEMBER — Presented June 2005

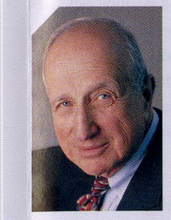
Owen K. Garriott

Owen K. Garriott was one of the original six astronaut-scientists chosen by NASA in 1965. On his first space flight in 1973 aboard Skylab, Garriott set an endurance record by spending 60 days in space. On a 1983 mission, he spent 10 days aboard Spacelab-1. In addition to his achievements in space, Garriott held several posts at the Johnson Space Center, including responsibility for all research in the physical sciences. After leaving NASA in 1986, Garriott consulted for various aerospace companies and served as a member of several NASA and National Research Council Committees. He also had a distinguished education career as a professor at Stanford University, where he performed research, led graduate studies, and authored or co-authored more than 45 scientific papers, chapters, and one book. He is also a recipient of the National Science Foundation Fellowship and the NASA Distinguished Service Medal.

Garriott at a Glance

- Former Director of Science and Applications at Johnson Space Center
- Former Associate Professor in the Department of Electrical Engineering, Stanford University
- Former Adjunct Professor in the Department of Biological Sciences, University of Alabama at Huntsville
- Member, Beta Xi chapter
- B.S. in Electrical Engineering from the University of Oklahoma, and M.S. and Ph.D. in Electrical Engineering from Stanford University

EMINENT MEMBER — Presented June 2005



Bernard M. Gordon

Bernard M. Gordon has played a key role in developing a half-century of pioneering technologies that have contributed to major advances in the fields of industrial instrumentation, medical imaging, computer systems, aerospace telemetry, and communications. Among his many accolades, he is often called the father of modern analog-to-digital conversion for his groundbreaking advances in the field. He also made contributions to the development of UNIVAC, the first commercial computer, and the first alphanumeric dot matrix display, as well as scanning devices that would be critical components of modern medical imaging and counter-terrorism technology. Gordon's concern for engineering education led to the establishment of the Gordon Institute at Tufts University, which teaches management and entrepreneurial skills.

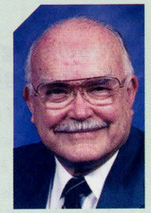
Gordon at a Glance

- Chairman, NeuroLogica Corporation
- Founder and Chairman Emeritus of the Board, Analogic Corp.
- National Medal of Technology Recipient (bestowed in 1986 by President Ronald Reagan)
- Member, Beta Theta chapter
- B.S. and M.S. from Massachusetts Institute of Technology (MIT)

Vladimir Karapetoff Outstanding Technical Achievement Award

This award is made annually to an electrical engineering practitioner who has distinguished himself/herself through an invention, development, or discovery in the field of electrotechnology resulting in significant benefits to humankind.

AWARD WINNER — Presented April 2005

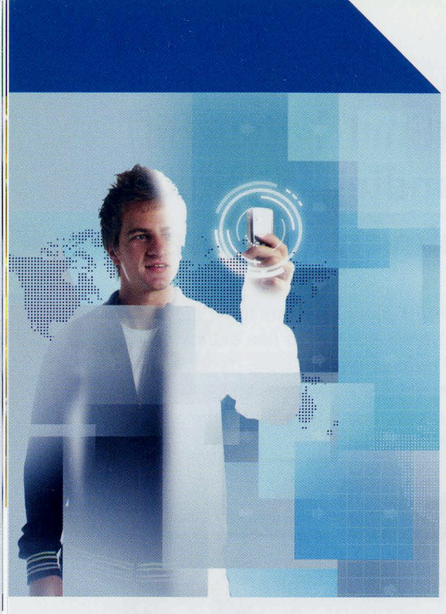


Stanley A. White

Stanley A. White has fathered many inventions and developments in advanced digital signal processing technology, as well as circuits and systems for navigation, flight control, and communications. His identification of an error in the Sidewinder missile system greatly increased the accuracy of that air-to-air defense system and has undoubtedly saved the lives of many U.S. military pilots. At North American Rockwell, White worked on the navigation and flight control for the Voyager program, was co-developer of a cardiac output computer, and was responsible for the engineering of an astronaut vital-signs monitor program. White has been granted more than 80 patents and has authored three NASA textbooks on control systems, microelectronics, and digital signal processing.

White at a Glance

- Former Scientific Advisor, Boeing North America
- Former Senior Scientist, Rockwell International
- Former Senior Technical Specialist and Group Scientist, Autonetics Research, Engineering, and Reliability Division, North American Aviation
- Member, Beta chapter
- B.S.E.E., M.S.E.E., and Ph.D. from Purdue University



Personal Communications in 2025

Success through Consumer-Driven Offerings

by Martin Cooper

We are experiencing a revolution in the telecommunications industry now. Although the revolution is facilitated by technology, the way we do things and the way we live have already started to change profoundly. The advances in technology are relatively easy to predict, but they are far less profound than the changes in our behavior. There will be extraordinary advances in technology, but, because it takes so long for technology to move from ideas and the research laboratories to practical implementation, we can pretty accurately tell what's going to happen for at least 20 years into the future. In fact, there won't be any technological surprises that will have an important effect on society between now and 2025. We have predictive tools that tell us what is going to happen in the fundamental technologies that determine the capabilities of our industry, tools with a long history of accuracy.

In contrast, there are no reliable tools to predict how people will accommodate the advances in technology. The users of technology, people, tend to be very conservative in the adoption of new technologies. People embrace new technologies only when they offer genuine functionality or they capture the attention of people in other ways. This paper will discuss the technological predictors briefly and delve deeper into the ways in which people will use the advances in technology.

I will be 98 years old in 2025 and, for one reason or another, I will be immune to either ridicule or adulation. I, therefore, have no qualms about making the following predictions.

Predicting the Technological Future

One example of technological predictors that will have vital impact on the telecommunications industry is shown in *Figure 2*. Moore's Law (see *Figure 1 on Page 4*) tells us that, by 2025, a single semiconductor chip will have the computing power of more than a trillion transistors, a thousand times more than today. These chips will cost about what a processor or memory chip costs today and will have comparable power drains. Further, the chips will contain both analog and digital devices so that far fewer "glue" chips will be necessary. Just think about it! You'll have access to computing power greater than the largest existing supercomputer in a device small enough to fit in your ear—or maybe implanted under your skin.

The law of Spectral Efficiency for Personal Communications is depicted in *Figure 2*. If you believe this chart (and the historical data supports it), the ability to provide bandwidth to people on the move in a limited amount of spectrum has doubled every 30 months for more than 110 years—and will continue doing so indefinitely.

But what do you do with all this power and bandwidth? Very simply, wireless bandwidth offers the opportunity for increased remote awareness to individuals—not only telecommunications, but tele-awareness. We can't live without our cell phones now because we can capture, wherever we are, the experience of hearing and talking to another person, or a machine, at a distance. This simple capability has changed all of our lives in the last 10 years. When you make a cellular call you expect a person to answer—a landline call is to a place. Imagine what will happen to us when we have the bandwidth to deliver—inexpensively—three-dimensional video, and senses of touch, taste, and smell. This may take a bit more than 20 years but will certainly happen.

The future of wireless technology will, therefore, comprise a variety of broadband telecommunication transport systems, each tailored to a set of user applications. The transport systems (air interfaces) will be very spectrally efficient and very low cost. The applications will, for a change, be very user-friendly despite their extraordinary complexity in both hardware and software.

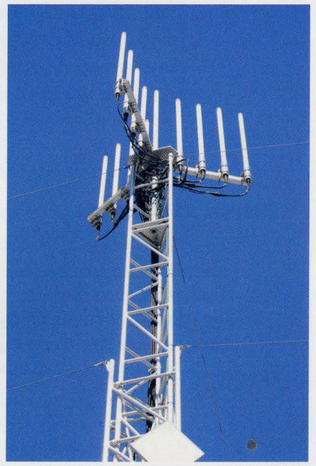


Figure 1

An ArrayComm iBurst mobile broadband system antenna array

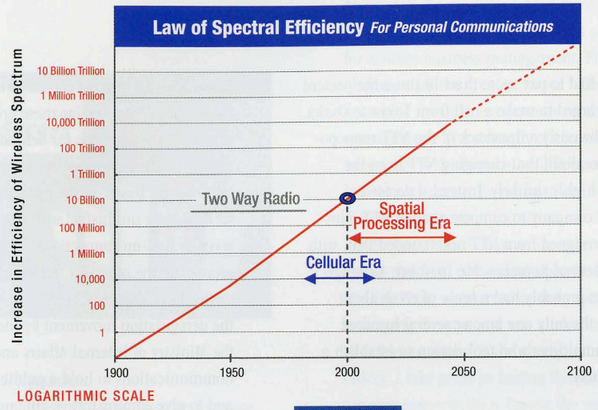


Figure 2

Convergence versus Divergence

The technocrats love to talk about the convergence of technology and the convergence of services. It is clear that, from a technological point of view, telecommunications and computing are converging in many respects. The dominant carriers like to talk about the convergence of voice, data, and video services. These are techno-centric views that are an unfortunate result of the monopoly legacy of the telecommunications industry. In fact, our industry is moving into an extended period of divergence.

Some elements of convergence are beneficial. There are certainly economies of scale in transport, especially at the national level. The Internet is providing us with connections between everyone and every place, and the World Wide Web is providing us with access to huge amounts of information. Carriers are trying to persuade us that the bundling of voice, data, and video is a simplification for consumers in the false presumption that consumers are pretty dumb.

But the truly important changes in the future involve divergence. People have different needs, varying tastes, and different capabilities for absorbing technology. There is an enormous opportunity to cater to these varying needs and capabilities. The large carriers who represented our monopoly legacy had neither the inclination nor the organization to cater to individual market segments, even though these segments might involve many millions of people. And yet, the benefits of economies of scale dwindle toward irrelevance when submarkets of the magnitude of tens of millions or even hundreds of millions of subscribers are involved, and that's how big these presently unserved segments are. We can expect to see, well before 2025, product and service offerings that are focused on age-related characteristics, the desire for different combinations of features, and economic limitations. Here are some examples:

- Simplified, easy-to-use, low-price cellular telephone service for seniors
- Intuitive and simple cellular telephone service for technophobes
- Music-on-demand devices that allow users to listen to what they want, when they want
- Simplified cameras that have only two buttons—one to take a photo, and the other to deliver the photo to a means of sharing—to make taking and sharing photos easy
- On-line game playing with no barriers of language, culture, or politics
- Medical diagnoses performed from a distance based on body function measurements

Conclusion

None of these revolutionary applications, however, will be realized without a new business model that separates the transport of information from the applications that make this information useful. We will see, in 2025, multiple means of wireless information delivery, each tailored to and optimized for a different class of applications. And when you buy a service, you'll very likely buy it from a service provider who works very hard to make the service fit your needs, in contrast with today's service providers, who seek to put us all in the same box in the name of economies of scale.

And that, in the telecom industry, is a true revolution. The consumer is king, the consumer makes the choices, and the consumer wins.

For the full-length version of this article, visit ***www.hkn.org.***

ABOUT THE AUTHOR

Martin Cooper

Executive Chairman and Co-Founder, ArrayComm, Inc.

Delta chapter - Illinois Institute of Technology

A pioneer in the wireless communications industry, Cooper conceived the first portable cellular phone in 1973 and led the 10-year process of bringing it to market. During 29 years with Motorola, Cooper built and managed both its paging and cellular businesses and served as Corporate Director of Research and Development. In 1992, he founded ArrayComm, Inc., which has grown from a seed-funded start-up in San Jose, Calif., into the world leader in smart antenna technology with 300 patents issued and pending worldwide.

Successful Entrepreneurship
Lessons from a Leader

by Sachio Semmoto

Over the last several years, Japan has made remarkable progress in the broadband market. Japan offers one of the fastest and cheapest services in the world, providing 50 Mbps ADSL service at $25. European and U.S. operators offer much slower ADSL services at $30 to $40. This strong Japanese broadband market was created by passionate venture companies, such as eAccess, entering the market and aggressively promoting competition.

To date, I have set up many companies in Japan. DDI (presently KDDI) and eAccess have had a great impact on Japan's telecommunications market. Both companies have been used as case studies at the Harvard Business School and have attracted attention in the United States. In this article, I would like to answer the question, "What is entrepreneurship?" based on my entrepreneurial experience.

Starting a New Entrepreneurial Venture

Until the mid-1980s I worked for Nippon Telegraph and Telephone Corporation (NTT), a company that monopolized the telecommunications market in Japan. Charges for long-distance calls were unbelievably high in those days. Customers had to pay more than 10 times the present amount charged to make a call from Tokyo to Osaka. This was obviously a drawback of the NTT monopolization. I realized that changing NTT from the inside was highly unlikely. Instead, I decided to establish a company to compete against NTT. This was why I resigned from NTT and founded DDI, with then President of Keyocera, Mr. Inamori. Although some others probably had a sense of crisis about NTT, I was the only one among several hundred thousand employees who took action to establish a rival company.

As a result, Japanese phone bills were dramatically reduced, due to fair competition among new common carriers, including Japan Telecom and DDI. Meanwhile, the company's revenue reached $5 billion in only five years. Based on this experience at DDI, I would like to highlight the following three key points to start up a new business:

1) Pay attention to people's needs.
Satisfy people's needs if you want to succeed. People's dissatisfaction is often visible as a "gap." In the case of DDI, there was a big price gap between the U.S. and Japanese call rates. Therefore, DDI focused to fill the price gap between Japan and the United States.

2) Take actions to do what others have not done.
There is a greater chance to succeed when you attempt something that others have not done. By being a pioneer, you have much more opportunity to create opportunity. DDI succeeded because it was the first company to compete against NTT.

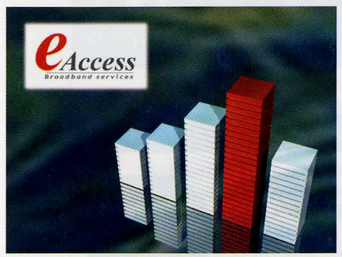
3) Be courageous and prepare to fight big battles.
Focus your efforts on fighting against large monopolized companies. The effort you put forth will make a difference. When you fight against something big, you will grow from the experience.

These were all true for eAccess, which I founded in 1999. The Japanese broadband market at the time was far behind most of the world. Everyone paid expensive connection charges based on the minutes used, while feeling unsatisfied with the very slow speed of dial-up connections. NTT was promoting the old ISDN technology, and again, I decided to compete with NTT. I led the deregulation movement by inducing the Ministry of Internal Affairs and Communications to hold a public hearing and to give administrative guidance to NTT regarding its unfair operations. Consequently, fair competition has emerged, newly established companies revitalized the market, and Japan became the world-leading broadband nation.

Entrepreneurial Characteristics

What kind of character is required to start up a new business operation and lead it to success? Entrepreneurs have to guide organizations with strong leadership. The following are key qualities necessary to become an entrepreneur.

> *Catch the waves of current trends.*
There are waves in the trends, and they ebb and flow. Unless you ride on the waves of trends, you cannot successfully sell your product or service, no matter how good it may be. It is important to always think about the waves, and to be one step ahead before they arrive. If you pay attention to society and to the hearts of people, you will be able to catch these waves.



> *Talk with passion.*
By nature, those who start from nothing are entrepreneurs. They start by themselves. You must devote yourself to what you are trying to do with great passion, and have fun with it. Then, promote your passion widely to people. When you do that, those who feel your passion will be drawn to you. Then, zero becomes 10, then 10 becomes 100.

> *Be bold, but be prudent.*
Although entrepreneurs need an aggressive character, they also need prudence to get things done. It is important to have both of these qualities, although they are two opposite character traits. You must choose which trait to exhibit depending on the situation.

> *Be hardworking.*
You must work harder than others, and learn things whenever you have spare time. Entrepreneurs must be active and positive-thinking so that they will be able to turn any hardship or failure into positive things.

> *Never give up.*
Once you start a business, you must not give it up along the way. If you believe in your business, you must not give up to the competition, and you must fight against others using your utmost intellectual abilities. When you give up, you fail. The success of business depends on whether or not you persevere.

Success in Venture Business

Along with the qualities I have mentioned, I would like to point out important points for venture business management. First, "humans are the greatest factor." The success of the business depends on the top management. The strength of eAccess lies here. I am a chief executive officer, and I have experience in founding many companies in the telecommunications market. Mr. Taneno, who had an active role as a co-founder of DDI, is the chief operating officer. Mr. Eric Gan, who served as the youngest managing director and was a telecom analyst at Goldman Sachs, is the chief financial officer. I take pride in having the strongest top management team among the venture companies in Japan.

Employees with passion are equally as important as a strong management team. DDI and eAccess employees have committed themselves to the dreams of their companies and they have worked hard to get the most out of their abilities. The heart of the company resonates with strength.

Also, it is important to have "ambitions for the good of the public and the people." At DDI, we aimed to "make phone bills in Japan cheaper," and at eAccess, we aimed to "become the number one broadband country in the world." Although the corporate objective is to seek profits, profit goals alone cannot convince employees to work hard and society to accept the company. It is important to set the ultimate goal, which motivates the employees and leads the company to success.

Conclusion

So far, I have described my thoughts about entrepreneurship, and I believe eAccess is a good example of a business based on the entrepreneurial theory. eAccess established a subsidiary called eMobile and will be investing about $3 billion to try to enter the gigantic and advanced market of mobile broadband. Mobile telephone frequencies in Japan are allocated for free by the national government. We hope to secure the 3G frequencies for mobile business by the end of 2005. If this becomes a reality, a six-year-old independent company will become a mobile telephone company; this will be an unprecedented event around the world.

Japan's mobile telephone market is currently dominated by a few companies, just like when I started up DDI and eAccess. From my experience, I am convinced that eMobile will be successful. Similar to what happened with ADSL, I would like to make the Japanese mobile telephone market the number one in the world. Enabling eMobile to grow into a world-class venture company is my dream.

ABOUT THE AUTHOR

Sachio Semmoto
Founder, Chairman, and Chief Executive Officer, eAccess Ltd.
Epsilon Sigma chapter - University of Florida

Dr. Semmoto founded eAccess Ltd in 1999, Japan's first true entrepreneurial IP/telecom company providing high-speed broadband telecommunication services. He also co-founded DDI Corporation (now KDDI) in 1984, Japan's first private interexchange carrier. His 30-year career includes executive positions at NTT and Kyocera. Dr. Semmoto has also published numerous papers and books and has lectured extensively on entrepreneurial management and information technology at leading universities, including Harvard, Stanford, Northwestern, Cambridge, Carnegie Mellon, and the University of California – Berkeley.

HKN Awards

Outstanding Young Electrical Engineering Award — 2004

Christopher W. Hickman
Executive Director, Engineering and Technology
Public Service Company of New Mexico

Hickman was named HKN's 2004 Outstanding Young Electrical Engineer for his outstanding contributions in electrical utility management and personal involvement with the Native American community.

Honorable Mention for the Outstanding Young Electrical Engineer Award — 2004

Douglas Tougaw
Associate Professor and Electrical and Computer Engineering Department Chair, Valparaiso University

Tougaw was awarded the 2004 Honorable Mention for the Outstanding Young Electrical Engineer Award for his notable contributions to the advancement of nanotechnology computer architecture and for contributions and leadership in engineering education.

Outstanding Teaching Award — 2005

Annette von Jouanne
Professor, School of Electrical Engineering and Computer Science
Oregon State University

von Jouanne was presented with the Outstanding Teaching Award during the 20th Annual Meeting of the Electrical and Computer Engineering Department Heads Association held in March 2005 in New Orleans, Louisiana.

Outstanding Chapter Awards — 2005

(from left to right)
***D. Munson,** University of Michigan*
***K. Erickson,** University of Missouri – Rolla*
***Karl Martersteck,** HKN President*
***R. Webb,** Georgia Institute of Technology*

Department chairs accepted their Outstanding Chapter Awards during the 20th Annual Meeting of the Electrical and Computer Engineering Department Heads Association in New Orleans in March 2005.

The Electric Pantheon Challenge Winners — 2005

As part of its centennial celebration, HKN designated 20 natural philosophers and mathematicians—whose concepts, experiments, and theories helped lay the groundwork for the electrical-engineering profession—as members of the society's Electric Pantheon. These pioneers were chosen by a jury of prominent historians of electrical technology. ECE students were challenged to identify the 20 philosophers and mathematicians selected.

***First Place:** **Steven Peters,** Delta chapter, Illinois Institute of Technology*
***Second Place:** **Khiem Nguyen,** Delta chapter, Illinois Institute of Technology*
***Third Place:** **Even Lobisser,** Pi chapter, Oregon State University*
***Fourth Place:** **Joshua Ottosen,** Pi chapter, Oregon State University*

ETA KAPPA NU

Electrical and Computer Engineering Honor Society

Dear Eta Kappa Nu Members and Friends,

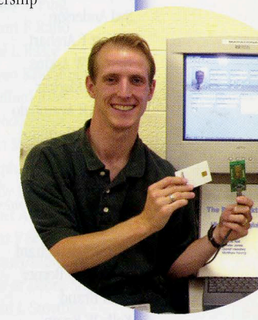
We wish to thank to the nearly 600 members who generously contributed to Eta Kappa Nu in 2004–2005. Many new initiatives—including the new HKN Web site, Student Chapter Projects, Leadership Forums, and the revitalized *The Bridge* magazine—are well under way, and your gifts have helped to fund these very important activities.

The HKN Board of Governors and leadership have continually explored new ways to be of service to students and alumni. The new HKN Web site has been launched (**www.hkn.org**), and fresh content is being added daily.

Additionally, HKN is now working jointly with the Electrical and Computer Engineering Department Heads Association (ECEDHA) to promote new chapter growth and involvement. For instance, through participation in special Student Chapter Projects developed by the HKN leadership, chapters are now providing new and greater services to their ECE departments and HKN as a whole (see *page 7*).

HKN is also planning regional Leadership Forums where student members will be able to share ideas and gain valuable leadership skills (see *page 7*).

Also, HKN's *The Bridge* magazine has taken on a new look this year in alignment with its new theme: "The World of 2025." In this and upcoming issues, prominent HKN members will look into their crystal balls to predict the changes that we might expect in the next 20 years in electrical and computer engineering.



We do hope you will consider a gift to HKN in 2005–2006, as well. The continuation of HKN's present initiatives can only be accomplished though the support of its loyal members and friends. Please help HKN provide greater service levels to its student members, professional members, and the society as a whole. Your contribution can be sent to the following:

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

To help support HKN at the leadership level, an HKN President's Council has been established. Council members contribute at least $1,000 annually to the society and provide their input and ideas to the HKN President Karl Martersteck.

To launch the Council, the International Engineering Consortium (IEC) will donate $1,000 for each President's Council member who joins in 2005–2006. This added support will augment a Council member's contribution and help HKN continue its momentum of the past year.

Also, those who contribute $100 or more will receive a free Life Subscription to *The Bridge* and be recognized on the HKN Web site and in *The Bridge*.

Thank you very much for your support of Eta Kappa Nu.

Warmest regards,

Robert M. Janowiak
Executive Director and Alpha Chapter Member
Eta Kappa Nu

Centennial and 2004–2005 Annual Fund Contributors

Eta Kappa Nu thanks its many generous donors who contributed during the 2004–2005 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 a new Web site, the revitalized *The Bridge* magazine, and e-mail communication with members.

$1,000 & Higher

Joseph Bordogna
Robert M Janowiak
Joanne Waite

$500 to $1,000

J Fred Bucy
John Dyer
Gordon R England
Alan Lefkow

$250 to $500

Bruce A Eisenstein
Norris Hekimian
Donald J O'Brien

$100 to $250

James Aagaard
Randolph K Adams
L Lyeal Amos
Syd Anderson
Robert F Arehart
Harold W Askins
John Aufderhar
Joseph R Avampato
Robert A Bartolini
Leo L Beranek
John B Berry
Connie Betten *in memory of*
J Robert Betten
Jeffrey J Blanchard
Michael O Bomer
John Brand
Kelly W Bryan
Diane M Burns
Mark Carey
Donald B Cork
Lawrence Daddario
Adrian Brian Danieli
Kenneth Gerard Descoteaux
Robert Duris
Robert J Dutko
Larry Dwon
Dennis M. Dwyer
James R Elliott
C B Evans
John Farley
Lyle Feisel
James Ferner
Daniel J Fleck
Dean Floyd
Frederick M France
Frank A Furfari
Francisco Galvez
Robert C Gebhardt
George E Gourrich MD
Richard J Gowen
Dale Hachel
Stanley E Harrison
Morris Hervey
Richard P Hilbig
Bion Hitchcock
John S Hoos
John Howell
Arthur Howes
Dale C Houser
Joseph Hughes
Anthony A Jaras
Miles Kanne
Anna Kluzak
Frank Kolb
Frank M LaBianca
Stuart L Labovitz
John LaTour Jr
David R Latta
Arthur C Lawrence
Philip Alan Lefcourt
Roger Mao
Curtis S Martin Jr
Kent R Martin
Earl McCune
William Mitchell
John K Miyasaki
Eugene L Mleczko
William Murray
Thomas A Nelson
Waldemar S Nelson
Alan Jay Noelle
Robert B Nourse
James A Oliver
Arthur Coleman Parr
Kshemendra Paul
David Pedersen
Frank Petsche
Lindsay Pickens
PJ Downes Associates, LLC
Neils Poulsen
Paul I Pressel
Jeffrey A Pride
Eberhardt Rechtin
Robert Robinett
Frank F Robison Jr
Nicholas M Rossi
Andrew Sage
Franklin Sazama
Norbert L Schmitz
Joe Schuler
Glen A Skaggs
Morton Sklaroff
Loren I Slafer
Robert Sommer
Ron Spanke
Bernard A Stankevich
Ronald Stokes
Jeffrey C Tomasin
Ben H Tongue
Percy B Vinet Jr
Dr. Robert J Walinchus
James Weaver
R Dudley White
Jack E Wojslawowicz
John W Wustenberg
Donald Zak
Samuel M Zollers
Gene Zuratynsky

$50 to $100

Otto Afreier
Ray Ernest Aker
Ronald J Aloysius
Walter L Anderson
Joseph E Armacost
James R Atkinson
Jon R Auton
Alan R Bair
Norman A Ball
Thomas Beckage
Theodore Bernstein
William Blume
Stanley M Blumenthal
Mark A Brattoli
Charles A Broutman
David Burks
Geoffrey Burr
Dominic Cameli
Garry F Campbell
Amy Carlson
Richard A Caste
Stanley E Causey
Thomas J. Chilis
Roger Clason
Ogal Claspell
James Coffey
Daniel E Colvin
Mark Covaro
David E Dixon
Myron Dixon
Thaddeus Dobry
Gerald Dreifke
Louis Dujmich
Randall Easter
Peter A Eggleston
Thelma Estrin
Robert Faaland
James E Fahs
Michael Fallat
David L Farnsworth
Timothy M Farrell
Richard W Fijal
Louis Filo III
Joseph S. Finston
Charles W Fox
William Freese
Allan B Friedland
Kenneth P Gibbs
Col. Thomas G Godfrey
James R Good
Donald P Gorman Jr
Geoffrey D Green
Edward Hamilton
Joseph Hamilton
Clinton Harper
Edgar Harras
Richard Healer
Evan K Heller
John Hengen
Robert N Hettrick
Michael A Isnardi
Jonathan C James
Gary L Johnson
Milton Johnson
Keith Jones
Carl F Jumps
Mark Kieler
James E Koryta
John B Kreer
Milton L Kult

$50 to $100 *(cont.)*

WJ Kusner
John W Kuzin
Michael Laszczyk
Gary K Lewis
John Lof
Richard M Longley Jr
David M Loop
Anthony N Lorusso
Susan Seto Lui
James Lurski
George R Lyman
David Macchiarolo
Christopher A Mangiarelli
Alan R Massengale
Lawrence W Messenger
Mathew Moore
Kirk Moser
James R Moulton
David Newbern
Donald G Nierath
Hideyuki Noguchi
David W Nordquist
Brian C Pass
Edward G. Perkins
Bernard Pfefer
Andrew Pipkin
Robert J. Plessett
William Porter
Roger C Purdy
Paul L Raspe
Wayne F Richardson, Sr
Herbert Riess
Williard Robinson
Robert L Rogers
Dale Rybick
Charles Schmidt
Hans Schroeder
Mischa Schwartz
Vernon Schwenk
Glenn B Shelton
Earl A Sheridan
Thomas M Shoemaker
Suzanne Siegel
Raymond Siler
James L Sitomer
Vincent D Skibicki
David Beardsley Slater Jr
George S Smeltzer
Kevin Snyder
Lester D Spencer
Eugene H Staiger
Alan K Steffe
Albert W Stewart
Dennis Stewart
Eric Stoll
Edmund R Stoughton
Ivan H Sublette
Howard Teitelbaum
William S Tjader
Richard Toepfer
Bruno J Trenkler
Stephen Veit
Charles Weiss
Lloyd E West
John R Whinnery
John G White
Laura Whittington
Douglas L Williams
Albert Winkler
Carig Woodworth
Richard Workman
J Ned Yelverton
Donald A Ziemer

$25 to $50

Joel C Arlow
Leon W Atwood
Walter Gordon Aurich
Maria Babula
Alexander Ballios
Richard Todd Barber
William Dale Barnes
Michael C Becher
Marvin Benson
George C Bentinck
Bernard A Biberdorf
Emil Bovich
Jennifer Ann Bowman
Robert R Boyd
Robert C Brackett
Thomas T Bucher
David C Bux
Brent S Capozzoli
Will Caraway
Charles Charman
Clinton C Christianson
Lawrence J Chu
Alvin Croy
Stanley G Day
Claude Deal
Michael DeMaio
Henry C Diener Jr
William Dlugos
William Donaldson Jr.
Robert B Dreisbach
James Bret Dronet
James George Dunham
Earle David Eason
Robert F Easton
Stanley E Eisenhard Jr
Wanda J Eyre
Linda Facto
Edward Fairchild
Robert Fenton
Jack D Fisher
Keith Flaming
Walter Frederick Jr
Fay E Fuchser
Dorothy Grahl
Victor H Green
Randall V Gressang
John Guagliardo
Danny A Hahn
Steven D Hall
Howard Hamer
Jerome G Handelsman
Mark Hardy
Donald D Harenberg
Gary Donald Harris Jr
Alan Hechtman
Eugene Henry
Larry R or Sue M. Hertzog
William R Hodson
Harold Hoeschen
Roger W. Homan
Emmanuel Horowitz
Robert Houlihan
Jeffrey L Howard
Richard Jacobs
Bruce W Jorden Jr
Thomas C Judd
Bruce T Kaemmerlen
Steen Kee
Raymond A Kemper
Mark S King
Floyd Kirschenmann
Herbert Klinge
Leonard Krause
Andrew Kuehn
Rudolph L Kuehn
Takis Laios
Robert Lajeunesse
Keith Anthony Larson
Reed E Larson
Marlene S. Lattner
Preston E Law, Jr
Marsha Lenz
Dirk Luckett
John C Luppens
John R Manning Esq
Ronald D Massar
Bill Lee Master
George L Matthaei
Allen McCorkle
William McSpadden
Robert C Meckstroth
Thomas D Mickus
Karl Miller
Roger K Miller
Melvin Morgen
Robert W Mowery
Meg Mueller
Elvin M Musselman
Thomas A Musselman
N. Waller & Assoc
Arnold Neil
Jeffrey Noel
Robert Hudson Parker
Shella Ann Paskel
Mark A Peterson
Carlos M Puig
Robert F Rallo
Paul L Raspe
Steven Reichman
J Clifford Riley
Theodore Roe
John M Ross
Joseph A. Sasso
Kathy L Schleicher
Elmer A Schmall
Doris V Schoon
Samuel/Elaine Sensiper
John or Debra Sigmund
David L Smythia
Paul L Sprainhour
Burton E Stevenson
James L Straka
Robert D Strattan
Mani Subramanian
Keith A Suhoza
Thomas Szebenyi
Thomas Taylor
Charles W Thabault
William Thompson
Elbert Trantow
Jack R Trump
Alan M Usas
Kevin Von Hoffmann
Howard B Wakefield
Hubert C Watton
Allen D Webb
Jay E Webster
James E Wills, Jr
Leon J Wood
Terry Wood
Frank P Yatsko

Get Connected at www.hkn.org

Update Your Member Profile Today!

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

NEW HKN Web Site

Professional Look and Feel

The new 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

Much of the content of the HKN Web site has been reworked and regrouped into new or separate pages and sections so that the site is easier to comprehend.

Easy-to-Use Navigation and Organization

The new HKN Web 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 now 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.

International Engineering Consortium
300 West Adams Street, Suite 1210
Chicago, Illinois 60606-5114 USA

NON-PROFIT ORG.
U.S. POSTAGE
PAID
INTERNATIONAL
ENGINEERING
CONSORTIUM