The World of 2025

FEATURES

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Successful Entrepreneurship: Lessons from a Leader

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LETTER FROM THE EDITOR

Robert M. Janowski | 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 significant initiative is improving communications with you and all other HKN members. In 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 vision 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 you, our 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 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. Furthermore, we have also established a strategic relationship with the Electrical and Computer Engineering Department Heads Association (ECEHDA) and recently held an HKN board retreat co-located with ECEHDA’s annual retreat. Additional areas of cooperation are being discussed.

HKN’s committees have also been working hard to select award winners and select the society’s directors. Alan Lefkow, Chair of the OCA Committee, has updated the selection process for the Outstanding Chapter Award. Tim Rottner, 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 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 100 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,

Robert M. Janowski

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Eta Kappa Nu (HKN) was founded by William D. Cary at the University of Illinois on October 28, 1894, to encourage excellence in education and to benefit the public. HKN leaders continue to recognize those students and professionals who have performed 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.
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Semiconductor Technologies for 2025: Needs, Challenges, and Opportunities

by Ralph K. Cavin, III and Victor Zhirnov

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 inescapable, 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). X, we can process per unit time. Similarly, for communication of information, a useful metric is bandwidth, A/X (bits/sec). For computation, the number of the physical information-bearing elements (e.g., logic gates or memory cells) available per unit area, N, [bit/m²] is a critical factor. A measure of computational capability on the device level is binary information throughput, X N/ (bit/sec/m²). 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 smaller and denser monolithic integrated circuits. Remarkably, the industry has been able to scale so that performance-per-dollar increases exponentially with time (about two

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 in ion implanted beam lithography). For example, for light, Einstein's formula E = hλ/k is Planck's constant, ε is speed of light, and λ 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 would be ε = 250 eV. In addition to driving up overall manufacturing energy cost, the energy to "print" far nanometer regime features far exceeds the bond energy of solids (~3-6 eV), and material defects from printing are inevitable.

2) Power consumption and heat dissipation

Let the energy processing cost for a bit of information be Eρ. For a chip with binary information throughout, the power density and the corresponding heat generation is on the order of P = Eρ N (W/cm²).

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. One way to evade the heat problem is to minimize Eρ. However, there is a fundamental limit, Eρm = 3kT/n0, beyond which devices do not function properly (kT Boltzmann's constant and T is absolute temperature).

The International Technology Roadmap for Semiconductor (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 optimized. 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.

Opportunities

In 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 "touch" matter to organize structures that we desire?

The bottom-up 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. On self-assembling biological systems depend on a non-equilibrium environment to achieve the complex and intricate shapes that provide a desired functionality. If we knew that we might learn from jigsaw 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 we face substantial challenges as scaling continues, primarily driven by the excessive amount of heat that high-performance devices will generate. Other "state variables" such as spin, phase, polarization, magnetic flux quanta, dipole orientation, etc., can also affect 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/cm² 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 physical systems?

In some applications, such as image processing, the human brain is a 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 processes that are energy efficient? Is brain "computation" digital?

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 500 years ago to answer questions that had been postulated by his era. For example, "Why is the speed of light, c, a fundamental constant?" (one of the implications of the answer is E=mc² or "Why is the energy of released photoelectrons independent of the intensity of the light?") (answer: Enth.). The answers to these questions helped to create the foundation on which we have constructed much of the information technolo- gies that we use today. We believe that opportunities abound 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
Gammans Omega chapter - Mississippi State University
Cavin designed signal and control systems at the Martin Mareks Crushing efficacy in his career. He served on the electrical engineering faculty at Texas A&M University and as an 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
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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 nanoscale devices.

www.hbnc.org
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 Epsilon
Date of Induction: November 19, 2004
Number of Inductees: 17

University of North Carolina at Charlotte

Chapter Name: Kappa Phi
Date of Induction: April 29, 2005
Number of Inductees: 36

Virginia Commonwealth University

Chapter Name: Kappa Chi
Date of Induction: May 6, 2005
Number of Inductees: 12

University of California, San Diego

Chapter Name: Kappa Psi
Date of Induction: June 2, 2005
Number of Inductees: 32

HKN Chapters in Action

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.

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

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.

Wave Energy Development 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, not only because of the following strategic facilities:

- OSU is the home of the nation's highest power university-based energy systems laboratory, the Marine Systems Resource Facility (MSRF), co-directed by the authors, with a 750kW dedicated power supply and full capabilities to reengineer back into the grid (Figure 1).
- OSU is the home of the Oregon H. Hindsdale Wave Research Lab (OHRRL) with world-class wave tank facilities, including a 142-foot wave basin (Figure 2).

The Oregon State University Wave Energy team is developing several novel device prototypes, including a Permanent Magnet Linear Generator Buoy, a Permanent Magnet Back and Pioner 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 Back and Pioner Generator Buoys, 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 generation, which could be integrated into host 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 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 technologies developing and no clearly superior engineering solutions yet established. The national wave energy center would enable the acceleration of research toward optimal technology 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 55 homes.

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 linked 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 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.

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Oregon State University

John Jouanne is the 2006 recipient of the C. Hilson MacDonald Outstanding Teaching Award from Eta Kappa Nu. Her research interests include power electronics converters, power quality, adjustable-speed drives, hybrid electric vehicles, and renewable.

Alan K. Wallace

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

Before joining the faculty at Oregon State University, Wallace worked as an electrical engineer for General Electric Corporate Research and Development Corp. of Kingston, Ontario. He also taught electrical machinery design and power systems analysis at the University of Nottingham.

www.hkn.org
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 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 1971. 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 1995, Bordogna was elected to the American Society of Engineering Education Hall of Fame and in 2001, the Semiconductor Industry Association honored him with its Leadership Award.

Bordogna at a Glance
- Alfred Hull 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 E. Garriott was one of the original six astronaut-scientists chosen by NASA in 1963. On his first space flight in 1973 aboard Skylab, Garriott set an endurance record by spending 62 days in space. On a 1982 mission, he spent 16 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 this field. He also made contributions to the development of UNIX, 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 autoregulation technology. Gordon’s concern for engineering education led to the establishment of the Gordon Institute at Rensselaer Polytechnic Institute, 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 1985 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 innovations 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 autocollinear signal monitoring 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 Sorensen, Autometrics 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

10 Electrical and Computer Engineering Honor Society

www.ekh.org 11
Personal Communications in 2025
Success through Consumer-Driven Offerings

by Martin Cooper

W e 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 to 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 demonstration, 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 other people in other ways. This paper will discuss the technological predictions briefly and delve deeper into the ways in which people will use the advances in technology.

I will be 90 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) 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 not cost 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 the famous "gles" chips will be unnecessary. 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 20 months for more than 50 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-presence. 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 telecommunications 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.

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 technocratic 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. Customers are trying to persuade us that the bundling of voice, data, and video is a simplification for consumers in the fake 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 decline with irrelevance when subsegments of the magnitude of tens of millions or even hundreds of millions of subscribers are involved, and that's how this 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 technophiles
- Voice-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 gaming 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 targeted 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 telecommunications 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, AranyaComm, 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 28 years with Northern, Cooper built and managed both in paging and cellular businesses and served as Corporate Director of Research and Development. In 1991, he founded AranyaComm, Inc., which has grown from a wind-funded start-up in San Jose, Calif., into the world leader in smart antenna technology with 100 patents issued and pending worldwide.
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 monopoly. 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 DD, with then President of Kyocon, Mr. Tomoaki. 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 IDD. Meanwhile, the company's revenue reached $1 billion in only five years. Based on this experience at DD, 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 DD, there was a big price gap between the U.S. and Japanese call rates. Therefore, DD 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. Being a pioneer, you have much more opportunity to create opportunity. DD 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 excess, 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 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 your product may be, it is important to always think about the waves, and to be one step ahead before you arrive. If you pay attention to society and to the hearts of people, you will be able to catch these waves.

Success in Venture Business

Along with the qualities I have mentioned, I would like to point out important points for venture business management. First, "human assets are the greatest factor." The success of the business depends on the top management. The strength of excess lies here. I am a chief executive officer, and I have experience in founding many companies in the telecommunications market. Mr. Tanaka, who had an active role as a co-founder of DD, is the chief operating officer. Mr. Eriko, who served as the youngest managing director and was a Visionary 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 important as a strong management team. DD and excess employees have committed themselves to the dreams of their companies and have worked hard to get the most out of their abilities. The heart of the company shines with strength.

Also, it is important to have "ambitions for the good of the public and the people." At DD, we aimed to "make phone bills in Japan cheaper." and at excess, 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 excess is a good example of a business based on the entrepreneurial theory. excess 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 DD and excess. 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, excess Ltd.
Epsilon Sigma chapter - University of Florida
Dr. Semmoto founded excess Ltd. in 1999. Japan's first true entrepreneurial telecom company providing high-speed broadband telecommunication services. He also founded DD Corporation (now IDD) in 1994, Japan's first private interexchange carrier. His 30-year career includes executive positions at NTT and Sonyco. Dr. Semmoto has also published numerous papers and books and has lectured extensively on entrepreneurial management and reference to technology at leading universities, including Harvard, Stanford, Northwestern, Carnegie, Cambridge, Keio, and the University of California – Berkeley.
HKN Awards

Outstanding Young Electrical Engineering Award

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

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

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 26th Annual Meeting of the Electrical and Computer Engineering Department Heads Association held in March 2005 in New Orleans, Louisiana.

Outstanding Chapter Awards

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

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: Elvin Nguyen, Delta chapter, Illinois Institute of Technology
Third Place: Bob Lobdell, Pi chapter, Oregon State University
Fourth Place: Joshua Ottosen, Pi chapter, Oregon State University

Dear Eta Kappa Nu Members and Friends,

We wish to thank 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 (ECEDA) 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, EKN'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 2006-2007, as well. The continuation of HKN's present initiatives can only be accomplished through 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

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**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.