THE BRIDGE

The Magazine of IEEE-Eta Kappa Nu

Focus on IEEE-HKN

- Suggestions for Electrical Research in Engineering Colleges
- A Tale of Two Cities: Biosensor Engineering for Water Management
- Special History Section
- HKN to IEEE-HKN: Objectives of the Merger *and* View of the Future

October 2015 Vol. 111 / No. 3

IEEE-HKN AWARD NOMINATIONS

As an honor society, IEEE-Eta Kappa Nu has plenty of opportunities designed to promote and encourage outstanding students, educators and members.

Visit www.hkn.org/awards to view the awards programs, awards committees, list of past winners, nomination criteria and deadlines.

Outstanding Young Professional Award

Presented annually to an exceptional young professional who has demonstrated significant contributions early in his or her professional career. (Deadline: 30 April)

Vladimir Karapetoff Outstanding Technical Achievement Award

Recognizes an individual who has distinguished themselves through an invention, development, or discovery in the field of electrical or computer technology. (Deadline: 30 April)

Outstanding Student Award

Presented annually to a senior who has proven outstanding scholastic excellence, high moral character, and exemplary service to classmates, university, community and country. (Deadline: 30 June)

Outstanding Chapter Award

Singles out chapters that have shown excellence in their activities and service at the department, university and community levels. Winners are determined by their required Annual Chapter Reports for the preceding academic year. (Deadline: 30 September)

C. Holmes MacDonald Outstanding Teaching Award

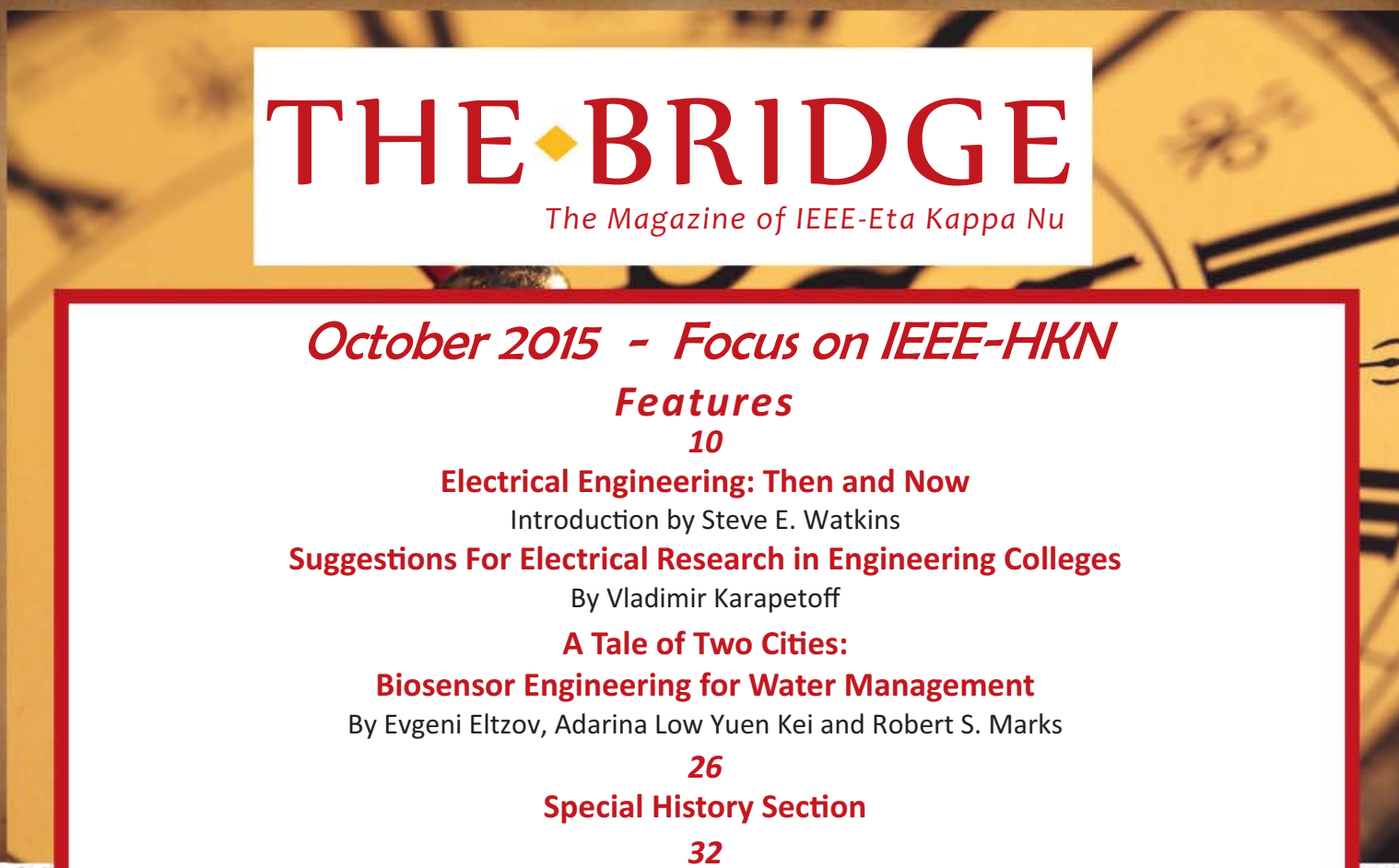
Presented annually to a dedicated young professor who has proven exceptional dedication to education, and has found the balance between pressure for research and publications, classroom enthusiasm and creativity. (Deadline: 30 April)

Distinguished Service Award

Presented annually to recognize those members who have devoted years of service to the society, resulting in significant benefits to all of the society's members. (Deadline: 30 April)

IEEE-Eta Kappa Nu (IEEE-HKN) was founded by Maurice L. Carr at the University of Illinois at Urbana-Champaign on 28 October 1904, to encourage excellence in education for the benefit of the public. IEEE-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 IEEE-HKN. Ideas and opinions expressed in THE BRIDGE are those of the individuals and do not necessarily represent the views of IEEE-HKN, the Board of Governors, or the magazine staff.

ISSN-0006-0809 Vol. 111 / No. 3



THE BRIDGE

The Magazine of IEEE-Eta Kappa Nu

October 2015 - Focus on IEEE-HKN

Features

Departments

Editor-in-Chief: Steve E. Watkins

Editorial Board Members: Mohamed El-Hawary, Catherine Slater, Stephen Williams

Managing Editor: Nancy Ostin **Assistant Managing Editor:** Sharon Strock

News and Copy Editor: Jackie Quigley **Digital Production Manager:** Joanne Van Voorhis

Advertising Sales | Business Development Manager: Mark David (+1 732 465 6473; m.david@ieee.org)

Cover collage design: Nicole Torres

IEEE-HKN INTERNATIONAL HEADQUARTERS

Editorial inquiries: IEEE-Eta Kappa Nu, 445 Hoes Lane, Piscataway, NJ 08854, USA
US Toll Free: +1 800 406 2590 | Outside US: +1 732 465 5846 | Email: info@hkn.org | www.hkn.org
Subscription address and email changes: IEEE Contact Center US Toll Free: +1 800 678 4333 | Outside US: +1 732 981 0060
Fax: +1 732 562 6380 | Email: contactcenter@ieee.org

Our Cover: These images highlight HKN's history and special chapter monuments. See page 8 and 9 for further details.

LETTER FROM THE PRESIDENT

EVELYN H. HIRT

Beta Sigma Chapter

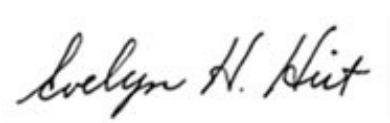
Dear IEEE-HKN Members and Colleagues:

This issue is focused on Eta Kappa Nu on the occasion of the five-year anniversary of its merger with IEEE to become IEEE-Eta Kappa Nu (IEEE-HKN). The journey has been fraught with challenges and promise. As the current President of IEEE-HKN and a former Governor of the old HKN Board of Governors, I'd like to share some personal reflections on our Honors Society.

As much as I cherish and enjoy the collaboration and camaraderie that our honors society offers, I've had to come to terms with the harsh reality that without a strong approach to maintaining a viable business model, the continued existence of the Society would be at risk. This concern played a critical role in initiating merger discussions. It was also a driving force in establishing an endowed Restricted Fund for IEEE-HKN within the IEEE Foundation as part of the merger agreement. Good news is that the restricted fund has the funded amount originally planned in it to fund baseline day-to-day operations. Bad news is that the amount needed for baseline day-to-day operations of the Society was under estimated. Unlike other IEEE organizational units, IEEE-HKN cannot significantly increase our business bottom line based on once-in-a-lifetime induction fees paid to Headquarters alone; however, IEEE-HKN is expected to be self-sufficient in funding our operations. Additionally, over half of a student's induction fee is paid by IEEE-HKN to cover their IEEE baseline student dues for one year. So, the traditional IEEE growth models don't quite fit IEEE-HKN. Going forward, your Board of Governors is working with IEEE to secure the viability of Eta Kappa Nu within the constraints we have. To help with both growth and stability the Board created two additional IEEE-HKN funds within the IEEE Foundation for Society Operations and Student Leadership. Contributions to any of these funds are considered a charitable contribution.

I wish I could report that HKN integration into IEEE has been fully achieved. The good news is that IEEE has welcomed IEEE-HKN with open arms and is more than willing to work with IEEE-HKN to make us successful and of enduring value to our members. The challenge for our Board of Governors is that there are areas of the post-merger integration plan that have either not come to fruition over the last five years, or dealt with the complexities of the HKN/IEEE-HKN model that were not adequately understood within IEEE. The Board of Governors is addressing these challenges, including facilitating access by IEEE-HKN to long-established IEEE organizational unit self-management tools for volunteer leaders and chapters to improve the effectiveness and efficiency.

There is still work to be done to realize that promise, and the vision that drove the merger. Your role here is to continue to identify and elect IEEE-HKN Governors and Officers who have the skills and desire to continue to work these issues for the benefit of IEEE-HKN and its members. Together we can build a bright and vibrant future for IEEE-HKN.



Phone: 800-406-2590
Email: info@hkn.org

LETTER FROM THE EDITOR-IN-CHIEF

DR. STEVE E. WATKINS

Gamma Theta Chapter

Dear IEEE-Eta Kappa Nu Members and Friends:

This issue of THE BRIDGE magazine has a theme of "Focus on IEEE-HKN." This issue celebrates the history of Eta Kappa Nu and the prominent roles its members have had in the profession. Among my favorite content items are: a 1916 listing of research areas by electrical engineering pioneer and HKN member, Vladimir Karapetoff; selected highlights from past issues of THE BRIDGE; monument photographs from our chapters; and an overview of student leadership conferences. We are well into our second century as an organization, and are celebrating our five-year anniversary as part of IEEE. May this look at our past give you an appreciation for Eta Kappa Nu's prior accomplishments, and a vision for the future.

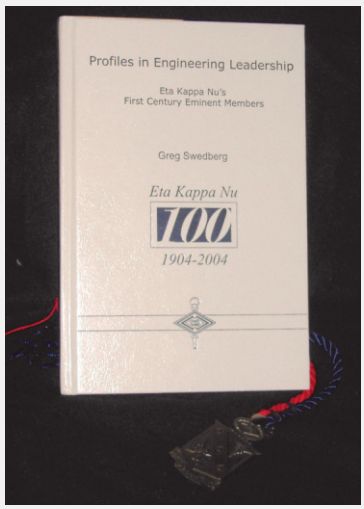
In 1950, HKN started inducting prominent engineers into the new category of "Eminent Member." As the highest membership classification, the governing body of HKN selects "individuals who, by their attainments and contributions to society, have shown themselves to be outstanding leaders in an IEEE-designated fields of interest, and great benefactors to society." Reading the career accomplishments of these select individuals gives a fascinating perspective on the influence of engineering on society. At the centennial of HKN (2004), *Profiles in Engineering Leadership: Eta Kappa Nu's First Century Eminent Members* was published by the IEEE History Center and the Eta Kappa Nu Association to document the histories of HKN's Eminent Members. This book is available at the Engineering and Technology History Wiki, an expansion of the IEEE Global History Network (search for "Profiles of Engineering Leadership" at http://ethw.org/). In addition to the listing of Eminent Members on the main IEEE-HKN web page, many induction programs and other related documents are available, including those for Eminent Members inducted since 2004.

I hope that you enjoy this special issue of THE BRIDGE as much as I have enjoyed working with the source material. Finally, I want to thank the editorial board, the IEEE-HKN staff, and our contributors for their roles in helping THE BRIDGE win its second APEX Award of Excellence (2015 Print Media -- Special Purpose Category for the Highlights issue, vol. 109, no. 4, see www.apexawards.com).

Regards,

Steve E. Watkins

Phone + 1 573-341-6321
Email: steve.e.watkins@ieee.org



***Profiles in Engineering Leadership: Eta Kappa Nu's First Century Eminent Members* was produced for the 100th anniversary of HKN in 2004.**

GUEST EDITORIAL

JOSEPH J. RENCIS

President, American Society of Engineering Education (ASEE)
Dean of Engineering, Tennessee Tech University

VISION FOR ENGINEERING & ENGINEERING TECHNOLOGY

My vision for engineering and engineering technology education is to graduate "Da Vinci Engineers" who will make significant contributions for the betterment of humanity.

> ***"Learning never exhausts the mind." -- Leonardo da Vinci***

Why do this? Da Vinci Engineers will have the foundation needed to work at the frontiers of research, technology, and innovation. The first frontier, research, lays the foundation; technology advances research; and research leads to innovation. When our students have engaging and meaningful experiences – in traditional instructional settings, through informal interactions with peers and faculty, and in the research environment – they will have the tools needed to develop innovative technologies to solve societal problems, create new industries and jobs, and make the world a prosperous place.

From left to right, Laishka Bruno, Dr. Joseph Rencis, and Austin Gray

How will we do this? All degree programs will include three dimensions of leadership. The first dimension, technical leadership, provides the foundation. Technical leadership, with discipline-specific knowledge, contributes strong problem-solving skills, open-ended design skills, creativity, and the confidence to innovate as common characteristics for all Da Vinci Engineers. The second dimension, professional leadership, will ensure Da Vinci Engineers are well-rounded. A focus on professional leadership will create dynamic and agile, yet resilient individuals with a commitment to lifelong learning, an entrepreneurial spirit, interdisciplinary teamwork, excellent communication, and high ethical standards. Finally, the third dimension, global leadership, will embrace the world. Global leadership is essential for Da Vinci graduates to build skills to address the world's challenges. These include the National Academy of Engineering Grand Challenges at the 30,000-foot level, as well as the practical challenge of succeeding in a rapidly changing world with multi-product platforms and multi-outsourcing options.

ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Throughout my career, I have experienced how transformative learning experiences can effectively broaden and deepen students' intellect and world views. I define a transformative learning experience as an opportunity inside or outside the classroom that enriches student learning and personal development.

One example is a co-op or internship, where students can make a life-changing transformation that puts their academic and career paths on a firm trajectory. Other examples of transformative learning experiences include: society-technology projects; industrial projects; research experience; study abroad; service-learning; learning community; leadership experience; independent study; etc. In-class curriculum will integrate these three leadership dimensions with an emphasis on innovation and entrepreneurship through interdisciplinary team-based projects and courses in a studio environment.

> ***"Tell me, and I forget. Teach me, and I may remember. Involve me, and I learn."***
> ***-- Benjamin Franklin***

What is the result? The vision is to graduate Da Vinci Engineers who will make significant contributions for the betterment of humanity. Da Vinci Engineers will move forward to be industry leaders, innovative business owners, and successful entrepreneurs. They will shape the future of their chosen field in a fast-changing world with a knowledge-driven global economy. The efforts of Da Vinci Engineers will reflect an education that embodies creativity and innovation, in addition to technical foundation. They will creatively take new discoveries from basic scientific research and translate them into technological projects, devices, systems and services that benefit society at the community, state, national, and global levels.

LETTER FROM THE DIRECTOR

NANCY M. OSTIN, CAE

Dear Members and Friends of IEEE-HKN:

I have been looking forward to this issue "Focus on HKN" all year! It has allowed me to reflect on Eta Kappa Nu through the years, including: the founders and leaders, our award winners, the evolution of the program, original charters of chapters, old copies of THE BRIDGE, and many fascinating items in our archives. In researching this issue, I have been privileged to talk with many of our alumni and former officers. These are the people that through the years have given so much to HKN. It is their sheer determination and love for Eta Kappa Nu that has kept this organization together; we owe them our gratitude for every success we have experienced. Thank you for your dedication and loyalty to IEEE-HKN!

In the future, I hope to be able to digitize all issues of THE BRIDGE (I had so much fun reading the old issues), our award brochures, and history documents. My vision is that these documents could easily be shared with our students of today, our longstanding members, and all those who seek us, so we can preserve the history and value in these documents of Eta Kappa Nu.

In preparing pieces for this issue, I have reached out to a great many people. I thank you all for your contributions; you have been very generous with your time and your memories. For those who I was not able to reach this time, I hope that you will tweet to share your stories, and connect with HKN members everywhere at #IAMHKN.

If you wish to contribute your HKN memorabilia, photos, copies of THE BRIDGE, or any other materials you have, please contact me at n.ostin@ieee.org.

As we celebrate the five-year anniversary of Eta Kappa Nu's merger with IEEE, and take a look back at our history, our accomplishments, and the strategic vision of the future of IEEE-HKN we thank you ALL for your steadfast loyalty!

Phone + 1 732-465-6611
Email: n.ostin@ieee.org

About Our Cover:

This commemorative issue features cover images highlighting HKN's history and ongoing projects. The top and bottom images show selected chapter monuments as described on the opposite page. The history coat of arms for HKN is shown to the center left and a photograph of Maurice L. Carr, founder of HKN, is shown center right. The center image shows the welcome page for the proposed IEEE-HKN Virtual Campus. Use hashtag #IAMHKN to tweet favorite HKN memories and current activities.

HKN on Campus - Chapter Monuments

The visibility of Eta Kappa Nu chapters on their home campuses is often aided by permanent monuments and displays. The Wheatstone bridge emblem is a common element. Such physical symbols reflect the pride members have in their organization and chapters. The monuments below illustrate the creative ways that chapters showcase HKN.

1- Beta Epsilon, University of Michigan, Ann Arbor; 2- Delta Gamma, Louisiana Tech University; 3- Beta Mu, Georgia Institute of Technology; 4- Alpha, University of Illinois at Urbana-Champaign; 5- Gamma Theta, Missouri University of Science and Technology; 6- Zeta Pi, University of New York at Buffalo; 7- Zeta Beta, Texas A&M University-Kingsville; 8- Epsilon Sigma, University of Florida; 9- Iota, University of Missouri-Columbia; and 10- Beta, Purdue University.

"Electrical" Engineering: Then and Now

Introduction by Steve E. Watkins, Editor-in-Chief

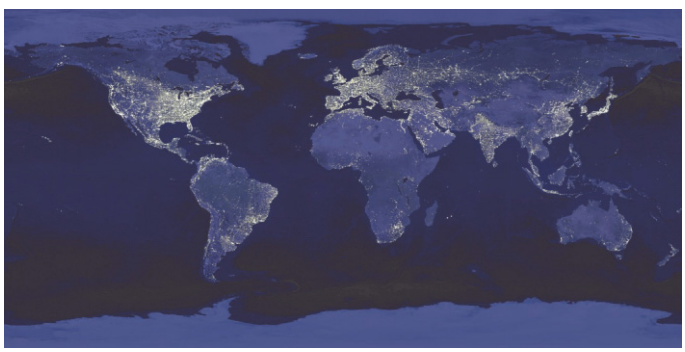
Electrical engineering as a profession grew out of the invention and commercialization of electrical technology for communication and power. Telegraph, telephone, radio, and power applications are early examples of technology that transformed society. An example of the significance of electrical technology is the NASA image below; it shows the extent of electrification through the world. The profession broadened over the years with the addition of related innovations in electronics, telecommunications, computers, etc. Today, the IEEE supports this diverse profession with 39 societies and six technical interest councils. We present two papers to represent electrical engineering then and now.

Vladimir Karapetoff (1876-1948) was a prominent electrical engineer and an active supporter of Eta Kappa Nu. In 1916, he wrote "Suggestions for Electrical Research in Engineering Colleges" for the American Institute of Electrical Engineers (AIEE), a predecessor for IEEE. This work provides a snapshot of the technical fields of interest 100 years ago. We provide a reprint of that paper here and a brief biography of this remarkable engineer. He was honored by HKN through the creation of the *Karapetoff Outstanding Technical Achievement Award* that is described as well. Many of his papers and books are available through IEEE Xplore and other online sources. His career was reviewed in:

> J. E. Brittain, "Vladimir Karapetoff: A Pioneering Electrical Engineering Educator," Proc of the IEEE, 85(10), 1662-1663, 1997.

Current research in IEEE fields of interest addresses many technical topics and many societal problems. One example is our second feature paper--an original work by E. Eltzov, A. L. Y. Kei, and R. S. Marks. It describes their developments toward a fiber-optic biosensor to monitoring water quality. This research involves instrumentation, sensing, optoelectronics, nanomaterials, biotechnology, etc. Further information on their research can be seen in:

> E. Eltzov and R. S. Marks, "Parameters to Consider in the Construction of Fiber-Optics Biosensors as Alternative Bioanalytical Tools," IEEE Instrumentation and Measurement Magazine, 12(5), 10-16, 2009.



The Earth Lights image was created by NASA as a map of permanent lights across the world. It indicates the extent that electrification has become part of modern life. Data courtesy Marc Imhoff of NASA GSFC and Christopher Elvidge of NOAA NGDC. Image by Craig Mayhew and Robert Simmon, NASA GSFC.

INTERNATIONAL YEAR OF LIGHT 2015

SPIE.

The year 2015 was proclaimed the International Year of Light (IYL) by the United Nations to recognize the importance of light-based technologies (see www.light2015.org). SPIE, the International Society for Optics and Photonics, is a founding partner for IYL and has many resources available (spie.org/IYL). SPIE is also a co-sponsor for LIGHT: Beyond the Bulb, an open-source exhibition program, which includes Earth Lights (lightexhibit.org).

SUGGESTIONS FOR ELECTRICAL RESEARCH IN ENGINEERING COLLEGES

BY V. KARAPETOFF

ABSTRACT OF PAPER

The primary object of the paper is to present a list of topics in electrical engineering suitable for thesis, research, and advanced study. A plea is made for systematic research, each college specializing year after year in only a few topics for advanced investigation. The author suggests that the Educational Committee of the Institute become a central place for information and a stimulus in applied electrical research, cooperating with engineering colleges and with individual inventors and investigators.

Various types of investigations arc enumerated, such as invention, experimental study, theoretical study, library search, and compilation of data. Some advice is given the young investigator as to how to proceed in the most efficient way and to avoid a disappointment.

"What topic shall I choose for my required thesis?" This is a question that will sound familiar to a teacher in electrical engineering. Sometimes the students put the question in this way: ''I have some spare time and should like to do research work; what would you suggest for a subject?" Again, once in a while a young practising engineer writes that he does not wish to become "rusty" and asks that a subject be suggested for systematic study in the evenings. Truth forbids the statement that such inquiries come often enough to be burdensome; nevertheless the writer found it convenient some years ago to compile "A List of Electrical Subjects for Thesis, Research and Advanced. Study,"as a ready reference in answering such inquiries. This list was privately printed in 1909 and has been used since by a number of the author's colleagues in various engineering colleges.*

A revised and augmented list is now offered to the profession in the hope that it may prove useful and stimulating to students, to teachers, and to engineers who are interested in research, invention, and advanced study in electrical engineering.

The author also recommends that the Educational Committee of the Institute revise this list from time to time and keep it up to date, soliciting additional suggestions from various technical committees, from prominent practising engineers and from teachers. In this manner the Educational Committee would in time become a source of information and stimulus for organized electrical research.

Anyone who follows European electrical periodicals will agree that this country is behind Germany and England in the invention of new types of electrical machinery and apparatus, in the discovery of new electrical phenomena, and in the development of working theories and numerical relations needed in our profession. Whatever the causes of our backwardness, we must find a remedy for it, and the most important

*For a similar list of topics in mechanical engineering see H. Wade Hibbard, "Thesis Directions for Students," Proceedings of the Society for the Promotion of Engineering Education, Vol. 21 (1913) p. 129.

Presented at the 33d Annual Convention of the American Institute of Electrical Engineers, Cleveland, 0hio, June 30, 1916.

first step is to systematize and organize research.

The American Institute of Electrical Engineers has not limited itself in the past merely to recording the progress of the art and the opinions of its members. Through its committees and representatives the Institute has participated in the solution of a number of important national and international problems, and it has never failed to take an active interest in activities by which it was able to render important service to the profession and to the nation.

The promotion of organized research in engineering and the encouragement of young men to train themselves in the art of invention is at present an important national problem, if we are to rank with the leading European nations and to be independent of them in times of need. The author has emphasized elsewhere more in detail the importance of systematic research and of encouraging the art of invention among young engineers.* The national engineering societies are naturally called upon to lead in this movement, and the American Institute of Electrical Engineers ought to do its share. In fact, one of the principal objects of the Institute, according to its constitution, is "the advancement of the theory and practise of electrical engineering and of the allied arts and sciences."

The Educational Committee of the Institute could well carry on this work if some of its members were selected with this purpose in view, and if it could arrange for cooperation with the other technical committees. This would be a distinct field of activity closely connected with the rest of the work of the Institute, and at a safe distance from the work of special educational societies, especially the Society for the Promotion of Engineering Education. This new activity of the Educational Committee of the Institute might be carried on as follows:

1. The Educational Committee could announce in the PROCEEDINGS and by letter to the electrical departments of the technical schools in North, Central, and South America that it is prepared to assist the students and young engineers by suggesting topics for research, invention, and advanced or special study.
2. The Educational Committee could regularly collect and publish suggestions as to timely topics for research from the technical committees of the Institute, from manufacturing and operating concerns, testing laboratories, consulting engineers, prominent scholars, etc.
3. The Educational Committee could collect information as to the facilities for research available in different schools, and the problems already solved or under investigation. The principal schools might be induced to conduct certain researches in cooperation, rather than to duplicate work. Each school ought to specialize in research along a few definite lines year after year, in accordance with the facilities available and the relation to the local industries. In this manner valuable results could be achieved, whereas now the attempts are mostly sporadic, leading nowhere.**
4. The principal results of research might be published regularly in abstract in the PROCEEDINGS, and thus made of general use, where now they are simply filed in college libraries.
5. The Educational Committee from time to time should publish in the PROCEEDINGS a brief account of the most important progress in apparatus, methods of measurement, mathematical relations, etc. In these accounts

*See his paper entitled "What has Engineering Education contributed to Scientific Progress and Invention," presented at the second Pan-American Scientific Congress in Washington, D.C., on Dec. 31, 1915, and published in the Bulletin of the Society for the Promotion of Engineering Education, April 1916, p. 597. See also J. A. Fleming, "Organization of Scientific Research," *The Electrician,* (London), Feb. 18, 1916.

**Perhaps the most instructive case of systematic research carried on through many years was that at the Elektrotechnisches Institut in Karlsruhe, under the inspired guidance of the late Engelbert Arnold (1856-1911). As a result of this work we have several volumes of the most accurate and useful information on dynamo-electric machinery and numerous valuable inventions; while scores of Arnold's former students all over the world, are prominent as inventors, investigators, designers, and scholars. In this country Professor Harris J. Ryan with his students has carried on investigations on dielectric stresses for years with splendid results.

emphasis should be placed upon the method of attack, logical reasoning, patience of the inventor or the investigator, the importance of a clear knowledge of physics, mathematics, mechanics, and chemistry, and in general all such facts as may encourage young investigators and help them in their own research.

6. The Institute might announce each year one or more prizes and medals for the best improvement in apparatus, measurement of some difficult quantity, the best theoretical investigation, etc. These prizes need not be over $50 to $100 each, and the money can be easily appropriated out of the general expense fund of the Institute. Prizes might also be announced for the solution of definite problems of special importance in manufacturing and manufacturers might be induced to furnish money for them.
7. The Institute could help both the electrical industry and the colleges by inducing larger electrical concerns to maintain industrial scholarships in engineering colleges that are prepared for the work. Such scholarships have proved very useful in chemical industry, and in the manufacture of cement, steel, etc.
8. The Institute might pave the way and lend its influence towards the foundation of a National Institute for Electrical Research, or even a National Institute for Engineering Research, similar to some existing institutes for medical research.

GENERAL REMARKS

1. The list furnished is by no means complete or exhaustive and is primarily intended to be suggestive. It would of course be out of the question to write out in detail the purpose and the program of every possible investigation in electrical engineering. The important preliminaries to almost any bit of research are to find out the present status of the problem, to formulate what is needed, and to devise the means for carrying on the investigation. Having selected a general topic the student should make a search in the

Vladimir Karapetoff Outstanding Technical Achievement Award of Eta Kappa Nu

The establishment of the Vladimir Karapetoff Outstanding Technical Achievement Award was announced in the May 1992 issue of The Bridge magazine of HKN. It has initiated through the support from Dr. Karapetoff's widow, R. M. Karapetoff Cobb. The 1992 recipient was Wilson Greatbatch for the implantable pacemaker. This annual award is given to a "practitioner of electrical or computer engineering who has distinguished himself/herself through an invention, development, or discovery in the field of electrical or computer technology. Factors considered in bestowing this award include the impact and scope of applicability, the impact on the public welfare, and the impact on the standard of living and/or global stability." It is a major IEEE-HKN recognition for career accomplishments.

Year	Past Recipients of the Vladimir Karapetoff Award
2011-2015	No Award Given
2010	Thomas Kailath
2009	Gerard A. Alphonse
2008	Leo L. Beranek
2007	Arun G. Phadke
2007	Stanley H. Horowitz
2006	Arun N. Netravali
2005	Stanley White
2004	Yau-Chau Ching
2003	Bernard C. DeLoach, Jr.
2002	Robert H. Dennard
2001	Chester Gordon Bell
2000	Amos E. Joel, Jr.
1999	Jack St. Clair Kilby
1998	Al Gross
1997	Jerry M. Woodall
1996	Harold A. Wheeler
1995	John L. Moll
1994	Nick Holonyak, Jr.
1993	George H. Heilmeier
1992	Wilson Greatbatch

literature of the subject, consult his instructors, and if necessary take the matter up with outside specialists.

2. The topics are suggested in general terms only, because it is not supposed that a beginner would use the list. If neither the student nor his teachers know anything about the present status of a certain topic, it is hardly likely or even advisable that the student should take it for his thesis. He needs an elementary text-book on the subject. If, however, at least one of them knows something about the particular topic, its mention in the list will be sufficiently suggestive, and will recall to his mind certain definite problems to be investigated, and he will know where to go for some first-hand information on the subject.
3. Each technical college will find it more effective and more useful from an educational point of view to induce successive students to continue each other's investigations for a term of years until definite results have been achieved. The college can then afford to invest a considerable sum of money in apparatus and will develop real experts among its faculty who supervise this research. With a proper selection of a few topics this policy would in a few years lead to the formation of a valuable specialized experiment station.

Continued on page 57 ...

Vladimir Karapetoff Biography

Vladimir Nikitich Karapetoff was born on Russia January 8, 1876 and died in New York on January 11, 1948. He received degrees from the Imperial Institute of Ways of Communications, St. Petersburg, Russia in 1897 and 1902. He came to the United States as an engineering apprentice for Westinghouse Electric Corporation 1902-1904 and became a faculty member at Cornell University, Ithaca, NY in 1904. He became a full professor and retired in 1939 as Professor Emeritus. He became a U.S. citizen in 1909 and became a professional engineer in New York State. His contributions include work as educator, author, editor, researcher, consultant, engineer, and volunteer. He authored many books, including two widely-used volumes on Experimental Electrical Engineering, and over two hundred papers and articles.

Karapetoff experienced much during his lifetime. While a student, he worked summers on the Trans -Serbian Railroad. As a Westinghouse engineer, he was involved with the Westinghouse exhibit at 1904 St. Louis World's Fair. He served in the U.S. Navy as a Lt. Commander during World War II. He published a book of poems "Rythmical Tales of the Stormy Years." He was a noted musician, invented a five-stringed cello, and received an honorary doctorate in music from New York City College of Music (1934). Also, he received an honorary doctor of science degree from the Polytechnic Institute of Brooklyn (1936). He became blind late in life and learned to read Braille.

Karapetoff was active in many professional organizations. He was elevated to **Fellow of the American Institute of Electrical Engineers** in 1912 and was awarded the Elliott Cresson Gold Medal of the Franklin Institute for contributions to computer and cognitive science." For 1917-1926 decade, he was research editor of *Electrical World*. He was a member of Eta Kappa Nu and a regular attendee at Eta Kappa Nu events.

A Tale of Two Cities: Biosensor Engineering for Water Management

By Evgeni Eltzov[a], Adarina Low Yuen Kei[b] and Robert S. Marks[a,b]

[a] Ben-Gurion University of the Negev, Israel
[b] Nanyang Technological University, Singapore

Abstract

The availability of safe water sources is a growing issue around the world. Engineering solutions to such societal problems transcend traditional boundaries of discipline as well as geography. This paper describes a particular type of biosensor that is being developed for water monitoring as a cooperative effort between the Ben Gurion University of the Negev, Israel and Nanyang Technological University, Singapore through the NEW NRF CREATE foundation.

Introduction

**"It was the best of times;
it was the worst of times." [1]**

The availability of safe water sources is critical for the health and welfare of people everywhere. Certainly, humanity has come a long way--with water management, through infrastructure, monitoring, and sewage treatment. However, available safe drinking water sources are threatened by demand and pollution from urbanization, industry, and agriculture. Monitoring techniques and devices are therefore needed for effective water management.

Available techniques for water monitoring have severe limitations. Conventional physicochemical analyses (high pressure liquid chromatography (HPLC) or gas chromatography (GL), albeit accurate and sensitive, require sophisticated laboratory equipment and highly trained personnel, are slow and expensive, and are restricted to the identification of a given target compound (herbicides, endocrine disrupting compounds, or heavy metals), without providing any indication about their biological effects (genotoxicity, cytotoxicity, endocrine disruptive compounds); whereby, compounds with dissimilar chemical structures may share similar biological toxic effects. Sometimes, they may miss residual toxins that are harmful at low levels, as defined by regulation. It would therefore be beneficial to develop a system that directly monitors toxicity in a continuous way, as well as at a point-of-site.

"And a beautiful world we live in, when it is possible, and when many other such things are possible, and not only possible, but done…" [1]

Indeed, nature has provided us with natural organisms, which can provide us with indication of toxicity of water samples. These sentinel species, such as fish, mollusks, and daphnia magna (water fleas), are more sensitive to many toxins than humans, and provide advance warning of water hazards--similar to the early use of canaries in coal mines to warn of high levels of carbon monoxide. However, testing with these organisms may be costly (maintaining fish), sometimes slow (mollusks), or suffer from inherent data variability (daphnia). Constitutively glowing marine bacteria, now adapted as commercial bioassay test kits (Microtox and Checklight® kits), are useful alternatives. These bacteria measure toxicity of water or soil samples. These tests show rapid responses; are quite sensitive (parts per billion range); are easily and cheaply cultured, maintained, and stored; are reliable; and produce statistically significant results. Knowing their molecular and genetic makeup, genetically modified bacteria (or yeast, or microalgae) can be produced as bioreporters. Unlike the natural ones cited above, where constitutive bioluminescence is decreased with increasing toxicity, the glow of genetically engineered systems is triggered only upon toxicant encounter. Again, these systems require a well-equipped laboratory, reducing their versatility for in-field testing or monitoring water on-line[2]. However, these biological systems may be adapted into biosensor systems[3].

"There is prodigious strength in sorrow and despair." [1]

This paper describes a whole-cell bioluminescent fiber optic biosensor that is being developed for water monitoring. Such work is an aspect of nanotechnology, in which biological structures were engineered; it also incorporates instrumentation and measurement approaches that have long been part of the electrical engineering field. The goal is a miniature, automated sensor that is optimized for one or more specific water pollutants.

The present story, a tale of two cities (Beer-Sheva and Singapore), relates how a new monitoring technology is being developed. Innovation at the newly created center in Singapore, Nanomaterials for Energy and Water Management, is a light at the end of the tunnel. The research is an international collaboration among the National Research Foundation (NRF Singapore), the Nanyang Technological University, the Ben Gurion University of the Negev, and other research partners.

Biosensor Technology

A biosensor is a self-contained, bionic, integrated device that provides a measurement of the concentration of a selected biochemical species. The term "bionic" is used to mean the combination "bio" plus instrumentation. Such a sensor has three major parts.

- A biorecongition element – a target analyte (e.g. a toxicant) interacts with a bioreporter organism immobilized at an interface.
- Interfacial chemistry – the transducer surface where the molecular interaction takes place and links the aforementioned biospecific entity with the physical transducer via chemical immobilization.
- Transducing element, such as in this case, the fiber-optic and associated optoelectronic.

Common design goals are to target size, complexity, discrimination, and sensitivity. Small sensors can be portable and facilitate use in the field. Low complexity devices may be less expensive and simpler to operate, and minimal sample preparation may be required, while non-qualified personnel may be able to operate the said system. The sensors should discriminate in that they respond preferentially to a desired analyte, and should provide the needed sensitivity to the analyte. Biosensors may be used to give a precise measurement, or to simply give a warning so that more precise methods can be employed. As such, biosensors complement classical analytical methods.

Whole cell bioluminescence is an important category of bioreporter types. Many whole-cell microorganisms respond to various analytes. Genetic modification can be used to optimize the response, e.g. make it more selective and sensitive to the analyte. The reaction may be varied, but a useful reaction is light production. Such a bioluminescent reaction facilitates use of fiber optic lines for signal transmission, while a plethora of available optoelectronics can be simply taken off the shelf to construct the integrated system.

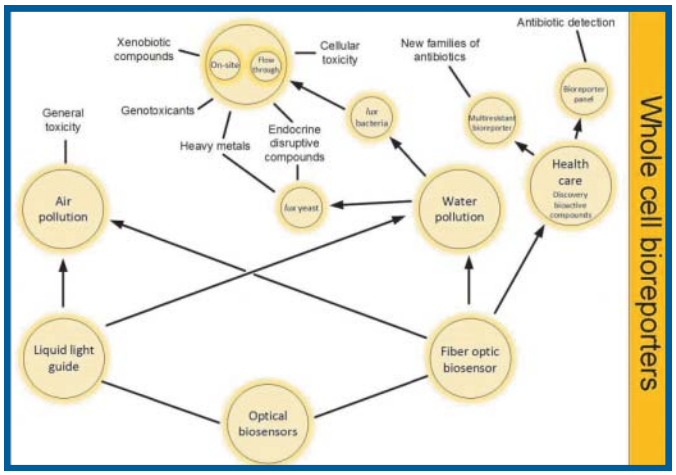


Figure 1. Possible tools using whole-cell bioluminescent with fiber optic transmission

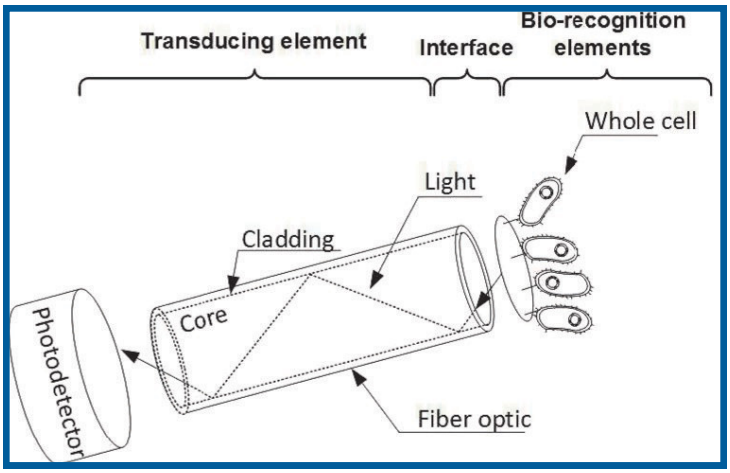


Figure 2. Schematic of a fiber-optic biosensor

Figure 1 shows an array of possible applications, using whole-cell bioluminescence with fiber optic or liquid light guide transmission.

Figure 2 shows the structure of a fiber optic biosensor. An enzymatic reaction occurs inside the organism with a byproduct being the emission of light...a glow. The far end of the optical fiber provides a good surface for the interface. Bioluminescence for such biosensors is typically in the blue-green region of the optical spectrum. The silica-glass optical fiber offers high-efficient coupling and transmission, while extremely sensitive photodetectors are available to convert the optical signal to an electrical signal. The optical fiber systems have advantages of being flexible, small, low cost, and inert, and thereby nonhazardous and biocompatible. Multiplexing is possible by using different wavelengths, or use of many different organisms.

Bioluminescent Fiber Optic Biosensor

The result of a collaboration among the research partners is the design of various configurations of a BioPen for water monitoring. The BioPen is a self-contained measuring device designed to measure water toxicants at low concentrations, such as mercury at 2ppb. Figure 3 shows an artist depiction of one version.

BioPen technology is the result of a multidisciplinary collaboration. The development may be described into two main categories of development--biological and engineering. Figure 4 illustrates the combination of various biological and engineering elements[4].

Genetically engineered bacterial cells, our chosen reporter organisms, glow upon toxicant stimulation of any one of a number of sensing promoters, such as: metabolic damage, membrane lipid damage, DNA damage, protein or oxidative stress damages, or heavy metals. The promoter is coupled to a luciferase operon (luxCDABE), that includes the synthesis of its own substrate without the need for external additions, thereby simplifying the assay--thus, explaining the glow. Via cell entrapment, we integrated these 'bioreceptors" at the tip of optical fiber transducers, forming a self-contained biosensor system[5], to-date, various configurations have been tested[6], enabling either a single time use, dispatchable device or, an on-line monitoring system[7]. The latter system (being more complicated to produce as a front line real-time alarm during long-term measurements, and requiring improved sensitivity and sturdiness) implies that we build a new and improved engineered prototype.

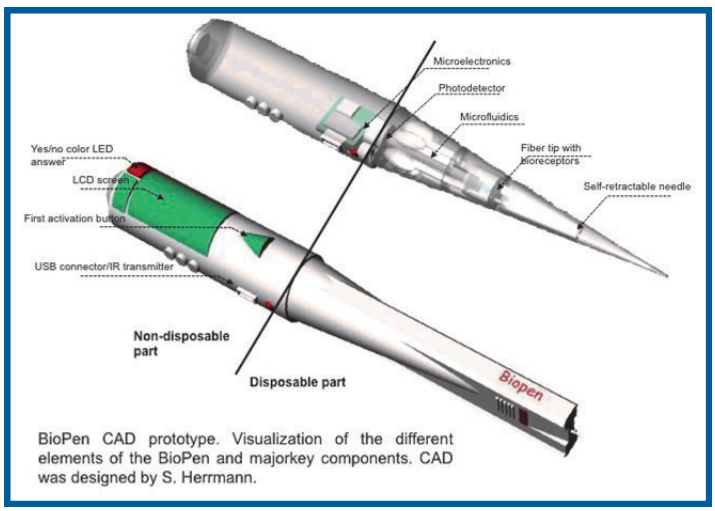


Figure 3. The BioPen for Water Monitoring

Development and Application of the BioPen

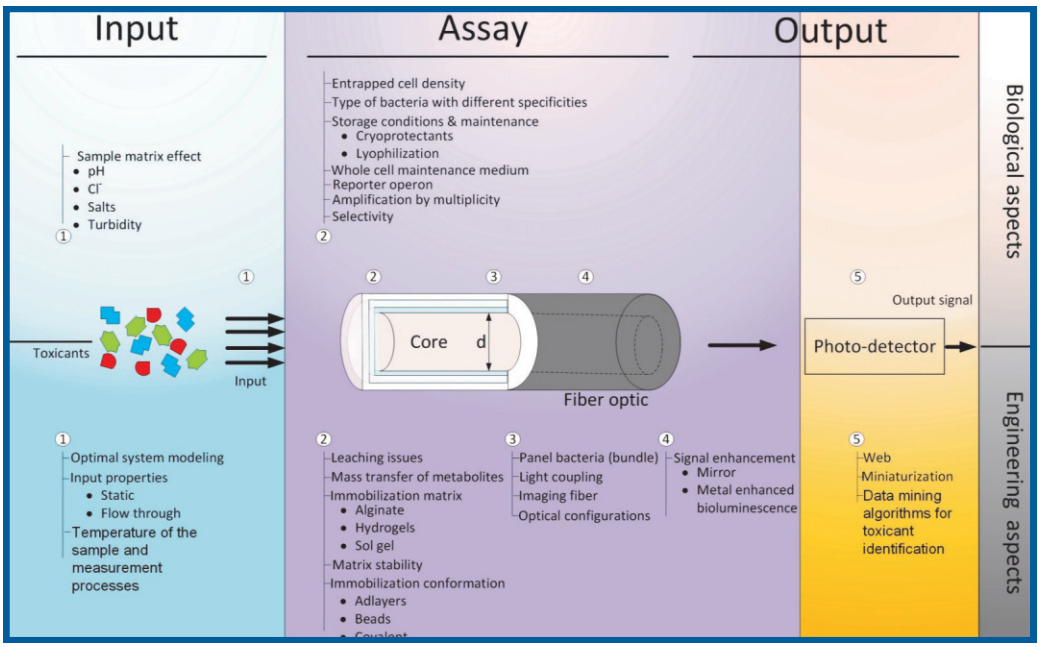


Figure 4. Biological and engineering aspects for biosensors based on optical fiber used for monitoring water toxicity

Figure 5 shows the stages in the development of the BioPen. In the early stages of development, the system was tested as a stand alone, dispatchable device, where one-time use biosensor probes were used in field conditions to test water (Israel, USA, Germany and Holland) or sediment (Spain), and this, in a static mode, where samples were collected into tubes. A further development was to adapt the device to measure water flow from a river as an early warning system at surface water inlets for drinking water, or at critical points in the drinking water distribution system. This was done in association with Minne Herringa at KWR, the Netherlands. Here, the fiber probe was subjected to a continuous, automated, water flow, sampling for putative toxicants. In so doing, a large number of new developmental issues appeared that required solving, such as: erosion of the fiber probe immobilization matrix housing the bioreporters, with a subsequent signal decrease or the need for temperature control; the need for the addition of nutrients, which brought a new set of problems such as cost; increased biofouling, that could decrease the diffusion rates of both the toxic analyte and the reporter's waste metabolites; the regulatory requirement to prevent the release into the environment of the sensing genetically modified bioreporters, while building a more complicated device including mechanics, a fiber probe chamber, and water flow piping.

The aforementioned provides new capability in on-line water monitoring systems. Further development will seek to add features and improve performance. Desired features include microarray identification of pollutants via luminescent kinetic fingerprints using a panel of bioreporters[8-9], nanostructured films to prevent bacterial leaching, and luminescence signal enhancement via nanometer thick metal film proximity[10].

Singapore and Israel have challenging water issues. Israel requires monitoring water constantly to ensure its water remains safe to drink and free of unwanted man-made contaminations from agricultural runoffs or terror attempts. Being able to go to the site in

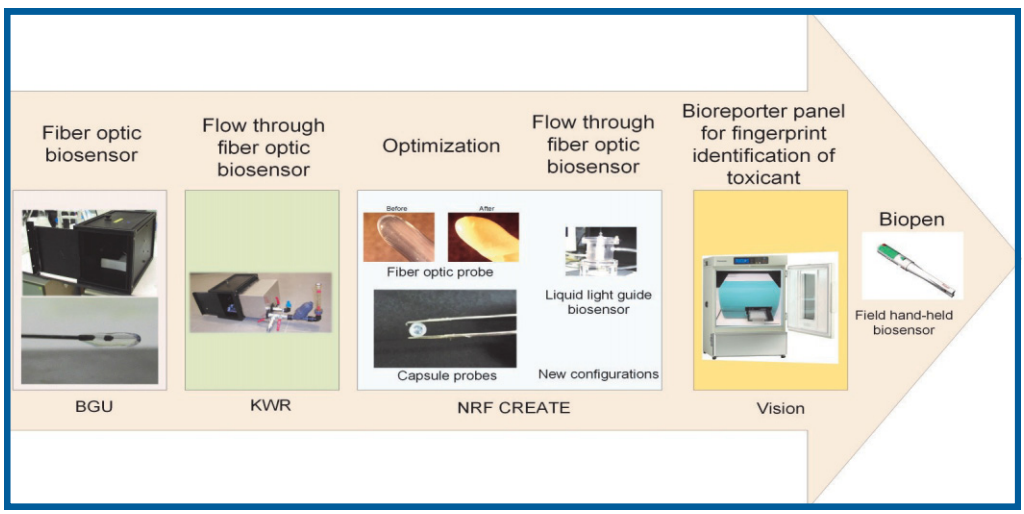


Figure 5. Development Stages for the Water Monitoring BioPen

question and measure on-site would be helpful. Singapore has come a long way to ensure sufficient and safe drinking water. There are 48 major waterways and water catchment areas covering two-thirds of Singapore's total land surface. The total water catchment area is set to reach 90% by 2060 with the introduction of technology that enables treatment of water with varying salinity near the shoreline. Currently, water monitoring on-site of reservoirs is conducted through sampling and online sensors using fixed online stations (which provide limited coverage), or by taking a boat to fixed locations to collect grab samples, or taking manual in-situ measurements. These techniques can be tedious and time-consuming. Fortunately, there had been no reports of major pollutants or sabotage activities in Singapore's water catchment areas. However, the water quality can still be affected by urbanization, recreation, and other human activities. Therefore, Singapore must not be complacent and a BioPen, which can detect the presence of trace amount of harmful toxicants on-site, can act as one such first line of a defense system.

Even though the security of the water catchment areas has never been compromised, there have been activities which were beyond the control of security agencies. Red tides and harmful algae bloom can be notorious in coastal water, leading to large scale fish deaths. These events are recurrent and brought about whenever there is a dry spell or drought. With global warming, the incidence of such events increases, and is likely to become an annual event. The latest plankton bloom, which occurred in February 2015, had caused more than 80% of fish deaths overnight, resulting in major economic losses. Therefore, fish farms need a simple tool to monitor the seawater and develop a contingency plan for future occurrence. A BioPen that can detect and monitor the water quality on-site will potentially help ease monetary losses in future algae blooms.

Conclusion

"Although it is a long time on the road, it is on the road and coming …" [1]

Safe water resources can only be maintained by innovative use of technology. Water monitoring is part of larger efforts involving public health, environmental protection, and sustainability. Due to the limited land area and the large population of Singapore, water challenges include urban and industrial pollution and water reuse. Due to the limited water availability in Israel, especially in the arid regions, water reuse and expansion of water availability are critical needs. These two countries are not alone. In the U.S., population growth in arid regions and pollution concerns make water monitoring and management important societal issues. The U.S. Environmental Protection Agency reported that in most of the U.S. states, multiple unregulated chemicals can still be found in tap water.

Two countries, Singapore and Israel, are poised to become world leaders in the water industry (desalinization, sewage remediation, water monitoring). It is therefore obvious that a synergistic collaboration between them would accelerate the process that would produce technologies to help alleviate the situation, where increasing parts of the world population live in areas of clean water scarcity. The Water Thrust component of the Singapore NRF CREATE program has developed tools in water remediation and water quality monitoring based on the use of nanomaterials. The BioPen, which enables water testing in the field by anyone, anywhere, anytime, is just one of many possible developments. Newer technologies are now coming out[11-12], including for monitoring of nanotoxicity of novel nanomaterials finding their way into the environment.[13]

"A day wasted on others is not wasted on one's self." [1]

Ben Gurion University, Israel, and the Nanyang Technological University, Singapore, are addressing these challenges in water-related management through a multidisciplinary approach involving biology, nanomaterials, optics, instrumentation, etc. Opportunities for research abound for engineers who have knowledge across disciplines and can integrate technologies. The ideal candidate would be one having studied Biotechnology or Biomedical Engineering, including skills in microbiological sciences, analytical chemistry, optoelectronics, polymer chemistry, and abilities in design engineering and software engineering.

References

1 Charles Dickens (1859) A Tale of Two Cities. With Illustrations by H.K. Browne. London: Chapman and Hall, 1859.

2 Hakkila, K., T. Green, P. Leskinen, A. Ivask, R. S. Marks and M. Virta (2004) Detection of bioavailable heavy metals in EILATox-Oregon samples using whole-cell Luminescent bacterial sensors in suspension or immobilized onto fiber-optic tips. Journal of Applied Toxicology. 24: 333-342

3 Polyak, B., E. Bassis, A. Novodvorets, S. Belkin and R.S. Marks (2000) Optical fiber bioluminescent whole-cell microbial biosensors to genotoxicants. Water Science and Technology. 42 (1-2) 305-311

4 Eltzov, E. and R. S. Marks (2009) Parameters to consider in the construction of fiber-optic biosensors. IEEE Instrumentation & Measurement Magazine. 12(5) 10-16

5 Polyak, B., E. Bassis, A. Novodvorets, S. Belkin and R.S. Marks (2001) Bioluminescent whole-cell optical fiber sensor to genotoxicants: system optimization. Sensors and Actuators. B 74: 18-26

6 Polyak, B., S. Geresh and R.S. Marks (2004) Synthesis and characterization of a biotin-alginate conjugate and its application in a biosensor construction. Biomacromolecules. 5: 389-396

7 Eltzov, E., R.S. Marks, Stefan Voost, B. A. Wullings and M. B. Heringa (2009) Flow-through real time bacterial biosensor for toxic compounds in water. Sensors and Actuators B 142: 11-18

8 Eltzov, E., D. Zeevi Ben-Yosef, A. Kushmaro and R.S. Marks (2008) Detection of sub-inhibitory antibiotic concentrations via luminescent sensing bacteria and prediction of their mode of action. Sensors and Actuators. B 129: 685-692

9 Eltzov, E., S. Pennybaker, R.S. Marks and A. Kushmaro (2012) Multi resistance as a tool for detecting novel beta-lactam antibiotics in the environment. Sensors & Actuators: B. Chemical. 174: 342-348

10 E. Eltzov, D. Prilutsky, A. Kushmaro, R.S. Marks, C. Geddes (2009) Metal-enhanced bioluminescence: a new approach for monitoring biological luminescent process. Applied Physics Letters. 94(8) 083901

11 Eltzov, E., A. Yeduda. And R. S. Marks (2015) Creation of a new portable biosensor for water toxicity determination. Sensors & Actuators: B. Chemical. 10.1016/j.snb.2015.06.153

12 Eltzov, E., A. Cohen and R. S. Marks (2014) Bioluminescent liquid light guide pad biosensor for indoor air toxicity monitoring. Analytical Chemistry. Accepted

13 Kun, J., R. S. Marks and R. E. Ionescu (2014) Influence of carbon-based nanomaterials on lux-bioreporter Escherichia coli. Talanta. 126: 208-213

About the Authors

Evgeni Eltzov received his BSc from the department of Biotechnology Engineering, Ben-Gurion University of the Negev, Israel, in 2005. He received his MSc and PhD from the Department of Environmental Engineering, Ben-Gurion University of the Negev, where he is now developing biosensors for the environmental and health care fields.

Adarina Low Yuen Kei received her PhD from the School of Materials Science and Engineering, Nanyang Technological University, Singapore in 2013. Her research interest includes exploring the effects of polymorphism on murine fibroblast behavior, and blood pathogen detection for water remediation. She is currently a postdoctoral researcher with the CREATE-NTU-HUJ-BGU program. Besides working on her research interest, she is also involved in bridging scientific innovations to commercialization.

Prof. Robert S. Marks is a Full Professor at the Department of Biotechnology Engineering, the Ben-Gurion University of the Negev, Israel, and affiliated to the National Institute for Biotechnology in the Negev and the Ilse Kats Centre for Nanotechnology. His PhD was done at the Weizmann Institute of Science (vaccines) and postdoc at the University of Cambridge (biosensors). He is presently a program co-coordinator for the NRF CREATE program "Nanomaterials for Water and Energy Management" through MSE at the Nanyang Technological University. He has published in viral immunosensors (Ebola virus, West Nile virus, Rift Valley fever, Dengue, Hepatitis C, Crimean-congo-hemorrhaggic fever) and has extensive experience in biosensors including chemiluminescent-based optical immunosensors to pathogen-elicited antibodies as well as amperometric immunosensors. He has developed new sensor configurations, such as establishing diagnostics based on luminescence emitted by primed neutrophils. His work also encompasses environmental toxicology such as monitoring water pollution via fiber-optic probes glowing in the presence of toxicants through their associated luminescent bacteria, or developing a nanometer particle-sensitive bioassay. His group has also participated in developing enzyme nanolithography, as well as ITO-based biochip configurations. He is the Editor-in-Chief of a 2007 2-volume Wiley *Handbook of Biosensors and Biochips* and Founding Editor of the *High-Tech of Biotech* book series from Pan Stanford. He is the author of 120+ papers and a couple dozen chapters, as well as four issued patents and a dozen filed.

IEEE-USA SPOTLIGHT

IEEE-USA FUTURE LEADERS FORUM

IEEE-USA provides many programs and events which may be of interest to IEEE-HKN members. Each issue of THE BRIDGE will provide an update on a specific IEEE-USA program. This issue features the IEEE-USA Future Leaders Forum.

The first ever national "Future Leaders Forum" presented by IEEE-USA will be held at Tulane University in New Orleans, LA on 28-30 July 2016. This innovative and exciting event will enable students and young professionals to gain knowledge not found in a classroom, while being immersed in the traditional New Orleans culture.

Tomorrow's "Leaders" are disrupting the monotony of business constructs at all levels—and this event embraces that! With an ideal mix of groundbreaking sessions and uniquely formatted talks and discussions, the "Future Leaders Forum" will challenge traditional Innovation, Leadership & Learning.

To register or for more information, visit ieeeusa.org/futureleaders.

IEEE-USA presents: FUTURE LEADERS FORUM
28-30 July 2016 | New Orleans, Louisiana

IEEE SOCIETY SPOTLIGHT

IEEE EDUCATION SOCIETY

IEEE offers more than 35 Societies that focus on technical information in specialized technology fields. Each issue of THE BRIDGE will feature an IEEE Society and include information on activities and information that can benefit IEEE-HKN members.

The IEEE Education Society strives to be the global leader in engineering education. It is an international organization that promotes, advances, and disseminates state-of-the-art information and resources related to the Society's fields of interest and provides development opportunities for academic, industry, and government professionals. Visit http://ieee-edusociety.org for more information.

Publications:

IEEE Transactions on Education - Focuses on educational research, methods, materials, programs, and technology in electrical engineering Founded:1958

IEEE-RITA - Focused on Latin America, Portugal, Spain - covers technological applications and research in education including design and research in new learning tools that focus on teaching and learning. Founded: 2006

IEEE Transactions on Learning Technologies - Focuses on online learning systems, intelligent tutors, educational software applications and games, and simulation systems for education and training. Founded: 2008

Conferences:

Frontiers in Education (FIE) Conference - FIE is held annually, mostly in IEEE Regions 1-7, and is a highly-respected major international conference focusing on educational innovations and research in engineering and computing.

IEEE Global Engineering Education Conference (EDUCON) - Held annually in IEEE Region 8 to provide a forum for academic, research, and industrial collaboration on global engineering education.

IEEE International Conference on Teaching, Learning, and Assessment in Engineering (TALE) - Held annually in IEEE Region 10 to provide a platform for both academicians and practitioners to share their experience and knowledge in engineering education.

Awards:

- **IEEE William E. Sayle Award for Achievement in Education**
- **IEEE Student Leadership Award**
- **IEEE Transactions on Education Best Paper Award**
- **Hewlett-Packard Harriett B. Rigas Award**
- **Mac E. Van Valkenburg Award**
- **Distinguished Member Award**
- **Edwin C. Jones, Jr., Meritorious Service Award**
- **Distinguished Chapter Leadership Award**
- **Chapter Achievement Award**

IEEE-HKN HISTORY SPOTLIGHT

THE BRIDGE...THEN AND NOW

THE BRIDGE Covers for 2004 and 2010

This issue of THE BRIDGE magazine of IEEE-HKN is identified as Volume 111. This publication history dates back to the first publication of Eta Kappa Nu which was a short booklet entitled *The Electric Field*. This name continued until 1908. The name of *The Eta Kappa Nu Yearbook* was used briefly. The first use of THE BRIDGE as the publication name occurred in 1910. The volume label was added later and the volume count dates to the publication year of 1905. Originally an annual publication, the number of issues per year has varied from one to four; the current publication schedule has issues in February, May, and October. A history of the magazine was included in an IEEE Spectrum article* upon the 75th anniversary of Eta Kappa Nu. Selections of content in THE BRIDGE from 1909 to 1995 were reprinted in a special millennium issue (Volume 96, No. 3, 2000). The role of THE BRIDGE in HKN's history was noted in the 100th anniversary issue (Volume 100, No. 1, 2004). The picture (opposite) shows a collage of magazine covers across the years, which has been reprinted from the latter issue. Above, see the covers from the 100th anniversary issue in 2004, and from the first issue as part of IEEE in 2010.

WINNER 2014 APEX® AWARDS FOR PUBLICATION EXCELLENCE

WINNER 2015 APEX® AWARDS FOR PUBLICATION EXCELLENCE

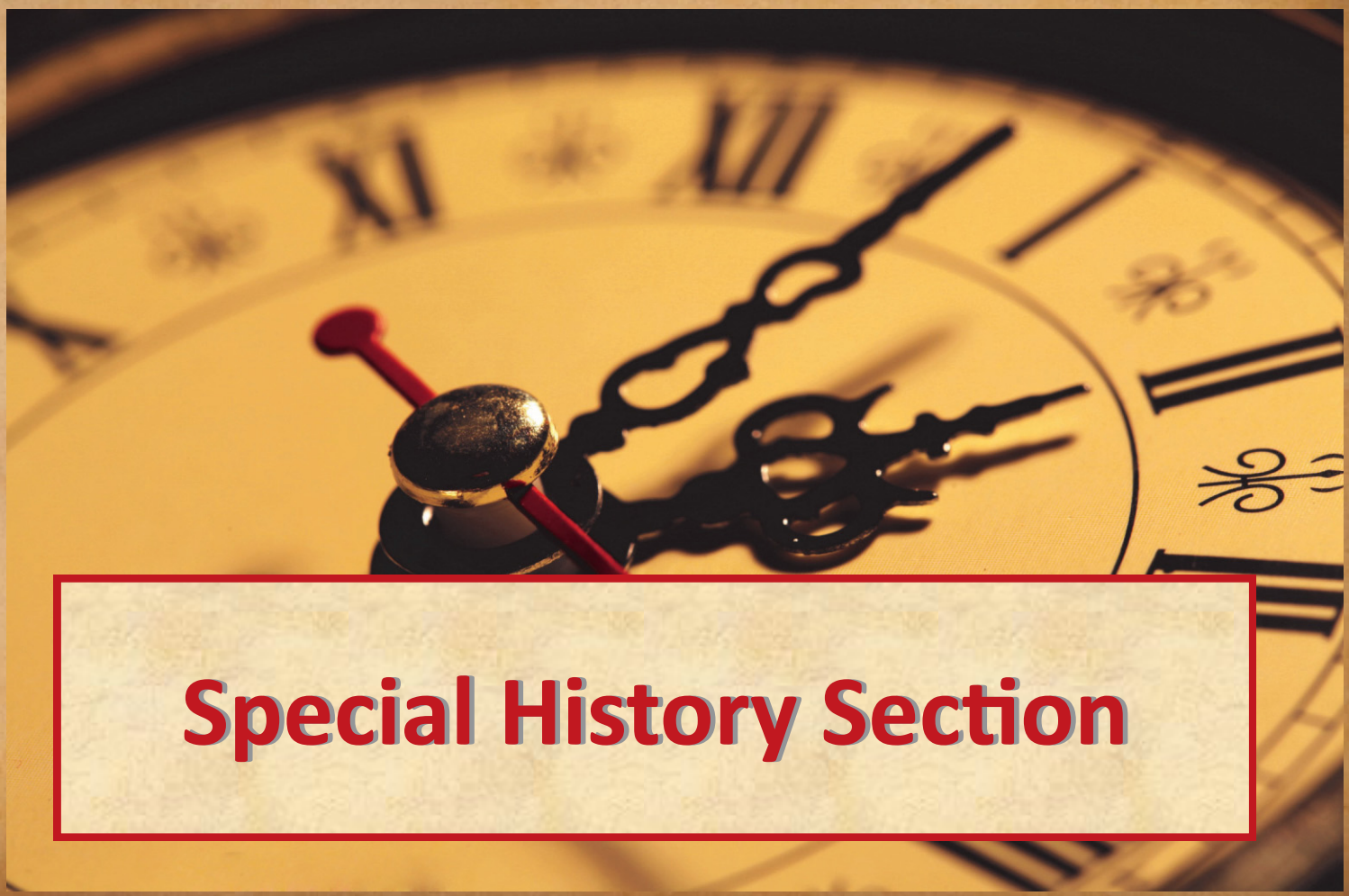
THE BRIDGE wins APEX Awards for 2014 and 2015

THE BRIDGE magazine has featured content from the founders, officers, members, and other leaders in the profession. Alton B. Zerby, Executive Secretary 1934-1958, wrote that the magazine serves "as a vehicle of communication between students and alumni." It continues to connect students and alumni, as well as to promote the activities and recognition programs of HKN, and to highlight the development of the profession. The role of editor sometimes has been a part of the duties of the executive secretary/director and sometimes has been a separate position. Two executive secretaries, Alton B. Zerby and Paul K. Hudson, served as editor of the magazine for more than twenty years each.

THE BRIDGE magazine is now a publication of IEEE and the flagship publication of IEEE-HKN. It is managed by an Editor-in-Chief and an Editorial Board, with support from the Director, IEEE-HKN and other staff. In both 2014 and 2015, it was recognized in the APEX international competition for outstanding publications, see left. The 2014 APEX Award of Excellence was in the "Most Improved Magazines, Journals, and Tabloids" category, and the 2015 APEX Award of Excellence was in the "Print Media – Special Purpose" category (for the Highlights issue, Volume 109, No. 4).

* John F. Mason, "The secret society that never was," *IEEE Spectrum*, 16(9), 55-57 (1979).

Covers of THE BRIDGE from the First Century of HKN



Special History Section

Eta Kappa Nu has a rich past. The organization has influenced generations of engineers and has promoted the profession greatly. This section gives an overview of the key events in HKN history and selected items from the archives. The content includes:

- Eta Kappa Nu Milestones
- Crossword Challenge
- HKN/IEEE-HKN Executive Secretaries/Directors
- Presidents' Memories
- Before STEM was STEM
- Student Leadership Conferences 2002-2016
- HKN to IEEE-HKN

A Founders Plaque was placed at the University of Illinois at Urbana-Champaign and lists the names of the ten original HKN members. It is located next to the Everitt Laboratory.

The archives of HKN and the chapters contain many interesting items. For instance, Alton B. Zerby, the HKN Executive Secretary from 1934 to 1958, wrote "From the Shade of the Cottonwood Tree: HKN's Early Years" in which he provides a fascinating read about the formation of the organization (see archive for the article). A plaque commemorating the founders is located at the University of Illinois at Urbana-Champaign (see right). Pre-college guidance films were produced in the 1950s and 1960s to interest students in engineering careers (see image in the "Before STEM was STEM" content) and are available to chapters.

ETA KAPPA NU MILESTONES

1904

Founders

1910

THE BRIDGE as publication name

1927

HKN Shield and Coat of Arms

1932

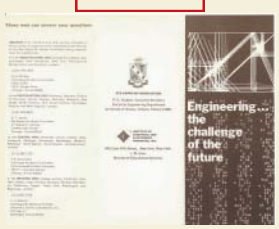
Outstanding Chapter Award

Initial Planning Meeting by Founders	23 Sept. 1904
Charter Date of University of Illinois (Alpha) Chapter	28 October 1904
First National Officer Term	1905-1906
First Use of THE BRIDGE as the Publication Name	1910
The HKN Shield and Coat-of-Arms Adopted	1927
First Paid Staff (Executive Secretary)	1928
Outstanding Chapter Activities Award Established	1932
Outstanding Young Electrical Engineer Award Established	1936
HKN Admitted to the Association of College Honor Societies	1947
First Eminent Members Inducted:	1950
Vannevar Bush, Royal W. Sorensen, & Vladimir K. Zworykin	
Charter of 50th Student Chapter	1950
HKN Produces Movie as a Career Guidance Film:	
Engineering-A Career for Tomorrow	1954
Charter of 100th Student Chapter	1964
Outstanding Electrical Engineering Student Award Established	1965
HKN Produces Movie "Engineering-The Challenge of the Future"	1970
Distinguished Service Award Established	1971
Outstanding Electrical Engineering Teacher Award Established	1972
Karapetoff Outstanding Technical Achievement Award Established	1992
Charter of 200th Student Chapter	1994
Formal Inclusion of "Computer Engineering"	2000
First Student Leadership Conference at Iowa State University	2002
Presentation of Outstanding Chapter Activities Award begin at Meeting of ECE Department Heads Association (ECEDHA)	2005
Official Merger with IEEE	1 Sept. 2010
First Chapters Chartered outside U.S. in Hong Kong (ΛΙ), New Delhi (ΛΗ), & Nova Scotia (ΛΘ)	2012

1964

100th Student Chapter Charter

1970



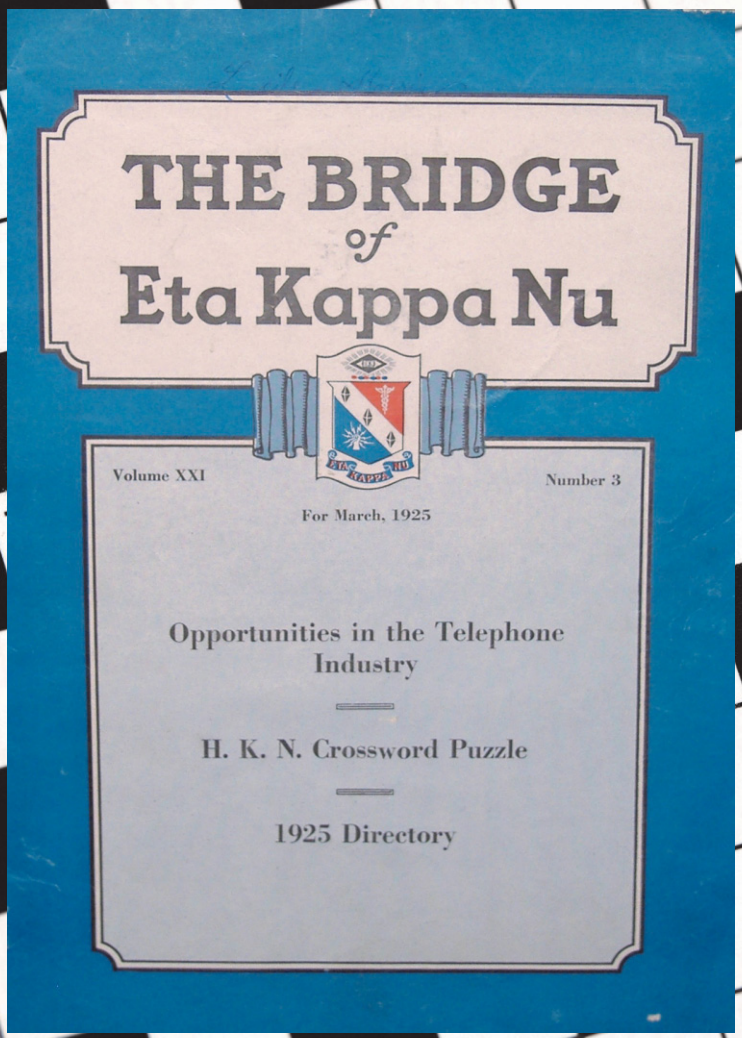
"Engineering - The Challenge of the Future" produced

2002

First Student Leadership Conference at Iowa State University

2009

Outstanding Chapter Activities Presentation at ECEDHA Meeting



CROSSWORD CHALLENGE

Members and chapters have been regular contributors to early issues of THE BRIDGE. The following H•K•N crossword puzzle appeared in the March 1925 issue with the following introduction:

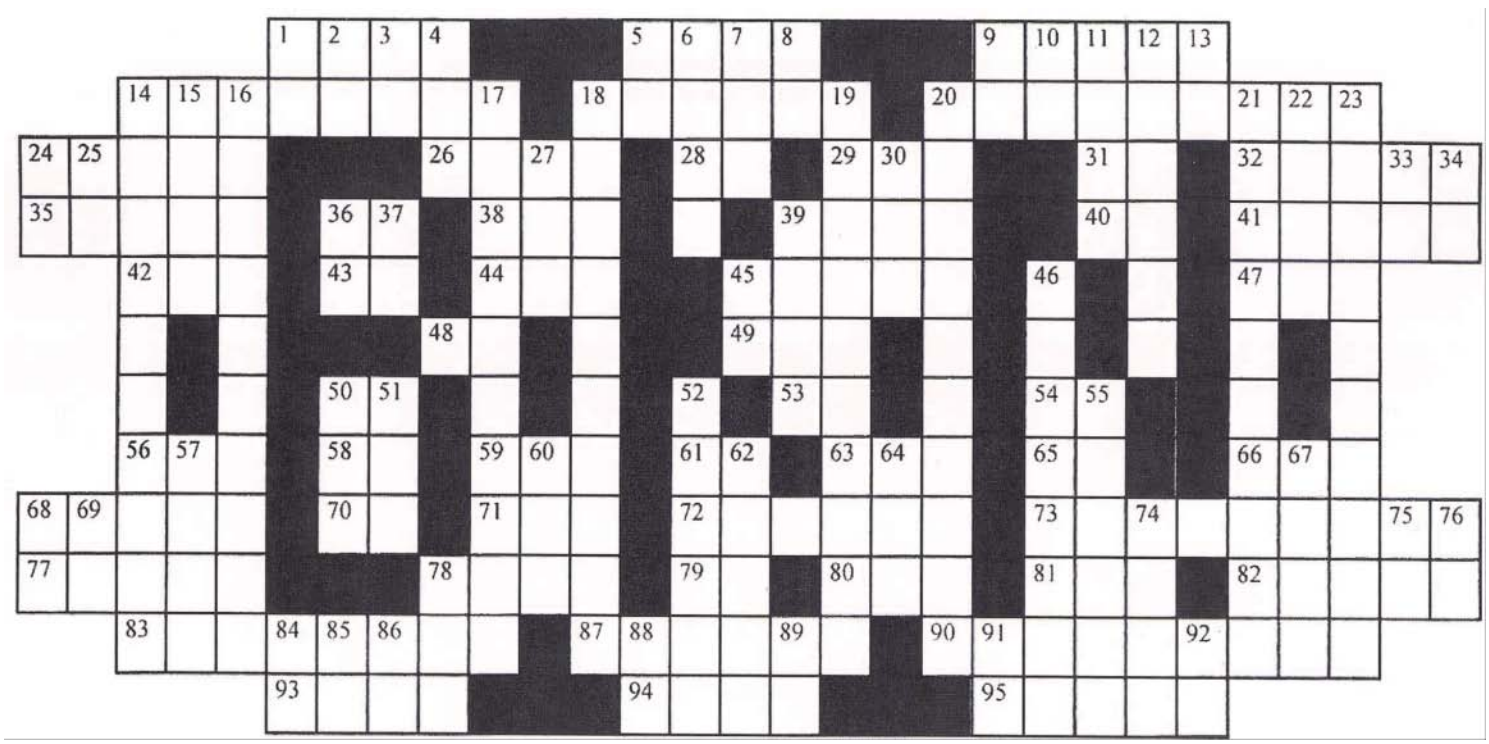
"This crossword was made up especially for THE BRIDGE by Brother Paul W. Kiesling, I '24. Unfortunately, Brother Kiesling has been prevented, by illness, from working since graduation. Having a great deal of spare time on his hands he constructed this exceedingly clever puzzle which we are very glad to print. We hope that Brother Kiesling will enjoy a speedy recovery so that he can start on his life's work."

Paul W. Kiesling eventually located in Denver, Colorado and had a successful career in the electrical power industry.

The names of the first twenty readers who can provide a correct solution by the end of the year will be published in the February issue.

Send your completed crossword to info@hkn.org. Solution to be published in February 2016 issue of THE BRIDGE.

*Note that the answers and clues reflect the time period for language, geography, culture, etc.



Crossword Challenge Clues

Horizontal

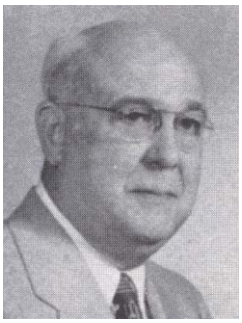
1. A married woman (German)
5. Proposed unit of Conductance (pl)
9. Unit of electric power (pl)
14. Gap
18. The official publication of Eta Kappa Nu
20. Source of an electric current
24. One of the twelve apostles
26. Scottish word for uncouth
28. Trade Mark of large electrical manufacturing concern
29. An accepted standard with which to compare variations
31. A negation
32. Abrasive
35. A warehouse or structure
36. River in Italy
38. A depression between two mountains
39. Ancient weight of money, of varying value
40. Direct current (abbr)
41. An embankment
42. Book of the New Testament (abbr)
43. Prefix meaning: Into or on
44. Personality
45. Review briefly
47. In behalf of
48. Aloft
49. Recite
50. Alternating current
53. State bordering on Georgia (abbr)
54. New Testament (abbr)
56. Personal pronoun "thou" "you" (Latin)
58. Very (scientific prefix)
59. Insect
61. Government department (abbr)
63. Past of light
65. Musical note
66. To steep or soak, as flax
68. Japanese statesman and financier
70. The sacred sound and spiritual icon in Indian religions
71. Sheltered side
72. A large richly laden ship, as formerly of Ragusa
73. A mode of action
77. A plant that dies after flowering (pl)
78. To fasten
79. Read (abbr)
80. Evil spirit
81. Same as 63 horizontal
82. A dwarf
83. The process of designating by figures
87. Sagacious
90. Pertaining to the doctrine that pleasure is the chief good
93. Wasted
94. A circuit or journey (archaic)
95. Sword (Latin)

Vertical

1. A French silver coin (in 1925) (abbr)
2. Right (abbr)
3. Precious element (symbol)
4. Country of South America (abbr)
5. Title of address (abbr)
6. Lofty
7. A brief poem
8. Relative weight (abbr)
9. Personal pronoun
10. Indefinite article
11. To move in a certain direction
12. A path or road
13. A continent (abbr)
14. Equals $\frac{Hx1x10}{4\ pi}$ (singular)
15. The stern of a vessel
16. Zealot
17. The brain
18. An instrument made by inserting in the moving coil of a sensitive D'Arsonval glvanometer, a bismuth-antimony thermo-couple, so that one-hundred-millionth of a degree centigrade can be measured (pl)
19. A curve
20. A process for producing engravings
21. Automatic aerial transportation by electricity
22. A Hebrew measure of 5.1 pints
23. A round of successive changes
24. A state bordering on Iowa (abbr)
25. For example
27. A tenon
30. Literary bits
33. Musical note
34. Nominative plural of the personal pronoun of the second person
36. Geometrical ratio
37. Condition of adherence
39. Intermediate as to time
45. Coin of British India (in 1925) (abbr)
46. Musical Instrument
50. Containing nitrogen
51. Device to convert rotary into reciprocating motion
52. Of, abounding in, or like spar
55. Subjects of discussion
57. Boss or knob
60. New (Comb form)
62. Degree of algebraic expression
64. A doctrine or system: Satirically
67. A small vessel for boiling water
68. An exclamation
69. Energy depending on motion (abbr)
74. A case for carrying small articles
75. Same as 70 horizontal
76. New England (abbr)
78. A bugle note
84. An eastern Governor (nickname)
85. Toward
86. Form of verb "to be"
88. Personal pronoun
89. Personal pronoun
91. Presiding Elder (abbr)
92. Same as 45 vertical

HKN/IEEE-HKN EXECUTIVE SECRETARIES/DIRECTORS

1928-1931	J.A. Umhoefer
1931-1934	Leyland A. Spangler
1934-1958	Alton B. Zerby
1958-1988	Paul Hudson
1988-1999	J. Robert Betten
2000-2005	Ron A. Spanke
2005-2006	Robert M. Janowiak
2006-2010	R. Plummer
2010-2011	Fern Katronetsky
2012-Present	Nancy Ostin



Alton B. Zerby

Nancy Ostin

Paul Hudson

J. Robert Betten

Ron A. Spanke

Robert M. Janowiak

Fern E. Katronetsky

PRESIDENTS' MEMORIES

"The stress on the Association's activities has changed throughout the years to fit the times. For example, during the Depression of the 1930s, Eta Kappa Nu's top priority—especially for its alumni chapters—was to help members find work. During its 78 years of existence, Eta Kappa Nu has always, as its main purpose, demanded more than scholastic excellence from its membership: Voluntary contributions to people, schools, and the electrical engineering profession "

-- Larry Dwon, 1958-1959 Eta Kappa Nu President (Taken from the "Looking Back" column, IEEE Potentials, vol. 1, no. 1, pg. 48, 1982).

"When I attended the University of Detroit-Mercy Beta Sigma Chapter induction last April, much to my surprise, they still incorporate the [shield] light-box used to explain the Eta Kappa Nu emblem as when I was inducted over 40 years ago. Although a bit of an antique now, the light-box brought back many wonderful memories and a sense of pride in my Chapter for trying to maintain continuity across the generations of Chapter inductees."

-- Evelyn H. Hirt, 2015 IEEE-Eta Kappa Nu President.

Before STEM was STEM

By Nancy Ostin, Director, IEEE-HKN

Before STEM was STEM, HKN was involved in encouraging students to consider careers in engineering. To accomplish this, two films: "Engineering – A Career for Tomorrow" and "Engineering – The Challenge of the Future" were produced. These two films were made by HKN in cooperation with The Institute of Electrical and Electronics Engineering (IEEE). Over the history of both organizations, there are many examples of cooperation, joint programs, shared leadership, and goal; the synergy between HKN and IEEE spans the century before the merger in 2010.

In 1953, the HKN 50th Anniversary Project Committee was looking for an idea to mark this milestone for Eta Kappa Nu in a meaningful way. The committee decided that the best idea would be to find a way to encourage young students to consider a career in engineering and to raise awareness of what an engineer is, and what they do. The committee decided to create an engineering career guidance film that could be shown to high school and college students.

Jack Farley chaired the movie committee and oversaw the production of "Engineering – A Career for Tomorrow." It was filmed at the University of Illinois, Urbana-Champaign with assistance (and film clips) from several Illinois companies. It takes place at a high-school career day, where "Joe Williams," a high school student, meets with "Mr. Paul Kelly," an engineer who explains the requirements to be an engineer, what engineering college work is like, and what he and other engineers do in their careers in industry.

The premier showing was on 13 May 1955 to over 75 people in industry, and those involved in

Image from "Engineering – A Career for Tomorrow" which was a career guidance film produced by HKN for its 50th anniversary.

producing the film. Over 130 copies were placed in the libraries of high schools, colleges, and businesses.

The second film, "Engineering – The Challenge of the Future" was made in 1967, as an update to the first film, and to reflect the rapid changes that were taking place in technology and the field of engineering. One thing striking about watching the two films together is the way the engineering profession had changed in the intervening years. In the earlier film, calculations are done manually, and the areas of engineering most stressed are power and communications. In the latter, engineers work at computer terminals, and much time is devoted to newer fields--including space exploration, electronics, and environmental engineering.

The movie committee raised $40,000 from the generosity of AT&T, IBM, RCA, Commonwealth

Edison, and other companies. With the expanded scope of the second film, IEEE became a co-sponsor. Over 300 copies of the film were sold to industry libraries, schools, colleges, and HKN and IEEE chapters. HKN and IEEE chapter members were encouraged to present the film to local high schools. This method of distribution increased the reach and impact of the film, having been shown to many thousands of high school and college students. The premier showing of the film was held at the HKN Outstanding Young Electrical Engineer of the Year Award ceremony on 24 March 1968.

The second film is a more sophisticated production, no doubt due to a larger budget that allowed for the use of a professional production company, and the participation of industries throughout the US. It features many engineering students, engineering professors, and working engineers talking about their training and work. It emphasizes how engineers work to solve society's problems, going beyond only solving industrial problems for their employers.

These films were made before STEM was STEM. HKN was a leader in promoting both engineering, and encouraging young people to consider a career in engineering, and answering the questions: What is an Engineer? What does an Engineer do? How does an Engineer help people? What happens after I graduate – What are the careers available?, and What does an Engineer do in the workday world?

When founded in 1904, one of the primary focuses of HKN was to help students to find jobs and network for all career engineers. After World War II, a new focus, one to encourage young people to consider engineering, evolved from the growing need for engineers in industry. Today, IEEE-HKN students and chapters are charged with service to others--on their campus, in their discipline, and in the community. Most do outreach to pre-university students, promote engineering curriculum and challenges, assist robotics groups or clubs, invite high school students on campus, and more. Last year alone, IEEE-HKN chapters performed over 55,000 hours of community service.

HKN Timeline of John (Jack) Farley

1947 - Inducted Alpha Chapter

1948 - Corresponding Secretary, Alpha Chapter

1953 - 50th Anniversary Project Committee; became first movie committee

1954 - President of the Chicago Alumni Chapter

1955 - Chairman of the HKN Movie Committee

1965-
1969 - HKN Board of Directors

1967-
1978 - Outstanding Young Engineer of the Year Jury

1968 - HKN Vice President

1969 - HKN President

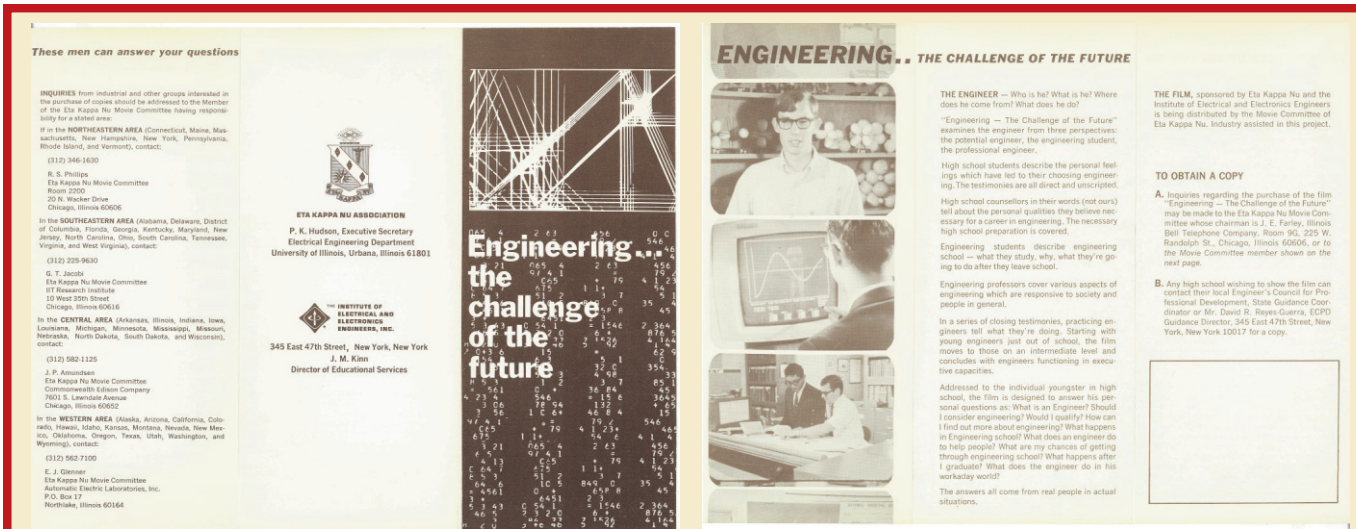
1972-
2000 - Outstanding Student Jury

1979 - Received the HKN Distinguished Service Award

1984 - Installed the Iota Beta Chapter at the Milwaukee School of Engineering

1986 - Installed the Iota Lambda Chapter at the University of Illinois, Chicago

John (Jack) Farley HKN President-1969; Chairman of the HKN Movie Committee



Promotional Brochure for the film "Engineering... The Challenge of the Future" (outside/inside)

Image from "Engineering – A Career for Tomorrow"

Instrumental in the making of the movies was Jack Farley. Now with 68 years of HKN involvement, he shared with me his memories of HKN, the experience of the movie committee, and his years on the Executive Board, and as President. He told me in a recent conversation that he was proud of "getting young people interested in Engineering, and to pursue a career in engineering. It was gratifying to produce these movies and to tell the story of engineering and that "Engineers are not the ones who drive the trains." His daughter, Daryl Farley Varney, second generation Eta Kappa Nu (inducted Alpha Chapter 1981), and Jack are organizing his papers and preparing to share with HKN and our archives his memorabilia and records so they can be part of the permanent collection in the IEEE History Center, HKN archives.

At the 75th Anniversary celebration of HKN (1979), Jack was quoted saying, "It is hard for me to realize 25 years have passed so quickly. But, I am looking forward to the next 25 years, and to the really big one – Eta Kappa Nu's 100th Anniversary in 2004." Jack Farley attended the 100th Anniversary of HKN at the University of Illinois, Alpha Chapter. He arrived with DVDs of the original film and the second film, "Engineering – The Challenge of the Future." The movies were played at the anniversary ceremony to commemorate the idea started 50 years earlier.

When I first spoke to Jack in 2014, the 110th year, and now as we celebrate five years of the merger with IEEE, he has shared many wonderful memories of his volunteer days with HKN; having been recruited by previous Executive Secretary Paul Hudson, his own experience with Bell Labs and using transistors to build the equivalent of the cell phone (for the railroad industry, for those in the back of the train to communicate with the Engineers--the other kind!), as well as his work in the 1950's during the cold war with Western Electric on defense-related projects. But mostly, that his most gratifying experiences were those in service to Eta Kappa Nu, and the contributions that have impacted thousands of young people, and in the value of Eta Kappa Nu.

IEEE and HKN--a shared vision and goal over the past century, merged in 2010, and are today moving forward together to continue the mission to encourage excellence, promote engineering, recognize individuals who through their exemplary scholarship, character and attitude represent the highest ideals of our profession.

Film Sponsors:

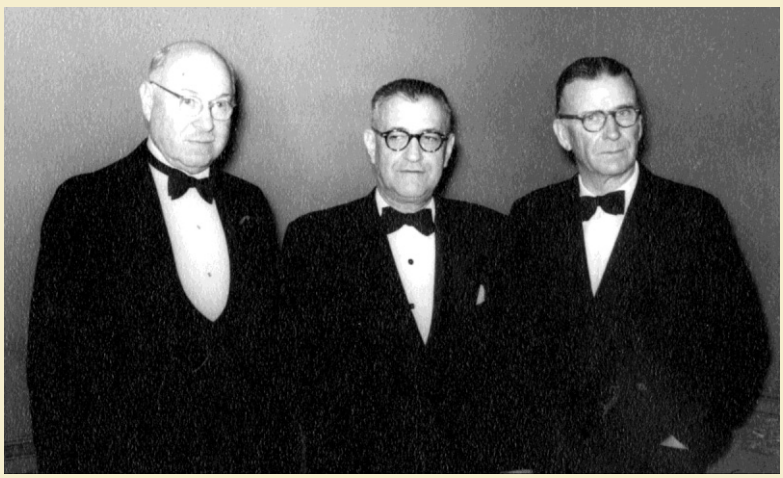
Companies financially supporting the production of the HKN film (Engineering – The Challenge of the Future):

A. B. Chance Company, American Telephone and Telegraph and Associated Companies, Baltimore Gas and Electric Company, Commonwealth Edison, Engineers' Council for Professional Development, General Telephone and Electronics Family of Companies, Honeywell Inc., Hughes Aircraft Company, IBM Corporation, Kearney-National Inc., McGraw-Edison Power Systems Div., Moloney Electric Company, Northern States Power Company, RCA, RTE Corporation, Southern California Edison Company, The Motorola Foundation, and Xerox.

Engineering Career Info:

- IEEE Pre-University
- EPICS in IEEE
- TryEngineering.org
- TryComputing.org
- TryNano.org

HKN MEMORIES



Eminent Members at the HKN 1953 Awards Dinner, January 1954: L-R: Prof. Reinhold Ruderberg (Harvard), W. R. G. Baker (GE), Mervin J. Kelly (Bell Labs)

1925 San Francisco Alumni Gathering

1937 HKN Banquet

Student Leadership Conferences 2002-2016

IEEE-Eta Kappa Nu provides many opportunities for its student members to develop leadership, communication, and organizational skills. Among those opportunities is the Student Leadership Conference (SLC) program. Since 2002, twelve conferences have been held across the U.S. SLC's bring student leaders and members together with leaders in the profession. Activities include chapter networking, leadership training, and distinguished lectures.

Each conference has been hosted by the local HKN/IEEE-HKN chapter with support from the HKN/IEEE-HKN leadership and staff, and from industry. The conferences with their host chapter and theme are shown below.

- 2002 Nu Chapter, Iowa State University
  "National Leadership Conference"
- 2004 Alpha Chapter, University of Illinois at Urbana-Champaign
  "Centennial Conference: Leading, Learning and Growing for the Past 100 Years"
- 2006 Beta Chapter, Purdue University
  "HKN Discusses Leadership Skills for Your Future"
- 2007 Mu Chapter, University of California, Berkeley
  "Making a Difference: Leadership through Innovation"
- 2007 Gamma Theta Chapter, University of Missouri-Rolla (now Missouri S&T)
  "Leadership for a New Century"
- 2008 Sigma Chapter, Carnegie Mellon University
  "In Pursuit of Excellence: Achieving Results through Leadership and Innovation"
- 2009 Theta Tau Chapter, University of Michigan, Dearborn
  "Driving Towards Tomorrow's Technology"
- 2010 Beta Xi Chapter, University of Oklahoma
  "Engineering in a Multidisciplinary World"

Gene Frantz, Texas Instruments Engineer, presents "The Speak and Spell™: The Birth of the DSP" at the 2014 SLC.

Opportunity to network at the 2009 SLC

- 2011 Alpha Chapter, University of Illinois at Urbana-Champaign
  "Engineering Creative Leadership for the Future"
- 2013 Epsilon Beta Chapter, Arizona State University
  "Individual Growth and Professional Development"
- 2014 Nu Chapter, Iowa State University
  "National Student Leadership Conference"
- 2015 Mu Chapter, University of California, Berkeley
  "Student Leadership Conference"
- 2016 Beta Epsilon Chapter, University of Michigan, Ann Arbor, to be held on 1-3 April

"The World of 2030" Panel answers questions during the 2007 SLC , Gamma Theta Chapter, University of Missouri-Rolla.

2013 Student Leadership Conference - Epsilon Beta Chapter, Arizona State University

During the first few decades of the organization, HKN held annual conventions. A few additional conventions were held, including one in 1954 for the 50th anniversary. These early meetings were primarily business meetings for chapter voting delegates. The focus of the modern conferences is on student members with training and educational programming. Any chapter interested in hosting a student leadership conference should contact IEEE-HKN Headquarters at www.hkn.org. A Student Leadership Conference showcases the institution of the host chapter and provides significant experience with conference planning for the local student leaders. If your chapter would like to apply to host the 2017 Student Leadership Conference, please visit http://bit.ly/SLCHostapplication for more information.

Attendees at 2015 Student Leadership Conference, Mu Chapter, UC Berkeley

Student Leadership Conferences Photo Gallery

2006 Student Leadership Conference -
Beta Chapter, Purdue University

2007 Student Leadership Conference -
Mu Chapter, University of California, Berkeley

2007 Student Leadership Conference - Gamma Theta Chapter,
University of Missouri-Rolla (now Missouri S&T)

2008 Student Leadership Conference -
Sigma Chapter, Carnegie Mellon University

2009 Student Leadership Conference -
Theta Tau Chapter, University of Michigan, Dearborn

2014 Student Leadership Conference -
Nu Chapter, Iowa State University

JOIN US FOR THE 2016 STUDENT LEADERSHIP CONFERENCE!

The annual IEEE-HKN Student Leadership Conference (SLC) is a premier event of IEEE-Eta Kappa Nu. Each year, students from all over the world gather at a different IEEE-HKN university chapter for an exciting and informative weekend of programs, and the opportunity to network with fellow students, industry experts, and the IEEE-HKN Board of Governors.

The 2016 Student Leadership Conference will be held on 1-3 April 2016, by the Beta Epsilon Chapter at the University of Michigan, Ann Arbor. The conference will focus on conversations about the role of the profession in society, while looking forward to emerging fields. Beta Epsilon is looking forward to seeing IEEE-HKN's current and future leaders come together to meet and collaborate for the betterment of our organization, and to apply the lessons learned for the benefit of their chapters and careers.

EMAIL INFO@HKN.ORG FOR MORE INFORMATION ON SLC 2016!

PRESIDENTS' MEMORIES

Richard Gowen, HKN President 1998- 2000

"It has been a privilege to be elected to HKN as an undergraduate in electrical engineering at Rutgers University and to also have the opportunity of serving HKN for two years as HKN President. It has been an honor to chair the Eminent Member Nominating Committee."

Eric Herz, HKN President 2003-2004

"For me, the most pleasant and rewarding experiences in HKN were in attending Eminent Member inductions and in participating in Eminent Member nominations."

Karl Martersteck, HKN President 2004-2006

"As for my favorite HKN memories, I would say that participating in the installation of new HKN chapters and inducting new Eminent Members top the list. The enthusiasm of new chapter members and faculty was always infectious and the satisfaction and appreciation of eminent members being publicly recognized by their peers was inspiring."

Dave Irwin, HKN President 2006-2008

"It is an honor to be a part of HKN. Serving on the Board of Governors and working with students has been one of the most rewarding experiences of my career. I am proud of the history of HKN and am very optimistic about the future of IEEE-HKN."

Bruce Eisenstein, HKN President 2008- 2010

"My term of office as HKN President spanned the three-year period from initiation of the idea to merge with IEEE through the merger. I am pleased that the result has led to the vibrant and strong IEEE-HKN that we envisioned a decade ago."

Stephen Goodnick, IEEE-HKN President 2011-2012

"As the first president of IEEE-HKN post-merger, I am very optimistic about the future growth of the organization, and very happy with the progress that has been accomplished over the past five years. One of the highlights of my tenure as President was the installation of the first IEEE-HKN Chapters outside of Regions 1-6."

John Orr, IEEE-HKN President 2013-2014

"Among my strongest memories from my time as President was my good fortune in meeting and conversing with some of our Eminent Members. These people take our core mission, the recognition of excellence in ECE and related fields, to the highest possible level. The inspiration that we receive from people like these represents a vital part of IEEE-HKN's continuing value."

HKN to IEEE-HKN

Objectives of the IEEE-HKN Merger

By Moshe Kam
Beta Alpha Chapter
Dean, Newark College of Engineering, NJIT
2011 IEEE President

Moshe Kam

The merger of IEEE and Eta Kappa Nu was the initiative of a group of volunteers, most of whom served both IEEE and Eta Kappa Nu. Several of these volunteers were Past Presidents of Eta Kappa Nu.

The first meeting on the merger took place in February 2005 in Scottsdale, Arizona. In this meeting, concerns were raised about the exclusive North-American focus of Eta Kappa Nu (at the time, all HKN Chapters were in the United States, and there were only preliminary steps taken to establish HKN Chapters in Canada). It was felt that lack of financial resources stifles HKN and prevents it from growing. In comparison with other engineering and science student honors societies, HKN seemed to be static, somewhat stagnant, very traditional, with little prospects for growth and innovation. There were islands of intense activity and original programs here and there, but these were isolated and relied more on local action by few industrious volunteers than on focused planning for the long haul.

There were parallel concerns at IEEE, regarding student retention and student leadership. IEEE was able to attract large numbers of student members, but retaining them as IEEE members after they have graduated with a Bachelor of Science degree proved difficult. The issue was traced to limited success in encouraging and recognizing student leaders. It was noted that HKN was much more successful than IEEE in identifying, training and nurturing future leaders among its student inductees.

It was also recognized that HKN was already heavily involved with the IEEE Educational Activities Board (EAB), and that many joint IEEE-HKN activities already take place, mostly under the auspices of EAB.

The apparent shortcomings and opportunities that characterized both organizations prompted the volunteers to suggest a merger. HKN would become transnational and would benefit from the financial resources, stability and infrastructure of IEEE. IEEE would benefit from the student-leadership training and nurturing that HKN excelled in fostering. IEEE would use HKN programs to enhance IEEE's appeal to students, as well as improve student retention and recruiting.

2010-Signing the merger documents

Five years after the merger, it appears that the observations of the 2005 discussion group were correct. HKN has expanded significantly since the merger, and now has many new chapters in venues outside North America, including Hong Kong, India, Qatar, Malaysia, and South Africa. New chapters are currently being formed in Abu Dhabi and Egypt. HKN is growing; it is more attractive to potential inductees; it is vital and innovative. HKN offers new programs and extensive training opportunities to student leaders. At the same time, IEEE benefits directly from the presence of HKN student leaders within IEEE ranks. Retention of IEEE-HKN members is significantly higher than that of IEEE student members who are not in HKN. The 2005 analysis appears to have been accurate. The steps taken as a result of this analysis, namely the fostering of the HKN-IEEE merger, have yielded the very results expected by the planners.

2010-Dick Gowen, IEEE Foundation President;
John Vig, IEEE President & CEO;
and Bruce Eisenstein, HKN President

Seated left to right: Dick Gowen, John Vig, Bruce Eisenstein.
Middle row: Arthur Winston, Fern Katronetsky, Eric Herz, Joe Lillie, Lewis Terman, Cecelia Jankowski and Teofilo Ramos
Back Row: Mike Lightner, Moshe Kam, Howard Michel, Evelyn Hirt, David Hodges, Pedro Ray, and Doug Gorham

HKN to IEEE-HKN (continued)

IEEE-HKN: View of the Future

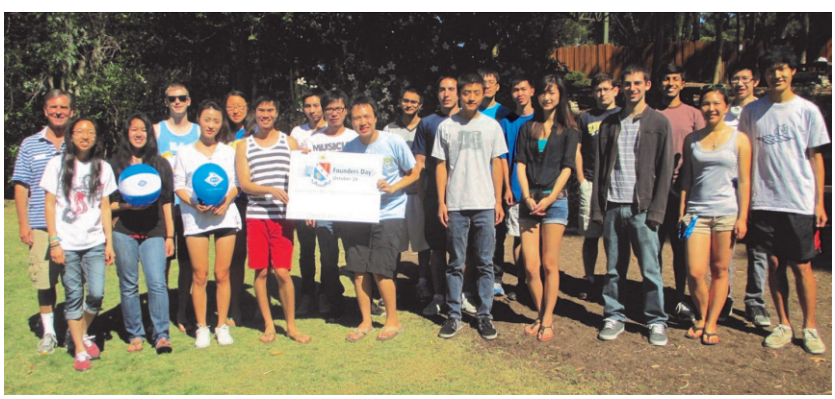
By S.K. Ramesh
Lambda Beta Chapter
Dean, College of Engineering and Computer Science, California State University, Northridge
2016 IEEE-HKN President

S.K. Ramesh

I am delighted to have an opportunity to share my thoughts and ideas with you on the future of IEEE-HKN, and the exciting times ahead. As I was reflecting on my thoughts for this piece, there was one statistic that stood out among the numerous wonderful contributions that our organization has made over its history: Over 50,000 hours of service to the community in the past year alone! And that's just from the twenty-three IEEE-HKN chapters that were selected for recognition as Outstanding Chapters during the past year. Collectively, when you consider the service contributions of all IEEE-HKN members in chapters around the world, you begin to appreciate the power and significance of our work. Our core values recognize and promote distinguished scholarship and innovation, inspire leadership, build character, and above all, encourage and recognize service to the profession and community. To me, IEEE-HKN is one of the finest exemplars for IEEE's tag line: "Advancing Technology for Humanity," and our members continue to make a difference in people's lives through their contributions every single day. On Founders Day (28 October) many of our chapters have celebrations and participate in service activities. We invite all of our alumni to join in and tweet #IAMHKN on 28 October.

Also, 2015 was a year to celebrate for our signature publication, THE BRIDGE. In 2015, THE BRIDGE received the APEX 2015 Award in the "Print Media-Special Purpose" category, coming on the heels of the APEX 2014 Award of Excellence in the "Most Improved Magazines, Journals & Tabloids" category. Our congratulations to the entire team and the Editorial Board on these well-deserved accolades!

Elsewhere in this issue, you can read about the progress we have made post-merger, and the challenges that we need to address to sustain and grow IEEE-HKN. As engineers, this is nothing new to us. We solve problems every day subject to "real-world" constraints, and discover along the way that the challenges often recede in the rear-view mirror while new opportunities emerge on the road ahead. Broadly, our strategic goals over the next five years are as follows: (1) Realize sustained membership growth; (2) Establish financial security; (3) Expand signature activities; (4) Grow alumni participation; (5)



The Iota Gamma Chapter, UCLA celebrates Founders Day

Celebrating Founders Day on 28 October

Students at the Epsilon Sigma Chapter, University of Florida, celebrate Founders Day

Integrate IEEE-HKN fully into IEEE; and (6) Establish Corporate Partnerships. Let me expand briefly on two of those goals: Membership and Financial Security.

The Board of Governors and staff have been focused on strengthening membership as a priority to build renewed interest in IEEE-HKN. We have over 10K alumni members worldwide, and over 2K in Regions 7-10. Consider also that we have over 8.7K active IEEE members within IEEE-HKN, with more than 360 in Regions 7-10, to help IEEE-HKN grow globally. We had 179 active chapters in 2014, compared to 97 in 2012. The presentations that we made during IEEE Sections Congress in August 2014 were well received and point to the growing interest in IEEE-HKN worldwide. These are good trends, but we still have work to do. We need to engage members and mentor/support students by continuing to focus on reactivating the remaining dormant chapters in Regions 1-6. Along these lines, you may have noticed that we are adding products, services, and engagement opportunities to increase the value of IEEE-HKN membership and support to IEEE-HKN chapters. Clearly, we need to increase revenue and build a strong financial foundation to support the growth of IEEE-HKN on the road to self-sufficiency. We will be working to increase donations to all three IEEE-HKN Funds in the IEEE Foundation through targeted campaigns. Strategically, we need to strengthen the partnership between IEEE-HKN and relevant industries in IEEE fields of interest. In the coming year, we will make it a priority to establish an industry advisory board and develop a corporate sponsorship program and a corporate recruiting program for IEEE-HKN members. I really think that this is critical to our future. Stay tuned for more information on these exciting endeavors.

Epsilon Xi chapter, Wichita State University, Chapter signature book and induction certificate

In closing, it truly is an honor and a privilege to serve you, and I look forward to working closely with the Board of Governors and Staff to ensure the success of our organization and build a stronger IEEE-HKN in the year ahead. I know we will continue the tradition of service and professionalism that marks IEEE-HKN as a shining beacon amongst professional honor societies. Meanwhile, if you have any suggestions or comments to improve our chapters and serve our members, please don't hesitate to let us know.
Mark your calendars and plan to attend the annual Student Leadership Conference at the University of Michigan in Ann Arbor in 2016, and have a great year ahead!

SUPPORTING IEEE-HKN

Support Our Future Leaders

By Jacqueline Quigley, IEEE-HKN Staff and Richard Allen, IEEE Foundation

As we recognize the fifth anniversary of the IEEE-Eta Kappa Nu merger and the 111th anniversary of Eta Kappa Nu, we thank you for your continued dedication and enthusiasm for the mission of IEEE-Eta Kappa Nu (IEEE-HKN), the Honor Society of IEEE.

Anthony Sutardja, 2015 SLC Conference Chair, Mu Chapter, welcomes attendees

Throughout the last 111 years, each HKN member has played an important role to ensure that Eta Kappa Nu continues to follow the vision first outlined by its founders in 1904. Many technological advances have impacted and changed the world during Eta Kappa Nu's lifetime, but Scholarship, Character and Attitude remain the guiding principles upon which the activities and objectives of IEEE-HKN are based. You are the reason that the mission of IEEE-HKN continues to inspire students and alumni members today.

One of the most valuable and satisfying aspects of membership in IEEE-HKN is the important opportunity for students and professionals to meet and work with fellow members at their local chapter and section to navigate real-world challenges. In addition, IEEE-HKN provides an annual venue for students from all over the world to gather at the IEEE-HKN Student Leadership Conference.

This year's Student Leadership Conference, held on 20-21 March 2015 at the Mu Chapter, University of California-Berkeley, was another successful event in the history of the conference. More than 120 students from around the globe attended the event held at the spectacular California Memorial Stadium on the UC-Berkeley campus. A student attendee from the Kappa Chapter, Cornell University commented: "Thank you so much! IEEE-HKN means so much to me. It is more than just a network or something I can put on my resume; it is a legacy, a community, and a part of my life that I feel truly honored to be a part of." The Mu Chapter planned an excellent agenda with featured speakers from Texas Instruments, General Motors, and leading Silicon Valley companies such as Coursera. Through various sessions on technology and industry developments, students gained valuable leadership and career skills. The Mu Chapter was also recognized for its 100th anniversary by the IEEE-HKN Board of Governors.

The success of this event created even more enthusiasm for the upcoming 2016 Student Leadership Conference, which will be held at the Beta Epsilon Chapter at the University of Michigan, Ann Arbor, Michigan, USA. The Student Leadership Conference continues to be the premier event on the IEEE-HKN calendar, and the only annual opportunity for IEEE-HKN students from around the world to gather at one central event to network with students from other chapters, faculty advisors, industry experts, and the IEEE-HKN Board of Governors.

The Student Leadership Conference is such a valuable event for IEEE-HKN students; therefore, IEEE-HKN provides travel stipends to each attending chapter to help alleviate some of the travel costs. In some cases, this stipend may mean the difference as to whether a student or chapter can attend the conference.

As the conference continues to grow and serve more students, the need for support for travel stipends has increased. Your past gift to the Student Leadership Conference has played an important role in expanding the conference's ability to reach more students and chapters.

To ensure that this growth continues in the future, we ask your consideration of a new gift to the IEEE-HKN Student Leadership Conference. A gift of $250US would fully fund a stipend for a school chapter. Gifts of $100US or more will be recognized in the Annual IEEE Foundation Honor Roll of Donors. Gifts of any amount are greatly appreciated.

All gifts are accepted by the IEEE Foundation and directed to the IEEE-HKN Student Leadership Conference, and are tax-deductible as allowed by law. The IEEE Foundation is a 501(c) 3 organization.

For more information on how to make a secure gift on-line, please visit www.ieeefoundation.org/Donate and select "IEEE-HKN Student Leadership Conference" in the designated pull-down box.

If you prefer to mail your gift, please send your check to this address: IEEE FOUNDATION, 445 Hoes Lane, Piscataway, NJ 08854, U.S.A.

Please note that your check should be designated to the "IEEE-HKN Student Leadership Conference," and please note code "BridgeOct15" on your check. If you need additional information to complete your donation, please contact the IEEE Foundation at 1-732-465-5871 or email donate@ieee.org.

We are very grateful for your interest and support in the continued growth of IEEE-HKN and the Student Leadership Conference. Please contact us with questions at www.hkn.org, or 1-800-406-2590.

Team Challenge event at the 2015 Student Leadership Conference Welcome Reception

Pure Storage Puzzle Hunt Challenge at the 2015 Student Leadership Conference

Strategizing for the Pure Storage Puzzle Hunt Challenge

New and Reactivated Chapters

The Lambda Psi Chapter - University of Johannesburg New Chapter Installation and Member Induction Ceremony

By Christiaan Mostert (Secretary)

"I sincerely promise that I will live up to, in word and in deed, the principles for which IEEE-Eta Kappa Nu stands. To the members now and to those to come after, I bind myself to the faithful observance of these promises. I give my solemn word of honor."

Prof. Saurabh Sinha, IEEE Vice President, Educational Activities, and Executive Dean of the Faculty of Engineering and the Built Environment, installs the Chapter and presents the Chapter proclamation to Prof. Johan Meyer, Head of the School of Electrical and Electronic Engineering.

These were the words spoken by the eleven inducted charter members and one Faculty Advisor of the new IEEE-HKN chapter, Lambda Psi. This Chapter was formally installed by the IEEE Vice President, Educational Activities and Executive Dean of the Electrical and Electronics Engineering Department of the University of Johannesburg, South Africa, Professor Saurabh Sinha, on 14 July 2015.

The University and charter members are honored to create the 237th Chapter of Eta Kappa Nu, and the second Chapter in IEEE Region 8. The Chapter will provide a channel that will be used to support students, as well as honoring and giving recognition to those who will join Lambda Psi in the future. It aims to influence the relationship between faculty, industry, and students, and create open communication.

The Chapter members will motivate, encourage and set an example for other students by exhibiting the three central ideas of IEEE-HKN. These ideas are *Scholarship*, which includes common sense and resourcefulness; unimpeachable *Character*, including sound judgment, ethical behavior and a willingness to work hard; and a positive *Attitude* and outlook on life, including tolerance for others and dependability. Through these actions and conduct, Lambda Psi aims to improve our school, aid and assist the community, and contribute to the engineering profession as a whole.

Lambda Psi's IEEE-HKN Inductee Ceremony of 14 July 2015: Front Row, Left – Right: Reolyn Heymann, Johan Meyer, Howard Michel, Saurabh Sinha, Pieter Erasmus
Back Row, Left – Right; Vuyana Ngwenya, Renier Swannepoel, Ronald Moorcraft, Miguel Carvalho, Vusi Mathebula, Christiaan Mostert, Mzolisi Makalima, Jabulile Sikwela, Bethuel Mashilo, Eduard Basson

We express our gratitude to the IEEE-Eta Kappa Nu organization, which made the creation of the Lambda Psi Chapter a reality. We are reminded that no full permanent success can be attained by taking the path of least resistance.

Welcome Back to Reactivated Chapters!

IEEE-HKN is proud to welcome back these reactivated Chapters:

- Theta Sigma, University of Bridgeport
- Gamma Sigma, University of Utah
- Kappa Lambda, University of Memphis

We thank the faculty advisors, department chairs, and student members of these Chapters for their dedication to reactivate their Chapters. If you know of a chapter that would like to resume active status, we are eager to work with you. Please contact Nancy Ostin, Director, IEEE-HKN, at n.ostin@ieee.org.

Kappa Lambda-University of Memphis Inductees – 20 April 2015. Pictured: Cody Rumburg, Ankita Mohapatra, David Arellano, James Elliott, Ashlesh Gawande, Landon Holmes, Brandon Howell, Nurmohammed Patwary, Kristina Walter, Charvi Majmudar, Pouya Bashivan, Ruhi Mahajan, William Thomas, Joseph Saliba, Joseph Miller, Nathaniel Warren,Matthew McGuire, Dereje Arega, Md Kamal Hossain, Md Maruf Hossain, Gilmanur Rashid, Hasti Shabani, Chad Lirette, Brandon Conner, Shiloh Guin

IEEE-HKN Professional Inductions – Spring 2015

During the spring of 2015, IEEE-Eta Kappa Nu chapters welcomed three distinguished new members as Professional Inductees. IEEE-Eta Kappa Nu extends our congratulations to these new members, and salutes their achievements.

Gary Tooker, former CEO of Motorola

On 24 April 2015, the IEEE-HKN Epsilon Beta Chapter at Arizona State University inducted Gary Tooker, Arizona State University electrical engineering alumnus, former Motorola CEO, and generous Fulton Schools supporter. "HKN wasn't established at ASU when Mr. Tooker graduated in 1962, and as a result, we want to honor his achievements and thank him for supporting Fulton Schools students," said Weidong Ye, Treasurer of the IEEE-HKN Epsilon Beta Chapter.

Gary Tooker, former Motorola CEO, takes the IEEE-HKN pledge at his induction ceremony at the Epsilon Beta Chapter.

In honor of his contributions to the engineering profession, the National Academy of Engineering (NAE) elected Tooker to become a member in 1996, one of the highest honors an engineer can receive. Mr. Tooker joined Motorola's Semiconductor Division in 1962, following his graduation from Arizona State University. He was promoted to positions of increasing responsibility, including General Manager of the Semiconductor Product Sector, and Chief Corporate Staff Officer and Director in 1986. He was named Chief Operating Officer in 1988, President in 1990, Vice Chairman and Chief Executive Officer in 1993, and was elected Chairman of the Board of Directors in 1996. Mr. Tooker retired from Motorola in 1999, and continued to serve as a company director until 2001. He is a volunteer and advisor to the ASU Fulton School of Engineering, a recipient of the Distinguished Alumnus Award, and an honorary Doctor of Human Letters from ASU.

Congressman Tony Cardenas, District 29, House of Representatives

On 26 May, the IEEE-HKN Lambda Beta Chapter at California State University, Northridge (CSUN) inducted Congressman Tony Cardenas as a member of their Chapter. He represents San Fernando Valley, CA-District 29 in the House of Representatives. Congressman Cardenas also represents Los Angeles on the prestigious House Committee on Energy and Commerce, the oldest of the "authorizing" committees in the House in the 114th Congress.

Congressman Tony Cardenas is congratulated at his induction ceremony by Lambda Beta Chapter Faculty Advisor Bruno Osorno.

Congressman Cardenas is a champion of STEM education and recently reintroduced two pieces of legislation to help encourage greater STEM education for American students. The first bill, H.R. 2056, the Computer Science Career Education Act, will award grants to a consortium between state or local educational agencies, institutions of higher

education, non-profit organizations, and employers with a documented need in the computer science sector. The second, H.R. 2057, the Computer Science in STEM Act, will help equip children with the skills they need to be successful in the 21st century workforce by strengthening computer science education for students from kindergarten through grade twelve. The bill would provide a framework in which state educational agencies and computer science teachers have the resources they need to improve computer science education for their students.

During the Excelencia in Education celebration honoring the CSUN AIMS2 (Attract, Inspire, Mentor and Support Students) program in Washington, DC, in September 2014, Congressman Cardenas shared with the audience his story of having missed the opportunity to accept the invitation to join the HKN Chapter while he was a student at UC Santa Barbara. The Lambda Beta Chapter is proud to welcome Congressman Cardenas in 2015 as Professional Member.

Peggy Nelson, Sector Vice President Engineering and Global Product Development Northrop Grumman Aerospace

Peggy Nelson receives her IEEE-HKN certificate from the Lambda Beta Chapter. From left to right: Catherine Hartnek, Lambda Beta Chapter President; Peggy Nelson; S.K. Ramesh, Dean, CSUN College of Engineering and Computer Science and 2016 IEEE-HKN President; Bruno Osorno, Lambda Beta Chapter Faculty Advisor.

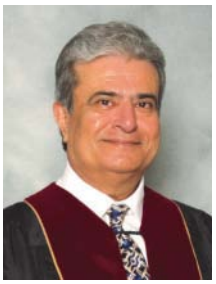
On 15 May, the IEEE-HKN Lambda Beta Chapter at California State University, Northridge, held a ceremony to induct Peggy Nelson, Sector Vice President of Engineering and Global Product Development at Northrop Grumman Aerospace. Ms. Nelson joined Northrop Grumman in 1983, and has held numerous significant positions throughout her career, including: Vice President and Program Manager of Advanced Mission Programs; Vice President of Safety and Mission Assurance; and Vice President and Project Manager for Prometheus 1. She earned her bachelor's degree in mathematics from the University of California, Los Angeles, and a master's degree in electrical engineering from California State University, Northridge. She has also completed the Executive School of Management program at the University of California, Los Angeles.

Ms. Nelson will be retiring from Northrop Grumman later in 2015. Tom Vice, Corporate Vice President and President of Northrop Grumman Aerospace Systems commented: "Leading a complex organization like Engineering and Global Product Development has been Peggy's most prominent role, and perhaps her most poignant — not just for leading a team of 10,000 amazing engineers or developing game-changing products, but also for being a tremendous champion of her team. Peggy has an incredible ability to build strong teams and inspire those teams to create disruptive breakthroughs. In her own words, Peggy believes it's about both the 'heartware' and the hardware. Her passion for fostering the next generation of scientists and engineers is evident in her commitment to science, technology, engineering, and math education -- from primary schools to universities. This is a personal crusade, and I expect Peggy will continue her groundbreaking work in this area long after she retires."

Ms. Nelson was also invited by the President of California State University, Northbridge, to speak at the commencement ceremonies held on 18 May. In addition to her numerous accomplishments in engineering, Ms. Nelson holds a teaching credential, and plans to teach part-time during retirement. Her interests are in Women In Engineering (WIE) and STEM education.

IEEE-HKN AWARDS UPDATE

Three individuals have been selected this year to be recognized for their achievements. These nominations by the IEEE-HKN Awards Committee were approved by the IEEE-HKN Board of Governors and the IEEE Educational Activities Board. The awards will be presented during the 20 November 2015 IEEE EAB Awards Ceremony in New Brunswick, New Jersey. Their accomplishments will be featured in the February 2016 issue of THE BRIDGE.



***IEEE-HKN Eminent Member Recognition:* Dr. Asad Madni**

"for technical attainments and contributions to society through outstanding leadership in the profession of Electrical and Computer Engineering"

IEEE-HKN Outstanding Young Professional Award: Mr. Payman Dehghanian

"for research on reliability-centered maintenance to improve cost effectiveness in the electric power industry"

IEEE-HKN C. Holmes MacDonald Outstanding Teaching Award: Dr. Preethika Kumar

"for dedication to fostering student success through the development of state-of-the-art courses, creation of stimulating classroom environments, and personal attention to every student"

Winslow Sargeant, IEEE-HKN Gamma Beta Alumni, Receives the 2014 IEEE-USA George F. McClure Citation of Honor

On 16 May 2015, the 2014 IEEE-USA Awards were presented at the IEEE-USA Annual Meeting. The George F. McClure Citation of Honor was presented to Winslow Sargeant, Ph.D., (Region 2), IEEE-HKN alumnus of Gamma Beta Chapter.

From Left to Right: Winslow Sargeant, 2014 recipient of the George F. McClure Citation of Honor, and Ron Jensen, Treasurer, IEEE-HKN Board of Governors

This recognition is awarded to honor members who have made exemplary contributions toward achieving the aims of professional activities in the United States.

Dr. Sargeant was recognized "for his dedicated representation of small business, especially technology start-ups, and his efforts regarding intellectual property rights and their effects on small business and entrepreneurs."

Dr. Sargeant is Managing Director of S&T, LLC, a firm supporting investment and business development for early-stage growth companies in cybersecurity, energy, communications, capital formation, and education. From 2010 to 2015, President Obama appointed him to the position of Chief Counsel for Advocacy in the U.S. Small Business Administration's Office of Advocacy.

IEEE-HKN Board of Governors Treasurer Ron Jensen attended the IEEE-USA Awards presentation and offered his congratulations to Dr. Sargeant on behalf of IEEE-HKN. Mr. Jensen noted that Dr. Sargeant mentioned his induction into HKN during his acceptance speech.

IEEE-HKN extends our congratulations to Dr. Sargeant.

Share Your IEEE-Eta Kappa Nu Pride

Official Society Merchandise Now Available

Medal $20	Honor Stole $20
Three Pin Types:	Honor Chord . . . $30
Crest $12	6" Table Covers . $99
Emblem $12	Key Pendant . . . $14
Key $12	Scarf $22
	Necktie $25

Save $10 by purchasing the "honor combo" one honor cord and one honor stole for $40

Save $21 by purchasing 10 of the same style pin for $99

New Items!

T-Shirts - $15.00

HKN Decals - $6 for 1, $50 for 10, $100 for 25

Gavels - $30.00

All items available at the IEEE-HKN store at:
http://bit.ly/HKNStore

HKN

IEEE
Advancing Technology for Humanity

MEMBER PROFILE

Howard E. Michel

2015 IEEE President and CEO
IEEE-HKN - Gamma Kappa Chapter

Since joining IEEE more than four decades ago, Howard Michel has held a variety of leadership positions, including Vice President of Member and Geographic Activities (MGA), where he led efforts to enhance IEEE's member and volunteer communities. Howard also chaired the Public Visibility Committee that created IEEE's "Advancing Technology for Humanity" tagline.

An IEEE Senior Member, Howard has been a member of the faculty of the University of Dayton, and is currently at the University of Massachusetts at Dartmouth. He is a consultant for the U.S. Department of Defense and private industry, specializing in the area of embedded systems, avionics, instrumentation and systems engineering. He has authored and published dozens of papers on intelligent systems, artificial neural networks, and optical computing. Howard also holds patents for a distributed seismic and acoustic sensor system for detecting low flying aircraft, and an advanced artificial neural network based on high frequency analog signals.

Howard had a long and distinguished career as a U.S. Air Force pilot, Satellite Launch Director, and engineer. He served as a senior U.S. Government technical representative enforcing technology-transfer control plans and procedures during two satellite launches--working with key technology leaders in the People's Republic of China. Other achievements include: successfully launching seven U.S. satellites by directing launch-base test and integration involving booster, satellite, and telemetry-range hardware; and developing U.S. Department of Defense engineering processes for mission-critical computer systems.

Why did you choose to study the engineering field (or the field you studied)?

It all goes back to what got me interested in engineering when I was a teenager. I loved to figure out how things worked. At about fourteen or fifteen, I was fixing broken TVs and I had a short-wave radio. I then moved into "ham radio" and ended up having discussions with people around the world.

ARRL The national association for AMATEUR RADIO®

Used with permission ARRL

But what was truly inspiring was—in talking with them—it let me know that there were a lot of people just like me out there. People who needed to know the 'how' behind the technology in their world. As I got older, that desire to know more led me to flying airplanes, launching rockets, and eventually to artificial neural networks. And for all of those pursuits, the drive for me was always the same—figure out how to do something—and then figure out how to do it even better.

What do you love about the industry?

What I love about my field is that it's always evolving, and that the potential is practically limitless. We're seeing what a lot of scientists and engineers are calling a "third revolution" in science and technology. The physical sciences—like engineering—are finding new applications within the biological sciences. A great case in point is the work going on right now in brain-machine interfaces. And that's just our side of the coin. On the biological sciences side, there's some extraordinary work going on in computational biology. It's really an incredibly exciting time to be getting into engineering.

What don't you like about the industry?

Tough question—mostly because I've liked everything about what I'm doing, and what I've done. But if I had to say something, it would be that people seem to be getting lost in the system. Engineers used to be company resources; to a large extent, they are commodities now. Engineers and managers share the blame here. Both parties need to take responsibility for developing human talent.

Whom do you admire (professionally and/or personally) and why?

It's the people who can make connections—and see patterns—across disciplines. People who see the answers to complex problems, that have been solved in, say, biological systems, as templates for solving problems in seemingly unrelated areas. They will be the ones ending disability, unlocking the potential of unlimited, inexpensive energy, and an uncountable array of other advances that will change our world and write the next chapter in technology's evolution.

How has the engineering field changed since you entered it?

Engineering was always a changing field; a new advance gave us a new perspective on our world, and that in turn led to more advances. It's always been like that—but now it's happening at breakneck speed and across multiple disciplines. What used to take years is being done in months. What used to be done in narrow technologies now requires expertise in multiple areas. In the 1950s and 60s, we used to graduate "engineers." In the 70s and 80s, we graduated "electrical engineers, mechanical engineers, and computer engineers." Now, the pendulum is swinging back. Engineers need to be versatile members of integrated product teams, able to solve a broad variety of problems.

In what direction do you think that engineering and other IEEE fields of interest are headed in the next 10 years?

Everywhere. I don't think you can point to one direction—and I don't think you should. I mentioned a "third revolution" earlier; I think that's going to have an enormous role in determining where IEEE's fields of interests head in the next ten years. I think we're going to see incredible engineering work done in what has traditionally been termed the life sciences, and I think we're going to see engineering—as a whole—form even more of the foundation for the infrastructure of tomorrow.

What is the most important lesson you have learned during your time in the field?

Never pass up an opportunity to tackle a challenge—Ever. If you do, you'll miss out on one of the key reasons why engineering is so extraordinary.

What advice can you offer recent graduates entering the field?

Realize that all you've done is earned a diploma—you haven't stopped being a student. Keep pursuing knowledge in your field, and as the years go by, broaden your pursuit of knowledge. Learn about what's cutting-edge in your field, and then learn about how other fields—fields you may know nothing about—are building off of the advances within your chosen field. And after you've done that, find something else interesting. There's a phrase "lifelong learning." It's been pretty overused the last few years, but in engineering, it's really a case of learning more every year, year after year. Those who constantly seek to add to their personal knowledge base change our world; those who don't—well, in my opinion, they really miss out.

If you weren't in your current field, what would you be doing?

My "current field" has always been changing. I started as a U.S. Air Force pilot. Then, I did research engineering and launched satellites. I'm now a professor and consultant in the area of embedded systems. But in all these jobs, I found a way to challenge myself both mentally and physically. I expect that I would continue to look for these same challenges.

MEMBER PROFILE

Kathryn N. Rodhouse

IEEE-HKN Gamma Theta Chapter

Kathryn N. Rodhouse is employed in Research and Development, Cybersecurity with Sandia National Laboratories, Albuquerque, New Mexico. She has a B.S. in Computer Engineering with minors in Mathematics and Computer Science, and an M.S. in Computer Engineering from Missouri University of Science and Technology (2011 and 2012, respectively). As a student, she was actively involved in honors research, in student organizations including IEEE and IEEE-HKN (Gamma Theta Chapter), and in service activities including a spring-break service trip to Guatemala and pre-college outreach events. Her achievements include recognition as the IEEE-HKN Alton B. Zerby and Carl T. Koerner Outstanding Student for 2011, as the 2011 IEEE Region 5 winner of the Larry K. Wilson Regional Student Activities Award, as first-place winner of the IEEE Region 5 Student Papers Competition, and as a recipient of the IEC's William L. Everitt Student Award of Excellence.

Why did you choose to study the engineering field (or the field you studied)?

Engineering wasn't ever presented to me as a palatable career option. Thankfully, I happened to take a programming class which opened the door to finding something I now truly love. Solving tough problems, problems that haven't been solved before, is challenging, frustrating, intimidating, yet insanely rewarding.

What do you love about the industry?

I find the constant change of technology in the industry to be very exciting. I know that the research problems I face today will not be the same in a few years. I know that working in engineering is going to continue to be challenging throughout my entire career. I know that I will have to constantly learn as the world changes and technology changes, so my experience is not dated. I also know that I am never going to get bored by repetition, and that the challenging component of my work will keep me passionate about my job for years to come.

What don't you like about the industry?

Engineering can be a roller coaster ride. Because you are often working on things that have no clear-cut solution, there are periods in the problem solving process that can be tragically bleak. There are days I've gone home from work with a pounding headache and a very depressing outlook, that I only get to look forward to banging my head against a wall for another workday. Fortunately, the feeling of immense satisfaction that comes with making a breakthrough makes the roller coaster ride worthwhile.

Whom do you admire (professionally and/or personally) and why?

There are many pioneers out there--people changing the world with new technology and research, and people pushing through stereotypes with ideas and visions. I've met some of those people, and I respect them profoundly. But to be completely passionate about something and to share that passion with the world, that's what I admire. For this reason, I've always appreciated Meat Loaf (the musical artist not the food). There's benefit to doing something purely for the love of it and the good that it brings to others. And that is something that I aspire to always live by: love what you do, and do good with what you love.

How has the engineering field changed since you entered it?

The engineering field and the world at large seem much more security aware now. Over the past few years, there have been some very public security breaches, causing more emphasis to be put on making engineered systems secure.

Kathryn Rodhouse receives 2011 Outstanding Student Award from IEEE-HKN President Stephen Goodnick and Missouri S&T Chair Kelvin Erickson.

In what direction do you think that engineering and other IEEE fields of interest are headed in the next 10 years?

When I first chose to study engineering (less than 10 years ago), Facebook was still pretty new and Blackberrys were still pretty popular, so it is hard for me to fathom the technological advancements that will occur in the next 10 years. Ten years from now, we will have the technology for self-driving cars and medical nanobots, but the security-conscious side of me also cringes on those fronts. We have the technology and brains necessary to make amazing things happen, but amazing things often come with a high risk. I hope that being security aware is a trend that we continue to see in engineering throughout the next decade.

What is the most important lesson you have learned during your time in the field?

The people you work with and meet along the way make your career. I spend most of the hours I am awake with the people I work with; if I didn't respect those people, work would not be an enjoyable or productive experience. I have found that it is important to work in an environment in which you are comfortable not being perfect, because you aren't always going to be at the top of your game; and frankly, you will likely never be the 'smartest' person in the room. It is imperative that you can work with others, which ultimately can mean letting go of ideas or solutions that you hold dear.

What advice can you offer recent graduates entering the field?

Become comfortable being uncomfortable--traveling to new places can be uncomfortable; meeting new colleagues, customers or technical experts can be uncomfortable; taking on leadership roles or new technical tasks can be uncomfortable. Thus far, my career has been a whole lot of me being uncomfortable in one way or another, but being uncomfortable helps me validate that I am growing as an engineer. If you seek out the uncomfortable and thrive in that environment, you are pushing yourself to do better, to be better. At least that's what I keep telling myself.

If you weren't in your current field, what would you be doing?

It's a pretty rare occurrence where I say to myself, "Man, I really wish I had that job." The last time it happened was in March watching the sports photographers at Cardinals Spring Training, a whim that passed pretty quickly. My point is that I love what I do, and can't imagine doing anything else. Engineering is what you make of it. I have a friend doing Doctors Without Borders using his engineering degree; I have another friend who works on rocket thruster designs; I happened into the field of data analytics--it is absolutely amazing the breadth of what you can do with an engineering background.

Finish this sentence: "If I had more time, I would…"

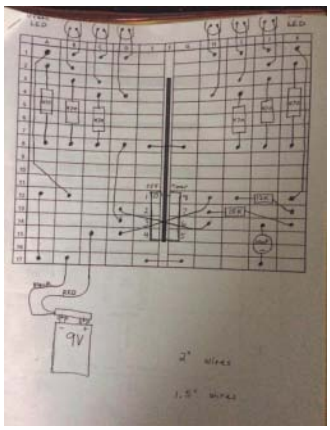
…catch up on my Hulu shows. My coworker and I joked that I should list all the television shows I need to catch up on. But truthfully, that joke isn't too far from what I would really do with more time. With more time, I would travel more, eat more, drink more, and talk more. Television shows are my substitute for wanting to get out, see new places, and experience new cultures. There just is not enough time to see the world and meet the crazy characters that are out there.

CHAPTER NEWS

NSBE Outreach Event at Battle High School

IEEE-HKN Iota Chapter, University of Missouri

The Iota Chapter of IEEE-HKN was honored to participate in a local outreach event on 12 December 2014, in partnership with the National Society for Black Engineers (NSBE). NSBE has been developing a pre-college initiative chapter located at Battle High School in Columbia, Missouri. The program held at Battle High School illustrates NSBE's commitment to provide opportunities to youth that teach and excite students about academic and career opportunities in engineering.



Circuit design for project

This particular event introduced students to a project in electrical engineering. The students were asked to create a blinking Christmas tree with LED lights, which seemed appropriate during the holiday season. The tree was composed of a 9V battery, a breadboard, 6 LED lights (3 green, 3 red), a few resistors, a capacitor, and at its heart, a 555 timer integrated circuit chip.

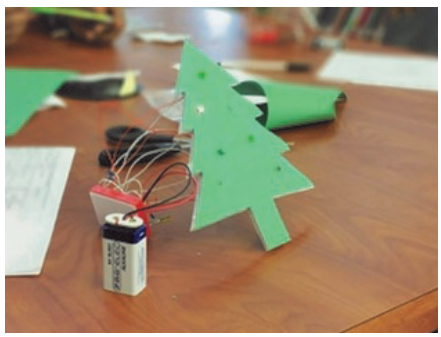

Preparing the Circuit

IEEE-HKN and NSBE played pivotal roles in the success of the event. IEEE-HKN members worked with the students to solder the leads to the ends of the LED's for 30 project trees. NSBE gave a short presentation on all the passive circuit elements, while a member from IEEE-HKN explained the operation behind the 555 timer and its oscillating signal.


Iota chapter members helping Battle High School students with their circuits

IEEE-HKN members were also present at all of the tables to help students understand the circuit, and troubleshoot problems. Originally, the event was scheduled for a half-hour, but almost all the students chose to stay through their lunch period to work on their project.

Overall, the event was a great success. The students loved having the chance to work with real circuits, and attained a sense of accomplishment when their project was completed. The program created a sense of excitement about the engineering world, and in particular, electrical engineering. We hope to plan similar events in the future with local schools; perhaps some of these students will be enrolled at the University of Missouri in the future, and will be walking through the halls of Engineering Building West.


The finished tree!

SUGGESTIONS FOR ELECTRICAL RESEARCH IN ENGINEERING COLLEGES *BY V. KARAPETOFF*

Continued from page 14...

4. As far as possible, only subjects of vital interest have been selected for the list, although the author does not believe that the immediate applicability of the results is of prime importance. What counts is the ability to size up a situation; to obtain the necessary information; to concentrate one's whole attention and interest on a problem, and to get definite results. Facts and relations that are of no practical use today may become very important presently.

5. Much valuable work can be accomplished by colleges and their advanced students through exercising a wise foresight as to future developments in the electrical industry. Often manufacturers feel disinclined to experiment on subjects whose commercial usefulness seems remote, and here is where a college can blaze the way, clear the situation, perform the first preliminary experiments and bring the results to the attention of those who may continue the work on a larger scale and with more accurate means.

6. A resume of the present situation is needed in most of the important topics for research. Sometimes a student without much imagination but with plenty of patience may be utilized for this preliminary work; he may thus become a useful contributor to the solution of a problem where he would have failed if allowed to undertake an original investigation. It is earnestly urged that students and others interested in the progress of our profession do more of this kind of work, describing in a connected and critical manner what has been done, how it was done, where the information is to be found, and what remains to be done. Such information freely published in magazines and transactions would not only serve as a powerful stimulus for research, but would relieve able investigators and inventors of a great burden.

PRINCIPAL TYPES OF INVESTIGATIONS

a) *Invention or improvement* in apparatus, in connections, in materials, in methods of manufacture, etc. If possible, always take an investigation of this kind, because the progress of engineering art depends essentially upon invention.

b) *Search in the patent records of the United States and foreign countries* with the view of determining the state of the art in a particular subject or branch of industry. Such a search often saves a great amount of labor, expense, and bitter disappointment later on. Moreover, a thorough knowledge of the combinations and means used by other inventors sometimes suggests one of the remaining combinations not covered by patents, or an improvement in the preceding inventions. If students and young engineers would do more of this class of work and less promiscuous inventing, we would have fewer annoying and disappointed inventors, and more inventions of real value.

c) *An experimental investigation* of some device or group of devices, a material, a process, etc., to determine the effect of certain factors, for future guidance.

d) *A theoretical investigation* of some relationship or phenomenon, with the view to explaining or generalizing certain observed facts; also to predict performance, to enable the designer to proportion a piece of apparatus, to avoid some harmful effect in operation, or to take fuller advantage of some beneficial effect.

e) *Compilative* or semi-compilative work, such as systematization of notation or nomenclature; comparison of theories, experiments or data of various investigators: unification and simplification of procedure in design or in other computations; preparation of tables, curves, formulas, etc., for a particular purpose; bibliography of a given topic, etc.

ADVICE TO THE YOUNG INVESTIGATOR

1. One who hopes to succeed in invention or research must possess persistence, accuracy, imagination, resourcefulness, good general education (so as to borrow methods from other branches of science) and in addition some special knowledge or skill directly pertaining to his problem. It may be experimental skill, dexterity with tools, mathematical ability, knowledge of foreign languages, etc. Often an attempted research ends in failure not because of alleged external difficulties but because the student selected the wrong kind of problem; for instance, one requiring experimental ability, when his strong point is library research. An insufficient knowledge of the fundamentals of one's profession often results in a failure in research, though it is sometimes difficult to convince the student of the connection between the two.

2. Before taking up a piece of special research ask yourself if the same time could not be more profitably spent in a study of some more general topic in electrical engineering. For example, would you spend, say, half a year in experimental research of the effect of wave-form of the applied voltage upon the core loss in a transformer, or would it be more useful for yourself to put the same time in a study of books and articles on transformers in general, their theory, construction, design, connections, etc.? This question no one but yourself can answer.

3. Remember that in practically every case you expect to continue the work of others; therefore be particularly careful to find out what has been done, avoid duplication, and give due credit to the preceding investigators. The

literature search may be properly begun with the "Science Abstracts," Part B, Electrical Engineering. In some cases, Part A, Physics, must also be consulted. The corresponding German publication "Fortschritte der Elektrotechnik" is also excellent, and perhaps more systematic; in addition to abstracts and periodicals, it contains new books and patent specifications. The well known "Engineering Index," and the card catalogues arranged by topics and found in the Engineering Societies Library in New York, in Carnegie Library in Pittsburgh and in large college libraries are also great helps. The indexes to the leading electrical magazines and transactions should also be consulted.

4. When planning some research or invention try to think of it in the light of the past and future development of the subject, and not as a detached little investigation of your own. This means that you must connect your work with that of former investigators, and present your results in definite form so that the following investigators can connect them with their work and profit by your labors.

5. There are problems on which no one is working, either because the situation is premature, or because others became discouraged through lack of results. There is an advantage in working on such a problem. Should you succeed, your credit and recognition will be so much greater. On the other hand, you are much safer working on a problem already staked out by others, where you are merely developing a detail. Some prefer exploring the wilderness, others keep near to beaten paths.

6. Almost any problem mentioned in the following list may be made as short and elementary or as long and thorough as is desired, from a superficial undergraduate thesis finished in a few weeks, to an expert's deep research carried on devotedly through a long series of years. Do not "bite off more than you can chew," but whatever you decide to do, do it well.

7. Do not try to maintain secrecy regarding your work, but try to draw into it and to interest in your problem as many other able persons as you can. Both you and they will be benefited thereby. Consider yourself to be but a thief's apprentice who is learning how to steal nature's secrets, but is not actually doing it yet.

8. Having made a patentable invention or obtained a patent do not try to hold it for an exorbitant price: Dispose of it on the basis of a reasonable sum down and a moderate royalty per year or per piece sold. If you have a real inventor's stuff in you, you will make many more important and lucrative inventions. Dispose of your first effort as soon as possible; it will be an encouragement for your further work.

ELECTRIC GENERATORS AND MOTORS

Output Coefficients

Theoretical justification and limitations of the D2L formula
Values of flux density, ampere-conductors per centimeter of periphery, and current density in actual machines
General study of the best utilization of active iron and copper
Elements of cost of machinery

Heating and Ventilation of Machinery

Flow of heat along and across laminations, along copper conductors, across slot insulation, through thick field coils, etc.
Heat transfer between various surfaces and the air, stationary and in motion
Temperature distribution in a given machine, and bettering its performance by more effective cooling
Forced ventilation
Cleaning and cooling of the air
Rating for intermittent service

Commutation in Direct-Current Machines

Actual phenomena of commutation with and without interpoles, by means of oscillograph
Commutation on a device imitating an actual armature coil
Interpoles, effect of their width and saturation; inductive shunts
Effect of compensating windings on performance
Study of brushes
Proposed formulas and theories of commutation, a critical review
Approximate methods of integration of the differential equations of commutation

Mechanical Construction and Stresses in High-Speed Machinery

Support of armature coils; dovetail stresses; vibration of shaft; stray currents in shafts; fastening of field coils; high-speed commutator; stresses in stationary frame; eccentric rotor

Armature Reaction and Inductance

Armature reaction in d-c. machines
Armature reaction in polyphase and in single-phase alternators
Proposed methods for compounding alternators
Exact theory of armature reaction and practical approximations
Leakage inductance of windings and the separation of slot leakage, end -connection leakage, etc.
Theoretical predetermination of leakage inductance
Transient condition during short-circuit
Hunting

Polyphase Induction Motor

Proposed methods for speed regulation
Performance characteristics and circle diagram above synchronism
Predetermination of power factor from design data
Magnetic leakage and its components
Exact circle diagrams of performance
Magnetizing effect of distributed windings
Experimental separation of losses
Methods for accurate determination of slip

Single-Phase Induction Motor

Proposed methods of starting
Rating of the same frame for one, two, and three-phase windings
Design of a single-phase induction motor
Experimental and theoretical investigation of the elliptical revolving field
Circle diagram of a single-phase induction motor

Single-Phase and Polyphase Commutator Motors

History of development
Classification of types
Means employed for improvement of commutation
Performance diagrams of the principal types of commutator motors
Comparison from the point of view of speed-torque characteristics
Comparison from the point of view of commutation

Experimental study of a commutator motor
General principles of design
Complete design of a single-phase railway motor
Design and construction of a working model, imitating the electrical relations in a commutator motor
Phase adjusters for improving power factor

General Design

Factors to be considered in the design of a new line of machines
Critical comparison of procedure used by various authors
M.m.f. required for the active layer
Design of a line of small machines for manufacture in large quantities
Layout of a factory for production of a given line of electrical machinery

Improvements in Methods of Testing

Critical study of methods for measuring temperature, core loss and the separation of hysteresis from eddy current
Measurement of friction and windage
Resistance measurements
Methods of loading a machine by means of circulating power (pumping back methods)
Measurement of speed, slip and acceleration
Load losses in single-phase alternators

Special Types of Electrical Machinery

Homopolar generator, reduction of brush friction, increase in speed
Constant-current machine for operating large arc projectors
Train-lighting generator driven from car-axle
Automobile starting motor and lighting generator
Magnetos for ignition
Synchronous motor with high starting torque
Electric variable-speed drive for automobiles
High-frequency alternator for radio work
Motor-generator set for intermittent load with energy stored in a fly-wheel, such as are used in steel mill and mine-hoist work
Combination of an induction motor and a polyphase commutator motor
Motor-converter consisting of an induction motor and a d-c. generator with inter-connected windings
Permutator or a converter with stationary field and armature and revolving brushes
Thury high-tension d-c. constant-current machine
Battery boosters and counter e.m.f. sets

TRANSFORMERS

Leakage Reactance

Experimental investigation of the influence of arrangement and shape of coils
Theoretical formulas derived from the equations of electromagnetic field
Influence of unequal distribution of current in large conductors
Internal vs. external reactance for safety of large systems during short-circuits

Economic Relations

The best distribution of losses for a given service
Amount of copper and iron as a function of relative prices of these materials
Best values of flux and current density

Influence of Wave-form

Effect upon the voltage drop, upon the iron loss, and upon the stresses in dielectrics

Temperature Rise

Theory of conduction of heat; experimental data; influence of various factors; safe temperature rise with various materials; devices for forced cooling
Artificial load for heat run
Extrapolation of heating and cooling curves

Connections

Comparison of delta and Y-connections under normal and abnormal conditions
Analysis of currents and voltages in T and in V connections
Doubling the frequency by means of two transformers

Electrostatic Stresses

And potential gradient in and around bushings, terminals, between coils, etc.
Extra stresses due to transient conditions
See also the section on Dielectrics

POWER PLANT DESIGN AND ECONOMICS

Standardization of electrical equipment for smaller plants
Elements of first cost and of operating expenses
Rational methods of charging for energy
Forms and blanks for accounting
Safety appliances, emergency devices, labor-saving apparatus
Parallel operation of power plants
Division of load between a steam and a water power plant
Uses of storage battery
Automatic substations

TRANSMISSION LINES AND CABLES

Mechanical stresses in towers and in conductors; influence of temperature
Skin effect in copper covered and steel wire and in stranded cable
Interference between power and telephone lines; theory, calculation of induced currents, experimental investigation, methods for reducing interference; the general problem of transposition
Locating faults with the line energized or dead
Protection against grounds and short-circuits, sectionalization, and relays
Actual experience with lightning and possible conclusions
Various types of protection against lightning
Theory of the ground wire
Current and voltage relations in lines with distributed properties
Standing and traveling waves; surges and protection against them
Experimental mechanical apparatus imitating electric waves
Transient electric phenomena studied experimentally and theoretically
Kelvin's law of economy and its various practical applications
Computation of electrostatic capacity and stresses of cables
Reduction of capacity in telephone cables
Propagation of signals in submarine cables

ELECTRIC TRACTION

General Projects

Design of a high-speed underground road for a large American city
Design of an elevated road for local and express trains
Electrification of a large steam railroad center
Electrification of a mountain division of a steam railroad
Gasoline-electric and straight gasoline cars for light traffic
Storage-battery car
Trackless trolley car
Competition of the motor bus and of the "jitney" with city, suburban, and interurban railways
The electric truck
The electric passenger vehicle
The dual power car

Electric traction of boats on a ship canal
Design and organization of repair shops for a large electric-railway system

Track, Trolley, Signals

Standardization of the materials, and of the methods of operation and maintenance
Rail corrugation
Continuous rail, electric welding, thermit welding
Bond testers
Stray currents and prevention of electrolysis
Overhead construction in various classes of service
Mechanical stresses in trolley wire, in messenger cables, and in the supporting structures; the problem of support on curves
The surface-contact system
Sectionalization of trolley circuits in freight yards, in large passenger terminals, etc.
Automatic switching
Automatic signals
The problem of safe and quick dispatching of high-speed roads

Rolling Stock

Quick and accurate predetermination of time-speed curves
Design of an apparatus for automatic tracing of time-speed curves
Resistance to motion of single cars and trains
Special equipment of an electric car or locomotive for various tests and experiments
Single-phase locomotive with an electro-dynamic converter or with a mercury-vapor rectifier
The possibilities and limitations of high-tension direct-current traction
Recuperation of power on electric roads
Control of high voltages or of heavy currents in an electric locomotive
Various types of drive; gears, side-rods, direct drive
Electrically controlled air brakes for high-speed roads

ELECTRIC LIGHTING*

**Contributed by Professor F. K. Richtmyer*

Light Sources

Proposed standards
New types of electric lamps
Position and shape of filaments
Temperature of operation
Color characteristics and effects
Design for special purposes; operating mechanisms

Lighting Accessories

Optical properties of diffusing and reflecting media
Globes, shades, and reflectors for special purposes
"Daylight" glass; means for eliminating glare

Visual Photometry

Sensibility of photometers
Size of photometric field
Errors due to instruments; errors due to operator
Effect of color sensibility of observer
Recording devices; calibrating devices; integrating photometers; flicker photometers
Standardization of absorbing solutions
Means for eliminating color differences
Standardization of conditions of measurement

Physical Photometry

The selenium cell and photoelectric cell
The bolometer
The thermopile
Absorbing solutions; photographic methods; other chemical methods; new methods

Studies in illumination

Survey and criticism of present conditions in various types interiors, in streets, etc.
Intensity and type of illumination necessary for various purposes
Eye fatigue and visual acuity as dependent on intensity of illumination, color, and system used
Design of systems of illumination
Illumination calculations

Terminology of illuminating engineering
Relation of art, architecture, physiology, and psychology to illuminating engineering

APPLICATION OF ELECTRIC MOTORS*

**Contributed by Mr. D. B. Rushmore*

Industries

Agriculture, automobile, bakeries, boiler works, bottling works, box factories, breweries, brick factories, broom factories, building construction, candy factories, carpet and rug factories, cement, clothing, corn mills, cotton mills, cotton oilseed mills, creameries, dairies, dye works, flour mills, foundries, freight handling, glass factories, glove factories, hardware manufacture, harness factories, ice machines, irrigation, knitting factories, laundries, lumber mills, machine shops, paper box factories, paper and pulp mills, piano factories, pipe mills, planing mills, porcelain factories, railways, refrigeration, rubber industry, shoe factories, shoe repairing, soap factories, spice factories, steel mills, stone quarries, stove factories, sugar industry, tanneries, textile mills, tile factories, tobacco factories, trunk factories, wagon factories, wall paper factories, woodworking factories, woolen and worsted mills

Classes of Service

Air compressors, blowers, coal cutters, concrete mixers, conveyors, cranes, crushers, dental appliances, dredges, elevators, exhausters, fans, hoists, ice cream freezers, lime kilns, locks, pumps, printing presses, rock drills, sewing machines, ship propulsion, towing machinery, turn-tables, vacuum cleaners, vehicles, washing machines

MEASURING INSTRUMENTS AND METHODS

General

Study of characteristics, errors, cost of manufacture, etc. of a given type of meter
Development of a new type to meet competition in price or to avoid infringing certain patented features
Design of complete calibrating equipment for a manufacturing concern, an operating company, a testing laboratory, a college, etc.

Special Instruments

Such as a double tariff meter, a maximum-demand indicator, a volt-ampere meter, an automatic synchronizer, a phase displacement meter; instruments, for recording rapidly -fluctuating currents and voltages, etc.

Instrument Transformers

Design, methods of calibration, errors, exact theory, vector diagrams, etc.

Extra-Accurate Measurement

Of various quantities used in electrical engineering, viz., current, voltage, power, resistance, inductance, capacity, speed, acceleration, slip torque, magnetic properties, dielectric properties
Analysis of methods, errors, applicability in various cases, new devices and new diagrams of connections

Magnetic Measurements

Measurement of permeability, core loss and retentivity
Effect of composition and treatment of steel upon its magnetic properties
Heusler alloys
Experimental investigation of distribution of a magnetic field using an analogous condition of flow of heat or electricity through metal, or flow of water
Detection of flaws in rails by a magnetic method

Relays

Overload, underload, and reverse load
Over or under-voltage; high and low frequency; low power factor
Merz-Price and similar selective arrangements
Time characteristics, instantaneous, definite time, inverse time, etc.
Relays for regulating voltage of generators, batteries, feeders, etc.
Regulation of power factor, frequency, speed, etc. by means of relays
Relays for submarine telegraphy

*RADIO TRANSMISSION**

**Contributed by Mr. C. W. Ballard*

Methods for producing damped oscillations for transmission purposes
Methods for producing damped oscillations of particularly constant amplitude for laboratory measurement purposes
Methods for producing undamped or continuous oscillations for transmission purposes
Study of radio detectors
Study of radio amplifiers
Study of the "beats" receiver and methods for producing oscillations for the same
Comparison of "tikker" and "beats" receiver for the reception of undamped waves
Advantages and disadvantages of using the "beats" receiver for damped waves
Directive radio communication
Study of the variation of signal intensity with varying wavelengths
Methods of modulating the antenna current for radio-telephony
Design of a compact portable decremeter
Study of radio measuring instrument
Design and construction of portable radio sets
Design and construction of radio apparatus suitable for instruction and demonstration
Modern theories of propagation of electromagnetic waves (without mathematics)
Experimental determination of "radiation resistance"
Mathematical theory of radio transmission

DIELECTRICS

Experimental study of various insulating materials under various conditions of service
Theory of dielectric stresses in two dimensions by means of conjugate functions
Experimental investigation of distribution of an electrostatic field using an analogous condition of flow of heat or electricity through metal, or flow of water
Surface resistivity
Design of high-tension insulators, bushings, transformer insulation, etc.
Reliability of spark gaps of various shapes
Measurement of extra-high voltages
Design and construction of a transformer for testing purposes
Study of insulating oils; development of a practical and reliable test
Compressed gas as electric insulation

MISCELLANEOUS PROBLEMS

Agriculture, electricity in
Amplifiers for weak currents and voltages
Arc phenomena
Automobile starting, lighting, ignition
Atmospheric electricity, oscillograph study by means of an antenna
Circuit breakers
Electromagnets
Farm lighting and power
Fixation of atmospheric nitrogen
Fuses
Heating and cooking; heat accumulators; high-resistivity alloys; temperature control; insulation
Magnetic separation of iron ores
Marine applications of electricity; electric drive of an ocean steamer
Pictures, transmission of, by electricity
Precipitation of suspended matter; smoke abatement
Rectifiers, aluminum, cathode ray, mercury, revolving, vibrating contact
Safety rules, standardization rules, and standard specifications of various associations in this country and abroad; a critical comparison
Submarine signaling
Thermo-electricity, generation directly from fuel
Telegraphy, rapid, multiplex, submarine with alternating currents
Telephone apparatus for the deaf
Telephone transmitters of great power; sensitive telephone receivers and relays, phantom circuits
Water purification by electricity
Welding, electric

Cute and Smart

Pictured is Sara Bengoetxea Jezso, daughter of Endika Bengoetxea and Veronika Jezso. Endika is a member of the IEEE EAB University Resources Committee and the Committee on Global Accreditation Activities. Endika is IEEE-HKN – raising the next generation of women engineers! Do you have a future IEEE-HKN member in your household? Let us know at info@hkn.org.

IEEE-HKN CHAPTERS

University Name	Chapter
Air Force Institute of Technology	Delta Xi
Arizona State University	Epsilon Beta
Auburn University	Xi
Baylor University	Kappa Tau
Bharati Vidyapeeth's College of Engineering	Lambda Eta
Boise State University	Kappa Pi
Boston University	Kappa Sigma*
Bradley University	Delta Upsilon*
Brigham Young University	Zeta Eta
Cal Poly San Luis Obispo	Epsilon Phi
Cal State Fullerton	Iota Omega*
California Institute of Technology	Iota Pi*
California State - Chico	Iota Zeta*
California State - Long Beach	Epsilon Theta
California State Polytechnic University - LA	Zeta Theta
California State University - Fresno	Theta Kappa
California State University - Los Angeles	Epsilon Nu
California State University - Northridge	Lambda Beta
Capitol College	Kappa Mu*
Carnegie-Mellon University	Sigma
Case Western Reserve University	Zeta
City College of New York	Beta Pi
Clarkson University	Gamma Gamma
Clemson University	Zeta Iota*
Cleveland State University	Epsilon Alpha
Colorado State University	Delta Pi
Columbia University	Gamma Lambda*
Cooper Union	Delta Chi
Cornell University	Kappa
Dalhousie University	Lambda Theta
Drexel University	Beta Alpha
Duke University	Delta Lambda
Embry-Riddle Aeronautical University	Lambda Upsilon
Embry-Riddle Aeronautical Univ. - Prescott	Kappa Iota
Fairleigh-Dickinson University	Theta Gamma*
Florida A&M Univ. - Florida State Univ.	Lambda Delta
Florida Institute of Technology	Zeta Epsilon
Florida International University	Kappa Delta
Gannon University	Iota Nu
George Mason University	Iota Mu*
George Washington University	Theta Iota*
Georgia Institute of Technology	Beta Mu
Hofstra University	Lambda Xi
Howard University	Lambda Gamma
Illinois Institute of Technology	Delta
Iowa State University	Nu
Johns Hopkins University	Gamma Upsilon
Kansas State University	Beta Kappa
Kettering University	Theta Epsilon
Lafayette College	Gamma Psi
Lamar University	Delta Beta
Lawrence Technological University	Theta Upsilon
Lehigh University	Chi
Louisiana State University	Delta Iota
Louisiana Tech University	Delta Gamma
Manhattan College	Gamma Alpha
Marquette University	Beta Omicron
Massachusetts Institute of Technology	Beta Theta
Miami University	Lambda Omicron
Michigan State University	Gamma Zeta
Michigan Technological University	Beta Gamma
Milwaukee School of Engineering	Iota Beta
Mississippi State University	Gamma Omega
Missouri University of Science & Technology	Gamma Theta
Monmouth University	Zeta Alpha*
Montana State University	Iota Kappa
National University of Singapore	Lambda Omega
Naval Postgraduate School	Theta Delta
New Jersey Institute of Technology	Gamma Kappa
New Mexico State University	Gamma Chi
New York Institute of Technology - NYC	Kappa Zeta*
New York Institute of Technology - Old Westbury	Iota Psi*
New York University	Beta Zeta +
New York University - Brooklyn	Zeta Sigma
New York University Polytechnic School of Engineering	Beta Beta +
North Carolina A&T State University	Theta Nu*
North Carolina State University	Beta Eta
North Dakota State University	Gamma Tau*
Northeastern University	Gamma Beta
Northern Illinois University	Kappa Alpha*
Northrop University	Zeta Mu +
Northwestern University	Beta Tau
Norwich University	Theta Xi
Oakland University	Iota Chi*
Ohio State University	Gamma
Ohio University Delta	Epsilon
Oklahoma State University	Omega
Old Dominion	Zeta Upsilon*
Oregon State University	Pi
Pennsylvania State University	Epsilon
Polytechnic University	Theta Theta*
Portland State University	Iota Theta
Prairie View A&M University	Zeta Lambda
Pratt Institute	Delta Theta +
Princeton University	Epsilon Pi*
Purdue University	Beta
Purdue University - Indianapolis (IUPUI)	Kappa Rho*
Rensselaer Polytechnic Institute	Beta Nu
Rice University	Theta Rho
Rochester Institute of Technology	Iota Iota*
Rose-Hulman Institute of Technology	Epsilon Eta
Rutgers University	Gamma Epsilon
San Diego State University	Zeta Tau
San Jose State University	Epsilon Iota
Santa Clara University	Epsilon Psi*
South Dakota School of Mines & Technology	Beta Chi
South Dakota State University	Gamma Rho
Southern Illinois University - Carbondale	Lambda Epsilon
Southern Illinois University Edwardsville	Theta Omicron*
Southern Methodist University	Gamma Omicron
Southern University A&M	Zeta Psi
St. Cloud State University	Iota Omicron*
St. Louis University	Delta Psi*
Stevens Institute of Technology	Iota Delta
SUNY - Binghamton	Kappa Epsilon
SUNY - Buffalo	Zeta Pi
SUNY - New Paltz	Kappa Omicron
SUNY - Stony Brook	Theta Mu
Syracuse University	Gamma Eta*
Tecnol¢gico de Monterrey	Lambda Rho
Temple University	Iota Sigma

Tennessee State University - Nashville	Zeta Kappa
Tennessee Technological University	Epsilon Rho
Texas A&M University	Gamma Mu
Texas A&M University - Kingsville	Zeta Beta
Texas A&M University at Qatar	Lambda Mu
Texas Tech University	Gamma Nu
The University of Hong Kong	Lambda Iota
Trine University	Zeta Phi
Tufts University Epsilon	Delta
Tulane University Theta	Alpha +
Tuskegee University Epsilon	Upsilon
Union College	Phi
Union University	Lambda Pi
United States Military Academy	Iota Phi
United States Naval Academy	Lambda Kappa
University of Akron	Zeta Zeta*
University of Alabama - Huntsville	Theta Eta
University of Alabama at Tuscaloosa	Delta Nu
University of Alabama Birmingham	Iota Alpha*
University of Alaska Fairbanks	Kappa Gamma*
University of Arizona	Iota Xi
University of Arkansas	Gamma Phi
University of Bridgeport	Theta Sigma
University of California - Berkeley	Mu
University of California - Irvine	Zeta Omega
University of California - LA	Iota Gamma
University of California - Riverside	Lambda Sigma
University of California - San Diego	Kappa Psi
University of California - Santa Barbara	Epsilon Tau*
University of Central Florida	Zeta Chi
University of Cincinnati	Tau
University of Colorado - Boulder	Rho
University of Colorado - Colorado Springs	Theta Chi*
University of Colorado - Denver	Theta Zeta
University of Connecticut	Beta Omega
University of Dayton	Iota Eta
University of Delaware	Epsilon Omicron
University of Denver	Delta Delta
University of Detroit Mercy	Beta Sigma
University of Florida	Epsilon Sigma
University of Hartford	Iota Epsilon
University of Hawaii at Manoa	Delta Omega
University of Houston	Epsilon Epsilon*
University of Illinois - Chicago	Iota Lambda
University of Illinois at Urbana-Champaign	Alpha
University of Iowa	Beta Iota*
University of Kansas	Gamma Iota
University of Kentucky	Beta Upsilon
University of Louisiana - Lafayette	Delta Tau
University of Louisville	Epsilon Chi*
University of Maine	Delta Kappa
University of Maryland - College Park	Gamma Xi
University of Massachusetts - Amherst	Delta Eta
University of Massachusetts - Lowell	Epsilon Zeta
University of Massachusetts Dartmouth	Zeta Xi
University of Memphis	Kappa Lambda
University of Miami	Epsilon Kappa
University of Michigan - Ann Arbor	Beta Epsilon
University of Michigan - Dearborn	Theta Tau
University of Minnesota	Omicron
University of Mississippi	Epsilon Omega
University of Missouri - Columbia	Iota
University of Missouri - Kansas City	Theta Pi
University of Nebraska - Lincoln	Beta Psi
University of Nevada - Reno	Theta Psi*
University of New Haven	Zeta Rho
University of New Mexico	Delta Omicron
University of New Orleans - Lakefront	Iota Rho*
University of North Carolina at Charlotte	Kappa Phi
University of North Dakota	Delta Rho
University of North Florida	Kappa Nu
University of North Texas	Lambda Zeta
University of Notre Dame	Delta Sigma
University of Oklahoma	Beta Xi
University of Pennsylvania	Lambda
University of Pittsburgh	Beta Delta
University of Portland	Theta Beta*
University of Puerto Rico at Mayag ez	Lambda Tau
University of Rhode Island	Zeta Gamma
University of San Diego	Kappa Eta
University of Scranton	Lambda Nu
University of South Alabama	Theta Lambda
University of South Carolina	Delta Phi
University of South Florida	Kappa Xi
University of Southern California	Upsilon
University of Tennessee - Knoxville	Beta Phi
University of Texas at Arlington	Epsilon Mu
University of Texas at Austin	Psi
University of Texas at Dallas	Kappa Kappa
University of Texas at San Antonio	Kappa Upsilon
University of the District of Columbia	Iota Tau*
University of the Pacific	Theta Omega
University of Texas at El Paso	Zeta Delta
University of Toledo	Epsilon Gamma*
University of Tulsa	Zeta Nu
University of Utah	Gamma Sigma
University of Virginia	Gamma Pi
University of Washington	Iota Upsilon
University of West Florida at Pensacola	Lambda Alpha
University of Wisconsin- Platteville	Kappa Theta
University of Wisconsin - Madison	Theta
Vanderbilt University	Epsilon Lambda
Villanova University	Delta Mu
Virginia Commonwealth University	Kappa Chi
Virginia Military Institute	Theta Phi*
Virginia Polytechnic Institute	Beta Lambda
Washington University - St. Louis	Delta Zeta
Wayne State University	Delta Alpha*
West Virginia Institute of Technology	Zeta Omicron*
West Virginia University	Beta Rho
Western Michigan University	Kappa Omega
Wichita State University	Epsilon Xi
Wilkes University	Kappa Beta*
Worcester Polytechnic Institute	Gamma Delta

* Inactive Chapter
\+ Closed Chapter

IEEE-Eta Kappa Nu Reminders

Chapter Management News

All Chapter management forms are now available for digital submission at www.hkn.org!

Required Forms

- Student Inductee Documentation – For each Induction Ceremony held
- Notice of Election of Officers – Submit this form every time Chapter Elections are held.
- Annual Chapter Report – Deadline: 30 June

Awards

- Outstanding Young Professional Award Nomination Form – Deadline: The Monday following 30 April
- Outstanding Student Award Nomination Form – Deadline: 30 June
- Outstanding Teacher Award Nomination Form – Deadline: The Monday following 30 April
- Karapateoff Outstanding Technical Achievement Award Nomination Form – Deadline: The Monday following 30 April
- Outstanding Chapter Award Nomination – Deadline: 30 September

Other Forms

- New Pledge Form – Submit pledge information and IEEE-HKN Headquarters will send pledges a personal invitation to the submitting Chapter!
- Professional Member Induction Form – For non-student new inductees.
- IEEE-HKN Certificate Replacement Order Form

IEEE-HKN Store

- **Honor Stoles & Cords** – Order early to ensure timely delivery! Rush orders accepted.
- **Pins**
- **Logo Clothing**

Order Online Today!

Online Forms and Payments

You can submit all forms and payments online. If paying with a check, first submit your form online, then mail your check to IEEE-HKN Headquarters. If you have questions, please email info@hkn.org or call U.S. Toll Free +1 800 406 2950 or worldwide +1 732 465 5846.

Like us on Facebook:
www.facebook.com/IEEE.HKN

Follow us on Twitter:
twitter.com/IEEE_EtaKappaNu

Connect with us on LinkedIn:
IEEE-Eta Kappa Nu

facebook twitter LinkedIn

Phone U.S. Toll Free: +1 800 406 2590 Outside the U.S. call: +1 732 465 5846
Email: info@hkn.org Website: www.hkn.org

Chapter News: Let us know what is happening at your chapter!