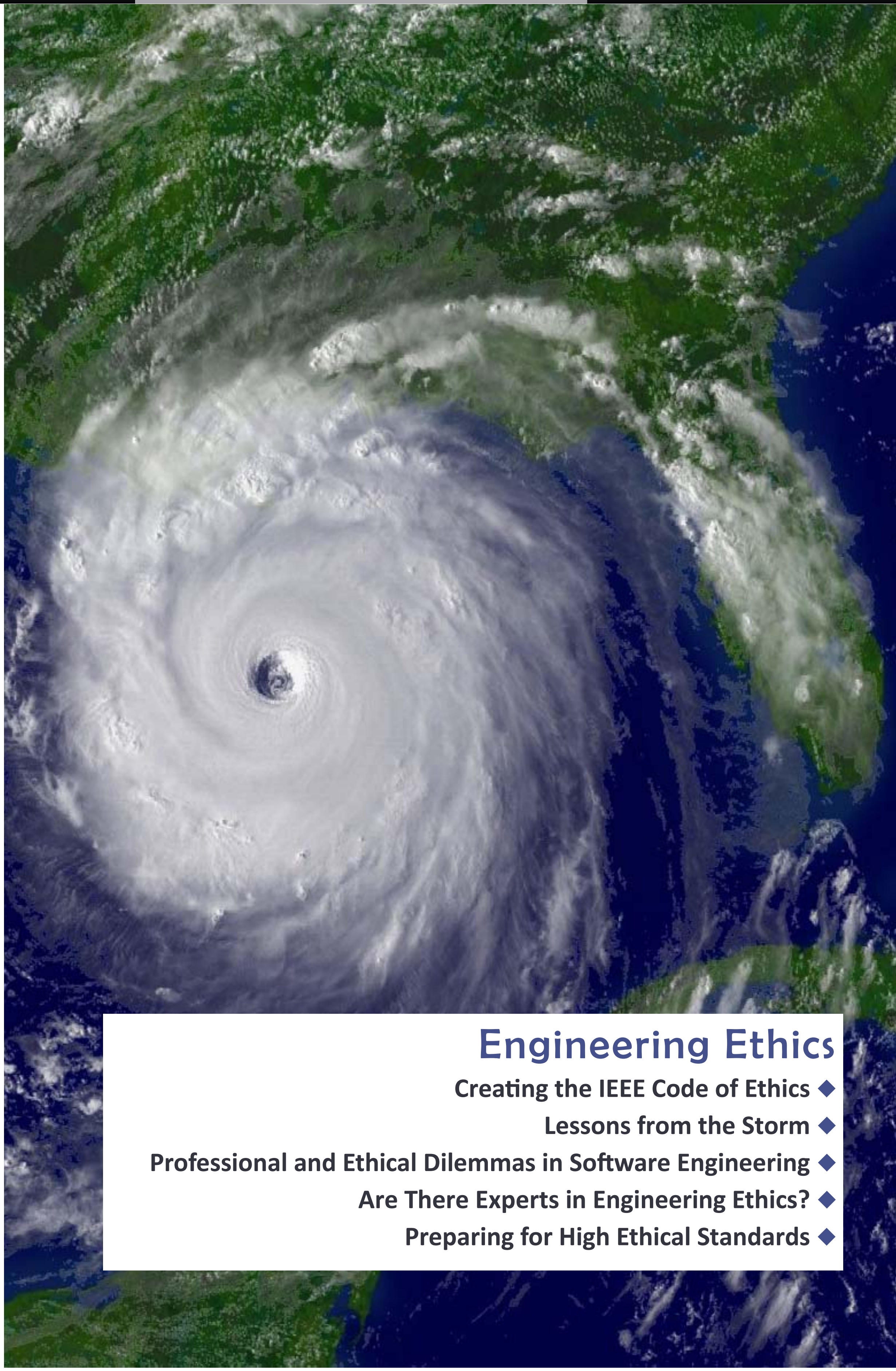
THE ◆ BRIDGE

The Magazine of IEEE-Eta Kappa Nu



Engineering Ethics

June 2013 Vol. 109 / No. 2

HKN IEEE

IEEE-HKN AWARDS

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 him or herself through an invention, development, or discovery in the field of electrical or computer technology. (Deadline: 30 April)

Outstanding Student Award

Annually identifies 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: 15 October)

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 and enthusiasm and creativity in the classroom. (Deadline: 30 April)

IEEE-Eta Kappa Nu (IEEE-HKN) was founded by Maurice L. Carr at the University of Illinois 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-Eta Kappa Nu. Ideas and opinions expressed in THE BRIDGE are those of the individuals and do not necessarily represent the views of IEEE-Eta Kappa Nu, the Board of Governors, or the magazine staff.

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THE BRIDGE

The Magazine of IEEE-Eta Kappa Nu

June 2013 Features

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LETTER FROM THE PRESIDENT

JOHN A. ORR
Alpha Chapter

Dear IEEE-HKN Members and Friends:

Spring is a great time of year for faculty members; not just for the renewal that we see in nature, but also because of the wonderful sense of accomplishment and new beginnings as our students complete a year of study or graduate and move on to the next phase of their lives. To our members who just graduated, I offer my congratulations and best wishes for professional and personal success. I hope that you stay involved with IEEE-HKN, and in particular if you live close to your alma mater, offer to help with chapter activities.

Epsilon Beta Chapter at Arizona State University merits enthusiastic congratulations for organizing a fantastic Student Leadership Conference in Tempe, Arizona. With over 100 participants, every aspect of this event was well-done. Students from universities around the world enjoyed the chance to get know each other, as well as to interact with leaders of the profession. The dynamism and vitality shown by everyone at the event set a great example for future conferences.

One of the great pleasures of being a faculty member is the chance to associate with some truly outstanding students – outstanding both as students and as people. This feeling is amplified as President of IEEE-HKN. At the ECE Department Heads' Annual Meeting in Orlando this March, I had the great pleasure to present this year's Outstanding Student Award to Mr. Larry Martin from the Delta Omega Chapter, University of Hawaii, Manoa. Another exceptional student is Mr. Akshay Gupta from Lambda Eta, our first chapter in India. Now a graduate student at Georgia Tech, Mr. Gupta was also present to accept our congratulations and Honorable Mention recognition. As usual, the recognition of 23 Outstanding Chapters was also a great event. This large number of very active chapters bodes well for the continued health of our organization.

To faculty and students, please accept my best wishes for a great summer; and to new graduates, my congratulations and very best wishes for a great start to your careers!

Very best wishes,

Phone + 1 508-831-5273

Email: j.orr@ieee.org

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LETTER FROM THE EDITOR-IN-CHIEF

DR. STEVE E. WATKINS

Dear IEEE-Eta Kappa Nu Members,

This issue of THE BRIDGE magazine has a theme of “Engineering Ethics.” Our honor society has selected “character” as a requirement for membership and the induction ceremony states that this requirement is linked to “honesty, ethical behavior, sound judgment, and, hard and occasionally disagreeable work.” Engineering is a profession, and one characteristic of a profession is having ethical obligations beyond immediate rewards and legal responsibilities. Just as members of the medical profession have defined their ethical standards with the Hippocratic Oath, engineering societies have formulated similar principles for conducting engineering work. Our features articles discuss the IEEE Code of Ethics and give insight into developing and maintaining a high standard of conduct as a professional. The theme for the Fall issue will be “Celebrating Engineering Accomplishments.”

Many chapters have prominent displays or monuments that give visibility to IEEE-Eta Kappa Nu. For my Gamma Theta Chapter at the Missouri University of Science and Technology, a large oak display case with the HKN Wheatstone Bridge in raised relief highlights Chapter information outside our auditorium, and a five-foot-tall Wheatstone Bridge welcomes anyone entering our building. Another example of an HKN presence is given on page 29 in our history spotlight. This Founders Plaque was placed by the Alpha Chapter on the campus of University of Illinois at Urbana-Champaign in 1929. Such physical symbols reflect the pride members have in the organization and their chapter.

To recognize innovative displays and monuments that promote IEEE-HKN, we invite chapters to submit photographs of their displays or monuments. We will showcase these submissions in future issues of THE BRIDGE. If you do not have a campus display, perhaps these examples will inspire you to add a permanent Wheatstone Bridge or other chapter display to your campus. Send photographs to my E-mail: steve.e.watkins@ieee.org.

Oak Display Case and Wheatstone Bridge
at the Gamma Theta Chapter

Best regards,

Steve E. Watkins

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

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LETTER FROM THE DIRECTOR

NANCY M. OSTIN, CAE

Dear Friends of IEEE-Eta Kappa Nu,

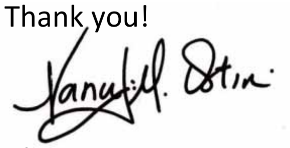
The past few months have been quite a whirlwind of exciting and fulfilling work with our Chapters and the Board of Governors on so many projects. Great things are happening within the IEEE-HKN organization, and we thank you all for your support.

The Student Leadership Conference (SLC), held on 15-17 March at Arizona State University, was a great success; congratulations to host Chapter, Epsilon Beta for an outstanding job! Over 100 students, representing 25 Chapters, participated in the three-day event. A detailed article about the conference can be found in this issue of THE BRIDGE. The full content of the conference, including some additional materials, will be repurposed and presented as a virtual conference this coming October.

During the ECEDHA meeting in Orlando, FL from 22-26 March, I had the opportunity to meet and talk with many of the Department Heads from our current Chapters, as well as others who are interested in forming a chapter at their university. Overwhelmingly, many Department Heads spoke of the benefits of having an IEEE-Eta Kappa Nu Chapter at their university. Based on this information, we will add our Department Heads to the e-newsletter we currently send out to Presidents, Corresponding Secretaries, and Faculty Advisors. Upon receipt of this newsletter, we ask that you please send it on to all members of your Chapter.

I have just returned from visiting the Alpha (University of Illinois Urbana-Champaign) and Beta (Purdue University) Chapters. My goal for visiting our chapters is to meet with current members about the issues facing chapters today, and discuss the value of IEEE-HKN and what it takes to make a chapter successful. I want share with everyone what I found to be the secret that makes both these Chapters extremely successful…a sense of Community. They have been able to establish a community that cares for its members and for all of the students in their disciplines. This community spirit encourages service to others. It welcomes first-year students, it nurtures second-year students, it supports third and fourth-year students, and is evident in the graduate students who actively participate and share their experiences and leadership!

The community you create at your chapter is powerful and supportive. It encourages and supports scholastic achievement, builds character, and is a lesson in leadership. To all IEEE-HKN Chapters and to alumni near and far, the impact you have on those you help continues to make a world of difference… Thank you!



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Creating the IEEE Code of Ethics

The history behind the process...

By Emerson W. Pugh

Abstract

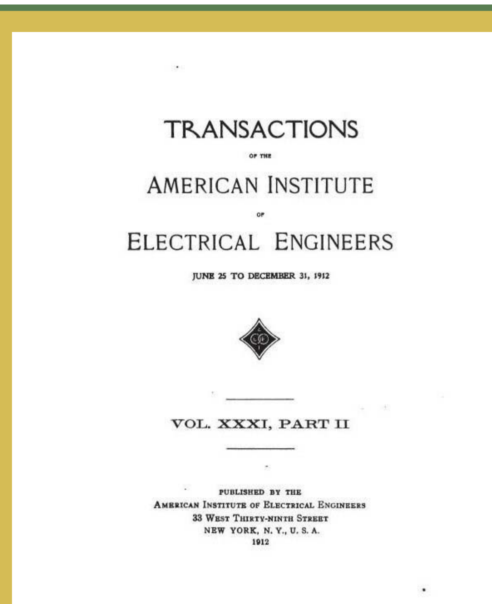
In 1912 the AIEE adopted its first code of ethics. It was called the "Code of Principles of Professional Conduct." Following the 1963 merger of AIEE and IRE that formed IEEE, a new code of ethics was adopted in 1974 and revised in 1979 and again in 1987. In 1990 the IEEE Board of Directors voted to adopt a shorter code, with content and wording more appropriate for a worldwide membership.

Prior to the early 1900s, ethics were viewed as a personal matter and therefore not a responsibility of engineering societies. Among those seeking a change in this point of view was Schuyler S. Wheeler, president of the American Institute of Electrical Engineers (AIEE).

In 1906 he gave his presidential address on the subject of "Engineering Honor." It was so enthusiastically received by the members that a committee (consisting of Schuyler P. Wheeler, H. W. Buck, and Charles P. Steinmetz) was established to begin work on creating an AIEE code of ethics.

Principles of Professional Conduct

It was not until six years later, in 1912, that a code of ethics was finally adopted. It was called the "Code of Principles of Professional Conduct" and was published in the December 1912 issue of the *Transactions of the American Institute of Electrical Engineers*. [See Figure 1]



TRANSACTIONS
OF THE
AMERICAN INSTITUTE
OF
ELECTRICAL ENGINEERS
JUNE 25 TO DECEMBER 31, 1912

VOL. XXXI, PART II

PUBLISHED BY THE
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 WEST THIRTY-NINTH STREET
NEW YORK, N. Y., U. S. A.
1912

Figure 1. Title page of the *Transactions of AIEE*, Dec. 31, 1912, in which the "Code of Principles of Professional Conduct" first appeared.

It was a long document that filled three pages of the Transactions. The wording was quite specific and reflected the fact that many AIEE members were self-employed. Major topics of the Code were "General Principles," "The Engineer's Relations to Client or Employer," "Ownership of Engineering Records and Data," "The Engineer's Relations to the Public," and "The Engineer's Relations to the Engineering Fraternity." Associated with these five major topics were a total of 22 specific canons.

This "Code of Principles of Professional Conduct" provided ethical guidance for AIEE members until 1963 when AIEE and IRE (Institute of Radio Engineers) merged to form the IEEE (Institute of Electrical and Electronics Engineers).

In that same year, the Engineers Council for Professional Development (which had been founded in 1932 by seven engineering societies, including AIEE) revised and updated its "Canons of Ethics of Engineers," and it asked its constituent societies to adopt them. Many engineering societies did adopt them.

IEEE Seeks Its Own Code

The IEEE chose to develop its own code of ethics. As an interim measure, it endorsed the three Fundamental Principles of Professional Engineering Ethics, which were stated in the Canons of the Engineers Council of Professional Development as follows: "The Engineer . . . (1) Will be honest and impartial, and will serve with devotion his employer, his clients, and the public; (2) Will strive to increase the competence and prestige of the engineering profession; and (3) Will use his knowledge and skill for the advancement of human welfare."

It was not until December 1974 that a new volunteer-developed "IEEE Code of Ethics for Engineers" was approved by the IEEE Board of Directors, under the leadership of IEEE President John Guarrera. In early 1975 it was added to the IEEE Policy and Procedures Manual and also publicized in the *IEEE Spectrum* issue of February 1975. [See Figure 2]

IEEE CODE OF ETHICS FOR ENGINEERS

PREAMBLE

Engineers affect the quality of life for all people in our complex technological society. In the pursuit of their profession, therefore, it is vital that engineers conduct their work in an ethical manner so that they merit the confidence of colleagues, employers, clients and the public. This IEEE Code of Ethics is a standard of professional conduct for engineers.

ARTICLE I

Engineers shall maintain high standards of diligence, creativity and productivity, and shall:

1. Accept responsibility for their actions;
2. Be honest and realistic in stating claims or estimates from available data;
3. Undertake engineering tasks and accept responsibility only if qualified by training or experience, or after full disclosure to their employers or clients of pertinent qualifications;
4. Maintain their professional skills at the level of the state of the art, and recognize the importance of current events in their work;
5. Advance the integrity and prestige of the engineering profession by practicing in a dignified manner and for adequate compensation.

ARTICLE II

Engineers shall, in their work:

1. Treat fairly all colleagues and co-workers, regardless of race, religion, sex, age or national origin;
2. Report, publish and disseminate freely information to others, subject to legal and proprietary restraints;
3. Encourage colleagues and co-workers to act in accord with this Code and support them when they do so;
4. Seek, accept and offer honest criticism of work, and properly credit the contributions of others;
5. Support and participate in the activities of their professional societies;
6. Assist colleagues and co-workers in their professional development.

ARTICLE III

Engineers shall, in their relations with employers and clients:

1. Act as faithful agents or trustees for their employers or clients in professional and business matters, provided such actions conform with other parts of this Code;
2. Keep information on the business affairs or technical processes of an employer or client in confidence while employed, and later, until such information is properly released, provided such actions conform with other parts of this Code;
3. Inform their employers, clients, professional societies or public agencies or private agencies of which they are members or to which they may make presentations, of any circumstance that could lead to a conflict of interest;
4. Neither give nor accept, directly or indirectly, any gift, payment or service of more than nominal value to or from those having business relationships with their employers or clients;
5. Assist and advise their employers or clients in anticipating the possible consequences, direct and indirect, immediate or remote, of the projects, work or plans of which they have knowledge.

ARTICLE IV

Engineers shall, in fulfilling their responsibilities to the community:

1. Protect the safety, health and welfare of the public and speak out against abuses in these areas affecting the public interest;
2. Contribute professional advice, as appropriate, to civic, charitable or other non-profit organizations;
3. Seek to extend public knowledge and appreciation of the engineering profession and its achievements.

IEEE spectrum FEBRUARY 1975

Figure 2. Code of Ethics for Engineers as it appeared in *IEEE Spectrum* of February 2, 1975, on page 65.

This "IEEE Code of Ethics for Engineers" had a brief preamble and four articles. The preamble said:

Engineers affect the quality of life for all people in our complex technological society. In the pursuit of their profession, therefore, it is vital that engineers conduct their work in an ethical manner so that they merit the confidence of colleagues, employers, clients and the public. This IEEE Code of Ethics is a standard of professional conduct for engineers.

The articles that followed had a total of 19 canons that were divided among four areas of ethical concern for engineers: 1) maintaining their own capabilities, 2) behavior at work, 3) relations with employers and clients, and 4) responsibilities to the community.

As IEEE membership grew, many of the newer members were not trained as engineers, and they desired to be properly recognized for their own professional status. In response to this desire, the opening phrase of the first sentence of the Code's preamble was amended in February 1979. In the phrase, "Engineers affect the quality of life for all people," the single word, "Engineers," was replaced with "Engineers, scientists and technologists." The remainder of the Code's preamble and all four of its articles were amended to be consistent with this change.

Impact of a Dissident Member

The next change to the IEEE Code of Ethics was motivated by the activities of a dissident member of IEEE who portrayed himself as the "defender of working engineers," as distinguished from the volunteer leaders of IEEE, whom he characterized as "fat cats." In addition to attacking IEEE policies and activities in his newsletter, he personally attacked several IEEE volunteers in various ways, including writing damaging letters to their employers.

Finding there was nothing in the IEEE Code of Ethics that specifically forbid this type of behavior, the IEEE leadership corrected the omission in November 1987 by adding Article V, which is quoted below:

> Members shall, in fulfilling their responsibilities to IEEE, its members, and employees:
>
> 1. Make no statement that the member knows to be false or with reckless disregard as to its truth or falsity concerning IEEE or the qualifications, integrity, professional reputation, or employment of another member or employee;
> 2. Neither injure nor attempt to injure, maliciously or falsely, the professional reputation or employment of another member or employee.

The "defender of working engineers" immediately charged IEEE leadership with taking this action without proper notification of the membership. In February 1988, IEEE President Russell C. Drew appointed an ad hoc committee to examine these charges, and to determine if any IEEE policies or procedures had been violated. The members of this ad hoc committee were Edward Bertnolli (chair), Dennis Bodson, Thomas Grim, and Emerson Pugh. We determined that the process by which the Code of Ethics had been revised in 1987 was legal and in keeping with the rules of IEEE. Nevertheless, we did recommend that all IEEE members be given an opportunity to review and comment on any future changes in the Code of Ethics before the Board voted on them.

Finding My Mission

Through my involvement on President Drew's ad hoc committee, I became interested in the possibility of rewriting the Code to make it shorter, loftier in style, and with content and wording more appropriate for IEEE members throughout the world. I was especially interested in this later goal because IEEE was growing more rapidly outside the United States than inside. By the end of 1987, 20 percent of IEEE's 293,129 members lived outside the United States. Also, I was IEEE President-Elect in 1988, and one of my goals was to increase the rate at which IEEE was becoming a transnational organization in its philosophies and governance as well as in the geographic distribution of its members.

By May 1988 I had written a first draft and had obtained support from the other three members of the ad hoc committee. The draft retained what I believed to be the major concepts of the then-current Code, but it was much shorter and had exactly ten canons. I liked the number ten because people throughout the world have ten fingers, they use a decimal system for counting, and many are accustomed to having a moral code specified by ten commandments.

I circulated this first draft to the members of the Ethics Committee of the IEEE United States Activities Board and to several other individuals. Most comments were supportive, but others expressed concern over the loss of the long-revered IEEE Code of Ethics.

PRESIDENT'S COLUMN

Must we give up ethics to eat?

Emerson W. Pugh

"I gave up ethics—to eat!" is the title of an article that originally appeared in the December 1957 issue of *Consulting Engineer*. The problem the author faced 30 years ago is no less real today. His solution, regretfully, is still just as common.

The author described how, as head of his own engineering firm, he had been unable to obtain government contracts without bribing public officials. Faced with either giving up his business or giving up his ethical principles, he chose the latter. He hired a "public relations counsel" who made the necessary arrangements for a percentage of each deal.

Those of us who are employed by large organizations are generally not confronted with this problem, but all of us have faced ethical dilemmas during our careers. Indeed, the complexities of the issues and decision processes may be greater for those employed by large organizations, where authority and responsibility are shared with others.

Fundamental to ethical dilemmas is the question: To whom do we owe our allegiance? To ourselves? Our family? An organization? Or to a larger community such as our country or the world? Being ethical generally implies acting in a manner beneficial to the larger rather than to the smaller group. Thus at its limit—and for the IEEE as a transnational organization—ethical behavior must be considered in the context of the world community.

But how are our ethical principles to be established? Can they be applicable worldwide? Who judges our behavior? How can ethics be enforced? Should ethical principles be discarded if they cannot be enforced or if many people violate them?

I do not have good answers for many of these questions. But our members seem to believe they know what ethics are, and that it is sometimes as important to adhere to ethical principles as it is to eat. Furthermore, when the IEEE Code of Ethics was revised in 1987, many individuals and groups expressed a desire to participate in that process. Many also expressed a desire to have a code of ethics with clear, simple wording.

Following up on these desires—and to begin a dialogue on ethics—I have attempted to simplify and clarify the IEEE Code of Ethics. I have done this by making use of suggestions submitted when the code was last revised and by seeking advice from many others. The resulting "simplified" version, printed below, no doubt also reflects some of my own views, which may or may not be held by other IEEE members or their colleagues.

Members who have thoughts on this subject that they wish to share should write to: IEEE President, Code of Ethics, 345 E. 47th Street, New York, N.Y. 10017, U.S.A. I may not be able to respond directly to everyone, but I have asked Edward C. Bertnolli, Vice President–Professional Activities, to establish a committee to review the responses to this column.

If there is enough interest and sense of direction in the correspondence, the committee will take appropriate action. For example, it may modify either the "simplified version" or the present version to provide a basis for further discussion and possible change, or it may conclude that some completely different action is needed. On the other hand, if there is little response, we shall report that to you and take no further action. The present IEEE Code of Ethics is displayed on p.11.

Simplified Code of Ethics

We the members of the IEEE—in recognition of the importance of our technologies to the quality of life throughout the world, and in accepting our obligations to our profession, its members, and the community we serve—agree and covenant:

1. to conduct ourselves in the highest ethical manner;
2. to make engineering decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public;
3. to avoid real or perceived conflicts of interest where possible, and to disclose them to affected parties when they do exist;
4. to help improve public understanding of technology and its proper use;
5. to maintain and improve our technical competency and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;
6. to be honest and realistic in stating claims or estimates based on available data;
7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;
8. to neither offer nor accept bribes;
9. to treat fairly all persons regardless of race, religion, sex, age, or national origin, and never to attempt to injure maliciously or falsely the person, property, reputation, or employment of others;
10. to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

Figure 3. President's Column from *The Institute* of April 1989.

Some were concerned that the more general wording of the proposed code would make "enforcement" more difficult. The idea that IEEE should enforce its Code of Ethics was quite common at the time, and some even wanted to provide financial help to members who suffered financially by following the Code.

Taking Charge as President

On January 13, 1989, two weeks after becoming IEEE President, I held a meeting to discuss the IEEE Code of Ethics with a group of well-respected IEEE leaders. Based on these discussions, I made a number of minor changes and one major change to the proposed code of ethics.

The major change was to delete a provision that admonished IEEE members "to report, publish, and disseminate information freely to others, subject to legal and proprietary restraints" and replace it with one that admonished IEEE members "to neither offer nor accept bribes." Stephen H. Unger, especially, had urged that a statement against bribery be included, and I had concluded that the admonition to provide information freely to others "subject to legal and proprietary restraints" would be interpreted so differently in countries throughout the world that it would have little real meaning. In the April 1989 issue of IEEE's newspaper, *The Institute*, I published the proposed IEEE Code of Ethics at the end of my "President's Column." [See Figure 3.]

The title I gave my "President's Column" was, "Must we give up ethics to eat?" This title was based on an article titled, "I gave up ethics to eat," which had been published in a 1957 issue of the magazine, *Consulting Engineer*. The magazine article told how the author found he could not get government contracts without bribing government officials. In my column, I pointed out how this thirty-year-old story related to problems still faced by IEEE members and how important it was for IEEE to have a code of ethics that was easy to read and appropriate to IEEE members throughout the world.

I asked readers to compare the proposed simplified IEEE Code of Ethics at the bottom of my President's Column with the then-current Code, which was printed elsewhere in *The Institute*, and I asked them to send me their comments. Readers were also advised that I had "asked Edward C. Bertnolli, Vice President-Professional Activities, to establish a committee to review the responses." Subsequently, Robert Alden, William R. Middleton, William R. Tackaberry, and Stephen H. Unger were appointed to the committee.

Proposed new Code of Ethics released by ad hoc committee

An *ad hoc* committee charged with simplifying the current version of the IEEE Code of Ethics has drafted a proposed replacement, reprinted below (left) along with the current version (right).

The new version, which the committee submitted to the Board of Directors in November, is now being distributed throughout the IEEE for members' review and comments. Formal discussion and consideration of the Simplified Code of Ethics is scheduled for the Board's August 1990 meeting. Before then, members are urged to read the rewritten code and send their opinions of it, pro or con, to President Carleton A. Bayless, IEEE, 345 E. 47th St., New York, N.Y. 10017.

The new Code is based on a version proposed by 1989 IEEE President Emerson W. Pugh in a President's Column in THE INSTITUTE [April 1989, p. 6] that was modified by members' responses to that column and the *ad hoc* committee's revisions. The committee, chaired by then Vice President–Professional Activities Edward C. Bertnolli, consisted of Robert Alden, William Middleton, William Tackaberry, and Steven Unger.

PROPOSED

We, the members of IEEE, in recognition of the importance of our technologies in improving the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to conduct of the highest ethical and professional order.

We further agree and covenant:

1. to make engineering decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public;
2. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;
3. to help improve understanding of technology and of its proper use;
4. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;
5. to be honest and realistic in stating claims or estimates based on available data;
6. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;
7. to neither offer nor accept bribes;
8. to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin;
9. to never maliciously or falsely attempt to injure the person, property, reputation, or employment of others;
10. to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

PRESENT

Preamble: Engineers, scientists and technologists affect the quality of life for all people in our complex technological society. In the pursuit of their profession, therefore, it is vital that IEEE members conduct their work in an ethical manner so that they merit the confidence of colleagues, employers, clients and the public. This IEEE Code of Ethics represents such a standard of professional conduct for IEEE members in the discharge of their responsibilities to employers, to clients, to the community and to their colleagues in this Institute and other professional societies. In order to protect and enhance the image and reputation of IEEE, its members, and the profession they represent, members must always conduct themselves in a manner reflecting the highest level of ethical conduct, honesty and openness.

Article I: *Members shall maintain high standards of diligence, creativity and productivity, and shall:* 1. Accept responsibility for their actions; 2. Be honest and realistic in stating claims or estimates from available data; 3. Undertake technological tasks and accept responsibility only if qualified by training or experience, or after full disclosure to their employers or clients of pertinent qualifications; 4. Maintain their professional skills at the level of the state of the art and recognize the importance of current events in their work; 5. Advance the integrity and prestige of the profession by practicing in a dignified manner and for adequate compensation.

Article II: *Members shall, in their work:* 1. Treat fairly all colleagues and co-workers, regardless of race, religion, sex, age or national origin; 2. Report, publish and disseminate freely information to others, subject to legal and proprietary restraints; 3. Encourage colleagues and co-workers to act in accord with this Code and support them when they do so; 4. Seek, accept and offer honest criticism of work, and properly credit the contribution of others; 5. Support and participate in the activities of their professional societies; 6. Assist colleagues and co-workers in their professional development.

Article III: *Members shall, in their relations with employers and clients:* 1. Act as faithful agents or trustees for their employers or clients in professional and business matters, provided such actions conform with other parts of this Code; 2. Keep information on the business affairs or technical processes of an employer or client in confidence while employed, and later, until such information is properly released, provided such actions conform with other parts of this Code; 3. Inform their employers, clients, professional societies or public agencies or private agencies of which they are members or to which they may make presentations, of any circumstances that could lead to a conflict of interest; 4. Neither give nor accept, directly or indirectly, any gift, payment or service of more than nominal value to or from those having business relationships with their employers or clients; 5. Assist and advise their employers or clients in anticipating the possible consequences, direct and indirect, immediate or remote, of the projects, work or plans of which they have knowledge.

Article IV: *Members shall, in fulfilling their responsibilities to the community:* 1. Protect the safety, health and welfare of the public and speak out against abuses in those areas affecting the public interest; 2. Contribute professional advice, as appropriate, to civic, charitable or other nonprofit organizations; 3. Seek to extend public knowledge and appreciation of the profession and its achievements.

Article V: *Members shall, in fulfilling their responsibilities to IEEE, its members, and employees:* 1. Make no statement that the member knows to be false or with reckless disregard as to its truth or falsity concerning IEEE or the qualifications, integrity, professional reputation, or employment of another member or employee; 2. Neither injure nor attempt to injure, maliciously or falsely, the professional reputation or employment of another member or employee.

Figure 4. The proposed new Code of Ethics and the old Code of Ethics published side-by-side in *The Institute* in February 1990.

Seeking Broad Support

From time to time during 1989, I met with this committee to consider a variety of changes that might make the Code more appealing to all members and also more likely to be approved by the IEEE Board of Directors. Of considerable concern was the strong disapproval of the proposed Code of Ethics by some IEEE volunteers who had spent many years working with the old version. Several of them believed a Code of Ethics should be written in precise legal language so that each provision could be enforced. At least one of them was known to be lobbying members of the Board of Directors to defeat the new Code of Ethics.

Also during my year as IEEE President, I discussed the proposed simplified Code of Ethics with IEEE members wherever I went. I was especially pleased that the provision on bribery was most strongly supported by members in countries were bribery was endemic. Previously, I had been concerned that members in such countries would reject the new Code of Ethics on the grounds that adhering to the provision on bribery was not realistic.

However, these members said bribery was a serious problem that needed strong refutation. They believed that a code of ethics should record what people aspire to do rather than what they may actually do. Clearly they did not believe IEEE could, or should try to, enforce its Code of Ethics – except possibly in regard to internal IEEE matters.

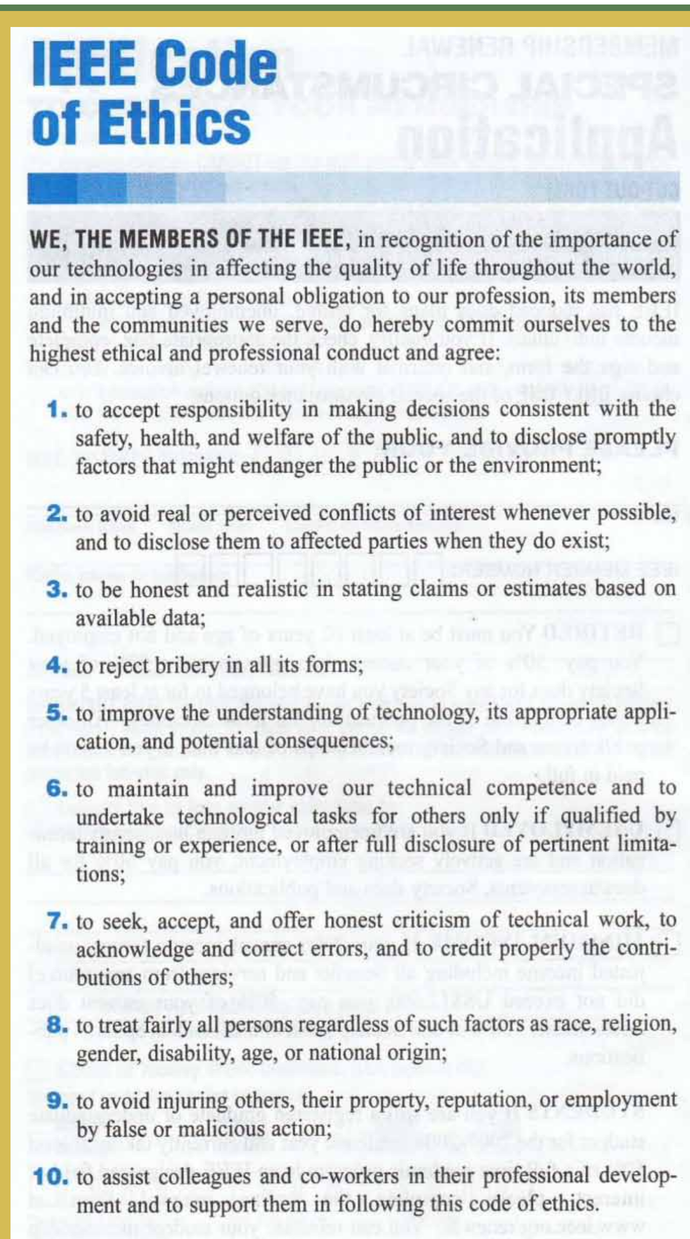
In February 1990 the simplified Code of Ethics was again presented in *The Institute* for comment by all IEEE members. This time it was printed side-by-side with the old Code. The old Code of Ethics had 591 words, whereas the simplified Code had 238. This was a 60 percent reduction in the number of words. [See Figure 4.]

The comments received from members indicated that no significant changes were needed. Nevertheless I continued to work with the committee to achieve the best possible wording throughout the document. In August 1990 the IEEE Board of Directors approved the simplified IEEE Code of Ethics, which became effective on January 1, 1991.

Unlike the old Code of Ethics, this shorter version has been broadly distributed and read throughout the world. For example, it is prominently displayed in the "IEEE Society & Special Interest Memberships & Subscriptions" document that is updated each year.

A Minor Change

The Code of Ethics remained unchanged for 15 years, until 2006 when the word "engineering" was removed from the first canon. This canon had said, in part, that IEEE members were "to accept responsibility in making engineering decisions consistent with the safety, health, and welfare of the public." With the word "engineering" deleted, they are now admonished, in effect, to "accept responsibility in making decisions (of all types) consistent with the safety, health, and welfare of the public." [See Figure 5.]



IEEE Code of Ethics

WE, THE MEMBERS OF THE IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

1. to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;
2. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;
3. to be honest and realistic in stating claims or estimates based on available data;
4. to reject bribery in all its forms;
5. to improve the understanding of technology, its appropriate application, and potential consequences;
6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;
7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;
8. to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin;
9. to avoid injuring others, their property, reputation, or employment by false or malicious action;
10. to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

Figure 5. "IEEE Society & Special Interest Memberships & Subscriptions" pamphlet of 2008 showing the IEEE Code of Ethics which is also prominently displayed in the current online version.

This change was motivated in part by the IEEE Board of Directors approval in February 2004 of a revision to IEEE Bylaw 1-104 that opens membership to professionals who do not see themselves as engineers. Following this change in the Bylaws, the IEEE Ethics and Member Conduct Committee reviewed the IEEE Code of Ethics, consistent with its mandate to promote ethical behavior and to advise the Board of Directors on ethics policy and concerns.

Not surprisingly, the opportunity to review the document caused some Committee members to think of many things that might be reworded or expanded. Fortunately, however, with the wise guidance of Theodore A. Bickart, the Committee generally focused on the target issue. Ultimately, the Committee recommended that the word, engineering, be deleted in the first canon of the Code. Consistent with the recommendation of President Drew's ad hoc committee of 1988, IEEE members, worldwide, were notified of this proposed change in the Code of Ethics by the Internet in November 2005 and then in the print edition of the Institute in December. The reaction of the membership was judged to be positive, and the Board of Directors approved the revision in February 2006.

From one perspective, it is surprising that any change was needed. After all, the Code of Ethics adopted in 1990 had been crafted to apply to members throughout the world – including those who did not consider themselves to be engineers. From another perspective, however, the use of the word, engineering, had been a troubling consideration even in 1990.

As we saw it then, if we failed to insert the word "engineering" it would have suggested that the IEEE Code of Ethics was being applied well beyond IEEE's normal areas of interest – an unacceptable concept for many. However, using the word, engineering, might have been objectionable to others who did not consider themselves to be engineers.

In the environment of 1990, we ultimately inserted the word "engineering." A major justification was our belief, that decisions made by scientists, engineers, or technologists, concerning the development or use of IEEE technologies in ways that could affect the "safety, health, and welfare of the public" were, by definition, "engineering" decisions.

By 2006 the environment had changed. No longer did it seem appropriate to limit the Code's applicability to decisions normally defined as "engineering decisions" when the "safety, health, and welfare of the public" was at issue. When no suitable replacement for the word "engineering" could be found, it was simply deleted.

Worldwide Focus and Personal Commitment

The IEEE Code of Ethics adopted in 1990, and revised in 2006, necessarily has much in common with those of other technical societies, but it is unique in many ways. Perhaps most important, it puts less emphasis on a member's responsibility to other members and greater emphasis on a member's responsibility to all people. Indeed, the IEEE Code of Ethics is consistent with IEEE's stated purpose of "fostering technological innovation and excellence for the benefit of humanity." This statement is often shortened to the tagline, "IEEE: Advancing Technology for Humanity."

IEEE members live in many countries, each with its own heritage, culture, and economy. By the end of 2012, 52 percent of IEEE's 429,085 members were living in countries other than the United States. The decision of the IEEE Board of Directors in 1990 to replace the old IEEE Code of Ethics with one tailored to an international membership is now well justified. Because of where they live or because of personal circumstances, many IEEE members will find it difficult to adhere to all provisions of the IEEE Code of Ethics. Nevertheless, it is a Code to which all members can aspire, and that is a good thing.

The structure, brevity and clarity of the IEEE Code of Ethics are important, but probably the Code's most obvious unique feature is the opening phrase: "We the members of the IEEE." Many readers will recognize the similarity of this phrase to the opening phrase of the Constitution of the United States of America, which was adopted in 1787. I chose this opening phrase because it indicates a personal commitment to the IEEE Code of Ethics by each IEEE member.

Acknowledgements

This article is based on an earlier article, with the same title, that I wrote for the Conference Proceedings of the 2009 IEEE Conference on the History of Technical Societies. I am grateful to IEEE for allowing me to reuse so much of that material without change. In writing that article, I expressed my gratitude to Theodore A. Bickart (who chaired the IEEE Ethics and Member conduct Committee in 2006 and 2007) for many helpful discussions, and I also thanked Tamara A. Seeley who (as Tamara A. Walsh in her role as Administrator, Governance, IEEE Ethics Committee Staff Secretary) prepared a report in 2001 and an updated report in 2006 on the History of the IEEE Code of Ethics. Her reports are available through the office of the IEEE Ethics and Member Conduct Committee. I am once again indebted to these individuals for their help, and especially to Theodore A. Bickart who read and commented on this article.

About the Author:

Emerson W. Pugh has a Ph.D. in physics and worked for IBM for 36 years in various capacities, including research scientist, product development manager, and corporate executive. He is the author or coauthor of a college physics text book and four books on the history of IBM and the computer industry. He is a long-time volunteer for IEEE, having served most recently as president of IEEE in 1989, chair of the IEEE History Committee in 1996-1998, and president of the IEEE Foundation in 2000-2005. Currently he is chair of the IEEE STARS Program on the IEEE Global History Network.

CONFERENCE NEWS

2013 Student Leadership Conference

The 2013 IEEE-HKN Student Leadership Conference was attended by over 115 IEEE-HKN members, from 25 Chapters, who traveled to Arizona State University from 15-17 March to participate in activities, listen to presentations from noted experts, and network with talented individuals. Arizona State University's Epsilon Beta Chapter and their Conference Committee, headed by President Idan Shtayer, ensured that the event ran smoothly and was filled with entertaining and informative events.

Attendees gather outside Old Main for a group photo.

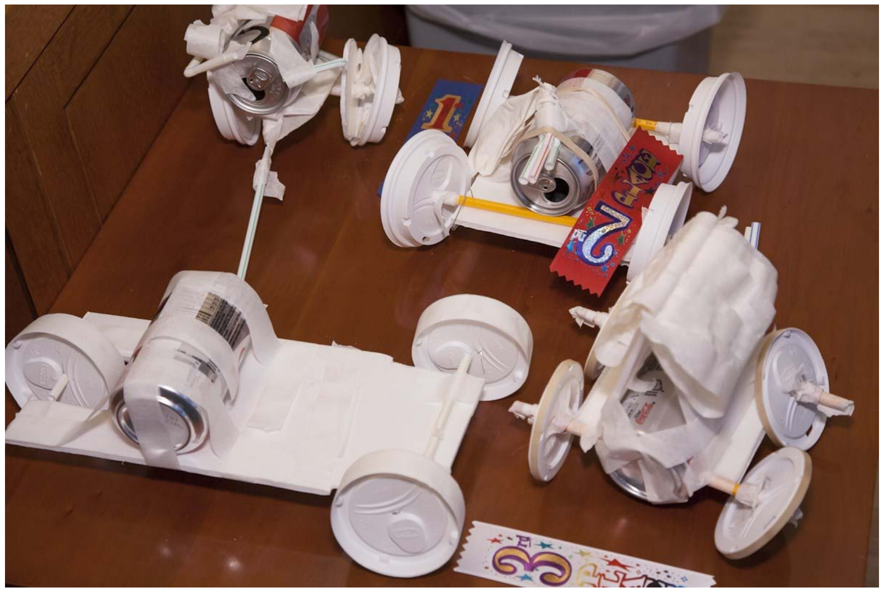
Local businesses and organizations including: Freescale, ACSS, National Instruments, IEEE Phoenix Section, and Arizona State University generously sponsored the event, helping students attend the conference by providing financial and logistical support.

Teams work to complete the task using only the materials provided to them.

After a welcome by host Chapter President, Idan Shayter, and Stephen Goodnick, Past IEEE-HKN President and Faculty Advisor of the Epsilon Beta Chapter, Shafiul "Jacky" Islam, IEEE Region 6 South West Area and Phoenix Section GOLD Chair, presented "IEEE Engagement Opportunities with Graduates of the Last Decade (GOLD)." Jacky is also Past President of the Iota Xi Chapter and a Software Development Engineer at Intel.

The highlight of Friday night was the "Engineering Team Challenge" run by Burt Dicht, IEEE Director of University Programs IEEE-Educational Activities, in which attendees from different Chapters were broken up into groups and tasked with creating a functioning balloon-powered soda can car using objects such as cardboard, paper, straws, glue, pencils, rubber bands, and tape!

During the competition, teams were judged by the distance their car was able to travel. The top three teams received Amazon gift certificates and the honor of having their car on display for the entire weekend!



The winning entries.

Saturday morning began with an inspiring video "Plug into the Power of IEEE", in which IEEE members from across the world and at all levels of industry and academia described why they are a part of IEEE and how being a member has added value to their lives and careers.

The Keynote Speaker of the Student Leadership Conference was Moshe Kam, Past President of IEEE and Department Head and Professor of Electrical and Computer Engineering at Drexel University, Philadelphia, PA. His speech highlighted the importance of service and giving back to the community. He encouraged all to follow the path of IEEE-Eta Kappa Nu and include service as a professional requirement.

Dr. Moshe Kam, Keynote Speaker

After the keynote speech, attendees were treated to the panel discussion "Dream Jobs 2013", moderated by Stephen Goodnick. The panel was made up of Brent Bushnell, who specializes in one-of-a-kind high-tech spectacles; Li Chen, a forerunner in augmented reality (even before Google); and Marcia Lee, who followed her engineering passion to the Khan Academy.

Following "Dream Jobs", attendees were given the choice of attending 3 separate workshops. These included: "Leadership Workshop" presented by Bill Badger, a professor for over 25 years, who's vision and commitment helped Arizona State University become recognized as home to one of the top construction programs in the nation; "Technology and Public Policy" presented by Russ Harrison, Sr. Legislative Representative of IEEE-USA; and "Training for Chapter Officers", presented by Evelyn Hirt and S.K. Ramesh, IEEE-HKN Board of Governors and Steve Watkins, Editor-in-Chief of IEEE-HKN's THE BRIDGE magazine.

When the workshops ended, attendees once again returned to the main hall for an insightful presentation by David Alan Grier, President of the IEEE Computer Society. His presentation featured "Technologies That Have Changed our Lives", and provided insight into technologies of the future.

Dr. Timothy Kurzweg moderates a race against time workshop to identify 50 ideas in 50 minutes. The list of great ideas will be made available to all chapters.

Following David Alan Grier's presentation, three additional workshops were offered: "Salary Negotiation", presented by Joyce Donahue, the Career Development Coordinator in the Ira A. Fulton Schools of Engineering Career Center at ASU; " 50 Ideas in 50 Minutes", presented by Timothy Kurzweg, Associate Professor in the Electrical and Computer Engineering Department at Drexel University and member of the IEEE-HKN Board of Governors; and "Engineering Ethics", presented by Steve Starrett, Director, Honor and Integrity System at Kansas State University.

This was followed by three final presentations: "LinkedIn Workshop", once again presented by Joyce Donahue; "Professional Adventure-Your Job Search", presented by Mike Andrews, Director of IEEE-Region 6; and "Designing Advanced Fighter Aircraft", presented by Burt Dicht.

After a day full of new ideas, students had time to talk with presenters and network with each other.

Following the reception, students returned to the main hall one last time for dinner and a presentation by James Bates, Senior Vice President and General Manager of Freescale. An Eta Kappa Nu member himself, Bates shared with the group his experiences throughout his career, and advised students how to best present themselves in their resume and during an interview. Best of all, he invited all students to submit resumes as Freescale is interested in hiring IEEE-HKN students!

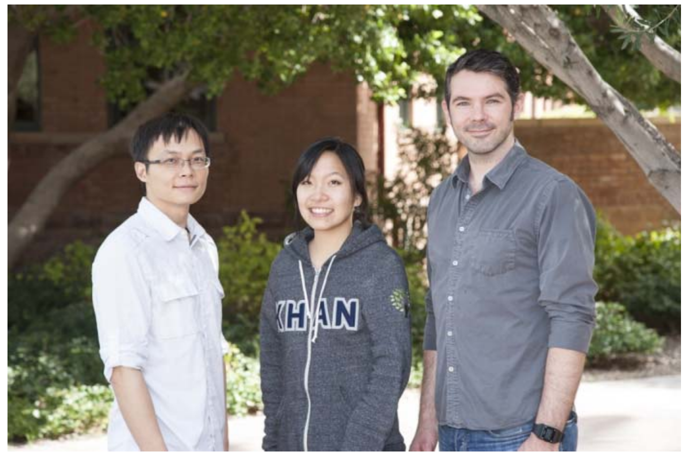
Tours were available on Sunday for students to get a taste of Arizona, including a tour of the Freescale "Fab" site and laboratory.

Thanks to the participants, speakers, sponsors and organizers, the 2013 IEEE-HKN Student Leadership Conference was a huge success!

IEEE-HKN Headquarters would like to thank everyone who chose to be a part of this experience. We hope to see you at the SLC in 2014, which promises to be an even bigger conference!

2013 Student Leadership Conference Gallery

Dr. Stephen Goodnick (R), moderator with the "Dream Jobs" Panel (L to R) Brent Bushnell, Li Chen and Marcia Lee



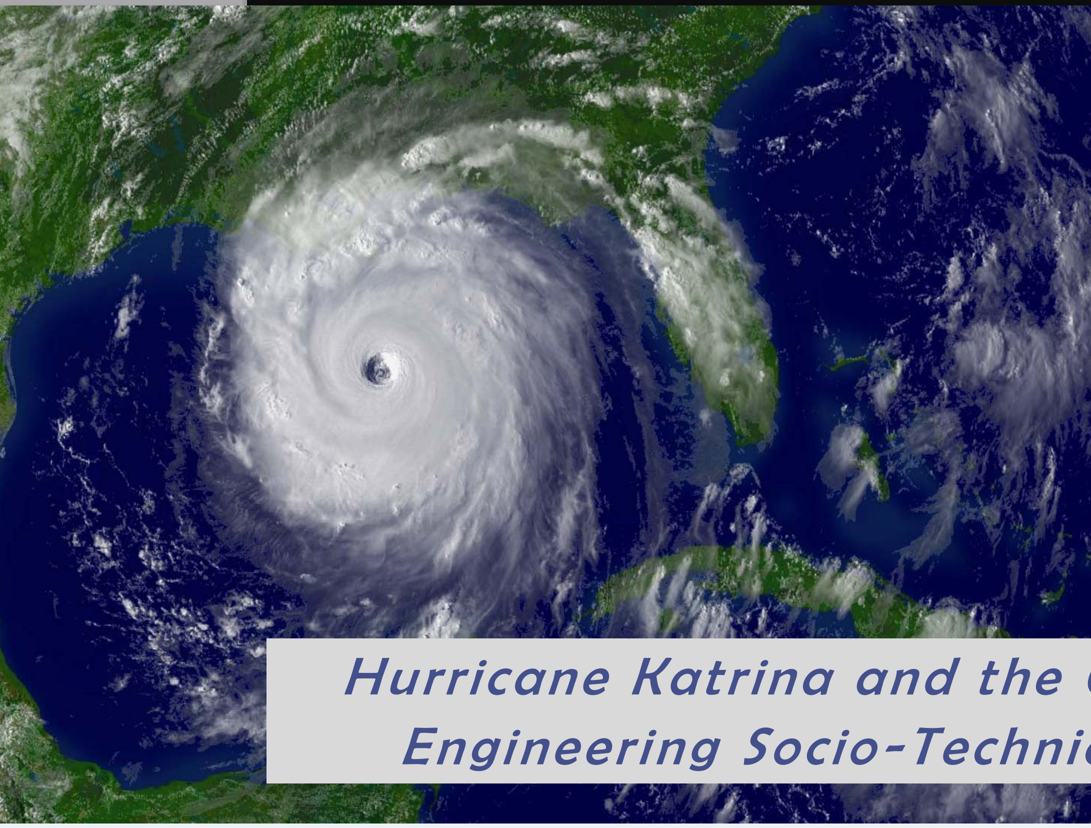
Dream Job Panelists (L to R) Li Chen, Marcia Lee and Brent Bushnell

Dr. David Alan Grier, President, IEEE Computer Society

Lunch Keynote presentation by Dr. David Alan Grier was a highlight of the day

James Bates, Sr. Vice President and General Manager, Freescale

ASU's Epsilon Beta Chapter and SLC Conference Committee



(Photo credit: NOAA)

Lessons from the *Storm*

Hurricane Katrina and the Challenges of Engineering Socio-Technical Systems

By Byron Newberry

Introduction

In his popular book *To Engineer is Human: The Role of Failure in Successful Design*, Henry Petroski stresses the importance of engineers learning from mistakes – sometimes catastrophic mistakes. Petroski, a civil engineer, illustrates his point using examples of famous structural failures resulting from design miscalculations, such as the Tacoma Narrows Bridge. But Petroski's advice for engineers applies beyond just erroneous technical analyses, or the failure of a single structure. Engineers of all types are frequently engaged in work on socio-technical systems – complex networks of technologies, people, and organizations. Examples include electrical power grids, cellular communications networks, or air transportation systems. Like the collapse of a bridge, failures of such systems can be catastrophic – a 2003 power grid failure in the northeastern United States and Canada left 55 million people without power for days, resulting in several fatalities and billions of dollars in economic loss. But unlike some bridge collapses, failures in socio-technical systems are not likely to be traced to a specific design error. More often, they result from the accumulation and complex interplay of many factors, comprising technical missteps, miscommunications, organizational dysfunction, and human foibles, no one of which may seem that severe when viewed in isolation. Despite these convoluted causes, or rather because of them, it is imperative that engineers learn as much as possible from failures of socio-technical systems.

To illustrate some of these problems, we can look to the 2005 Hurricane Katrina disaster in New Orleans and surrounding areas. The New Orleans Hurricane Protection System (HPS) that was in place in 2005 is a good example of a socio-technical system. It employed a variety of technologies, including levees, floodwalls, barriers, gates, and pumping stations, and it protected hundreds of square miles of area containing hundreds of thousands of people. The design, construction, operation, and maintenance of the HPS depended upon a variety of organizations, including the U.S. Army Corp of Engineers (USACE), the Sewerage and Water Board of New Orleans (SWBNO), the Orleans Levee District (OLD), and a multitude of construction firms, environmental organizations, and citizens' groups, not to mention the political bodies charged with authorizing and funding the system. And the HPS was intimately interwoven into the lives of the people who lived and worked in proximity to it every day.

Hurricane Katrina was a large scale disaster by any metric we might use: over 1800 fatalities; hundreds of thousands displaced from their homes and jobs; severe disruption and degradation of quality of life; hundreds of billions of dollars of economic loss from extensive destruction of property and infrastructure; and, the need for copious outside assistance in relief and recovery efforts. Further, Katrina was a complex disaster. The potency of a natural hazard intersected with and exposed the vulnerabilities of human-constructed systems. But the structural failures of levees, which allowed floodwaters into the city, were only proximal causes of the tragedy. In what follows, we will explore some of the underlying problems in more detail.

Figure 1. U.S. 90 Bridge in Biloxi, MS (Photo credit: NOAA)

Failure Modes

Often the most visible problems in a socio-technical system failure—and the ones most readily associated with engineers—are the technical problems. One of the prime tasks of a design engineer is to anticipate the ways in which something can fail and then design to ensure such failures do not occur. A premium is placed on getting it right, particularly when the consequences of failure are high. The Katrina case reveals a variety of technical problems associated with unaccounted-for failure modes. One example is a series of bridge failures along U.S. Highway 90 in coastal Mississippi, just east of New Orleans. As seen in Figure 1, much of the bridge decking was removed from its piers. The combination of storm surge and large wind-driven waves allowed the water level to reach the bridge deck, uplifting sections and sliding them landward. The attachments between the deck and the piers were not designed to resist such forces, though they could have been.

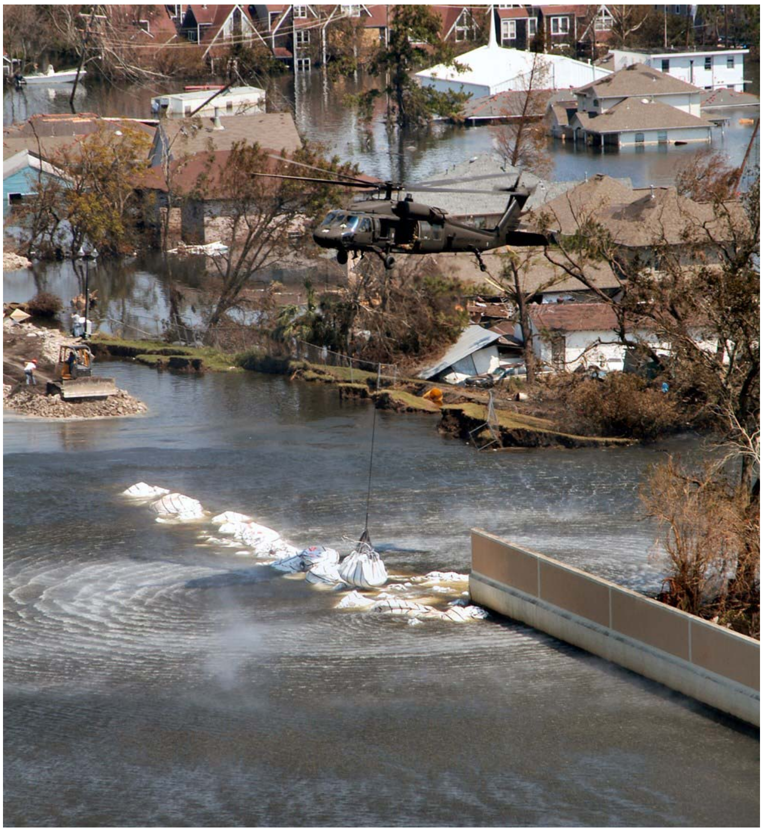


Figure 2. 17th Street Canal Breach (Photo credit: U.S. Army Corps of Engineers)

Some of the most devastating structural failures in New Orleans occurred along the canals that penetrate into the heart of the city. These breaches contributed to the majority of flooding in the city and were among the most prominent images in the media coverage of the disaster, such as seen in Figure 2, where a helicopter works to plug a breach.

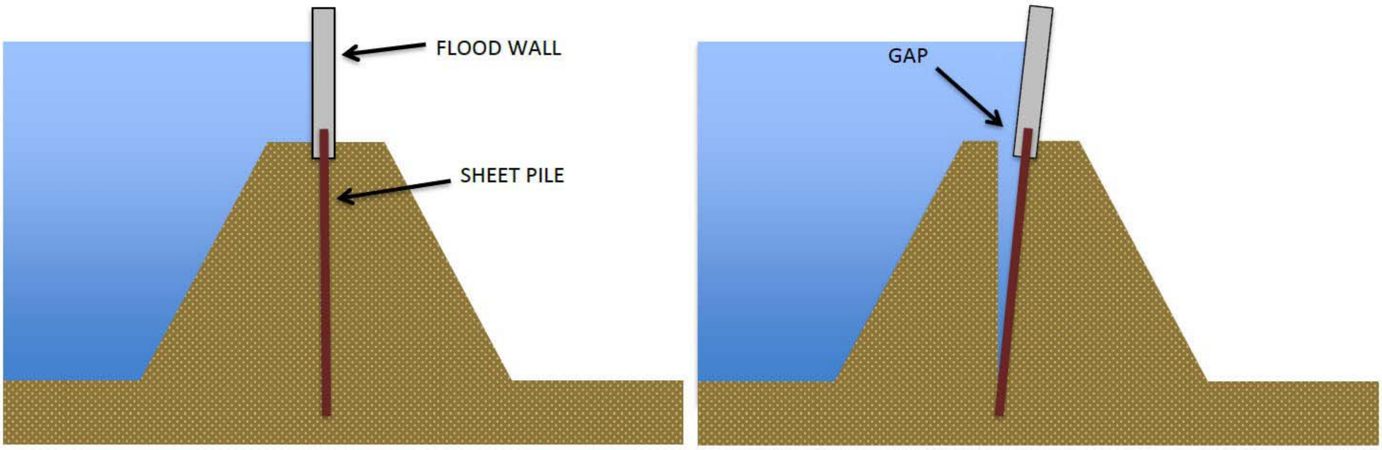


Figure 3. Levee-Sheet Pile-Flood Wall System with Gap (Illustration Credit: Byron Newberry)

These failures were also due, in part, to problems of unanticipated failure modes.

Along these canals, the earthen levees were topped with concrete floodwalls. These floodwalls attach to the tops of sheet piles, which are corrugated metal curtains that extend down into the centers of the earthen levees, as shown in Figure 3. The design was intended to withstand water levels up to the tops of the floodwalls. However, during Katrina the canal levees failed in several places before the water levels reached that high.

When water levels rose partway up the floodwalls, similar to what is seen in the illustration, the floodwall and sheet pile rotated backwards slightly in many places. This opened a vertical gap in the levee, allowing water to enter and exert pressure directly on the face of the sheet pile, effectively cutting the levee in half. The back half of the levee then slid away from the canal in several locations, allowing floodwaters free passage. The tilted floodwall and water-filled gap can be seen in Figure 4. This mechanism of failure was not envisioned during the design of the levees, and therefore was not designed against.

Incomplete Information

Engineering decisions are always made with incomplete information. The practical necessity of completing projects in a timely fashion must be balanced against the risks of uncertainty. In making such tradeoffs, it is incumbent upon engineers to draw upon the best information available. Of course, some information only becomes available after the fact. A main reason technologies evolve over time—improving in performance or safety—is because of new information gained through experience. But experience depends on having first tried something. Thus there is an inevitable chicken and egg relationship between technological development and knowledge. This fact dictates that engineers should exhibit a healthy prudence when venturing very far into the technological unknown. Unfortunately, there are times when important information is available, but is overlooked,

Figure 4. Water-filled gap along London Avenue Canal (Photo Credit: U.S. Army Corps of Engineers, IPET)

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miscommunicated, misinterpreted, or simply left unused, and with negative consequences.

For just one example, consider the water-filled gap problem just discussed. Information existed that could have helped identify the failure mode, but that information was never properly used. In the mid-1980s, the USACE conducted a full-scale test of a sheet pile/floodwall system. During the test, larger than expected tilting of the floodwall occurred, resulting in incipient failure at water levels below those predicted in the design. It is likely that the observed movement of the structure caused the soil to separate from the front side of the floodwall, but there was no record of this being observed due to a plastic liner that obscured the view of the base of the floodwall. Later, as follow up to the tests, more advanced analytical methods were developed which did consider the possibility of a water-filled "tension crack" in front of the floodwall. These results appeared in both USACE technical reports and in the peer-reviewed literature. But this new knowledge was never properly translated from testing and research into practice, and floodwall design proceeded without considering this failure mode.

Figure 5. Scour from overtopping along the Inner Harbor Navigation Canal (Photo Credit: U.S. Army Corps of Engineers, IPET)

Resiliency

The New Orleans HPS in place at the time of Katrina has been described as a series system. A series system, like a chain, is only as strong as its weakest component. For example, the East Bank protected area of New Orleans—the heart of the city—is essentially a bowl surrounded by a ring of levees. A few localized breaches of the canals within that ring permitted floodwaters to fill the entire bowl. But systems protecting such high value areas ought to demonstrate resilience—i.e., the ability to tolerate local failures without compromising the entire system, or, when conditions temporarily exceed design conditions, to endure and resume functioning once excessive conditions have passed. Resilient systems are characterized by multiple lines of defense (parallel system instead of series), ductility (the ability to perform even when capacity is exceeded), and excess capacity (margin of safety).

An example of a lack of ductility in the HPS system was the scouring of trenches on the inboard sides of floodwalls due to water flowing over the top of the wall. Figure 5 shows such a scour trench behind a section of the Inner Harbor Navigation Canal (IHNC) floodwall. Such trenches on the inboard side of the wall reduce foundational stability and make the wall more susceptible to toppling due to the force of the water on the outboard face. The fact that the floodwalls were overtopped at various locations during Katrina indicates that design heights were exceeded by water levels at the peak of the storm surge. But that alone would not have been disastrous. While overtopping allows some amount of floodwater into protected areas, the amount is relatively small compared to the amount of water that can enter through a breach. Overtopping abates as soon as the surge subsides, whereas flow through a breach may continue for quite some time (for days in the case of the New Orleans outflow canal breaches). A levee that remains intact after overtopping exhibits ductility—even though it is temporarily overwhelmed, it continues doing its job as the water level drops. A levee that suffers a breach as a result of overtopping is brittle—it ceases to function, allowing flooding to continue even as the water recedes. Brittleness of this type was observed at many locations throughout the New Orleans HPS, including possibly contributing to a particularly destructive breach along the IHNC.

Figure 6. Floodwall with new splash pad, Orleans Avenue Canal (Photo Credit: John McQuaid)

What makes this type of failure particularly vexing is that they may have been preventable with relatively little expense. Splash pads behind floodwalls, along with other types of armoring on the levees to prevent erosion mechanisms, would have made the system much more ductile. In the aftermath of Katrina, the USACE has worked to retrofit many levees with armoring, as shown in Figure 6.

Complex System Changes Over Time During the Design

Large, complex projects, which often span long time frames, are subject to changes in physical, societal, and organizational environment, and in technological tools and knowledge. This makes the design a challenge for engineers who, in general, would prefer to meet a fixed set of specifications given a fixed set of constraints. Difficult conundrums can arise when changing conditions render partially-completed design objectives obsolete. One very prominent example of the effects of time on the New Orleans HPS project involved land subsidence . The New Orleans HPS project had been ongoing for over forty years. During that time, the land in the New Orleans area was sinking due to the compaction of silty deltaic soils, in some cases by several feet. This contributed to measurement errors and a progressive mismatch between initial design targets and eventual system performance. In some places levees/floodwalls wound up a couple of feet lower than intended.

With construction of the system spread over the entire time interval, and with knowledge accumulating about the changing conditions while construction was ongoing, the Corps was faced with difficult decisions. They could continue working off the original plan, effectively ignoring subsidence, and produce an end result that, while looking correct relative to current ground level, was really much too low. Alternatively, they could progressively revise the specifications for components yet to be built. This would mean they would take subsidence into account by incrementally increasing new levee/floodwall heights with time. But this would have caused some new problems. First, it would have greatly increased construction expense since higher levees/floodwalls are more costly. Second, it would have resulted in a non-uniform system, with component heights stair-stepping from oldest to newest. This has some potentially severe consequences due to the introduction of stress concentration points (as will be discussed in the next section). Another alternative was that they could continually revise specifications for the entire system, which would mean a continuous cycle of going back and renovating already-built components to bring them up to current standards. This would entail significant added time and cost. Approval and funding from Congress would have been difficult, and such never-ending construction would have been a tough sell to local residents.

The Corps would have been subject to significant criticism no matter which of these paths it took. On the one hand, we might make an ethical argument that the Corps should have refused to do anything other than pursue the latter course, because that was the only one with a chance of satisfying the original intent with respect to level of protection. Not surprisingly, this is the course that, in hindsight, many observers said the Corps should have taken. On the other hand, the first course (and more or less the one actually followed) might be defended on the grounds that it provided the quickest and least expensive path to getting a complete baseline protection system in place, even if the latter stages were knowingly being built to inadequate specifications. In fact, a former chief of engineering for the Corps' New Orleans District gave just such a rationale.

This problem of change-with-time in long-term projects suggests the need for adaptable designs. There are always uncertainties in the future, so if flexibility can be incorporated in the design upfront to account for a range of possible futures, time and cost can potentially be saved down the road. As an example, a major source of future uncertainty for society's infrastructure is climate change. Though there is much agreement that climate changes will cause challenges in the next century for water resources, energy production, and flood protection, among other things, the great uncertainly associated with the magnitude of such changes makes the planning of engineered infrastructure difficult. Thus, much research is currently being devoted to developing adaptable designs – designs that will not be economically wasteful for the best-case scenarios, but which can be easily adapted to worst-case scenarios if needed.

Physical Interfaces

As a long-time teacher of engineering design classes, my experience has been that interfaces are the most frequent source of problems for students trying to implement their designs. Student teams will routinely partition their designs into subsystems and then work diligently to perfect each one independently. But when they attempt to integrate their subsystems into the larger system they find that there were important details that needed to be considered at the interface.

There were many problems that occurred during Katrina due to physical interfaces—or transitions. Figure 7 shows a failure along the New Orleans East back levee. This failure was typical of many failures throughout the system. Here, a section of levee topped with a concrete floodwall transitioned into a section of levee without a floodwall. But at the point where the sections joined, the top of the bare levee was lower than the height of the adjacent floodwall. When the storm surge overtopped this area, the height mismatch at the point of the transition had a stress concentration effect—the water behind the higher floodwall was funneled around the corner where it joined the lower levee. The water current generated at this discontinuity scoured and eroded the back side of the levee. This caused the sheetpile to overturn, creating a breach that allowed floodwaters to continue entering long after the surge level had subsided below the original levee crest.

Organizational Interfaces

Another series of transitional failures occurred at penetrations in the levee system. Penetrations are locations where railways, roadways, or other features intersect with levees and floodwalls. These locations may have transitions between types of earthen materials and between structural elements such as floodwalls and gates. For example, at one location along the IHNC, a gap existed in the floodwall where a rail line crossed the levee and

Figure 7. Transition failure along the New Orleans East back levee (Photo Credit: US Army Corps of Engineers, IPET)

continued onto a railroad bridge over the canal. There was also a roadbed that ran through the gap parallel to the rail line, which provided access to canal-side facilities operated by the Port of New Orleans. In the event of a storm, the gap in the floodwall was supposed to be sealed by rolling a steel floodgate into position. In the months before Katrina struck, the floodgate was damaged by a train and had been removed for repair. As Katrina approached, sandbags were piled in the gap, but these were easily washed away by the storm surge, creating a major breach through which floodwaters passed. To make matters worse, the soils used to fill the levee at this location were highly-erodable sands, unlike the denser clays to either side, which resulted in considerable erosion of the levee through the gap. The earthworks at the location of the gap were apparently constructed by organizations more concerned with the transportation features, not those responsible for flood control.

This example highlights the influence that organizational interface problems can have on physical interface problems. There were at least five agencies with overlapping responsibilities at the site: the USACE (responsible for levee construction and flood control), the rail company, the Port of New Orleans (responsible for shipping within the canal), the State Highway Department, and the local levee board (responsible for levee maintenance). Each of these agencies had different agendas with respect to the design, construction, operation, and maintenance of the site. But it was not clear which, if any, assumed ultimate responsibility. Sometimes when everyone is responsible, then no one is responsible. The details of interface points in a system are critical for system performance, but unfortunately these points and their details often fall between the cracks. This is either because different organizations responsible for adjacent features do not communicate effectively. Or, it may be that due to the long project duration newer features are built adjacent to older features without sufficient attention to making smooth transitions. It behooves engineers to pay careful attention to interfaces and transitions, and to ensure that someone has definitive responsibility for such transitions. This latter observation also has implications for public policy for engineering in socio-technical systems.

Risk perception

In the aftermath of Hurricane Katrina, New Orleans faced conflicting objectives with respect to recovery. A major question was simply whether it was wise to rebuild and repopulate the riskiest areas. Discussions of whether certain areas should be repurposed for lower-risk uses must contend either with appeals to preserve traditional places and ways of living, or with economic drives to return properties to profitability. But a significant problem that plagues such discussions is the ability—or lack thereof—to sustain over the course of time an accurate perception of the risks, along with the initiative to adequately mitigate them. Many factors contribute to this problem, including the massive physical scale of the system and its corresponding costs, a lack of awareness of accurate information about levels of risk and protection, the long timescales involved, and short term desires and objectives. All of these factors provide fuel for various peculiarities of human psychology that can lead to inadequate responses to risk.

Figure 8. Orleans Avenue Canal (Photo Credit: US Army Corp of Engineers)

A false sense of security about levees is an endemic problem, not only in New Orleans, but wherever levee systems are built. Levees, like many other types of technologies, provide an impression of human control over nature. For the people behind the levees, this impression has unfortunate consequences, since failures of levee systems are a fact of life. On the one hand, people can become vulnerable to disasters because they are naïve about the protection afforded by levees; they move into high-risk areas without a true understanding of the possible consequences. Figure 8 shows housing developments in the shadow of the Orleans Avenue Canal. On the other hand, agencies, groups, and individuals often facilitate exposure to risk, either wittingly or unwittingly, by developing flood-prone land in the pursuit of short-term benefits. This latter is part of a cycle of flood plain development that has been termed the levee effect. The levee effect is a paradox in which the construction of levees designed to protect assets in flood-prone areas actually serves to increase the ultimate exposure to risk by providing an aura of protection that invites the placement of additional assets in harm's way. This increase in development may prompt the construction of additional flood defenses, which in turn serves to accelerate additional development. Thus, the quality of additional defenses does not necessarily keep pace with the increase in value of what is being defended. The levee effect is a manifestation of a more general phenomenon that has been called the safe development paradox, whereby attempts to design protective measures to facilitate some type of development in the face of serious hazards inadvertently results in greater risks and the potential for future catastrophes.

Historical contingency and lock-in

Engineering work often is constrained by previous decisions. Sometimes the basis for those prior decisions may now seem to have little relevance. For example, the design of a new automobile is constrained width-wise by the standard width of roadways. A car too wide for typical roads would be of little value to consumers. But road lane widths are little different from ancient times, and were initially dictated by factors such as the strength of wooden axles and the pulling power of draft animals. In order to be useful, early automobiles had to conform to existing roads. So, modern engineers are still constrained in some sense by considerations that are no longer relevant. Even if we decided there was some advantage for modern cars and roadways to have different widths, the cost of converting our entire road transportation system would be prohibitively expensive, so it would not be likely to happen without some overriding impetus. This is an example of a network effect. When a technology grows into an interdependent network (such as road systems, or communications systems, say), issues of standardization can make it difficult to make fundamental changes without significant costs. The cost of converting everything at once is prohibitive, but incremental conversion is problematic since early converts face incompatibilities with the rest of the system. Thus, historical contingencies concerning the adoption of certain practices and standards have significant consequences for future engineers, at times effectively locking them in to certain courses, even when the rationales for those courses may no longer be relevant.

In the case of New Orleans, if we could erase the slate and begin planning the city and its flood defenses from scratch, we would likely come up with something that looks much different from what now exists. In fact, we might well locate the city somewhere else. But abandoning the city, or razing it and starting over, is not going to happen. Certain realities are locked-in for New Orleans due to the historical contingency of where it was founded, and of the actions that have been taken over the years to grow the city while defending it from storms. The problem of flood protection in New Orleans is not amenable to being solved with any finality. Land subsidence, loss of coastal wetlands, predicted sea level rise, the inexorable flow of the Mississippi River, and the human drive to preserve—and further develop—the city, will mean that protection efforts will not only be never-ending, but likely ever-escalating. Also, the hurricane protection levees comprise a network that is interdependent with the city's drainage system, as well as with the levee system that constrains the flow of the Mississippi River, both in New Orleans and in locales upstream. Contemporary decisions about flood defenses must contend with these network effects, as well as with the legacy of countless previous decisions going back to the first levees built shortly after New Orleans was settled by Bienville in 1718. Figure 9 shows a portion of a 1759 map of New Orleans, which notes a "Bank to Preserve the Town from the Inundation." The city's drainage canals, for example, are an integral part of the current hurricane protection system, and their failures during Katrina played a prominent role in the disaster. Yet those drainage canals owe their existence not to considerations of hurricane protection, but to efforts to improve sanitation, reduce disease, and develop new land going back to the early to mid 19th Century.

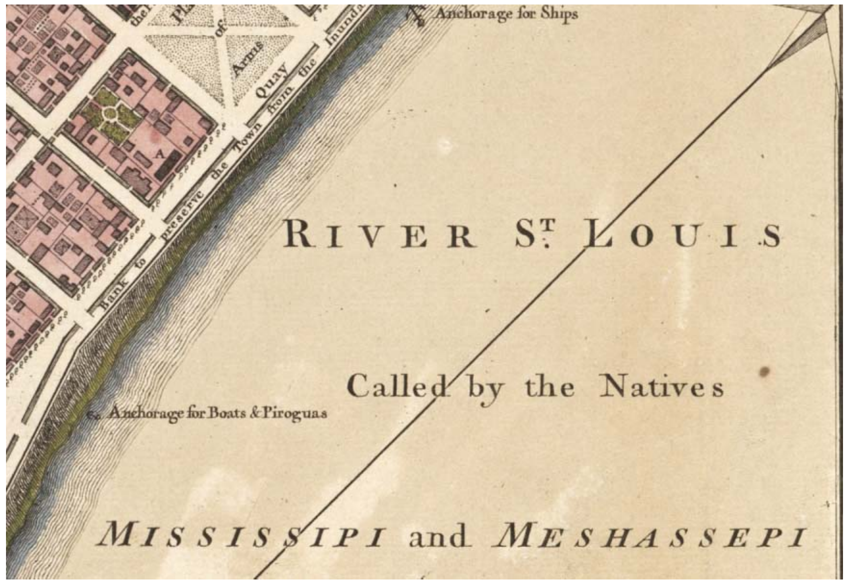

Figure 9. 1759 Jefferys Map of New Orleans
(Image credit: Leventhal Map Center at the Boston Public Library)

Conclusion

The more insight engineers, and engineering students, develop into the sometimes subtle pitfalls that bedevil complex systems and projects, the greater the chance that far-sighted planning can be brought to bear to minimize them. With that in mind, we have attempted to use the Katrina case to highlight a number of issues that pervade such engineering work. These include problems of unanticipated failure modes, lack or misuse of information, the importance of resiliency, the effects of time, balancing competing interests, attending to the details of interfaces, the fickleness of risk perception, and how the past constrains the present. As we have seen, these issues intertwine, with the examples used for one often overlapping several others.

About the Author:

Byron Newberry is Professor of Mechanical Engineering at Baylor University in Waco, Texas. His background is in aerospace materials and structures, and he has worked in the aircraft industry. In addition to courses in the mechanics of materials, structures, and machines, he teaches engineering design and engineering ethics to both mechanical and electrical engineering students. He is a licensed Professional Engineer in Texas, and is a member of IEEE, ASME, and ASEE. He serves on the executive board of the National Institute for Engineering Ethics and is editor for the Springer book series *Philosophy of Engineering and Technology*.

FOUNDERS DAY 2013

This is your invitation to participate in Founders Day 2013. Please join with all of the IEEE-HKN Chapters around the world on Monday, 28 October to celebrate our founders and the principals on which Eta Kappa Nu was formed. Our goal is to build awareness of the service and benefits of IEEE-HKN, raise our visibility on campus, encourage others to join, and invite members to participate in programs sponsored by their IEEE-HKN Chapter. Plan now to have a program or community service project to honor our founders. Share your ideas with all Chapters – share your plans and photos with Headquarters by emailing ieee-hkn@ieee.org.

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IEEE-HKN HISTORY SPOTLIGHT

FOUNDERS PLAQUE AT ALPHA HKN CHAPTER

The Alpha HKN Chapter at the University of Illinois at Urbana-Champaign has a special Bridge display on their campus. A Founders Plaque was installed on 9 November, 1929 and lists the names of the ten original members. The plaque is installed next to the Everitt Laboratory with a Bridge Monument.

Eta Kappa Nu Honorary Electrical Engineering Fraternity founded at the University of Illinois Oct. 28, 1904.

Milton K. Akers	**Maurice L. Carr**
Charles E. Armstrong	**Hibbard S. Greene**
Ralph E. Bowser	**Fred D. Smith**
Carl K. Brydges	**Edmund B. Wheeler**
William T. Burnett	**Frank H. Winders**

Dedicated November 9, 1929

IEEE-HKN PRESENTS AWARDS

Outstanding Chapter Award

Presented March 2013

The 2011-2012 Outstanding Chapter Awards were presented on 25 March 2013 at the ECEDHA Conference in Orlando, FL. Twenty-three (23) Chapters were recognized for their achievements and service provided to their departments, universities, and communities.

The Outstanding Chapter Award was presented to the Department Head of each university that was recognized.

Plaques were presented to each Department Head in a ceremony presided by Alan Lefkow (HKN 1947) and John Orr, Chair of the Outstanding Chapter Award Committee and current IEEE-HKN President.

According to Alan Lefkow, "I am delighted to announce that the new criteria for selecting outstanding chapters have allowed us to recognize all of the chapters who are doing outstanding work. This year, 23 Chapters are being honored, three of which are receiving the award for the first time and one is our new Chapter, Lambda Eta, installed only last year at Bharati Cidyaeeth's College of Engineering in New Delhi, India."

The Outstanding Chapter Award is truly an example of the value of an IEEE-Eta Kappa Nu Chapter. The contributions of these twenty-three Chapters represented 50,000 hours of service given to the departments, universities, and communities they serve. Additionally, each member of the twenty-three chapters provided at least 50 hours of service in one academic year.

While praising the Award winners, IEEE-HKN President John Orr said, "The commitment to service and helping others is one of the reasons IEEE-HKN is a valuable experience both for the member and the Chapter. The three requirements to be invited to join IEEE-HKN, scholarship, character, and attitude are the keys to a successful career and life; these Chapters are shining examples of that commitment."

Master of Ceremonies and Outstanding Chapter Award Chairman Alan Lefkow

Chapters were recognized as Outstanding Chapters based on the amount of community service they perform.

IEEE-HKN PRESENTS AWARDS

Outstanding Student Award

Presented March 2013

The 2012 Outstanding Student Award was presented to Larry Martin, University of Hawaii at Manoa on 25 March 2013 at the ECEDHA Awards Dinner in Orlando, FL.

(L to R) Outstanding Student Award winner Larry Martin with IEEE-HKN President Dr. John Orr.

Larry Martin was recognized for his academic excellence, service, and leadership, as well as contributions to his fellow students, his University, the Omega Delta Chapter, and his Community. His credentials include the "Outstanding Graduating Senior in Electrical Engineering" award, and the "Student Engineer of the Year" Award by the Hawaii Society of Professional Engineers. Additionally, Larry was ranked first in his graduating class. He has won several scholarships and awards for his research projects, including the National Consortium for MASINT Research Scholarship, and the Chevron Engineering Scholarship. Larry is a member of the Delta Omega Chapter, served as the Bridge Correspondent, and was Secretary and Member of the IEEE Student Activities Council.

IEEE-HKN Faculty Advisor Dr. Wayne Shiroma attended the dinner and shared these comments, "Larry is truly the most unique student I have had the opportunity to work with. In addition to his exemplary academic performance, Larry has shown leadership and the attitude required of a successful professional that are the founding principles of IEEE-Eta Kappa Nu."

Ashkay Gupta was recognized and presented with the "Honorable Mention" award from the Outstanding Student Awards Committee at the ECECHA Award Dinner on 25 March 2013.

(L to R) Receiving the Honorable Mention Ashkay Gupta with IEEE HKN President Dr. John Orr.

Akshay Gupta served as the Chapter President for Lambda Eta, IEEE-HKN at BVCOE, New Delhi; he was instrumental in the installation of the first IEEE-HKN Chapter in India.

He graduated with a gold medal for the Best Student Award. He is currently pursuing a Masters in Computer Science at Georgia Tech, where he works as a graduate research assistant at the Computational Perception Lab. He works in the NSF Expeditions in Computational Behavior Science group, which aims to create Behavior Imaging technology for support and diagnosis of autism. His research interests are machine learning and computer vision, and his papers have been published in 8 international journals and conferences, which are available on the IEEEXplore Digital Library. His current projects include building an intelligent agent for a joint human-agent improv performance at the ADAM lab at Georgia Tech. He is also a volunteer for Children's Heathcare of Atlanta, where he works on the software system at Marcus Autism Center.

Professional and Ethical Dilemmas in Software Engineering

Brian Berenbach, Siemens Corporate Research
Manfred Broy, Technical University of Munich

The authors identify, categorize, and name nine specific ethical and professional dilemmas in software engineering, placing them in the context of the IEEE code of conduct, with the hope that giving such behavior a name will increase awareness and decrease the frequency with which these dilemmas occur.

Humans have been engineering things for hundreds of years, and for all that time they have faced essentially the same ethical challenges we have outlined elsewhere. So what makes software engineering significantly different? Software engineering is a discipline with which many people are unfamiliar and where issues and problems are harder to spot in advance. Therefore, people must trust software engineering experts even more than experts in other fields of engineering.

Software engineers often engage in unprofessional or unethical behavior without realizing it.[1] In ethics courses, or through professional association codes, practitioners might be warned of situations or dilemmas that could eventually lead to unethical behavior, such as “Avoid harm to others.”

A joint ACM/IEEE-CS task force has created a code of ethics for addressing issues of unethical behavior (www.nspe.org/Ethics/index.html). But too often the focus is on headline scenarios and not on the (initially) mundane situations that abound in our profession. Further, ethical training might not be given the needed emphasis during undergraduate education.[2-4]

Rather than an isolated ethical lapse, what typically makes the headlines is the result of a sequence of related ethical lapses. When such scenarios cascade, there tends to be a magnification effect.

An ethical dilemma occurs in software engineering when the professional must make a choice between competing values, such as personal versus professional. For example, a sales manager might sign a contract to deliver a software product knowing, or having been advised, that the product will take longer to deliver than the promised date. The sales manager's dilemma might be that his employer is under pressure to meet a financial target, or there might be job-related consequences.

In response, the project manager creates an unrealistic project schedule, which lead development staff choose to defer to so that they can achieve political or organizational goals. A chain of unethical or unprofessional behaviors could then take place that eventually leads to massive penalty payments, lawsuits, layoffs, or even bankruptcy. Yet none of the players in this process will admit to or recognize that their behavior was unethical or unprofessional.

CATEGORIZING DILEMMAS

To shine some light on these kinds of subtle but nonetheless unethical or unprofessional situations, we have given each dilemma a name. Readers might disagree with our choice of labels, but we doubt they will disagree that the behavior is inappropriate.

This list is not and cannot be comprehensive. We cover the most significant instances of ethical dilemmas. All those we describe involve common occurrences. We cannot be sure that simply naming them will solve anything, but it will help us discuss them.

Keep in mind that not every wrong behavior is unethical. If people do not know better and behave wrongly, they are not acting unethically. It certainly is unethical, however, for people to make decisions when they know they lack the knowledge needed to make sound professional decisions.

The term ethical behavior refers to how an individual or an organization ensures that all its decisions, actions, and stakeholder interactions conform to the individual's or organization's moral and professional principles. These principles should support all applicable laws and regulations and are the foundation for the individual's or organization's culture and values. They define right from wrong.

Typically, incompetence, unprofessional behavior, personal misconduct, mismanagement or, more commonly, a seemingly inconsequential chain of small ethical or professional lapses brings about the situations that make headlines.

For example, if a project is running late, the project manager might be tempted to cut short the requirements definition phase, hoping to make up for some lost time. In order to get the product out the door, developers base their testing not on the requirements, but on developer descriptions of how their code will work. The team then delivers the result to the customer with possibly catastrophic consequences, such as an unusable product, contract cancellation, or lawsuits.

This behavior is shortsighted at best and certainly unprofessional. Wrong decisions lead to bad results. If a person who should know better makes wrong decisions, and if personal interests motivated those decisions, the behavior becomes unethical.

When students enroll in introductory ethics courses, they learn about clear and extreme situations. This environment makes it relatively easy to distinguish when behavior crosses the line or is unethical. However, real life is not so simple, and the following dilemmas come from scenarios that occur all too frequently.

Mission impossible

This dilemma occurs when an individual is asked to create or accept a schedule that is obviously impossible to meet. Because of perceived pressure, or for other reasons, the person creates or accepts the schedule knowing it is unrealistic.

The consequences of this lapse in judgment can range from loss of qualified staff to significant loss of revenue. Overwork and burnout cause loss of staff. Loss of revenue can derive from the premature announcement of a product's availability, which then reaches the marketplace later than anticipated. Meanwhile, customers stop buying the current product in anticipation of the new product's arrival.

Mea culpa

This dilemma occurs when staff members must deliver a product that still lacks key functionality or has known software defects. The market's anticipation can create pressure to release the product prematurely, before a competitor does or before contractual obligations -- possibly associated with a penalty clause -- come due.

The mea culpa dilemma occurs when staff members must deliver a product that still lacks key functionality or has known software defects.

A risk assessment is worthwhile and might reveal that, under certain circumstances, releasing early could be beneficial. However, problems might arise if no one performs a risk assessment or the actual risks prove much greater than perceived.

In the short term, delivering incomplete software products causes customer dissatisfaction. Long-term repercussions might include a bad reputation and loss of market share or sales. If incomplete deliveries happen often enough, the company could go out of business. In a worst-case scenario, company staff could be exposed to civil or criminal penalties.

Rush job

Occasions can arise in which either a poor work ethic or perceived pressure to deliver compromises quality. A developer working on a software product delivers working code, but the quality of the product is shoddy, with minimal or no rationale and little or no documentation. The programmer might feel under pressure to deliver, becoming more concerned about meeting milestones than ensuring quality.

The rush job and mea culpa dilemmas differ markedly. In the mea culpa mode developers still deliver a product, although one missing functionality. However, in the rush job scenario, full functionality can be present, but the resulting low-quality product does not meet set standards because developers intentionally traded quality for speed of implementation.

Not my problem

Occasionally, a project team or staff will concern itself with day-to-day activities, accepting the development culture's status quo and showing no inclination to improve productivity or quality. For example, error codes might be hard-coded in the software rather than placed in a table. When developers ignore best practices, they can leave the door open for civil, and in some rare cases criminal, liability. We call this dilemma not my problem because team members frequently will state that quality, productivity, and best-practice issues are someone else's responsibility.

Red lies

Red lies occur during meetings with clients or management, when representatives make statements about a product or project that are known to be untrue -- such as stating that a project's delivery is on schedule when the team already knows they cannot deliver it on time.

There is a little bit of not my problem in red lies. For example, rather than admit that a project is behind schedule, a project manager could rationalize that the burden of making up the lost time will fall on the development team. This lets the manager report an idealized schedule. If the development team does not meet this schedule, that failure becomes their problem.

The use of the color red is significant in this case because it indicates what might happen to the company's bottom line if this behavior becomes pervasive or ongoing.

Fictionware versus vaporware

The fictionware dilemma occurs when an organization or individual promises or contracts to deliver a system for which some agreed-on features are infeasible. Fictionware and the frequently used term vaporware differ in that a fictionware product exists but lacks a variable amount of the specified functionality. In the case of vaporware, the product simply does not exist. This situation typically occurs when people feel under intense pressure to meet sales targets; denial can make it difficult to read a request for proposal objectively.

Fictionware contracts are endemic in contracting organizations that decouple sales commissions from delivery. The sales representative might have only a vague understanding that the contracted-for project is infeasible, but that person really does not care because the commission is contingent on the contract award, not on long-term profitability.

Mitigating problems with fictionware can best be achieved by coupling merit or bonus payments to after-completion project profit, and by giving engineering professionals significant upfront responsibility and authority to influence the bidding or quotation process.

Nondiligence

This behavior occurs when important documentation such as requests for proposals, requirements documents, or contracts does not receive a thorough review. In the case of nondiligence, agreements might be made without a careful understanding of what is being agreed to, either because of failure to carefully evaluate a specification or failure to pay close attention to staff when they voice their concerns.

Canceled vacation

A canceled vacation syndrome can arise when managers pressure staff members at the last minute to cancel planned trips or otherwise sacrifice their personal time -- and possibly money through, for example, nonrefundable trip reservations -- to meet a short-term deadline.

While working at a consulting company, one of us observed several consultants being told to cancel their vacation plans so that a project milestone could be met. In one case, the employee's parents were flying in from overseas, and the trip plans had been finalized nearly a year before the trip date. The forced cancellation indicated a lack of planning on the part of project management, and while potentially solving a short-term problem, in this particular situation it caused an even more serious long-term staffing and morale problem. Every employee asked to cancel a vacation left the company within a year. Moreover, management killed the project shortly after the trip cancellations occurred. So the company that fostered this canceled vacation syndrome gained nothing and lost several valuable employees.

Sweep it under the rug

This syndrome occurs when unforeseen issues arise that could potentially damage a project or company but, to keep things running smoothly, developers ignore the issues in the futile hope they will vanish. For example, a tester uncovers a flaw in a communication system and calls it to the attention of his supervisors. They determine that while the flaw is real, the odds of its impacting the delivered product are relatively small and, besides, once the customer starts using it, the responsible parties will have moved to another project.

Nondiligence occurs when important documentation such as requests for proposals, requirements documents, or contracts does not receive a thorough review.

Sweep it under the rug differs from not my problem in that it deals with mishandling or ignoring infrequently occurring unique problems, whereas not my problem occurs when developers fail to address systemic infrastructure or process problems .

ACM AND IEEE ETHICS CODES

The Software Engineering Code of Ethics and Professional Practice contains a set of 24 imperatives that deal with professionalism, the interaction between professionals and society, and leadership (www.ieee.org/about/corporate/governance/p7-8.html); the ACM Code of Ethics and Professional Conduct contains a set of 10 imperatives that deal with honesty, responsibility, conflicts of interest, technical competence, and fairness (www.acm.org/about/code-of-ethics).[5,6] We have cross-referenced the dilemmas listed with their relevant imperatives in the ACM-IEEE codes, as Table 1 shows. The imperatives are well-crafted and comprehensive.

Table 1. Mitigation strategies: Cross-referencing dilemmas with imperatives.

Ethical dilemma	Applicable ACM–IEEE imperatives	Comment
Mission impossible	Honor contracts, agreements, and assigned responsibilities—"a computing professional has a responsibility to request a change in any assignment that he or she feels cannot be completed as defined."	The difficulty with honoring agreements and not accepting impossible assignments is that often in the organizational culture acceptance of any assignment is the norm when the assignment comes from a supervisor.
Mea culpa	Strive to achieve the highest quality, effectiveness, and dignity in both the process and products of professional work—"The computing professional must strive to achieve quality and to be cognizant of the serious negative consequences that may result from a poor quality system."	The imperative is too broad to allow the professional to recognize when it applies in routine situations.
Rush job	See mea culpa	See mea culpa
Not my problem	See mea culpa	See mea culpa
Nondiligence	Give comprehensive and thorough evaluations of computer systems and their impacts, including possible risks.	Mixed teams of project management, marketing, and sales can make it difficult to achieve this objective, especially if the opinions given do not coincide with senior management's goals.
Fictionware/Vaporware	Be honest and trustworthy.	Honesty and trustworthiness are much more difficult to achieve with organizational dynamics than as an individual. Nonetheless, per the ACM imperatives, there are times when a professional should take a stand or walk away from an assignment.
Canceled vacation	Not covered by the ACM code of ethics. The ACM imperatives deal with fairness and discrimination, not the mistreatment of staff.	The ACM code deals only with generic fairness and nondiscrimination.
Sweep it under the rug	Strive to achieve the highest quality, effectiveness, and dignity in both the process and products of professional work; also, honor contracts.	Management often resolves problems that occur during construction and testing of software; unfortunately, many managers are unaware of or consider themselves not bound by ACM ethical codes.

These imperatives have not served the professional software community as well as they might for a variety of reasons:

- A large percentage of software professionals do not belong to the IEEE or the ACM.
- Many individuals working on projects might not be software professionals, but instead are product or project managers.
- Many ACM and IEEE members are unfamiliar with these ethics codes.
- Even when somewhat familiar with the imperatives, peer, organizational, or other pressures might be brought to bear.
- In some cases, the imperatives are vague and require study to understand when they apply to a particular situation.

We have selected several imperatives relevant to the ethical dilemmas described here to highlight how they might not provide adequate guidance to the software professional during daily activities.

Be honest and trustworthy

Determining what honesty entails might be open to question. Just as a heavy gravitational field can bend light, heavy organizational or financial pressure can bend the truth. For example, telling a client that software is operational when, in fact, it is under construction; forecasting a delivery date that is achievable only if the staff works 24-hour days; or stating that there are no known problems with software when, in fact, testing or development have reported serious problems.

The problem is not only that honesty might be open to interpretation, but that intense organizational and financial pressure might be applied to cast issues in a particularly biased light.

Quality, effectiveness, and dignity

As conscientious developers, we should strive to achieve the highest quality and greatest effectiveness in both the processes and products of our professional work -- and we must do so with dignity.

We learn in requirements engineering that terms like "highest quality" are inherently ambiguous. We also know that quality comes at a price. There comes a point at which the cost to find a product's last few defects outweighs the benefits of finding them. Sometimes recognizing that achieving the highest quality might not be feasible renders the whole issue of quality moot.

For example, because of a shortage of professional staff, or for other reasons, there might be no peer reviews on a project. Code reviews are one of the most effective mechanisms for finding software defects; without peer reviews, an organization might be asking for trouble. Staff might not know that reviews are missing from their process or they might recognize that the reviews are missing but accept management's position that there is no time to conduct them properly.

If an organization is not diligent, its process can easily degenerate into an anarchic hacking environment.

CRIMINAL VERSUS UNETHICAL BEHAVIOR

Sometimes an individual or organization engages in practices that go beyond unethical and stray into the outright criminal.[7] The individual involved might not realize that the practice or the lack of best practice is criminal. In the US, there can be variances in every state in how the laws are interpreted. Outside North America, laws can vary widely, and a practice that is not criminal in one locale can be in another. Thus, individuals might break the law without realizing it.

In all cases at all times, software professionals should be cognizant of the financial, legal, and political repercussions of irresponsible behavior, including condoning behavior of which they themselves might not take part.

Negligent homicide

Negligent homicide involves the killing of another person through gross negligence or without malice. Usually, this sort of unintentional killing involves actors who should have known they were creating substantial and unjustified risks of death by conduct that grossly deviates from ordinary care.[8] The IEEE Code of Ethics commits "to accept responsibility in making decisions consistent with the safety, health and welfare of the public, and to disclose promptly factors that might endanger the public or the environment."

Reckless endangerment

Reckless endangerment occurs when a person engages in conduct that creates a grave risk of death to another. Those engaging in this behavior might not be aware they are endangering others' welfare. Reckless behavior itself is sufficient.

Depraved indifference

Depending on the laws of the jurisdiction, in a more serious kind of reckless endangerment the person engaging in behavior that took the life of another did so under circumstances that evinced a depraved indifference to human life -- fully aware that those actions might lead to another's injury or death, but indifferent to that outcome.

Software professionals should be cognizant of the financial, legal, and political repercussions of irresponsible behavior.

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Unethical versus criminal behavior

A professional might engage in criminal behavior without realizing that he or she had done so by acting as follows:

- *Not tracing requirements to test cases.* A requirement might state that a radiation dosage for an x-ray machine can, under no circumstances, exceed 5 RAD. If the developer permits larger doses to occur, and the tests do not pick this up, the organization might be criminally liable for failure to follow best practices such as end-to-end traceability.
- *Hard-coding error codes.* A rail signaling system hardcodes errors. Without a table containing the error codes, it becomes impossible to effectively find and test each error condition. This makes it possible for an untested error that occurs during operation to cause a signal to freeze in the go position, resulting in a train collision. The company that created the signaling system can be held criminally liable because basic software engineering texts can show that error management during software development is a fundamental best practice.

One ACM-IEEE imperative is "Know and respect existing laws pertaining to professional work." Unfortunately, in some infrequent situations, professionals learn after the fact that they might have broken laws or are subject to criminal or civil penalties. In the eyes of the law, it is still the individual's responsibility to ensure that best practices are followed, regardless of perceived organizational or management pressure.

DILEMMA MAGNIFICATION EFFECTS

When ethical dilemmas are coupled or chained together, the results can be more damaging than any one dilemma occurring alone.[9] For example, nondiligence might result in late delivery. At that time, it might be possible to renegotiate a viable schedule. However, to make up for lost time, a mission impossible dilemma results in difficult schedules with organization pressure applied. The probability of project failure now increases as things become more chaotic and process suffers.

Delivery pressure causes the rush job dilemma as developers abandon best practices to get the software out the door. The probability of project failure increases again as failure to follow best practices might result in an untenable product or delivery that never works. In general, the dilemmas tend to cascade: The earlier in the process the dilemmas are recognized, the easier it might be to alter behavior and steer toward a positive or at least less negative outcome.

MITIGATION STRATEGIES

When faced with a potential ethical dilemma, one of the best mitigation strategies is to perform a risk analysis before deciding on a course of action. An effective preventive strategy involves providing a working code of conduct and holding ethics training sessions for all staff. Table 1 lists additional preventive strategies.

While most companies and organizations have ethical codes of conduct, software professionals might not recognize that such codes apply to everyday practices as well. All the dilemmas we have described occur commonly, but often the participants do not recognize that their behavior is unethical.[10] Perhaps by naming the dilemmas as developers do with software patterns, it will be easier to recognize their occurrence and take corrective action.

Ethical dilemmas can cascade, with an increased probability of project failure with each misstep. Unfortunately, we lack the data to quantify the contribution of each dilemma to the probability of project failure.[11] Such information can usually be found buried in the failed projects file cabinet.

When ethical dilemmas are coupled or chained together, the results can be more damaging than any one dilemma occurring alone.

One possible mechanism for preventing such behavior is professional or corporate education.[12] Clearly, it is not enough to reach out to members of the IEEE or the ACM as the initial or causal dilemma in a chain might occur further upstream -- during contract negotiation or product definition, for example.

Further, IEEE and ACM ethical imperatives must be clearly communicated to computer science and software engineering students and professionals so that they can recognize unethical behavior, see the relevance to their work, and swiftly stop or mitigate it.[13-16]

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MEMBER PROFILE

Steve E. Watkins

Steve E. Watkins is Professor of Electrical and Computer Engineering and Associate Chair of Electrical Engineering Undergraduate Studies at Missouri University of Science and Technology (formerly University of Missouri-Rolla or UMR). He has been a 2004 IEEE-USA Congressional Fellow, the Faculty-Member-in-Residence for the 2005 Washington Internships for Students of Engineering (WISE) Program, a visiting physicist for the U.S.A.F. Phillips Laboratory at the Kirtland Air Force Base, and a visiting scholar for Nippon Telegraph and Telephone in Tokyo, Japan. He is an author on 1 patent, 3 book chapters, 42 archival papers, and 76 other works in the areas of smart structures, sensing systems, and engineering and pre-college education. He works with pre-college engineering summer camps and has served the community on the local school board (Board President 2008-2012). He is the current Editor-in-Chief for THE BRIDGE magazine of IEEE-Eta Kappa Nu, and has served as a journal guest editor for two special issues related to pre-college education. He was inducted into HKN in 1981. His other professional memberships are IEEE (senior member), the American Society for the International Society for Optical Engineering (SPIE) (Senior Member). He served on the HKN Board of Governors (2004-2007), has been a faculty advisor to the Gamma Theta Chapter since 1992, and was the host advisor for the 2007 HKN Student Leadership Conference at UMR. He received IEEE Region 5 Awards for Outstanding Member (2005) and Outstanding Educator (1999), received an IEEE Regional Activities Board Award for work on the IEEE Student Ethics Competition, and was selected as a finalist in the 1993 HKN Outstanding Young Electrical Engineer Award Program. As a student, he was an NSF Graduate Fellow and the 1983 recipient of the HKN Alton B. Zerby Award. He is author of "IEEE-HKN, the Electrical and Computer Engineering Honor Society," which appeared in *IEEE Potentials* (July/August 2012). He received a Ph.D. degree from the University of Texas at Austin and M.S. and B.S. degrees from UMR. Other information can be found at www.Linkedin.com/in/WatkinsSteveE.

Why did you choose to study the engineering field?

Before college, my most interesting and challenging courses were in mathematics and electronics. Studying electrical engineering in college seemed like a natural choice and the field gave me enormous career flexibility. While in graduate school, the opportunities to try teaching and research convinced me that an academic path would be a good fit. I appreciate the many educators that demonstrated excellence in both their subject and teaching.

What do you love about engineering?

Engineering is all about solving puzzles. It is finding the right pieces and putting them together to accomplish something of significance. In an academic career, I get to combine engineering problem solving with mentoring students.

What don't you like about engineering?

The fact that engineering is a profession - no different than law or medicine - yet we do not enjoy the same level of recognition that those fields do.

What don't you like about engineering...and why?

Society is often slow to implement technological advances. The transfer of research to practice often faces obstacles and public policy decisions often are not made on technical merit.

Whom do you admire, and why?

James Buchanan Eads (1820-1887) is a remarkable example of an engineer and inventor. Although lacking formal training, he invented a salvage boat and diving bell, and made a fortune retrieving sunken cargo from the Mississippi River system. As a successful businessman, he devoted the remainder of his life to projects that supported the U.S. during the Civil War and that developed transportation infrastructure. With a rare combination of business, management, and technical skills, he built Union ironclad riverboats, built the Eads Bridge at St. Louis, and established a jetty system near New Orleans.

How has the engineering field changed since you started?

Modern engineering tools and resources have transformed how we work and what we can accomplish. During my high school tour of the local engineering school, students were busy writing programs on punch cards and using the library's card catalog. Now I conduct similar tours for high school students in which I showcase computer learning centers and electronic library access .

What direction do you think that the engineering field is headed in the next 10 years?

Much of the historical advance in computing power has been based on faster and more densely-packed devices. Physical limitations for traditional device scaling technologies have been reached. Alternative approaches in hardware design and the associated software will offer new creative opportunities and will change next-generation computing technologies.

What is the most important thing you have learned in the field?

The value of teamwork and communication skills; most engineering work requires some degree of collaboration. Engineering work is only meaningful when it can be communicated to others. Dr. Ralph C. Smedley of Toastmasters once said, "One of the best ways to discipline one's thinking is to put it in writing."

What advice would you give to recent graduates entering the field?

First, never stop being curious. Inspiration for the problem at hand may come from unexpected sources and other disciplines. Second, be active in professional organizations such as IEEE. Your career will benefit from such regular interaction with your professional colleagues.

If you were not in the engineering field, what would you be doing?

If I were not directly engaged in engineering, I would probably being doing something closely related. Public policy, especially related to technology, has always been an interest.

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

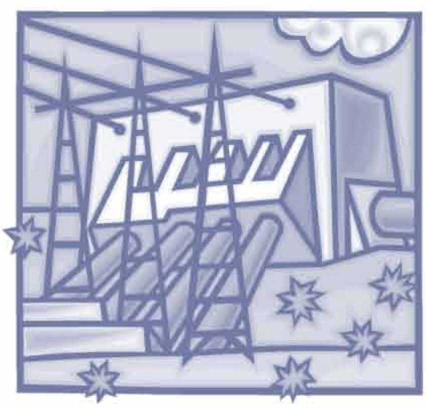
...spend more time outdoors and add to my regional/family history projects."

MEMBER PROFILE

Stephen Williams

Dr. Stephen Williams is Professor and Chair of Electrical Engineering and Computer Science at Milwaukee School of Engineering (MSOE). The EECS department has over 750 students and 32 full-time faculty members in four accredited undergraduate programs and three graduate programs. His interests include control systems, engineering design, and educational assessment. Prior to his 20 year academic career, Stephen worked in the government and commercial sectors for the US Navy and for Allied Signal Aerospace.

In addition to working as an editor for THE BRIDGE, Dr. Williams serves as Chair of the IEEE Real World Engineering Projects Advisory Board, an ABET program evaluator for the IEEE, a member of the IEEE Educational Activities Board (EAB) Faculty and Departments Committee, and Secretary-Treasurer of the ASEE Electrical and Computer Engineering Division.



Why did you choose to study the engineering field?

I grew up with an innate curiosity of how things work. Since my father and grandfather were both utility power plant electricians, studying electrical engineering was a natural pursuit for me, it was in my blood! In fact, my brother and brother-in-law also have electrical engineering degrees.

What do you love about engineering?

I appreciate the great things that can be accomplished through collaborating with talented, committed professionals. The satisfaction of achievement is far greater when shared with others.

What don't you like about engineering?

The application of technology without regard to societal impacts. I believe we have made significant progress in more holistically considering the ramifications of new technologies, but there is still much work to be done to inherently and persistently address issues of sustainability, livability, and global systems interactivity.

Image Credit: NASA

Whom do you admire, and why?

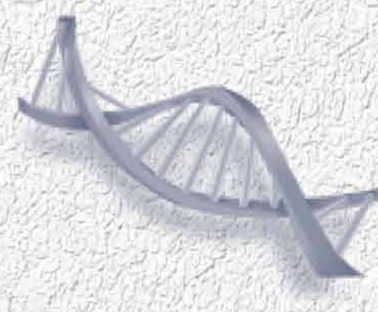
Contemporary scientists and engineers such as James Hansen who have the courage to continue their research in the face of significant political opposition and despite threats to their careers. I admire a reasoned approach which reaches conclusions based on careful, dispassionate observation and analysis. Such an approach adapts at any given time to the most convincing evidence and research available.

How has the engineering field changed since you started?

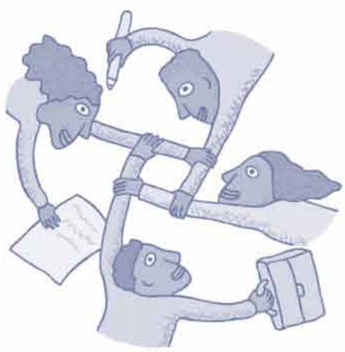
Over my career, the engineering field has moved from applying fantastic technologies that improve lives to being a field that is increasingly asked to solve seemingly intractable large-scale problems. I am very encouraged by young engineers who are determined to make a difference by facing these challenges head-on. However, technical progress toward solutions can be stymied by the lack of political will.

What direction do you think that the engineering field is headed in the next 10 years?

One near-term area of new engineering is the storage, retrieval, and processing of information via actual and mimicked biological systems. A great example is ongoing research in encoding information in DNA. Using this technique, existing technologies could be leapfrogged in areas such as massive storage density and long-term retention.



What is the most important thing you have learned in the field?



The need to work with others to achieve goals. Many breakthrough innovations today are derived from the synthesis of concepts across widely disparate disciplines. Such synthesis necessitates multidisciplinary teamwork. At MSOE, there are students and faculty involved with NIH-sponsored research that have teams including biologists, computer scientists, electrical and mechanical engineers, medical doctors, and physicists. These teams work on problems ranging from biomolecular composition and structure characterization to genomic big-data processing.

What advice would you give to recent graduates entering the field?

Develop your own method for staying current, go after what interests you, and take risks. At one time, engineering was thought of as a static career spent at one or two companies. One result was that the field attracted students who may have been risk-averse. The static engineering career is obviously no longer the case. Technological change is accelerating, information is ubiquitously available and the global marketplace is more interdependent. Engineering careers today are highly dynamic. I do believe that engineering education is adapting and that today's graduates are prepared for the changing field.

If you were not in the engineering field, what would you be doing?

Many years ago, I decided to pursue a doctorate in electrical engineering instead of going to medical school.

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

…run more marathons."

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Are There Experts in Engineering Ethics?

By Karl D. Stephan

As a student, every class day you listen to lectures by experts: people who know more than you do about technical topics. While you may never become as qualified an expert in Fourier transforms or microelectromechanical systems as some of your professors, you attend lectures because you want to join the ranks of a larger class of experts known to the public as engineers. So expertise is an inseparable part of engineering education.

When you graduate, your engineering expertise gives you special powers and abilities that less qualified people do not possess. With such a privilege comes the responsibility of using your talents wisely and ethically. But ethical training, at least in terms of credit hours, seems to take a back seat to technical training in engineering schools. Back in 1999, I published a survey of 254 U.S. engineering schools that showed that fewer than a third of the schools surveyed required all their undergraduate students to take a course in which engineering ethics was mentioned in the catalog description. And only about 17% required a stand-alone ethics course for all students. While some progress has been made since then in incorporating ethics into the curricula of many engineering schools due to a change in accreditation requirements that occurred around 2000, it is likely that most engineering students still do not take a stand-alone course devoted exclusively to engineering ethics.

Is this a problem? Shouldn't engineering students, the people who will soon be developing the latest high-tech engineered products and services, also get the benefit of the very latest and best in ethical training too? If ethics is so important to engineering, where are all the ethics experts to teach the latest in ethics advances?

This question used to bother me a lot. From the time I learned there was such a thing as engineering ethics, I had the impression that while some ethical problems could be solved by your average engineer, there were others that were simply beyond the abilities of most people, and somewhere there were specially trained ethics consultants, maybe, that you would call in for the hard cases. In fact, I simply extended the expertise model I was familiar with in the technical aspects of engineering, to the realm of ethics. But I have since learned that this was a mistake.

As you progress through a typical modern engineering program, you are trained to think scientifically. By "science" we mean knowledge that is based on observations and experiments and that can be objectively verified by more observations and experiments. This is good as far as it goes, but it is easy to fall into the trap of thinking that all knowledge is, or should be, scientific in the same sense. The engineer who decides on which person to date by developing a spreadsheet with weighting factors for all candidates based on appearance, talents, and so on is clearly taking this scientific approach too far. (At least it's clear to me—but maybe you think it's a great idea!) The point is that there are areas of our lives—matters of human relationships, trust, faith, and other issues of the heart—in which the scientific method is not the best way to find out what you need to know.

Ethics, it turns out, is one of those areas. In the third century B.C. there were no engineers in the modern sense of the word. People built some amazing things back then—bridges, temples, aqueducts—but science as we know it played no part in their technical knowledge, which was based mainly on tradition or trial and error. Around 360 B.C. a man named Aristotle wrote a book on ethics that ethics experts (otherwise known as moral philosophers) still read, comment on, and teach from today. Does that mean that unlike technology, which continually builds on new scientific knowledge as well as advances in technology itself, the field of ethics has seen no progress for over 2,000 years?

Yes and no. Yes, because the questions answered by ethics have to do with human beings and human nature, and human nature has not changed fundamentally in all that time. The ethical dilemmas, the temptations to do wrong, and the habits of character that Aristotle discussed are the same basic kinds that you deal with every day of your life. But the subject of ethics has progressed in the last 2,300 years in the sense that the world we inhabit is radically different from Aristotle's Athens. It is much more interconnected, physically and intellectually. It moves faster, and engineering mistakes that in Aristotle's time might result only in a few people getting crushed by a collapsing balcony, can now result in the deaths of thousands in widely separated parts of the world.

For the first hundred years in the history of modern engineering (which dates back only to 1830 or so), there were essentially no classes, textbooks, or experts in engineering ethics. Yet during that time millions of people benefited from engineered products that, by and large, were made and sold ethically (though with notable exceptions). This happened because most people who have the self-discipline and intelligence to master an engineering field and do things right technically also have the moral qualities it takes to do the right thing ethically. I believe engineering ethics arose as a separate discipline in the 1960s mainly as a response to the increasing complexity of the engineered world. Most students need to be taught that, for example, an engineering organization in which everyone individually has the best of intentions and makes what looks like the right decisions on a personal level nevertheless can do great harm.

An Ethical Point of View

For the past few years I have written a weekly engineering ethics blog (http://engineeringethicsblog.blogspot.com/). Does this make me an engineering ethics expert? I have never taken a philosophy or theology course for credit. I won't go so far as to say that anybody can become an expert in this field, but anyone with an engineering degree can take the trouble to look at a problem from an ethical point of view. You can ask questions such as: Who is affected by what I'm doing? What are their interests? How could they be hurt or helped by this engineering activity? What are my responsibilities and those of my organization? Simply asking these questions and trying to find answers takes you a long way down the road to truly ethical engineering.

"There is no single place where you can find the rules to follow in engineering ethics," Stephan says.

Engineers like rules, and you may ask what the rules are in engineering ethics. There is no single place where you can find the rules to follow in engineering ethics, just as you will find that for a sufficiently complex engineering problem, there is no such thing as the unique "best" design. However, just as there are systematic ways of approaching engineering design problems, there are step-by-step procedures you can learn that will enable you to approach ethical problems intelligently. Many people (including myself) rely on their respective faith traditions for ethical guidance. Despite the fact that the different great religions teach radically different things about the unseen world, it turns out that what they say about how we should act in the present world is pretty much the same in its essentials. Even people without a religious faith commitment generally have a conscience—an inner voice that helps them know right from wrong—and they know when they are doing wrong. The challenge for all of us, believers or otherwise, lies in whether we listen to that voice, and what we do about what it tells us.

So don't worry if you missed out on the advanced engineering ethics class—although if you have a chance to take an ethics course, by all means do so. I missed out, but that didn't stop me from writing about the subject every week. And it shouldn't stop you from being as ethical as you can be in your chosen engineering career.

Further Reading

Aristotle's Nichomachean Ethics is available in a number of good translations in English and other languages. For a good short treatment of how the world's religions basically agree with regard to fundamental moral principles, see The Abolition of Man by C.S. Lewis. My survey on ethics education appeared in the October 1999 issue of the ASEE Journal of Engineering Education (vol. 88, pp. 459–464, with erratum vol. 89, p. 1, Jan. 2000).

About the Author

Karl D. Stephan (kdstephan@txstate.edu) obtained a B.S.E.E. from Caltech, an M.Eng. from Cornell, and a Ph.D. in microwave engineering from the University of Texas at Austin. After 16 years at the University of Massachusetts, Amherst, he joined Texas State University -San Marcos in 2000, where he is now a professor at the Ingram School of Engineering. He has published over 80 journal and conference papers in the fields of microwave engineering, atmospheric physics, the history of technology, and engineering ethics.

A Sense of Community

By Nancy Ostin

Recently I had the opportunity to visit the Alpha and Beta Chapters. I would like to thank the members and Faculty Advisors of both Chapters for their warm welcome, their willingness to share thoughts and ideas with me, and for allowing me to participate in their Chapter Activities!

Beta Chapter knows how to have fun. They enjoy going out together, invite all ECE students, and often pay for an item – at Five Guys, they paid for the fries!

The Beta Chapter (founded January 1905) at Purdue University is the second oldest Chapter in our organization. Beta Chapter is known for their famous “lounge” and ECE building snack bar, renowned for serving the “best bagels and hot coffee this side of campus!” Members have even been known to trek through two feet of snow to insure food and drinks would be available for purchase in the morning!

Beta Chapter has done a wonderful job of tapping into the power of their Graduate Students, has learned how to pass on traditions, and has established a strong sense of community. Their lounge gives Beta Chapter high visibility on campus, and serves as a central place for ECE students (and others!) to relax. They also have a robust number of both “service” and “fun” events, work closely with their departments, and act as a good resource for all ECE students.

Beta Chapter President, Tim Pritchett, at Eta Kappa Nu Monument at Purdue University.

Beta Chapter also mixes fun activities into their schedules. Their deep sense of community is strengthened by “Smash Car Monday’s“ video game tournaments, “Tech Talks”, and their “Undergraduates underground guide to surviving ECE” pamphlets.

Alpha Chapter, the founding Chapter of Eta-Kappa-Nu, is located on campus at the University of Illinois Urbana-Champaign. Alpha also has a very strong team of officers who have a noble sense of giving back and understand that they need to develop their pledges into future officers to achieve long term success.

I was impressed with their commitment to help underclassmen by providing technical assistance, tutoring and exam prep study groups, as well as their commitment to community service. Active Alpha members visit first and second year classes at the beginning of each semester to invite ECE students to acquaint them with IEEE-Eta Kappa Nu, to take advantage of study programs, and also offer to serve as peer advisors. All of their events are open to all students.

Alpha has a small lounge on campus they share with the IEEE Student Branch, and sells a small assortment of snacks to the students and faculty of ECE. There are many parallels between the two chapters, both offer very similar assistance to new students, tutoring, class guides and exam packets, community service, and have pledge leaders to work with their incoming members.

Alpha is successful at bringing in corporate sponsorships, with both their resume book and sponsor programs. They have shared their outline of this program as a resource for all IEEE-HKN Chapters. This is the start of our on-line resource where we will ask all chapters to share successful ideas.

Alpha Chapter IEEE Student Branch and Eta Kapp Nu window (L-R) Kashev Dalmia, Liana Nicklaus, Li Ma, Ian Wetherbee

The common thread was the sense of community both Chapters have developed. I encourage each chapter to share how you create a sense of community. What are ways that your chapter uses local resources and talent (not every Chapter will have a lounge or snack bar) to be the focus of your community? Describe how students who seek assistance find the IEEE-HKN Chapter members? Describe how your chapter has created an environment dedicated to service where members can develop the scholarship, attitude, and character that is at the center of what it means to be IEEE-HKN.

I would love to visit your Chapter, attend your induction, or participate in a Chapter program. In the meantime, please send me photos and stories about what you are doing at your Chapter, any resources you would like to share, or an invitation to visit! Call me with questions, suggestions, or ideas. This is our community; let's do all we can to make it as strong and as valuable for each other as we can!

Thank you to Tom Talvadge, Faculty Advisor Beta Chapter, and to Jonathan Makela, Faculty Advisor Alpha Chapter and to Beta Chapter President Tim Pritchett, and Alpha Chapter President Dennis Yuan.

Alumni Reconnect

This is our "Call for Alumni to Reconnect!" We are reaching out to all HKN members and requesting that they reconnect with us. It's easy; simply:

- Visit our "Alumni Reconnect" page and post a memory or message
- Call the IEEE Contact Center at +1 800 678 4333 (US and Canada) or +1 732 981 0060
- Visit www.ieee.org/contactcenter or email info@hkn.org or n.ostin@ieee.org

All HKN records were transferred to IEEE at the time of our merger. Even if you are not an IEEE member, please take the time to ensure we have your current contact information. If you are an IEEE member, your HKN affiliation should appear on your card. If it does not, please contact info@hkn.org.

Alumni who reconnect can take advantage of opportunities to speak at local chapter events, provide a tour of a facility to a local IEEE-HKN chapter, be a mentor to a student on a design project, stay involved with a Chapter, and easily connect with other alumni. Stay connected – fulfill your pledge to help IEEE-HKN members now and those to come. Reconnect today! Email us: info@hkn.org or n.ostin@ieee.org

Preparing for High Ethical Standards

Embracing ethics and upholding integrity while at university......

By Steve Starrett

INTRODUCTION

Engineering education is principally focused on building technical skills and problem solving abilities of students. However, learning about professional ethics as related to engineering work is necessary as well. Various Code of Ethics for Engineers have been adopted by engineering societies such as IEEE, ASCE, NSPE, etc. These codes set forth the obligations that engineers have to society and other standards of conduct. These codes are typically presented as components of any ABET accredited engineering program and are content for the fundamentals of engineering examination. Formal curricula components of ethics lectures, workshops, and courses supplement the morals and ethical standards that students have developed from their parents, childhood friends, adult friends. In addition, honor societies like IEEE-Eta Kappa Nu promote high ethical standards as part of membership. The academic standards in the classroom are yet another learning opportunity as engineering students face situations that are not dissimilar from those that they will face in engineering work. College and university campuses often promote ethical behavior in the academic setting through the application and enforcement of an Honor Code or Honor Pledge. The university community (i.e., joint effort with students and faculty working together) declares expected academic integrity standards and then determines appropriate sanctions for when standards are not met.

ACADEMIC HONOR STATEMENTS

Many universities and colleges have an Honor Code or Pledge. The Honor Pledge at Kansas State University is "On my honor, as a student, I have neither given nor received unauthorized aid on this academic work." The College of William and Mary has had a student administered Honor Code that started in 1736. Their Honor Code is very detailed and over 20 pages long. Texas A&M University has a long-standing tradition of honor. Their Aggie Honor Code is "An Aggie does not lie, cheat or steal, or tolerate those who do." Military academies have similar honor codes such as the U.S. Military Academy at West Point, "A cadet will not lie, cheat, steal, or tolerate those who do." Some top-ranked schools, such as Harvard and Yale, do not have Honor Codes, however, now after recent cheating scandal at Harvard are now considering creating one (Harvard considers instituting honor code, Peter Schworm, Boston Globe, 4/6/13). The purposes of an Honor Code or Pledge are to instill in students that they are part of the entire university community, to build trust among the individuals that make up the community, and to define the expected behavior for remaining a part of the educational community.

Last summer, I became the Director of the Honor and Integrity System at Kansas State University. The Honor and Integrity

System office administers Honor Pledge violation reports. We have an Honor Council that is made up of 27 students (undergraduate and graduate) and 27 faculty and staff members. Each college is represented on the Honor Council, and the faculty senate and student senate approve of the nominations. Honor Council members serve as hearing panel members and as case investigators. Students do have the majority vote on hearing panels and they are often tougher on their peers that violate the Honor Pledge than the faculty members are. They view academic dishonesty as a threat to the hard work, dedication and reputation of those that uphold the Honor Pledge and ultimately obtain degrees from Kansas State University. The Honor Council student members will not stand for that.

The Honor and Integrity System office assists faculty in upholding academic integrity in their courses. When professors or instructors determine an Honor Pledge violation has occurred then they submits a violation report to the Honor and Integrity System. The report includes what the violation was (e.g. unauthorized collaboration, plagiarism, falsification, or unauthorized aid), and what the recommended sanctions are. There is a clear and detailed process available for a student who contests the alleged violation. Professors and instructors can issue up to an XF grade (failing due to honor violation) as a sanction. The X can be removed from the transcript if the violator takes the Development and Integrity 1-hr course. For students that have multiple violations then an Honor Council hearing panel will determine what additional sanctions are needed such as grade changes, permanent XF, and they can recommend suspension or expulsion to Provost.

The Honor Pledge and related system was created after a cheating scandal involving a few hundred students rocked our campus and gained national news. A student was given permission to take a test early because of a conflict with other obligations. The student began the misconduct by informing some friends about what was going to be on the exam, until eventually, by the end of the semester, hundreds of students were informed of exam questions ahead of time. The hard-working students of Kansas State University were outraged by this poor conduct because it jeopardizes the reputation of their degrees. Correspondence from alumni poured into campus expressing their strong concern. The message was clear, academic integrity is vital to Kansas State University and it must be ensured.

There are currently over 25,000 students on three Kansas State University campuses, so each semester, there are bound to be some individuals taking shortcuts on academic work. Having been at Kansas State for about 19 years now, and as the Director of the Honor and Integrity System, I am very supportive of universities having an active Honor Pledge or Honor Code, and a related office to administer violation reports. This provides a vital resource for faculty and teaching staff to ensure academic integrity, it provides a valuable learning experience for those students that receive Honor Pledge violations, and it provides excellent leadership experiences for those students on the Honor Council. The decisions they make effect lives, and the long-standing reputation of Kansas State University.

IDEAS AND WORK AS A STUDENT AND ENGINEER

There is a natural transition from being a student being committed to an Honor Pledge or other academic standards and an engineer committed an engineering Code of Ethics. The concept of an individual upholding integrity to benefit the greater community is the same. Following are some of the more common Honor Pledge violations:

- **Unauthorized collaboration in the classroom.** This is when the professor has declared that an assignment/exam/project is to be done independently. For example, an assignment is to write a computer code independently. Certainly students must learn how to create code from others (i.e., professors, teaching assistance, internet, peers, etc.). The violation occurs when a student works with another student to create a segment of code, copies code from another student (current or previous), copies a segment of code from the internet, has someone else write the code, … Creating the code independently assignment process maximizes the learning experience for the students. One of the most extreme cases over the 15 years of our Honor and Integrity System is when a student posted a course project on freelancer.com. The senior student accepted bids on the project, selected a contractor, paid contractor $350 to complete the project, and turned it in exactly as created by contractor. The professor was notified by individuals on freelancer.com that a course project had been posted to the site. This is not acceptable to the freelancer.com community. The student also had previous Honor Pledge violations and was expelled.
- **Unauthorized collaboration in an engineering career.** As an engineer, the protection of intellectual property is very important. Planning, design, construction and/or production of a specific solution to a problem or need is why engineers are compensated. Taking of other people's ideas or intellectual property without proper credit,

"The internet has made it so easy to find knowledge about anything, copy and paste it into an assignment document, print and turn it in for a grade."

acknowledgement or permission is against the IEEE Code of Ethics Canon #9, "…avoid injuring others…"

- **Plagiarism in the classroom.** The internet has made it so easy to find knowledge about anything, copy and paste it into an assignment document, print and turn it in for a grade. Referencing and citing other people's work is very important while studying at American universities and colleges. Middle schools and certainly high schools teach students how to reference materials properly. Students are expected from their first day on campus to understand how to reference and cite materials. Having said that, some instructors also believe plagiarism happens when structures of papers or even paragraphs follow a source's format and style too closely. This isn't so widely taught in high school. So, it's important to visit with professors in heavy writing classes to thoroughly understand their expectations. There are also plagiarism checking software that can be used, such as those at www.grammarly.com and www.plagtracker.com. There is also computer code plagiarism checking software available too.

  Many students have violated the Honor Pledge by plagiarizing something from the internet. Most are sanctioned with a zero on the assignment and the requirement to take an academic integrity related 1-hr course. An example situation was when a graduate student had a writing assignment to write a life-story type document. The student made a poor decision to copy a blog entry word for word and submit it as his life story. The student had multiple Honor Pledge violations related to plagiarism in graduate courses. The student's comments were, "I have attended many universities. I have an undergraduate degree and a master's degree from different schools. I have never before seen a university so interested in verifying that assignment content was not plagiarized." The student was expelled.

- **Plagiarism in an engineering career.** Engineers write lots of reports. Students do not like to hear that but its true. There is easy access to knowledge online and its inappropriate for an engineer to find a similar report and copy text. This type of conduct is against IEEE Code Ethics item #9 and #3, "to be honest…"

- **Unauthorized aid in the classroom.** Virtually any solution manual can now be found online. Using references to learn how to solve a problem is encouraged and is what engineers do in the profession. Copying solutions and submitting them as original academic work, however does not represent knowledge that a person possesses. Faculty are trying to teach subject matter to students. They cannot assess whether that knowledge has been learned if a student copies solutions from a solutions manual. The student is also violating their main reason for going to college, to learn skills and knowledge to apply in a career.

- **Unauthorized aid in an engineering career.** The bid process can be very competitive with companies doing all they can to obtain information about their competitors. When engineers give bribes to obtain confidential information that gives them an unfair advantage then that is directly against IEEE Code of Ethics item #4, "to reject bribery in all its forms."

I do hear students say something like, "I won't take shortcuts like I do while in college when I start working." These students do not realize that a person cannot turn integrity on and off like a switch. Future behavior is naturally based on previous behavior and decisions. University students are developing and creating their approaches to academic integrity, personal ethics; and for engineering students, their commitment to high engineering ethical standards. It is important for an engineer's development to maintain high academic integrity standards while pursing an engineering degree. Ethical decisions and judgment become second nature. There are many ethical situations engineers can face: safety vs. financial gain, marketing vs. truthful statements, what to do with undesirable testing results, offers of gifts and favors, and the appropriate use of high-technology devices. In brief, the following presents an idea on how to approach engineering ethical dilemmas.

DEVELOPING PROFESSIONAL JUDGMENT AND SOLVING ENGINEERING ETHICAL DILEMMAS

People take a variety of approaches to solving ethical dilemmas. Following are some ideas to consider:

- Consult IEEE Code of Ethics or other relevant codes. Use this information as strong ammunition when being pressured to do something that is against the Code.
- solve situations like an engineer. Analysis, study, consider, develop solutions just like it was a technical problem.
- Consult with trusted and respected others about the situation.
- Study engineering ethics educational materials available.
- Take a webinar or a class on engineering ethics.
- Consider what is best for most.
- Consider what virtue is critical for you and make sure that requirement is met in solution.
- Consider if people close and important to you fully understood your actions and decisions, would they respect your decision?

Years ago I gave an engineering ethics workshop to a group of about 50 professionals at a very nice dinner club. I was in my early 40s and was about the youngest person in the room. The atmosphere was friendly, the food was excellent and there were many friendships several decades in the making. I presented a situation where the engineer had to decide if he was going to proceed way up the chain-of-command to rectify what he knew was a major threat to public safety. His non-engineering supervisor did not think the safety issue was a crisis like the engineer did. I presented the question of, "What would you do if you were the engineer faced with this situation?" One person spoke his opinion of, "I would follow the directive of my supervisor. I have a family to feed, you are asking to get fired to buck the instructions of your boss, it just wouldn't be worth it." Immediately, his peers criticized his remarks. One individual stated it so well. "You have to protect the safety, health and welfare of the public. When the situation goes from bad to awful then someone is going to get injured or killed. The engineer's reputation will be forever ruined. The company is not going to protect engineer or care about his reputation. The engineering community isn't going to accept the excuse of "My boss told me to keep my mouth shut." You can always get another job, but you cannot get another reputation. As I near the end of my working career, I believe this strongly."

"People take a variety of approaches to solving ethical dilemmas…"

As students pursue engineering education they should be aware that they are building upon their foundations of integrity, the foundations their parents started. It is just the beginning to a long and dedicated engineering career upholding the safety, health and welfare of the public.

About the Author

Steve Starrett, Ph.D., P.E., D.WRE, F.ASCE, is Associate Professor of Civil Engineering and Director of the Honor and Integrity System at Kansas State University. Dr. Starrett earned his B.S. degree in civil engineering from the Missouri University of Science and Technology, an M.S. and Ph.D. in civil engineering from Iowa State University. He has been on that faculty at Kansas State University for 19 years. His technical expertise is in water resources engineering. He also teaching engineering ethics graduate level courses and serves on the Executive Board of the National Institute of Engineering Ethics. He is a founding member of the nearly established Committee on Ethical Practice with the American Society of Civil Engineers.

ALUMNI NEWS

A Visit with the LA Alumni Chapter

By Nancy Ostin

While visiting Los Angeles in February I had the pleasure to lunch with two distinguished gentlemen from the LA Alumni Chapter, Mr. Tom Rothwell and Mr. John DeGraw. We met at The Hacienda Hotel in El Segundo, where the LA Alumni Chapter generally holds its meetings. It's safe to say there was a lot of HKN history at one table!

Mr. Rothwell was inducted Eta Kappa Nu in 1953, and Mr. DeGraw was inducted Eta Kappa Nu in 1996 to the Upsilon Chapter at the University of Southern California. Both have continued to be involved with their Chapters as guest speakers, and historians. They are the heart and soul of the LA Alumni Chapter, and members of the "Outstanding Student Award" committee, which is sponsored by the LA Alumni Chapter.

LA Alumni President John DeGraw (L) and Chair Emeritus OSA Tom Rothwell (R) proudly display the HKN Key, a pledge project from 1953.

We are proud to announce that Mr. Rothwell has been given the title of "Outstanding Student Award Committee Chair Emeritus", and Mr. DeGraw will serve as "Outstanding Student Award Committee Chair". In the recent Board of Governors meeting, held in conjunction with the Student Leadership Conference, President Orr asked the Board to join him in recognizing their contributions and dedication; we greatly appreciate their many years of service!

Mr. DeGraw commented; "It is a busy time for the LA-Alumni Chapter as we will be attending and assisting with initiation ceremonies at several local universities in the Southern California area. Since 1965 the LA-Alumni Chapter has administered he Outstanding Student award for HKN, we carry on the tradition of recognizing deserving computer and electrical engineering students. We strongly encourage all chapters to nominate an outstanding senior each and every year. Further information can be obtained at HKN.org". Editor's Note: Nominations are due 30 June

This visit was a wonderful opportunity for me to learn about the history of Eta Kappa Nu and the traditions of Chapters. It was an honor to talk to these gentlemen, who together represent 77 years of HKN history. We discussed many ideas for the future of our organization, including ways to better involve our alumni. This fall IEEE-HKN will launch the ALUMNI RECONNECT program – an outreach to all who have been inducted HKN, including those who have lost touch. It will be an opportunity for alumni to update their contact information, share memories, and get involved in with HKN again!

Here are some of the ways Alumni can get involved: sign up for the Speakers Bureau or Distinguished Lecturer series, offer tours of your facility or propose projects for Chapters, mentor a student on a senior design or capstone project, serve on a Board level committee or on the Board of Governors, or become the Alumni Representative to a Chapter.

Please look for the Alumni Reconnect on www.hkn.org, and get back in touch with headquarters! While there you can update your contact information, register for some of the opportunities listed above, and become an expert willing to share that expertise with a student.

This is your chance to be there for the IEEE-HKN members of today, and for those of the future!

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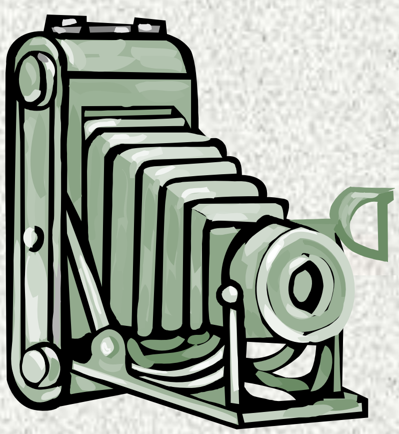

Do you have an historical photo or document that relates to IEEE-HKN that you would like to share in THE BRIDGE? We welcome your memories or memorabilia, which we may feature in the new IEEE-HKN History Spotlights section of THE BRIDGE. Just email your contributions to info@hkn.org.

Important Dates!

30 June: File your Annual Chapter Report before you leave campus for the summer

15 October: You can submit additional information to qualify for the Outstanding Chapter Award until 15 October.

28 October: IEEE-HKN Founders Day

1 October-1 November: Annual IEEE-HKN Board of Governors election; all eligible members can vote. To be eligible, you must have submitted your Annual Chapter Report, and have inducted members in the past two years.

Fall 2013: Look for our VIRTUAL CONFERENCE which will debut in October.

Student Leadership Conference 2014: Plan early to send a delegation! Don't miss out on this important IEEE-HKN exclusive event.

New Member Requisition and Election of Officers Online Forms

Find our new online forms on the Documents and Forms page under the Chapter tab at hkn.org.

You can submit and pay online. You can attach a document or a spreadsheet. If you are paying by check, please submit online, and mail the check along with a copy of the paperwork.

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