THE ◆ BRIDGE

The Magazine of Eta Kappa Nu

AUTUMN 2009

Taking a Closer Look at Smart Grids

FEATURES

Smart Grids – Planning the Intelligent Utilities of the Future

Smart Grid Architecture

Data Marts – A Wealth of Untapped Information

HKN

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LETTER FROM THE EXECUTIVE DIRECTOR

Roger L. Plummer

Dear HKN members and friends,

A few noteworthy items since the last issue of *THE BRIDGE*:

You will be pleased to know that the IEEE-HKN merger, while still in a process of review, is ever closer to becoming a reality and it is our hope that it is completed soon.

In June 2009, two outstanding contributors to the ECE profession and to humanity, Gerald Posakony and Eric Herz, were recognized as HKN Eminent Members at the IEEE Honors Ceremony, held in Los Angeles, CA.

Also, the C. Holmes MacDonald Outstanding Teaching Award committee has been reactivated, and we encourage you to nominate a faculty member who taught with excellence and who may have made a notable impact on your academic career. The application form is at www.hkn.org.

The Annual National Leadership Conference was recently held this year at the University of Michigan, Dearborn entitled "Driving Towards Tomorrow's Technology." The networking among the chapters, team building exercises, and exposure to cutting-edge technologies such as hybrid vehicles and smart grid applications received enthusiastic feedback from these future leaders in ECE.

We appreciate the continued support of HKN members and the 2009-2010 academic year brings with it more opportunities to support the positive work of Eta Kappa Nu. We encourage you to stay involved with your local chapter, write for *THE BRIDGE*, join a committee, or nominate a worthy candidate for award recognition. Don't hesitate to be in touch if there is anything we can do.

Warmest regards,

Roger Plummer

LETTER FROM THE EDITOR

Barry J. Sullivan | Beta Omicron Chapter Member

The electric power grid is infrastructure with a capital "I," on a level with roads and bridges in its scale and scope. It is also essential to our way of life. Without a source of electricity, most of the appliances and gadgets we take for granted in our daily routines become interesting but useless configurations of inert matter.

This critical infrastructure is on the verge of a major technical upgrade. The term "smart grid" refers to the addition of a communications layer to the power grid, allowing grid operators greater operational visibility and control. It will also give their customers access to information that will allow them to become smarter consumers of electricity.

The three articles in this issue present different aspects of the emerging smart grid. The first article by Jeff Wacker and Anthony Erickson serves as an introduction to the topic, providing the motivation and a detailed definition for the smart grid.

The other two articles address the wealth of data that will be collected from a smarter grid. The article by Jeffrey Katz takes a broad view of the architecture for collecting data in a secure manner, while the one by John McDonald considers the knowledge that can be derived from the data once it is collected.

We encourage HKN members to suggest topics and share their experiences through full-length articles and member profiles. If you are interested in contributing an article or a profile, please contact me at *editor@hkn.org*.

Warm regards,

Barry Sullivan

HKN

Autumn 2009

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

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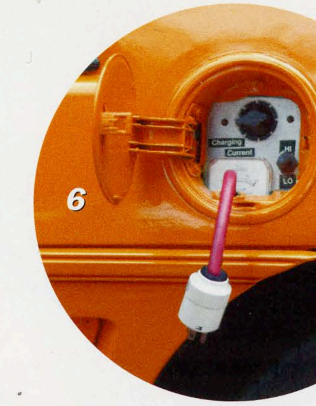
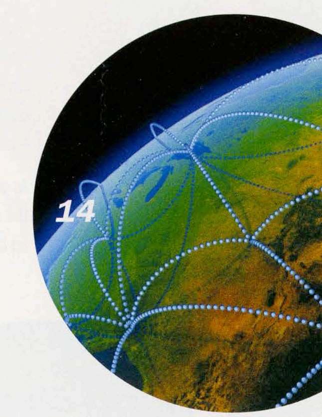
THE•BRIDGE

The Magazine of Eta Kappa Nu

features





departments

award winners

2009 HKN Student Leadership Conference

More than 60 enthusiastic HKN student members from across the country gathered at the University of Michigan, Dearborn (UMD) November 6–8, 2009 for a weekend of leadership activities organized by Theta Tau chapter. This year's conference theme was "Driving Towards Tomorrow's Technology," a most appropriate focus for the Motor City.

The conference kicked off with a warm welcome from Provost Catherine Davy and a brief report from two members of the HKN Board of Governors, Eddie Pettis and Evelyn Hirt, who were thrilled to meet the members and represent the organization's administration.

The students enjoyed the lectures by Nick Thorne, Ford Motor Company, Haukur Asgeirsson, DTE Energy, Sherif Marakby, Ford Motor Company, and Brian Theriault, General Electric. The speakers provided technical information about advancements in vehicle applications such as the Ford's new Sync voice activated system, and the progress of environmentally friendly hybrid systems and battery powered vehicles. Demonstrations of the Sync technology and the chance to see a Saturn Vue prototype which had been converted from a hybrid electric vehicle (HEV) to a plug-in hybrid electric vehicle (PHEV) were highlights of the conference.

The discussions not only had a technical focus, but each speaker shared professional experiences – advising students to find a position and a company that suits their interests and lifestyles. Brian Theriault, a recent UMD graduate, reminded the students to stay humble, respect their co-workers, and communicate in a positive manner. Everyone agreed on the importance of continuing education in an ever-changing profession, whether it is reading industry-related magazines, attending conferences, taking courses, or even asking for guidance from colleagues.

One of the most important aspects of leadership development is communication and team building. Hank Lenox, a clinical professor at UMD, organized the students into small groups to design and evaluate the processes in the "Mouse Trap" game and the groups' competitive natures came out as they tried to capture more mice than their peers. Sunday morning's session, "Dominoes for Engineers," run by Natu Natarajan, gave a real world scenario for students to design a small part of a bigger project and piece together series of transmitters to light up LEDs in various designs.

As always, the chapter development discussion was a highlight of the conference and provided an opportunity for the students to share the activities and ideas of their home institutions with other chapters. Each student said they learned something that can be implemented in their own chapter in the area of recruiting, fundraising, volunteering or social activities. The brainstorming notes from this discussion are available online at **www.hkn.org**.

Thanks to the University of Michigan, Dearborn, Dynetics, and IEEE for sponsoring the activities of the conference. Without their support, Theta Tau would not have been able to organize and conduct such a successful event.

If your university is interested in hosting a future conference, please contact HQ at *info@hkn.org* for information about how to submit a proposal.

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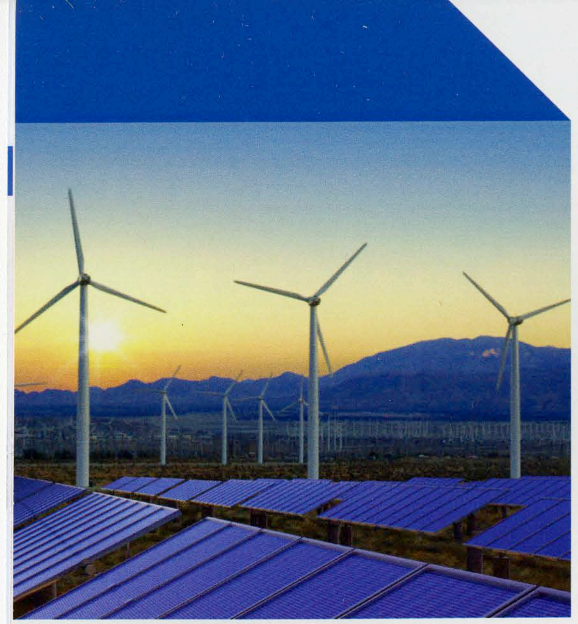

Smart Grids—Planning the Intelligent Utilities of the Future

by Jeff Wacker and Anthony Erickson

Introduction

Economics and ecology are creating a new utilities marketplace.

Driven by the surging worldwide demand for electrical power, and challenged by the need to ensure stable supplies, to improve efficiency and to reduce the carbon footprints of their companies and customers, utilities are searching for a new and better business model. A number of economic, social, political and market forces are pushing utilities to adopt a more intelligent approach to the generation and delivery of electricity.

The emerging Smart Grid encompasses far more than the traditional utility distribution network. Made possible by a new generation of embedded computing, advanced metering and data management technologies, Smart Grids will soon allow utilities to anticipate and shape consumer demand for electrical power. By managing the demand curve, utilities can achieve the important strategic goals of reducing consumption and meeting customer expectations, while creating a more sustainable and profitable long-term business model.

In this viewpoint paper, we examine the demands of the coming Smart Grid environment. We analyze the requirements of the Smart Grid, and its implications for consumers, businesses and utilities. Finally, we explore how the convergence of information and ecological technologies will shape this new and promising utilities marketplace.

A Historical Perspective

While the fundamental structure of the electrical grid has remained virtually unchanged since Nikola Tesla won the "War of Currents" in the 1890s, the dramatic growth in global demand for electric power has radically changed how utilities must operate. In recent years, as developing economies plug millions of new businesses and consumers into the worldwide grid, global demand for electricity has skyrocketed.

While utilities planet-wide generated 8,027.1 billion kilowatt hours of electricity in 1980, surging demand had more than doubled that number by 2006, when the world generated 18.2 billion kilowatt hours of electricity.[1] That dramatic upsurge in electrical generation was driven by growing populations, by new power-hungry technologies and by improved living standards in many parts of the world.

Not surprisingly, the highest growth rates in electricity generation during those 25 years were seen in Central and South America, Asia, and in Middle Eastern countries where populations were moving away from traditional rural or agrarian lifestyles and toward societies defined by increased industry, growth and consumerism.

Those macro trends have created a "perfect storm" for many utilities. Consumers have developed a big box consumer mentality wherein they believe they can consume as much low-cost electric power as they desire. Yet, while consumption and consumer expectations are at all-time highs, serious challenges now threaten power supplies the world over. From the price and availability of natural resources, to aging infrastructure and political, regulatory and market forces – utilities must confront a number of significant problems.

Energy in general, and utility services in particular, will continue to greatly affect economic growth, security and living standards on both the national and international levels. How will utilities, consumers and governments respond to those challenges? At the very least, utilities must continue to invest in electrical generating capacity and other basic infrastructure.

But in our view, to meet these daunting generational challenges, utilities and society at large must also accelerate investments in the innovative technologies needed to bring enhanced management, reliability and sustainability to the global power grid.

Green Drivers

A number of forces are pushing utilities toward a more reliable and sustainable approach to the business of electricity.

As noted previously, the fundamental law of supply and demand is affecting price and availability worldwide. Utilities now struggle to balance base load demand against the more expensive infrastructure requirements of peak loads, with the latter accounting for 30 percent of cost for many companies.

Given those realities, the economics of conservation become more provocative every business day. For most utilities, the average cost of generating a new kilowatt hour of electricity is 10 cents, while the cost of saving a kWh is just 1.7 cents. While alternative energy sources are attractive and continue to garner positive and sought-after press coverage, conservation is now seen as the undeniable "fifth fuel" by many utilities. Dubbed "Negawatt power" by Amory Lovins, the idea of investing in improved efficiency as a way to reduce overall electric consumption is gaining support in the utilities sector.

In fact, a number of social, political, economic and technological forces are now driving utilities to be green.

The public is increasingly concerned about climate change and the environment, and those concerns are being expressed in the actions of lobbying groups, more active shareholders and the voting public. Governments the world over are responding with environmental policies that range from carbon emissions reduction targets to cap-and-trade schemes, sustainable procurement policies and energy-based requirements for electronics and other consumer products.

Many consumers are prepared to pay a premium for eco-friendly products and services. Yet at the same time, those same consumers have embraced successive generations of power-hungry new user devices, applications and always-on services.

At the corporate level, companies are now under pressure to reduce e-waste pollution and their overall carbon footprints, all while managing the rapid growth in power consumption by servers, data centers and other IT systems. Companies in virtually every industry must meet new and higher standards for reporting on a range of environmental activities. Forward-looking organizations now work to create and publicize their "green sheen" as a key indicator of corporate responsibility.

Those diverse constituencies now expect utilities to deliver reliable, affordable and environmentally sound electricity service.

Getting Smart: Smart Power

How can utilities meet those expectations? Forward-looking suppliers are already developing and deploying more intelligent ways to develop, generate and deliver electrical power. In this new utility marketplace – where economic and ecological challenges and opportunities converge – might be called Smart Power.

In this emerging Smart Power reality, utilities must learn to affordably combine the historic "obligation to serve" with a new and equally compelling "need to conserve." To achieve this smarter, conservation-minded objective, utilities must by necessity move beyond the limitations of demand measurement (understanding demand as it happens) and toward the more complex and challenging realm of demand management (anticipating, shaping and reducing demand).

Actually shaping the electricity demand curve, without overly impacting the Western lifestyle, will require utilities to employ more intelligent equipment, operations, transmission and utilization solutions. That in turn will force utilities to migrate from the electromechanical to the digital age and encourage them to consider megabytes as well as megawatts and to distribute information bits as well as atoms.

This transformation, ultimately, will usher in the age of virtual presence, contextualized content and an accepted behind-the-scenes regimen of utility demand management. Smart Power will be defined by ubiquitous sensors and intelligent homes, smart meters and grids, and growing collaborative interconnections among consumers, businesses and the utilities that serve them.

By combining the power of information technology with the emerging science of environmental technology, utilities can create a more intelligent and sustainable business model.

Government

Governments around the world are currently planning or making intelligent, green investments in utilities, infrastructure and other energy-related projects.

In the United States, the Obama Administration's New Energy for America plan envisions the creation of 5 million new jobs through a strategic $150 billion investment in clean energy systems, the domestic manufacture of 1 million plug-in hybrid cars by 2015, a cap-and-trade program to reduce greenhouse gas emissions by 80 percent by 2050, and a goal of generating 25 percent of the nation's electricity from renewable resources by the year 2025.[2]

Other global governments, nongovernmental organizations and international efforts are also focused on the need to control energy and

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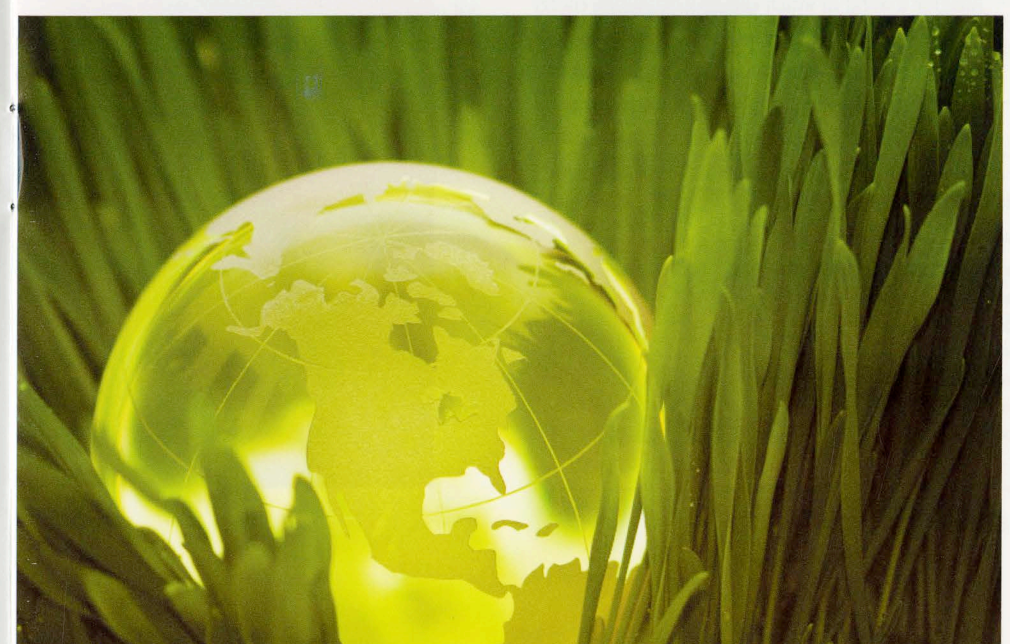

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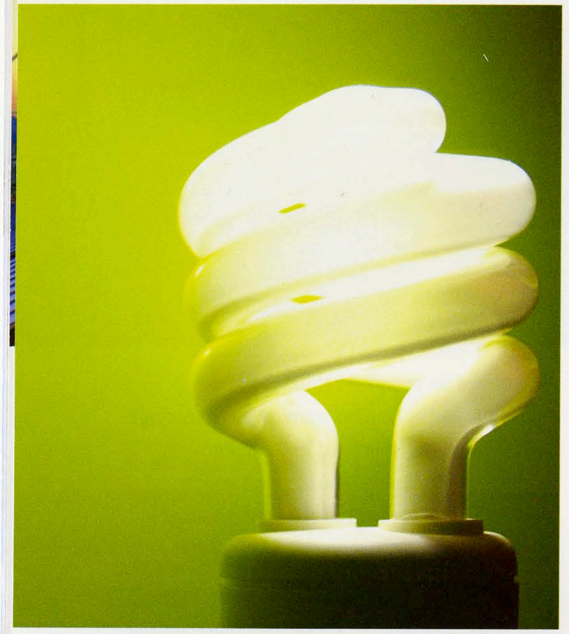
1 U.S. Department of Energy, Energy Information Administration: World Total Net Electricity Generated Most Recent Annual Estimates, December 2008.
2 Change.gov, Office of the President-Elect Energy & Environmental Plan, December 2008.

(...Continued) Smart Grids—Planning the Intelligent Utilities of the Future



other types of consumption, to reduce carbon emissions and to create more practical and sustainable economies.

At the more localized level, governing agencies can ensure that Public Utilities Commissions (PUCs) realign their focus to encourage and require conservation, as opposed to the consumption-oriented policies of the past. Local, state, national and even international governing bodies can and must encourage the creation of green jobs and economies, often through positive policies such as tax incentives and targeted infrastructure investments.

Utilities

Utilities must also do their part to support and drive the coming green economy.

Electricity suppliers must focus on intelligently matching energy supplies with consumer demand. To effectively shape the demand curve, astute utility executives are beginning now to plan and deploy the systems needed to support the coming Smart Grid and Energy Internet environments. Utilities should begin now to ramp up their learning curves on Advanced Meter Infrastructure (AMI), nano-sensors, embedded intelligence and other emerging technologies.

At the same time that they continue to invest in additional capacity and distribution infrastructure, forward-looking utilities are moving aggressively to integrate renewable sources of energy into a practical and economic energy mix. Utilities should encourage energy-into-the-plant solutions, on-site generation and co-generation on the part of commercial customers. Finally, utilities must focus on the "fifth fuel" of conservation by encouraging and managing smarter, reduced and nonpeak energy usage.

Consumers

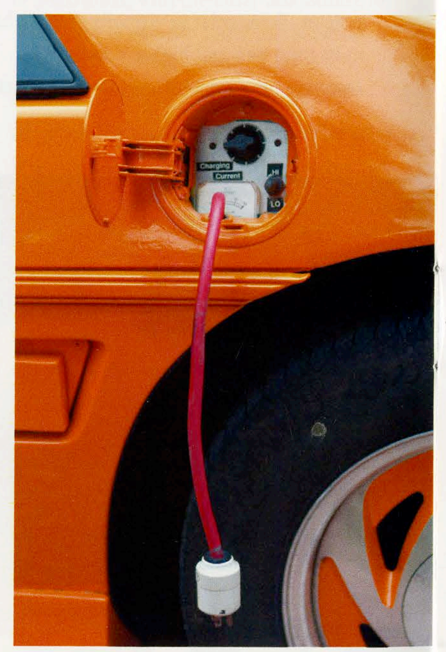
Families and individuals also have a part to play in the emerging Smart Power environment.

To support the new era of energy demand management, consumers will accept a new generation of embedded sensors and controls that will help manage the use of heating and air conditioning systems, washers and dryers, personal computers, and other electricity-using devices. Personal energy plans, controlled by Smart Black Box units in the home, will allow consumers to set the broad outlines of their electricity usage below which automated systems will ensure that customers receive safe, reliable power in the most efficient way possible.

Imagine a world in which cars become rolling energy storage units (RESUs) that dramatically reduce carbon emissions, while consuming, buffering and actually contributing to grid-based power supplies. Envision communities where businesses and residential households function as regional generation and storage units (RGSUs) that leverage solar, wind and other power sources in an intelligent electrical network guided by nano-sensors and supercomputers.

Consumers can help reduce e-waste by disposing of PCs and other electronics properly and less frequently. Studies show that of the 205.5 million units of end-of-life computer products generated in 2007, 157.3 million units, or 82 percent, were disposed of primarily in landfills. Research also shows that lead, mercury, cadmium and brominated flame retardants are among the substances of concern in electronics. These substances are included for product performance characteristics but can cause problems if the products are not disposed of properly. Computer monitors typically contain an average of 4 lbs. of lead.[3]

At the DC level, companies can introduce liquid cooling, dehumidification, flywheel UPS and fifth light lighting strategies to reduce energy usage. At the server, IT managers can use variable, deep sleep and other power-saving modes to reduce energy usage and costs. Embedded computing is optimizing equipment and lighting for optimal performance and reduced emissions. Companies can also help by virtualizing systems and activities where possible, by consolidating operations and by improving network and application performance through modernization, rationalization and optimization.



References
3 United States Environmental Protection Agency e-Cycling 3 2008 Frequently Asked Questions.

Other practical suggestions include increasing the time between hardware replacement cycles, the use of thin clients that have fewer moving parts, cascading high-end equipment downward to manage simpler tasks, and the proper disposal of obsolete systems.

Creating Collaboratories

To create and operate the Smart Grids of the future, utilities must address a number of fundamental requirements.

Those requirements include preliminary planning and the formulation of a detailed business plan, the selection of a workable architecture and the deployment of a system capable of managing the massive volumes of data needed to support an intelligent utilities infrastructure. Utilities must also address the crucial issues of implementation, integration and long-term governance of the Smart Grid environment.

Few utilities have or want to build the complex internal structures needed to plan and manage a Smart Grid environment. That is why many successful utilities have formed collaborative partnerships with "smart partners" capable of contributing the hardware, software, tools and automation needed to function in the coming Smart Power environment.

Utilities can apply this expertise and technology to meet a number of strategic objectives. In the context of the emerging Smart Grid, utilities can leverage these capabilities to shape and manage end-user consumption while reducing CO2 levels emitted from electricity generation. Those same systems can help power suppliers ensure a stable and secure supply of electricity, gas and water, while delivering the cost savings that allow utilities to invest in new initiatives designed to improve services, secure supplies and ensure sustainability.

Conclusion

In today's challenging marketplace, utilities must capture or maintain shares of deregulated markets and improve the security of power supplies ... all while reducing the environmental impact associated with their businesses.

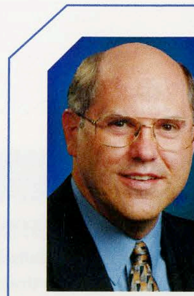
To do that, forward-looking utilities now see the need for more intelligent operating structures that combine the power of information technology with the emerging capabilities of environmental technology. The resulting Smart Grids will enable utilities to anticipate and eventually shape consumer demand for electricity. That will, in turn, allow power suppliers to satisfy both their traditional obligation to serve and the new drive to conserve.

But to create this more intelligent utility model – described by some as Smart Power – utilities must master and leverage a new generation of embedded computing, AMI, data and integration technologies. Utilities and governments worldwide must continue to invest in the innovation and infrastructure needed to plan, build and operate the Smart Grid environment.

By partnering with allies that understand the convergence of information and ecology, utilities can meet the seemingly contradictory goals of reducing consumption and meeting customer demands. In doing so, utilities can also create a more profitable and sustainable business model.

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

ABOUT THE AUTHORS



Jeff Wacker

Director of Strategy, EDS, an HP company

Mr. Wacker is an EDS Fellow and an EDS Futurist. As a director of Strategy for EDS, Wacker is responsible for shaping the future goals of EDS through innovative and market-leading strategies focused on advanced and emerging capabilities. Currently, Wacker is working extensively with Eco 2.0 IT (Economically Sound Ecologically Sustainable Information Technology) and is a core member of EDS Environmental Sustainability initiatives. Keeping with his role as futurist, Wacker continues to work with broad technology trends. His presentation "Five Technology Forces Changing The World" explores the impacts of Infotech, Biotech, Nanotech, Robotech and Envirotech on our personal as well as our business lives.

Anthony Erickson

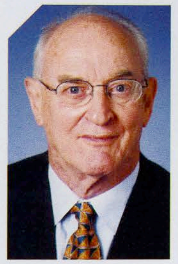
EDS Global Utilities Industry Leader, EDS, an HP company

Mr. Erickson is responsible for determining global strategy and key initiatives that allow EDS to provide innovative solutions to utility clients. His career has been focused on identifying new business opportunities and helping clients understand and integrate innovative technology solutions. Before joining EDS, Erickson led IBM's Energy & Utilities sales for its Global Business Services division. He was responsible for managing a team of professionals who sold and serviced IBM's industry business solutions. He participated in developing IBM's go-to-market strategy for solutions supporting the Intelligent Utility Network, Enterprise Asset Management, Corporate Support Services and Customer Operations Transformation.

Two New Eminent Members Inducted

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

EMINENT MEMBER — Presented June 2009



Eric Herz

Eric Herz began his career in the aerospace industry at Sperry Gyroscope Company as a project engineer on the development and field tests of a military radio navigation system. This experience launched twenty-eight years of work as an engineer and program manager on a variety of high-profile initiatives, including the Atlas, Mercury, space shuttle and cruise missile programs.

His impact on the profession extends well beyond his personal engineering contributions, however. He worked extensively in support of the professional activities of the IEEE, serving in a wide variety of volunteer positions from the sections to the board of directors. After leaving industry, he was general manager and executive director of the IEEE for fourteen years, where he contributed significantly to the growth and reputation of the organization. He is also a past president of HKN and active in the awards program.

Herz at a Glance

- IEEE Director Emeritus
- General Manager and Executive Director, IEEE
- Fellow, IEEE, Chinese Institute of Electronics, and American Association for the Advancement of Science; Governor, American Association of Engineering Societies; President of Eta Kappa Nu, Council of Engineering and Scientific Societies, IEEE Aerospace and Electronic Systems Society; Executive Director and Treasurer, IEEE Foundation; Vice President, Technical Activities, IEEE
- Member, Beta Beta chapter
- B.E.E degree from Polytechnic Institute of Brooklyn, honorary Doctor of Science degree from Manhattan College

EMINENT MEMBER — Presented April 2009

Gerald J. Posakony

Gerald Posakony received his first exposure to the acoustic and electromagnetic technology that would become his life's work during World War II. Serving in the US Navy, he was responsible for the radar and sonar equipment on board the submarine USS Roncador. His subsequent contributions to ultrasonics enabled the technology to move from curiosity to an important tool for medical diagnosis and nondestructive evaluation. In the early 1950s he was the lead engineer on an ultrasonic diagnostic imaging system for investigating disease processes in the human body. The device was considered experimental at the time, but the technology served as the basis for most of the ultrasonic devices in use today. His work in nondestructive testing includes the application of ultrasound to inspect nuclear power plant components and solid rocket motors. He has served on the Board of Directors of both the American Society for Testing Materials (ASTM) and American Society for Nondestructive Testing (ASNT), holds 14 patents, and has authored or co-authored more that 80 technical papers.

Posakony at a Glance

- Senior Research Scientist, Pacific Northwest National Laboratory
- Deputy Manager, Applied Physics Center, Pacific Northwest National Laboratory
- Vice President and General Manager, Research Division, Automation Industries
- Fellow, ASNT and ASTM; ASTM Award of Merit, ASNT Gold Medal and Lester Lecture Awards, American Institute for Ultrasonics in Medicine Medical Pioneer Award
- B.S. in electrical engineering from Iowa State College

Eta Kappa Nu Association Financial Report

For the year ended June 30, 2009 (Reviewed)

STATEMENT OF FINANCIAL POSITION

ASSETS

CURRENT ASSETS	
Cash and cash equivalents	$122,011
Membership and contribution receivables	3,105
Awards inventory	10,573
Total current assets	135,689
INVESTMENTS – at Market Value	448,572
Total assets	$584,261

LIABILITIES AND NET WORTH

CURRENT LIABILITIES	
Accounts payable	$35,061
Accrued Expenses	
Directors Compensation	20,634
Total current liabilities	55,695
LONG TERM LIABILITIES	
Unearned subscription revenue	415,571
NET ASSETS	
Unrestricted	112,995
Total liabilities & net worth	$584,261

STATEMENT OF ACTIVITIES

REVENUE	
Memberships	$94,495
BRIDGE magazine subscription and ads	19,318
Merchandise sales (net of $6,817 of costs incurred)	14,825
Contributions	27,609
Sponsorships	14,000
Total Revenue from Operations	170,247
OPERATING AND ADMINISTRATIVE EXPENSES	
Management fee	122,604
Awards	9,620
BRIDGE production	26,665
Chapter support	30,202
Directors, officers and committees expense	23,583
Office and administrative expenses	25,791
Professional fees	21,005
Total Operating and Administrative Expenses	259,470
Net loss from operations	(89,223)

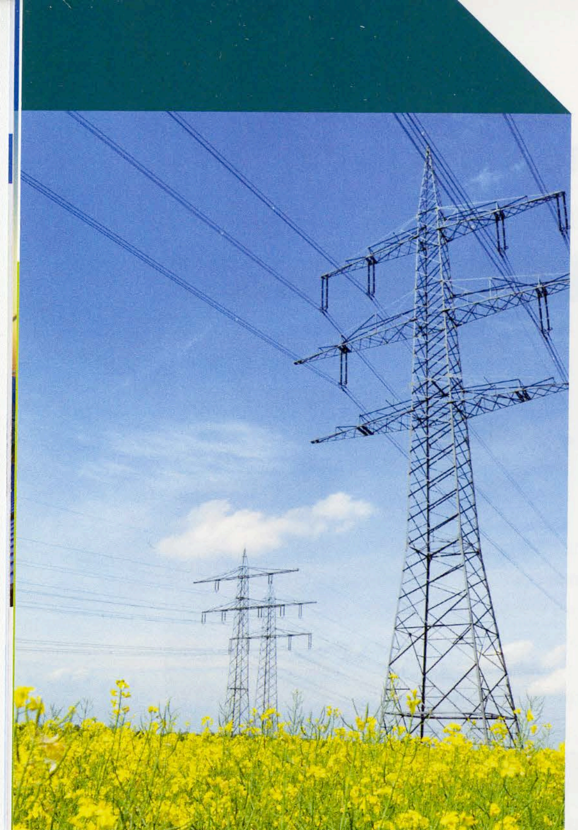
OTHER INCOME (EXPENSES)	
Dividends and Interest	$28,356
Realized loss on the sale of investments	(100,896)
Market value depreciation of investments	(90,748)
Investment advisory fees	(5,982)
Net Other Expense	(169,270)
NET LOSS	(258,493)
NET ASSETS – BEGINNING OF YEAR	371,488
NET ASSETS – END OF YEAR	$112,995

STATEMENT OF CASH FLOWS

CASH FLOWS FROM (USED FOR) OPERATING ACTIVITIES	
Cash received from memberships, contributions and program activities	$165,851
Cash paid for operations	(354,569)
Net cash used for operating activities	(188,718)
CASH FLOWS FROM (USED FOR) INVESTING ACTIVITIES	
Investment earnings – net of advisory fees	23,107
Proceeds from the sales of investments	206,743
Purchase of marketable securities	(167,560)
Net cash from investment activities	62,290
NET DECREASE IN CASH AND CASH EQUIVALENTS	(126,428)
CASH AND CASH EQUIVALENTS BEGINNING OF YEAR	248,439
CASH AND CASH EQUIVALENTS END OF YEAR	$122,011

Reconciliation of Net Gain to Net Cash Used for Operating Activities

NET LOSS	($258,493)
ADJUSTMENT TO RECONCILE NET GAIN TO NET CASH USED FOR OPERATING ACTIVITIES	
Investment activity attributable to investing activities	169,270
Cash received or expended to	
Decrease in accounts receivables	2,237
Decrease in inventories	1,836
Decrease in accounts payable and accrued expenses	(90,118)
Decrease in unearned subscription revenue	(13,450)
Net cash used for operating activities	($188,718)



Smart Grid Architecture

by Jeffrey Katz

Introduction

The electric power system grid is one of the last major infrastructure items to be automated. While the electromagnetic technology principles of the basic grid haven't changed significantly, the need for more grid observability and control has. For basic definition, we will refer to the major components of the present grid from power plant to consumer as generation, transmission, and distribution.

The boom in distributed renewable energy and its demands for a bi-directional grid are driving the need forward, as are sentiments for improving consumer control and awareness, giving them the ability to engage in real-time energy conservation. On the technology front, advances in wireless and other data communications make wide area sensor networks more feasible. Distributed computation is certainly more powerful. Even architectural issues such as interoperability, event driven programming models, and security are now being addressed in their own forums such as the GridWise Architecture Council's Grid Inter-Op and the Open Smart Grid users group.

Data Models

Once data is obtained, in order to preserve its value in a standard format, designs are often based an XML-oriented data base. Modern implementations of these data bases have improved performance characteristics and the International Electro-technical Commission's Common Information Model, though oriented more to assets than operations, is a front-running design choice. A well-designed data model not only makes exchange of data and legacy program adjustments easier, but it can also help the applicability of security and performance requirements. The existence of data models is often a good indicator of an intact governance process in a utility's smart grid project, for it facilitates use of the data by multiple applications, and enables enhancement of the future return on investment.

Communications

Customer workshops and blueprinting sessions have shown that one of the most common issues needing to be addressed in the smart grid is the design of the wide area communication system. Utility assets are all around the countryside. Data communications architecture affects data rate performance, the cost of distributed intelligence and the identification of security susceptibilities. There is no single communications technology that is suitable for all utilities or even for all operational areas across any individual utility. Rural areas may be served by BPL, while urban areas benefit from MPLS and purpose designed RF mesh networks, enhanced by their proximity to fiber. The smart grid architecture focuses on security, with standardized interfaces that can accept new technology, enablement of remote configuration of devices to minimize any touching of smart grid devices once installed, and future-proofing the protocols. Utilities do not want a communication network rebuild within five years of deploying an AMI-only network. Communications architecture also considers power outages, so battery back-up, solar recharging, or other equipment may be required, since the smart grid state needs to be sensed even when the part of it is without power. Even such arcane details such as the antenna on a smart grid wireless device being the first thing to blow off in a hurricane are considered.

Security

Certainly the smart grid's purpose is to enhance network reliability, not lower its security, but with the advent of the North American Electric Reliability Council's Critical Infrastructure Protection regulations, and similar requirements outside the U.S., security has risen to become a prime consideration in Smart Grid. Security is addressed in phase one of the smart grid architecture. Unlike the data center security endeavor, field-deployed security has many new situations and challenges. There is security at the substation – for example who can access what networks, and when, within the control building. At the other end, security of the meter data in a proprietary AMI system is addressed so that only authorized applications and personnel can access the data. SOA Appliances are network devices to enable integration and help provide security at the Web services message level. These typically include an Integration Device, which streamlines SOA infrastructures; an XML Accelerator, which offloads XML processing; and an XML Security Gateway, which helps provide message-level Web services security. A Security Gateway helps to ensure only authorized applications are allowed to access the data, whether an IP meter or an IED. SOA appliance security features complement the SOA security management capabilities of software. On the other hand, existing products such as ISS security appliances come in to play where the network is IP. Services play an important role also, since once a smart grid project is done, the security landscape still evolves due to ever present hackers. Thus penetration testing and anomaly detection with tools such as Info Sphere Streams, are considered for on-going vigilance.

Analytics

A smart grid generates much more data, but most utilities do not plan to add many more engineers to interpret it all. That is where analytics supports the processing, interpretation, and correlation of the flood of new grid observations. One part of the analytics is performed by existing applications, and this is where data models and integration play a key role. Another part of the analytics dimension is with new applications and the ability of engineers to use a workbench to create their customized analytics dashboard in a self-service model. Many utilities have power system engineers in a back office using spreadsheets; part of the smart grid concept is that all data are available to the community to use modern tools to analyze and predict grid operation. Analytics need a dedicated data bus, separate from an ESB or enterprise SOA bus, in order to meet the timeliness and quality of service to support operational analytics. This is because situations on the electric grid occur quickly, and timely analysis is the only relevant analysis. A two-tier or three-tier (if one considers the substations) bus is an architectural approach to segregate data by speed and still maintain interconnections that support a holistic view of the operation. Connections to standard industry tools are considered at design time, rather than as an additional expense commitment after smart grid commissioning. Analytics tools such as Cognos Now and ILog are used to build specific applications for the utility to better understand, and then improve, their operation. The definition of 'improve' however, varies by utility and sometimes by department. For example, optimization can be for least fuel cost, or least emissions produced, or most time with redundant circuit capacity, or maximum equipment lifetime.

Integration

Once data is sensed, securely communicated, modeled and analyzed, the results need to be applied for business optimization. This means new smart grid data is integrated with existing applications, and metadata locked in legacy systems is made available to provide meaningful context for that data. This is accomplished by enabling systems as services per the classic SOA model. However, common data formats, data integrity, and name services are also blended in to the architecture. Data integrity includes verification and cross-correlation of information for validity, and designation of authoritative sources and specific personnel who own the data. Name services addresses the common issue of an asset – whether transformer or truck – having multiple names in multiple systems. An example might be a substation that has a location name, such as Walden, a GIS identifier such as latitude and longitude, a map name such as nearest cross streets, a capital asset number in the financial system, a logical name in the Distribution Management System topology, an abbreviated logical name to fit in the DMS GUI, and an IP address for the main network router in the substation. Different applications may know new data by association with one of those names, and that name may need translation to be used in a query with another application.

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

ABOUT THE AUTHOR

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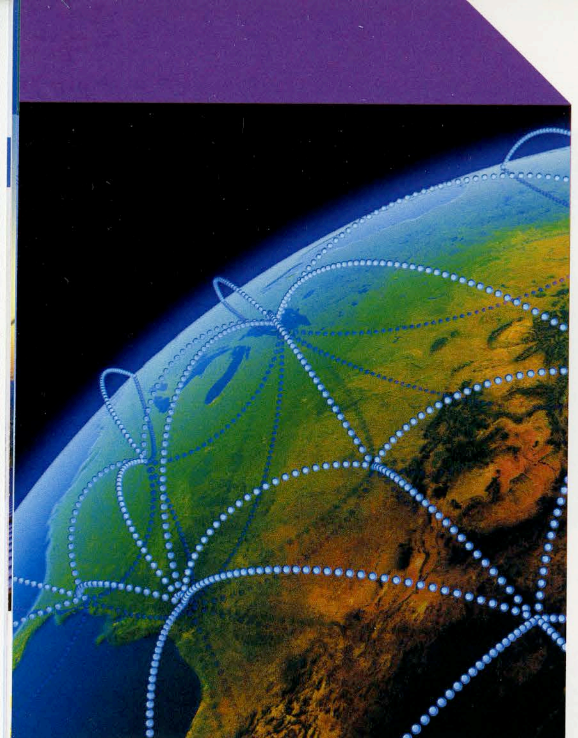
Mr. Katz is the Chief Technology Officer for IBM's Energy & Utilities Industry. He is involved with the application, development, and innovation of IBM products, services, technology and research for electric power companies and related organizations. He has worked on the IBM industry group's strategic growth case, the IBM Innovation Jam workshops, the IBM Intelligent Utility Network initiative, and is the primary industry liaison with IBM Research. He led the IBM internal Innovation Jam brainstorming project for Nuclear Power.



Data Marts – A Wealth of Untapped Information

by John McDonald

Imagine running a business at only 2–4% productivity, or only using 2–4% of your laptop's memory. Certainly, that wouldn't be an efficient use of resources. Today, utilities use only about 2–4% of the operational data available to them when making decisions, according to a recent study by IBM. What if utilities could easily access that untapped data, analyze it, and share it across every function within the organization? The measurable improvements to business productivity would be immense.

Electric utilities have already realized some success at implementing smarter grid technologies to improve system efficiency, reduce outages, and manage their assets more effectively by investing in substation automation. However, few utilities seem to realize that they can achieve even greater returns on their investments in automation by simply tapping into the wealth of information collected by these automated components, and delivering it to decision makers throughout the organization. For the purpose of this article, a "data mart" is a collection of data recorded, stored, integrated and distributed by automated systems.

What is Operational and Nonoperational Data?

Operational data is the fundamental information used by system operators to monitor and control the power system, and indicates the real-time status, performance and loading of power system equipment. Operational data is transmitted to the Supervisory Control and Data Acquisition (SCADA) master every two seconds, and includes circuit breaker status, bus voltages, line current, and substation alarms.

Nonoperational data is historical information used primarily for functions other than system operation, such as engineering or maintenance. Nonoperational data is stored in local "historian" archives, and includes historical trends such as circuit breaker contact wear records and digital fault recorder logs.

Simply put, operational data indicates what is *happening*, and nonoperational data indicates what *has happened*. In the data mart, integrating operational and nonoperational data can reveal *why* things happened.

What We've Done Historically

While many utilities have implemented microprocessor-based devices and SCADA technology, which have the ability to gather and sort incredibly detailed historical data records, most automated systems have only local archives – known as historians. Unfortunately, these local historians have not always been designed for data mart integration – which enables data marts to harness and integrate data, process it into useable information, and relay it to applications and personnel for analysis and use at all levels.

The timely delivery of accurate performance data – from generation to consumption – enables smarter decision-making, helping utilities more effectively maintain their assets by planning equipment upgrades and realizing longer life spans for aging components. Data marts can also eliminate potential confusion from duplication of data residing in multiple databases. Unfortunately, many utilities may be unaware that this wealth of information exists or that the technology is already available to unleash and utilize the information trapped inside.

Accessing the Data You Want – at the Data Mart

Accessing and retrieving valuable "operational" and "nonoperational" data from the data mart can be as simple as going to your neighborhood convenience store. The data mart is a server or group of servers that retrieve data from local data marts, which are typically linked to systems such as SCADA, substation automation, power plant distributed control systems, maintenance management, outage management, and customer information systems. Corporate data warehouses access and store these data points and files centrally, and integrate the data sets into unique packets of information that can be delivered to, or accessed by, specific user groups in engineering, operations, and maintenance.

Let's Go to the Data Mart

Leveraging data mart technology requires the proper implementation of automation *and* integration. Automation and integration are commonly viewed purely as the installation of computerized monitoring and control devices in the substation, but it is the enterprise integration of these devices and systems that lead to the promised benefits.

To get to there, we need to follow three pathways:

> Implement and integrate Intelligent Electronic Devices (IEDs) to access operational data and send to the SCADA master station

> Access nonoperational information stored in the IEDs and send to the corporate data warehouse

> Enable remote access to the IEDs

The first pathway, often called the operational data path, is between the substation integration and automation systems and the SCADA system. This pathway involves implementing IEDs, integrating IEDs, and deploying substation automation applications.

- IEDs are microprocessor-based devices with two-way communication and computer processing capability that can monitor power system conditions and provide hundreds of operational data points as well as a wealth of nonoperational data. IEDs are paramount to the data mart information flow because they are implemented in nearly every piece of power system equipment and can collect and store *both* operational and nonoperational data.

- IEDs must then be integrated to provide operational data flow (such as real-time line voltage and current) along with nonoperational data flow, such as on-demand or event-triggered data logs of events and digitized waveforms. Nonoperational data logs provide valuable information, enabling engineering and maintenance groups to piece together individual occurrences or conditions that lead to major events, such as outages or equipment failures.

- Substation automation applications are then deployed to monitor and control operating functions and applications, including SCADA, alarm processing, and automatic load restoration.

The second pathway (called the nonoperational data path) involves gaining access to the nonoperational information stored in the IEDs and transferring the data to the corporate data warehouse. Information along this path is on-demand and non-periodic. Depending on user requirements, nonoperational data can be pushed from the substation to the warehouse, or pulled from the substation through a warehouse application.

The third pathway is to enable users at locations outside the substation to remotely access information stored in the IEDs. Two-way data flow between the remote access point and the IED will enable users to remotely review device settings, change parameters, and download nonoperational IED data for analysis. Often called pass-through or loop-through, this communication path can be as simple as a secure dial-up line or dedicated fiber-optic connection.

Transforming Data into Knowledge, Knowledge into Action

Most utilities currently rely on IEDs to provide only operational data, therefore realizing only 20% of the potential benefit of each IED installed in their system. By implementing the proper integration architecture, IT infrastructure, data warehousing and remote access capability, utilities can leverage data mart technology to tap into that unrealized 80% of each device's return on investment. Data mart technology can also improve power generation efficiency and reliability, while at the same time reducing operating and maintenance costs related to outages and major equipment failures. Data mart technology – it's a smart pathway to the smart grid.

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

ABOUT THE AUTHOR

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Mr. McDonald is a well-known and respected expert with 35 years of experience in Transmission & Distribution. A Fellow of the IEEE and Past President of the IEEE PES, he was awarded the IEEE Millennium Medal in 2000, the IEEE Power & Energy Society (PES) Excellence in Power Distribution Engineering Award in 2002, and the IEEE PES Substations Committee Distinguished Service Award in 2003. He received his BSEE and MSEE (Power Engineering) degrees from Purdue University, and an MBA (Finance) degree from the University of California-Berkeley. He is a member of Eta Kappa Nu and Tau Beta Pi, and is a registered Professional Engineer (Electrical) in California, Pennsylvania and Georgia.

Member Profiles

Deanna Byington
Sr. Engineer, NERC Compliance MidAmerican Energy
Member, Gamma Rho

Career Highlights

Over my career to date, I have enjoyed participating in big projects. These have included initial energizations of plant distribution system, initial sync of new generators, design of replacing electro-mechanical relays with microprocessor based relays, and designing control system upgrades. I have also relished small troubleshooting victories like helping technicians find a failed MOC contact in a switchgear cubicle or reviewing fault data from a relay. However, my greatest satisfaction has been my ability to develop a diversity of skill sets in the electric generation field. These skills have helped me to obtain a job that allows me the flexibility to balance my career interests with raising my three beautiful children. With four separate and unique units at the Neal Generating Station, I have the diversity in design and projects to retain my interest with limited travel requirements.

Education and Career

It is difficult to isolate a specific portion of my formal education that has proven the most useful to my career. As I look back, I have used the knowledge gained in a portion or pulled out the textbook for review of each course at some point in my career. I credit enthusiastic, caring, and knowledgeable professors in both my undergraduate and graduate studies for my current success.

Advice to Engineering Graduates

My advice to new graduates is that graduation is just the beginning of your education. Be open and willing to learn from experienced engineers, textbooks, white papers, experimentation, test results, vendors, technicians, electricians, operators, maintenance personnel, and end users. Combined with review, research, and reflection, each can contribute to your existing knowledge base and prepare you to perform more efficiently and effectively on each subsequent project.

Grant Erickson
Principal and Founder Nuovations
Member, Omicron

Career Highlights

It is said that luck occurs where opportunity meets the prepared and in my case, my career has seen a good measure of that fortune and along with that, great professional satisfaction. I enjoyed and will never forget the tremendous opportunity to work right out of college for then nascent start-up Brocade and during my years there, directly participate in its growth into a dominant player in its industry. Following that, I had the pleasure of being part of the world-class team of people at Apple working on and delivering the iconic iPod and iPhone products, which are recognized the world-over. Finally, most recently, I have had the tremendous privilege to have spent the last couple of years launching my own company and its first set of products and all the challenges and rewards that come along with that.

Education and Career

Perhaps surprisingly, the educational opportunities that have afforded me the greatest career successes have been those outside the core engineering curriculum. Whether learning to work well as part of a team through group project work, learning how to be an effective and persuasive writer and communicator through liberal arts coursework or learning how to speak the language of commerce through economics and business coursework, all these have served as highly-effective force multipliers of my engineering education and training.

Advice to Engineering Graduates

The old saw that it is not necessarily what you know but who you know that will land you that next great job typically rings true. Toward that end, while it is important that you excel in the classroom, it is equally important to achieve and excel outside it. Take that summer internship. Talk to those graduate students and figure out how you can help contribute to their research efforts. Volunteer. Attend cross-functional and cross-disciplinary symposia and lectures. Network. Get involved in your local HKN, IEEE or TBP organizations. In short, get involved and you will marvel at the doors that open before you.

Gary Bruce Helming
Sr Telecommunications Technician Northwestern Energy
Member, Iota Kappa

Career Highlights

I was really on the ground floor on a lot of utility technologies. Montana Power was one of the most technologically advanced utilities on the planet for many years, it was small, and I had a lot to do with its success. MPC was the first utility in the nation to use digital microwave and invented its own line of SCADA equipment (Tetragenics). When its consulting business folded, I was able to do a lot of the work that it had as my own business. While doing consulting work at major west coast utilities, I found that the traditional progression was to move engineers into project management positions, where their technical skills wilted. I resisted that move and rearranged my work and my career so that my consulting work is in the field with my hands on the technology. Besides making the job better from my standpoint, I have found that the people close to the technology survive corporate shakeups much better than middle management too!

Education and Career

At MSU, I went through the whole telecommunications program and even developed another telecom class as a grad student. I went through the entire power engineering track too. This placed me well for doing power utility telecommunications and controls. In these tough economic times, the power industry still has a lot of good jobs that are hard to fill. I have worked hands on with the technology for many years. I enjoy being the person that people go to with technical questions. I have many engineering friends who haven't used their technical knowledge in years. I am really using what I learned and am adding to it all of the time! My MSU education was very adequate. I keep in touch with people at MSU to this day!

Advice to Engineering Graduates

While the corporate progression track might take you toward higher management (which is what some engineers want), if you truly went into engineering for your love of the science and not just because it seemed like a good way to get a job, then stay as close to working with the technology as possible. Companies are looking for people with specific experience with specific technologies. If you have that, you will probably have better employment stability and can also more easily branch out to be your own boss too. With companies coming and going, you have to look out for yourself. Keeping your hands on the technology, I think, is the best way to do it.

Member Profiles

John A. Kassebaum
CTO and Chairman of the Board of Directors Stellarwind Bio Energy, LLC
Member, Beta

Career Highlights

I would say that my career has had three great highlights. The first was the stunningly successful development and deployment of a shipboard all-digital sonar system for which the development team won a prestigious "Hero's of Reinvention in Government" Award – signed by then Vice President Al Gore. My role was essentially software system architecture and design. The second was a similar role at Escient and Openglobe in which our team created a world-class software development and quality process which was used for the development of several lines of consumer electronics equipment in the A/V space. Finally, my current efforts—the most rewarding so far—are toward solving our nation's energy security problems by harnessing micro-algae for the production of fuel oil. My website—www.stellarwindbioenergy.com—can give you more info on that.

Education and Career

I would say that my education provided merely a starting point for my professional endeavors. I have always loved the process of learning, but only seldom has the exact technical content of my education been particularly relevant to the challenges that face me. The most important take-away from my education has been the ability to translate real-world problems into mathematically solvable models. The results obtained from this modeling and analysis has been either readily implementable or testable against the real world. This extra level of quantification and discipline has made all the difference.

Advice to Engineering Graduates

Learn to think broadly about the world and how to represent problems in ways that can be tested and improved. Synthesis of new approaches using experience and theory from differing fields or disciplines will be necessary in order to be truly outstanding in the world we are now building. We have much broader and quicker access to information now than in the past, but to use that information one must have a both a firm technical foundation as well as a broad view. Never stop learning.

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- *Presented annually to an exceptional young engineer who has demonstrated significant contributions early in his or her professional career*
- *Nominations due April 1*

Vladimir Karapetoff Outstanding Technical Achievement Award

- *Recognizes an individual who has distinguished himself or herself through an invention, development, or discovery in the field of electrical or computer technology*
- *Nominations ongoing*

Distinguished Service Award

- *Acknowledges an individual who has devoted time and energy to the Eta Kappa Nu Association through years of active participation*
- *Nominations ongoing*

Outstanding ECE Student Award

- *Annually identifies an ECE senior who has proven outstanding scholastic excellence; high moral character; and exemplary service to classmates, university, community, and country*
- *Nominations due June 30 to the LA Alumni chapter*

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, due October 15 for the preceding academic year*

C. Holmes MacDonald Outstanding Teaching Award

- *Presented annually to a dedicated young professor who has proven exceptional dedication to ECE education and has found the balance between pressure for research and publications and enthusiasm and creativity in the classroom*
- *Nominations due November 1*

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