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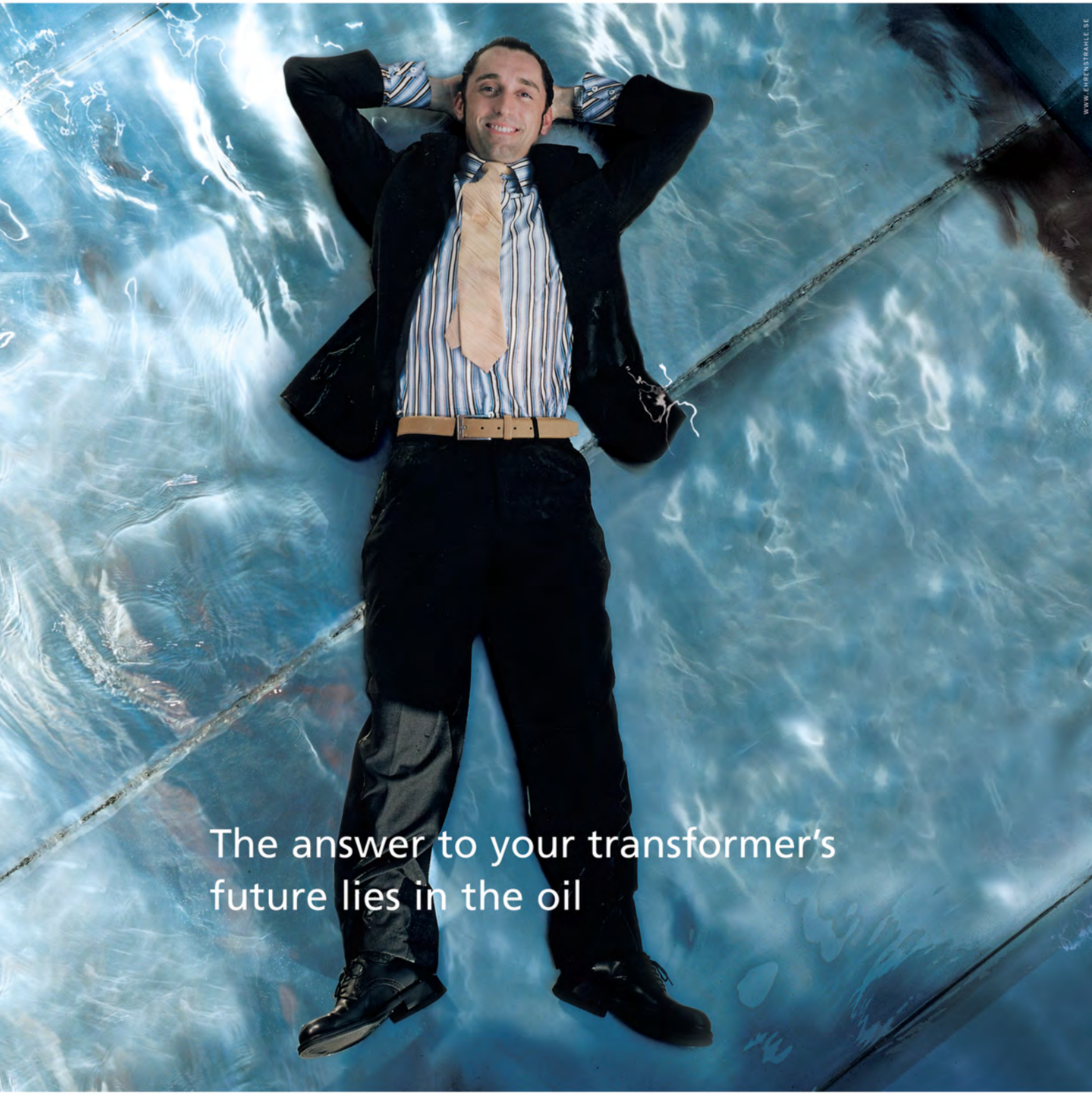
Electric Energy T&D MAGAZINE

NOVEMBER-DECEMBER 2006 Issue 7 • Volume 10

In this Issue

Dramatic Changes in the Metering Market



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"CCAB/BPA WORLDWIDE MEMBERSHIP APPLIED FOR DECEMBER 2005"

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COVER PAGE PHOTO: **Felicity Rainnie, Mexico**

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Thomas Ganswindt, Chief Executive Officer, Elster Group

www.elster.com

At the AMRA's Autovation 2006 in Nashville, TN the voting members of AMRA approved the slate of officers and trustees for 2006-2007

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The recipient of The Robert J. Green Distinguished Service Award was Ronald J. Chebra, KEMA Consulting.
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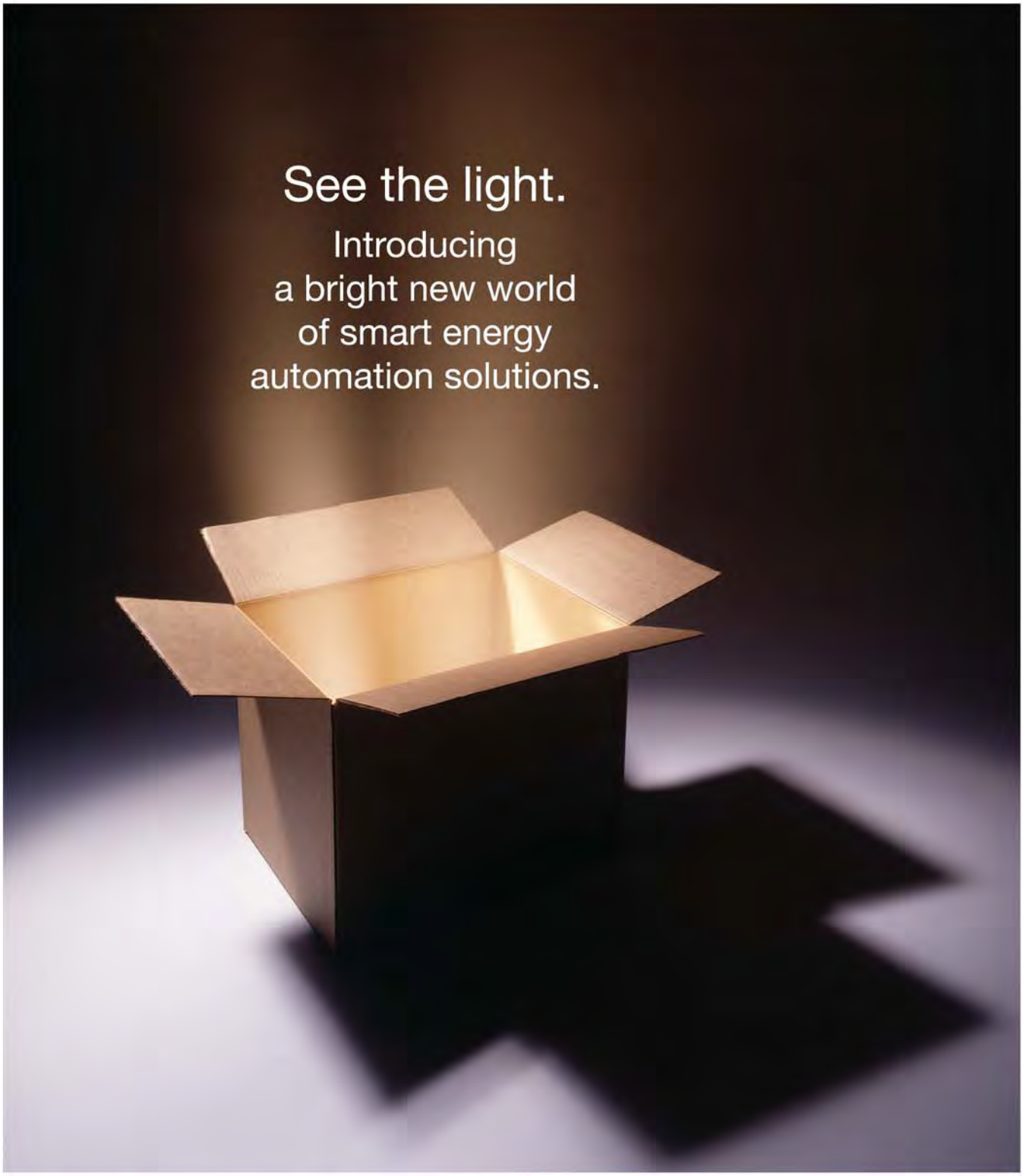
Bismarck State College and Energy Coalition Partner to Address Workforce Shortage

With the impending retirement of a significant number of utility workers (industry groups estimate between 40 and 50 percent of the workforce will be eligible for retirement within five years), utility companies are scrambling to address the issue. Many companies have turned to online education as a strategy for workforce development and a resource to recruit, train and retain skilled and knowledgeable employees.

For many years, developing business–education partnerships has been a successful way for companies to help build its workforce. A unique model expanding to an industry level-education partnership emerged in 2001 when the Energy Providers Coalition for Education (EPCE) was formed. EPCE immediately partnered with Bismarck State College (BSC) to build on the college's success in serving the energy industry and to develop quality online learning solutions designed for the electric power industry.

The EPCE coalition is comprised of utilities, associations, labor, contractors and education providers that work together to develop relevant and applicable online courses and degree programs for the industry. The material is industry-driven and standardized, which ensures a common body of knowledge across the field. With EPCE industry input, BSC has developed an online Certificate and Associate of Applied Science degree in Electric Power Technology and Nuclear Power Technology. In addition to the Power Plant and Electric Power programs, BSC also offers Process Technology, Nuclear Power Technology and Electrical Transmission Systems Technology programs within their Energy Technology division.

Since 1976, when the college created its Power Plant Technology program, business and industry have partnered with BSC to tackle the workforce needs of the energy industry. Bismarck State College is known for its strength in developing occupational and technical courses with training available on-site, on the BSC campus or online. Customized training and development projects are also available.



"Our online energy courses & programs provide online learning solutions which benefit both companies and employees at each step in the workforce development process," said Joan Kleven, Energy Technology Online Advisor at Bismarck State College. "From recruitment to training to retaining, our online programs help organizations achieve their goals by creating and maintaining a knowledgeable workforce."

Bismarck State College's online courses and programs are now leveraged by industry partners in various ways for workforce development. The industry uses these online programs in three steps, with the objective to build and maintain a pipeline of qualified workers.

In the first step of workforce development, recruiting, the online programs focus on incoming energy workers. The online programs are a resource to help qualify future energy workers with the aim to build a pipeline of skilled and knowledgeable candidates for employers.

Online programs can also be used in the second step, developing current workers. Energy companies and employees can utilize the online courses in order to learn more about the industry, qualify for jobs on a career path and to advance within the industry. By taking certain courses, employees can engage in professional development that will help them to advance within the industry.

Mark Peterson, a graduate of the program, enjoyed the experience and knows that what he learned is applicable to his career. "The classes did challenge me and juggling work and family around classes was tough but well worth the effort. I feel I learned many new things and refreshed my skills in other areas."

The third step in the process is retaining employees. With the pool of qualified workers continually shrinking, employees will have many opportunities to take control of their career. Companies that wish to recruit the best and the brightest must show that they support education and the employees' desire to earn a degree. By offering employees a chance to continue their education, companies ensure the likelihood that employees will not only increase productivity, but will also create a loyal workforce.

When the retirement bubble bursts, the companies that are on top will be the ones that adequately prepared for the workforce shortage. Companies that are willing to collaborate with first-rate technical colleges will be able to ensure a steady stream of qualified energy workers at all levels of the company.

For more information, on Bismarck State College, visit www.bismarckstate.edu/energy . For more information on the EPCE coalition, visit www.epceonline.org

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To deliver a constantly updated resource for utility professionals seeking new and innovative ways to meet and solve industry challenges

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What's on **YOUR** Desktop?

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ANNUAL CANWEA CONFERENCE, TRADE SHOW DRAWS RECORD NUMBER OF DELEGATES,EXHIBITORS

The winds of change are blowing strongly through Canada's electical energy sector and the extent and pace of change can be gauged by the attendance at the Canadian Wind Energy Association (CANWEA) 22nd annual Conference and Trade Show which was held in Winnipeg October 22-25. Robert Hornung, CANWEA's president, reported that 1,250 delegates registered for the conference - 15% more than ever before - and 120 exhibitors as compared to 71 at the 2005 gathering.

"There is tremendous interest in wind energy," Hornung said. "We have never seen this level of support before."

In his report on the state of the industry, Hornung noted that 2006 was a record year for wind-generated electrical energy. "As of today, we have 1,218 megawatts of wind power available," he said. "That includes new installations creating 534 megawatts this year, more than double last year's construction of facilities delivering 240 megawatts. By the end of the year, we should have over 600 more megawatts and possibly more than 700 more on stream than we had at the beginning of the year. That means that more than $1 billion in new investment over the year."

He added that by the end of the year, Ontario will have surpassed Alberta in total megawatts generated by wind power. He noted that British Columbia, Quebec, Newfoundland and New Brunswick are planning to being more wind energy on stream next year.

"We are projecting that another 600-700 megawatts of wind energy will be built next year with even more for 2008," Hornung said. "By 2015, wind energy should account for 45 of Canada's electrical needs."

By comparison, he noted that natural gas currently accounts for 4% of the country's electrical needs. "We believe there is significant room for growth," Hornung said. "There are 1,300 megawatts worth of projects ready to go. We foresee wind generated energy accounting eventually for almost 20% of our country's electric energy needs."

Delegates at the opening plenary session also heard from representatives of Manitoba Hydro and the provincial and Federal Governments. Gary Lunn, the Federal Minister of Natural Resources, spoke via videotape of the importance of wind energy in the government's environmental program. "We look forward to CANWEA"s continued leadership in this area," he said.

Jim Rondeau. Manitoba's new Minister of Science and Technology,Industry and Mines, spoke about Manitoba's leadership in developing environmentally-friendly sources of electric energy from hydro to wind as well as geothermal heating and hydrogen-operated buses.

"Manitoba is the most energy efficient province in Canada," he said. "We are a leader in clean energy development."

Rondeau also introduced a video on the 99-megawatt wind farm that became operational at St. Leon, a town about 150 miles southwest of

Winnipeg, last spring. The St. Leon wind farm is the largest in North America. It provides power for 35,000 homes.

Ed Wojczynski, Manitoba Hydro's Power, Planning & Development Division Manager, noted how excited the utility was "to have this impressively successful conference in our hometown".

He pointed out that Manitoba Hydro is one of the largest electrical exporters in Canada. "For many years we have had the highest percentage of provincial generation exported to the US," he said. "Last year, we had the largest net exports of electrical energy of any province."

Wind is part of a suite of energy options that Manitoba Hydro is developing that will balance environmental, social and economic factors.

The portfolio of new resources is composed entirely of clean renewable resources: wind, hydro, biomass, conservation programs for every type of customer, a large geothermal program and more. All of these are low impact.

Manitoba Hydro, Wojczynski said, sees an increasingly bright future for wind generation. Higher energy prices and supply concerns mean increased costs. There is also growing demand and environmental constraints. "These factors are increasing the economics and attractiveness of wind, hydro and other renewables which can act to displace coal, oil and natural gas generation," he said.

"In Manitoba, we are fortunate to have not just excellent clean hydro potential but one of the better wind resources in North America. We are, of course, excited with the St. Leon development having come into service this year. We look forward to gaining more hands-on experience with St. Leon in our system and to the responses to our 300 megawatt RFP coming out this winter. We in Manitoba Hydro and Manitoba are very pleased to have these resources for ourselves and also to share with others especially in the US.

If the transmission infrastructure between Manitoba and Ontario or Saskatchewan can be finally fully established, then the wind and hydro resources in Manitoba could contribute to resolving the energy supply and environmental concerns in Ontario and Saskatchewan as well."

While the picture for further growth for wind energy is rosy, Robert Hornung did caution that there are still challenges ahead. These include uncertainty as a result of the change in government at the Federal level and difficulties at times with municipalities that may not understand the benefits, a shortage of transmission lines and the increasing cost and scarcity of turbines as demand has for the moment outstripped supply.

Overall though, he said, 2006 has been a very success year for wind energy generation. "And yet, we have barely scratched the surface," he noted. "We have come a long way, but we still have a long way to go. I am confident that if everyone - government, utilities and system operators - works together, we will succeed."

by Myron Love

Circle **126** on Reader Service

Elster, a world leader in advanced metering technology, announces business alignment in North America

Elster announces that it is aligning three of its business units in North America. The North American alignment includes Elster Electricity, AMCO Water Metering Systems, and a new business unit called Elster Integrated Solutions (EIS).

The business alignment results in three separate, but coordinated businesses serving markets in North, Central, and South America. Elster Electricity will continue to focus on providing state-of-the-art metering and metering system technology to electric utilities. AMCO Water Metering Systems will continue to focus on and provide advanced metering products and meter reading solutions to water utilities. The focus of EIS will be in delivering AMR/AMI system solutions across gas, electricity, and water to multi-utility customers. EIS will lead the business transformation of operations technology utilizing information technology and intelligent networks with the existing Elster Electricity and AMCO Water Metering Systems business units. EIS will bring a common vision and integrated plan across gas, electricity, and water.

This alignment enables Elster to increasingly deliver focused AMR and AMI solutions across all utility segments. Mark Munday, CEO and president of Elster Electricity, has been named executive vice president of the electricity and water businesses in North America.Another key appointment in North America is Sharon Allan named president of EIS. AMCO Water Metering Systems continues under the leadership of president Blake Snider.

"This new business alignment enables Elster greater focus and response across all segments of the utility market. This structure is a direct result of discussions with our customers about their plans and needs, and is an important step in aligning Elster with the changing market needs for products, systems, service, and solutions," affirms Mark Munday, Elster Group executive vice president, North America electricity and water.

Blake Snider, president of AMCO Water Metering Systems comments, "I am very excited about our path forward. As the leading global provider of utility metering solutions, Elster Group is well positioned to take full advantage of emerging metering communications opportunities. Our North American alignment will ensure that these opportunities are maximized."

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About Elster in North America

Elster consists of two major business units in North America: Elster Gas and Elster Electricity and Water. Elster Gas delivers gas metering solutions to a host of customers across the region and is headquartered in Madison, Ohio. The Elster Electricity and Water business unit serves utilities in these two sectors with operations located in Raleigh, North Carolina and Ocala, Florida. Elster Integrated Solutions, a new business unit in Raleigh, North Carolina, helps utilities improve their revenue cycle services, customer service, delivery reliability and workforce utilization as well as implement demand response and conservation programs.

For more information, visit www.elster.com

Circle **127** on Reader Service

Laserfiche Automates Document Workflow in the Electric Sector

Mahendra Garg recently realized the Public Utilities department at the City of Anaheim, Calif. was suffering from "black hole syndrome." The principal engineer with the Anaheim electric utility took one look at the jumble of blueprints, wiring schematics, job site Polaroids and handwritten notes from Anaheim civil engineers and knew something needed to be done to make things more efficient.

It's no secret that the flood of paperwork associated with running an electrical utility can be overwhelming. Maps, memos, work orders, change orders and countless other documents must all be kept on record – and then there's all the paperwork involved with mandatory year-end government filings.

In Anaheim, it all added up to 5,000 boxes stuffed with files dating back to the 1930s taking up two entire floors of precious space in city hall offices.

"Part of our problem was that we weren't doing the proper record destructions on a regular cycle at all," says Garg. "We were holding on to a lot of files we didn't need."

So city officials brought on records manager Ron Smith to develop a systematic, uniform document and records management system. The completely restructured way of processing and storing records would be digitized and built around a legally approved records retention schedule in accordance with government regulations. Document and records management software would automate much of the process.

"It really was a black hole when we got started," Smith said. "I'd pull these boxes out for the engineers and we couldn't always find files for them. Our level of service was suffering horribly."

Smith looked at a number of different software systems and decided on a document and records management system from Long Beach, Calif.-based Laserfiche. Working closely with Laserfiche software specialists, Smith was able to scan and digitize virtually all of the utility's documents. Now, electrical utility workers can find any document they need in seconds by searching for any word that appears on the document. Laserfiche's secure records retention controls automatically dispose of certain records at the appropriate times.

Smith's project in Anaheim mirrors a movement toward digitizing documents that is sweeping electrical utilities of all sizes across the country. Faced with a never-ending flow of paperwork and strict records regulations, utilities are increasingly turning to digital document and records management solutions to get paperwork under control and run efficient, legally compliant operations.

The Intermountain Power Agency (IPA) in South Jordan, Utah, sells about 13 percent of the energy it produces to Anaheim. IPA is using a system similar to Anaheim's to process and manage all documents related to generating an average of more than 13 million megawatt hours of energy each year from its two coal-fired units.

In Anchorage, Alaska, Chugach Electric Association is using a Laserfiche document and records management system in multiple business areas, including legal and regulatory affairs and customer service. Chugach employees use the system to perform content searches to locate documents in response to discovery requests and to retrieve content from the Regulatory Commission of Alaska Web site. The electric cooperative has linked its document and records management software to existing corporate databases to minimize data entry, automate data capture, and share non-privileged documents among departments.

"All departments have found ways to use our document management software to meet their particular needs," says Aundrea Kell, Regulatory Affairs Analyst at Chugach. "Our customer service representatives, for example, use the system to handle customer requests more efficiently, which our members notice and appreciate. And it's all involved virtually no training time or added costs."

A benefit of taking paperwork digital is the fact that the information stored is never static. Document management systems can be expanded with e-mail and Web tools to make information more accessible in a secure environment and adapt to constantly changing regulations. Chugach, for example, already makes its operations parts inventory and images available via the Web to users with the Laserfiche Web Link utility. Meanwhile, in Anaheim, Smith will soon begin integrating the utility's Laserfiche system with the utility's Geographic Information System (GIS) and computer-aided drafting applications to expand functionality even further.

But there's no doubt that even a simple document management system goes a long way in terms of getting a handle on paperwork in the electric utility industry.

"Records are records and there are all kinds of theoretical aspects to working with them," says Smith. "But in the end, you simply have to be able to manage them."

For more information, on LaserFiche, visit www.laserfiche.com

Circle **128** on Reader Service

PowerStream Chooses FlexNet™ System for Ontario

Pittsburgh, PA - More than 80,000 of the newest and most advanced electric meters in the industry will soon be deployed in the York Region of Ontario. PowerStream, one of Ontario's six largest electricity providers, will use the FlexNet AMI solution, provided by Sensus Metering Systems and its Canadian distributor, KTI Limited, to meet their requirements for the Ontario Government's Smart Metering Initiative.

PowerStream, part of the Coalition of Large Distributors (CLD), selected the Sensus FlexNet system from the "Vendor of Record" shortlist consisting of five AMI solutions. The CLD is comprised of the six largest Municipal Electric Utilities in Ontario. CLD completed a thorough technical and economic evaluation of today's AMI solutions in order to select "Vendors of Record", which Ontario utilities can engage to begin deployment of Smart Meters in their respective franchise areas.

"Our selection process evaluated every technology available today." said John Sanderson, PowerStream's Vice President, CDM and Metering. "We chose Sensus' FlexNet system because it satisfies our stringent technical requirements, utilizes minimal network infrastructure; and is a true multi-utility platform, which communicates over a secure licensed spectrum."

FlexNet is a radio frequency, fixed network utility meter reading system designed to increase meter reading efficiency, reduce overhead costs, and enhance customer service. Its two-way fixed based design is able to reach distances up to 700 square kilometers of coverage, depending on terrain, from one collector. The patented technology allows for Internet-based programming of the network and meter endpoints, as needed.

In addition, the system is designed to be scalable to accommodate growth as a utility expands the meter deployments throughout its service territory. Because the FlexNet system is a tower-based AMI network, reliance on additional infrastructure, such as numerous collection points is avoided. The system has a simple, single-tier design: from meter to tower, substantially reducing infrastructure cost.

"We believe our system was chosen because of it's advanced functionality and ability to perform in a variety of rural, urban and suburban environments," said Dan Harness, president of Sensus Metering Systems. "We are eager to start working with the PowerStream AMI team, and we look forward to helping meet the Ontario Government's AMI and Conservation objectives."

For more information, please visit
www.sensus.com or www.PowerStream.ca
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Welcome to the TWACS® Universe of Solutions

TWACS® TECHNOLOGY

TWACS communication technology is truly unique, as it works by modulating the voltage waveform at the zero-crossing point, resulting in a communication system that uses the utility's network at the frequency for which it was designed and built. Data can be transmitted through any transformer or wiring configuration. TWACS technology requires no line conditioning or repeaters, and is not affected by capacitor banks, noise harmonics, feeder switching or underground to overhead transitions.

SYSTEM TECHNOLOGIES

DCSI provides utilities with a true two-way communication system and associated transponder products for advanced metering, Interval Data Retrieval, Dynamic Load Profiling, Time-of-Use data for Critical Peak Pricing, near-instantaneous Outage Verification, Load Control and Management, Power Delivery Quality Monitoring, Prepayment, Remote Hard Disconnect/Reconnect, and Tamper/Leak/Theft Detection. In addition, the TWACS Outage Assessment System (OASys™) is available as well as Short-Hop Radio Frequency (RF) as a solution for reading proximate gas, water and pit-set meters.

ADVANCED APPLICATIONS

TWACS OASys™ technology enables outage discovery, notification of appropriate personnel before the first customer call, system-wide outage assessment and accurate monitoring of restoration progress. TWACS technology enables delivery of vastly increased amounts of interval data at an extremely high rate of speed by fully exploiting parallelism inherent in the electrical grid. Utilities will find that compliance with provisions of the Energy Policy Act (EPACT) of 2005 relating to advanced metering devices can be more easily satisfied with deployment of the TWACS system. TWACS Prepaid Metering technology (PowerStat) enables utilities to offer customers the benefits of a more flexible billing approach, which will serve to provide those customers better means of managing and controlling energy expenses. Gas, water, propane and pit-set metering is enabled by utilizing the Badger Meter ORION® and TWACS technologies. Since TWACS provides two-way communication to, and into, each home and business, opportunities exist for communication-based consumer services, including energy efficiency, billing options, home automation and remote site monitoring.

LOAD CONTROL

TWACS load control and interval data delivery enables a utility to meet Demand Response provisions of the 2005 Energy Policy Act. TWACS multifunctional load control enables utilities to reduce highest-cost peak demand by creating the optimum diversity of deferrable loads without impacting energy sales, resulting in improved load factor. The system avoids creation of new peaks during system automatic load restoration - under system control or upon command. The TWACS load restoration system measures effectiveness by recording whether or not load is on at the time of shed cycle. It also minimizes the impact of inrush current that follows an extended outage by initiating cold load pickup.

COMPATIBILITY

The TWACS system is compatible with most residential and commercial meters including single-phase mechanical meters produced by all major manufacturers, several solid-state electric meters in their native protocols, nearly all water/gas dial encoders, and pulse generators/initiators. TWACS management software communicates with other utility computer systems and substations and is MultiSpeak3™ compliant for billing systems interfacing.

CUSTOMERS

DCSI's customers include ATCO Electric, Bangor Hydro-Electric, Florida Power & Light Co., Idaho Power, PG&E, PPL Electric Utilities, Puerto Rico Public Power Authority, TXU Electric Delivery, Wisconsin Public Service Co., and over 200 electric cooperatives and municipal utilities. PPL's project is the largest two-way advanced metering deployment in North America, and FPL's TWACS Load Management program is the world's largest two-way PLC Load Control project.

SYSTEM EFFICIENCY & INTEGRITY

The cost-effectiveness of the TWACS system is proven by its years of service to a wide range of utility customers. It's two-way communications capability has allowed utilities to leverage their systems with the introduction of new component and software applications without obsoleting existing equipment. The integrity of DCSI's system is an outgrowth of strategic research and development, superior design and production practices, and proactive technical service.

DCSI maintains a strong avenue of communication with TWACS clients via an interactive "customer care" program and an Annual User Group Conference.

Whether the reason to install an automated system is operations efficiency, healthier cash flow, improved customer satisfaction, or the ability to apply multiple value-added services – deploying a TWACS system is an investment in the "future proof" tool for the industry.

DCSI

Distribution Control Systems, Inc. (DCSI) is located in St. Louis, Missouri, and manufactures and markets their Two-Way Automatic Communication System (TWACS®) solutions utilizing power line communications (PLC) technology for utilities deploying automatic meter reading and advanced applications. Over 8 million two-way devices are installed or under contract.

To learn more about TWACS®, call 800-297-2728. Or visit us on the web at www.twacs.com.

A POWERFUL LINE OF THINKING

By Michael A. Marullo, Contributing Editor

Maybe It's a Sign

By the time you read this the holiday season should be in full swing and filled with constant reminders about why you should buy this or that from one company or another. You are probably getting flooded with visual, audible, print and electronic media, all trying to win your favor (and your credit card number) before the shopping frenzy is over for another year. It's a bigger deal than you might think since a lot of retail business may do 50% or more of their business during the last few weeks of the year, virtually making or breaking them.

In the utility industry, about the closest we come to that kind of market intensity is perhaps during the first quarter or so when there seems to be a conference, trade show or other industry event practically every week – or sometimes more than one a week – until late March or early April. And, although it still pales in comparison to the Thanksgiving-Christmas retail run up, there is at least one glaring similarity between these otherwise unrelated periods. That is, they both exhibit behavior characterized by sellers going to extraordinary lengths to impress potential buyers – and how successfully they do it has a huge impact on their future well being.

Sure, we all complain about how commercial it has all become, but don't think for a minute that you aren't being influenced by all the hoopla; you are. Believe me, even if it's only to become more resolute about what you don't want, don't like or refuse to become a part of, you ARE being influenced in one way or another. Right now, however, someone out there is saying, "Oh yeah, well not me!" (And they really believe it too!)

Over the years, I've had quite a few fellow engineers tell me that they are – and I quote: "…way too smart to be influenced by all of that Madison Avenue hype." Too smart, eh? Well, it's true that a lot of consumerism is about being savvy, but definitely not all of it. A big chunk has more to do with being human than it does with your cranial capacity. (The last time I checked, no one was claiming to be either too human or not human enough!) Because we are human, certain things appeal to us, sometimes without our even realizing it. Here's a quick example of this interesting human phenomenon…

The other night we decided we would have pizza for a weekly dinner outing with some friends at a new place that had just recently opened. Being of Italian descent and having had a pizza restaurant in our family for most of my childhood, I'm pretty particular when it comes to pizza. But no one I knew had ever been to this place, so I really had no idea what to expect. Besides that, it was located across from a shopping center in a dingy little strip mall with mostly service outlets and other fairly nondescript businesses. So, why did I go there? I'll get to that in a minute.

First, I want to tell you that this joint has the best pizza in New Orleans, hands down. Besides that, the place is squeaky clean; the salads are crisp and fresh; the service is prompt and courteous; and the prices are very reasonable. We had a great dinner and everyone agreed that we would go back there again soon and often. But you're probably dying to know by now what got us there in the first place, right? Very simple: their sign. As we were leaving the mall one evening a week earlier we noticed that one end of the otherwise tired, mostly run down, little shopping center across the street had a bright and colorful new look.

Indeed, you would have to be blind to miss the visually appealing red, green, purple and yellow neon sign proclaiming their arrival. Despite feeling a little foolish to be sucked in by a sign, that's why we went there – the first time, that is. But that sign spoke volumes about the place: Clean. Crisp. New. Bright. Quality. Why quality, you might wonder? Because the sign was bigger, brighter and way more expensive than it needed to be just to make us aware it was there. I figured (rightly or wrongly) that anyone who would put that much into their sign would almost certainly have a plan to deliver on all that sign seemed to promise!

In any case, we've been back several times already and told a lot of our friends about it too. Last night, we were there again and soon struck up a conversation with the folks at the table next to us, who were pondering what to order. We told them the pizza was fantastic, which seemed to give them the confidence they needed to go ahead and order. As we were waiting for our food to arrive, we made small talk (which

these days always involves discussing how everyone managed in Katrina!), and eventually the conversation came around to why they chose this particular place.

Finally, somewhat sheepishly, they admitted that it was – you guessed it – the sign! We laughed about how we had both been seduced by this glass, gas and electric creation that was so appealing we just couldn't resist seeing if the promise would be delivered. At that point I looked around and couldn't help but wonder how many other guests were there for the same reason. Now, I'll attempt to put this all in context for you (if you haven't already figured it out).

Wouldn't you hate to miss out on attracting a key customer's attention because your booth wasn't as appealing or perhaps your ad wasn't as inviting as your competitor's? Wouldn't you be disappointed to find out that the substation equipment you just spent a fortune on and waited a year to get could have been supplied by someone else faster and cheaper and with a better performance result if only you'd known about them? Wouldn't it be a shame if you and/or your colleagues never found out that there was a better way to communicate work orders to the field and track them in real time because you/they decided that there's never anything new at a trade show that might be worth checking out? I could go on, but you I think get the picture.

Sure, it's easy to sit back and do your Christmas shopping at a few familiar sites on the Web or make a call to your favorite catalog store (hey, how about fruitcakes for everyone?!). And, it's just as easy to assume that no one will ever build a better mousetrap and that there's nothing new or innovative that you won't find out about from your current inner circle of suppliers. Well, you know what they say about ASSUME: it makes an ASS out of U and ME.

New and different isn't always better or cheaper… and bigger, brighter and fancier don't always lead to quality or value, but how will you know if you sequester yourself in a cocoon of familiarity? So, the next time you see an intriguing advertisement or have an opportunity to attend a conference, don't limit your horizons by focusing all of your attention on preserving the status quo. Who knows… maybe it's a sign.

Happy Holidays, y'all,

- Mike ■

PS Should your travels happen to bring you to the New Orleans area this holiday season or in the new year, send me an email, and I'll be happy to clue you in on this place – the pizza is truly awesome!

Behind the Byline

Mike Marullo has been active in the automation, controls and instrumentation field for more than 35 years and is a widely published author of numerous technical articles, industry directories and market research reports. An independent consultant since 1984, he is President and Director of Research & Consulting for InfoNetrix LLC, a New Orleans-based market intelligence firm focused on Utility Automation and IT markets. Inquiries or comments about this column may be directed to Mike at MAM@InfoNetrix.com.

Outage Management from the Field

How Mobile Workforce Management Tools Increase Customer Satisfaction and Improve Internal Processes

By: Tim Kesler, Technical Advisor, Dominion, Michael Hearney, VP Sales and Business Development, Waterfield Technologies and Janet Mushrush, Director of Utility Sales, Twenty First Century Communications

POWER OUTAGES

In an environment of increasingly longer and more devastating storm seasons, customer service demands placed on utility companies have grown exponentially.

As a result of several major storms over the past ten years, especially the 2004 and 2005 hurricane seasons, utility end-users including many critical care customers have been without power for extended periods of time. In events such as these, communication and information from the utility are essential and expected aspects of customer service.

3.5 million people lost power in the 1998 ice storm that hit Southern Quebec and Maine. The Northeast Blackout of 2003, the largest in North American history, affected an estimated 10 million people in Ontario and 40 million people in eight U.S. states. Ice storms in December 2004 knocked out power to approximately 350,000 people in Ohio and nearby areas, leaving 20,000 central Ohioans in the dark for eight days. During the 2004 hurricane season 8.5 million households lost electricity. The 2005 season brought record devastation. During the height of hurricane Dennis, 680,000 customers were without electricity in four southern states. Throughout the season, power outages struck nearly 98 percent of Southern Florida.

THE CUSTOMER EXPERIENCE

What the industry rates "top-drawer" or "excellent" customer care can still be miles behind a growing – sometimes exponentially growing – customer expectation. Consumers want certain assurances, not only that their utility is aware of their outage, but they also want to be informed of the cause. They need to know that someone is working on the problem, and they also expect information regarding repair progress and estimated restoration time.

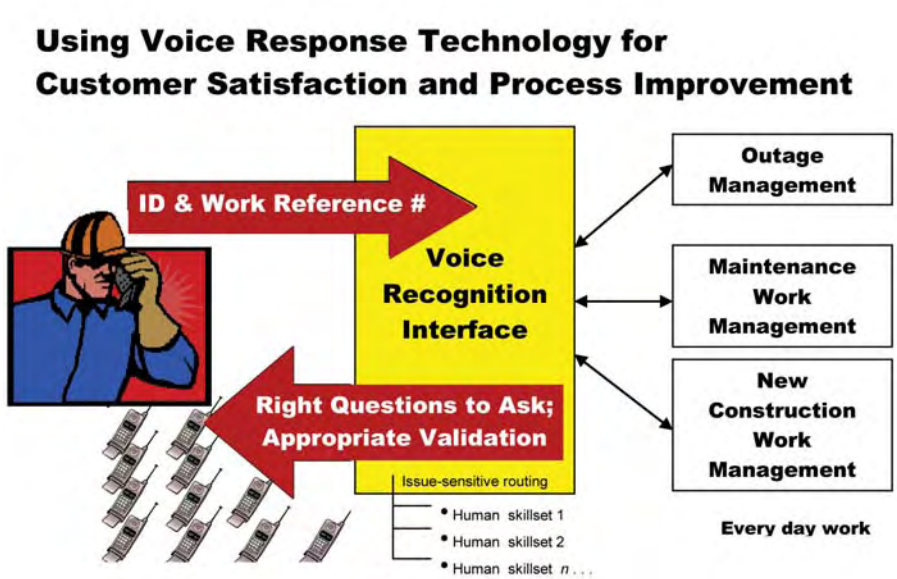
TRADITIONAL TOOLS

The traditional set of tools to manage outages and communicate with customers include the Call Center which deflects calls away from the dispatchers; automation such as Interactive Voice Response (IVR) and High Volume Call Answering (HVCA®) which deflect calls away from call centers; and Outage Management Systems (OMS) to provide information to call centers and IVR/ HVCA® solutions to keep them from calling the dispatcher.

However, notwithstanding the sophistication of many of these systems, there is a critical disconnect: lack of real-time information from the field leads to significant problems. OMS provides system-generated updates based on historical (rather than actual) data; or it provides daily (or every other day) updates. This leads to stale information provided to customers via the IVR/ HVCA® solution, causing customers to prompt-out to a customer service representative whose information is no better. This cycle increases call volume from frustrated customers who repeatedly call back for information – and generally become more unhappy after each interaction with the utility.

This is an old problem, for which various solutions have been tried, from storm rooms to operations coordination centers, to closing hubs. At the end of the day, though, there is no substitute for real-time information from the field.

The Mobile Data Terminal, or MDT does allow for outage and other job tickets to be updated in real time from the field. Unfortunately it presents several challenges. Some training is required. Not all crews are equipped with them. And they do not solve the problem of communicating with mutual aid crews, outside contractors, tree crews, and other workers, especially during a major event.



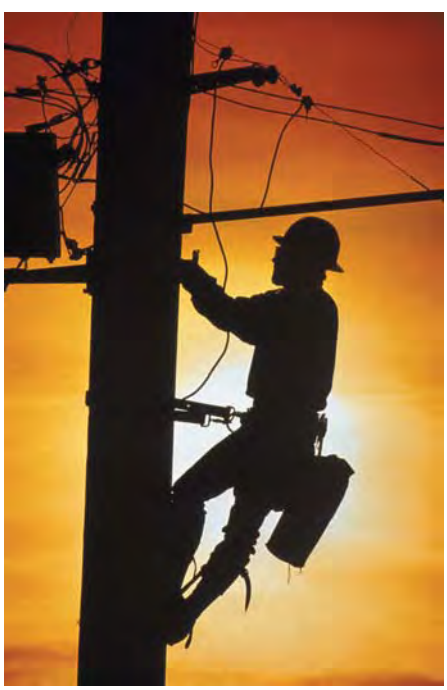
DOMINION'S EXPERIENCE

Dominion is one of the nation's largest producers of energy, manufacturing close to 6.3 trillion cubic feet of proved gas and oil reserves and approximately 28,100 MW of electric generation. It serves 4 million franchise gas and electric delivery customers in 5 states and 1.2 million unregulated retail energy customers in 9 states.

One of Dominion's greatest challenges was retrieving critical information from the field in a timely manner in order to provide progress reports during a storm, update its customers, validate today's jobs, and plan tomorrow's work.

There were several issues that needed resolution. Work crews were having trouble getting through when calling in to complete work. There were both busy signals and office-staffing challenges. Often there were thousands of jobs to close, and these numbers increased by the hundreds during storms.

This contributed to untimely reporting. Throughout the day, even though work was completed, some work progression was going undocumented. This resulted in a lack of information available to the utility for planning, and poor information provided to customers. Frequently crews would delay reporting until the end of their shifts, causing a "big thud" at day's end.



In addition, very poor or no job closing documentation after-the-fact became a significant handicap against long-term improvement.

To resolve these issues Dominion considered in-house systems with diverse and complicated job-closing requirements. Ultimately it was not reasonable to fund the specialized equipment necessary for everyone to interface with these systems, particularly off-system contractors and mutual aid crews.

Work crews responding to outages and downed lines needed to be able to call in without receiving a busy signal. Members of mutual aid crews, regardless of equipment type, needed to be able to connect with Dominion to report job status and receive assignments. And demands on call center staff need to be alleviated.

Immediate data collection and real time reporting were also necessities so the utility did not have to wait until an end of shift -- or even after an event -- to analyze performance and customer service.

For typical day-to-day work management, the utility also needed a simple, non-hardware solution to progress work from one status to the next; so that once a job was complete the next team could be dispatched to perform follow-up work.

The need was for Voice Recognition capability that could handle the call volumes that occur during storms, ask the questions and document the required responses, and relieve the pressure on the office staff by allowing routing to the right skill set for exceptions. Dominion needed technology that provided the above with just a standard phone.

THE SOLUTION

After evaluating its options, Dominion chose a Voice Recognition Mobile Workforce Management System called Field Connect, developed by Twenty First Century Communications and Waterfield Technologies. It is a fully hosted, automated job tracking system that uses the latest in advanced speech technology and direct real-time interface to allow field personnel to report job status quickly, easily and immediately, simply by speaking into their phones.

In order to use the system, field personnel simply call in and identify themselves. They speak which work order they want to close, and the system takes it from there. The system asks the questions to be answered for the type of work reported, prompting proper responses when appropriate and passively confirming responses as the conversation moves along.

CLOSING THE LOOP

Dominion's system integrates with the utility's existing architecture, allowing all field personnel (utility crews, mutual aid, and contractors) to update Outage Management, Work Management, and Customer Information Systems by using their voice and a phone.

Key for Dominion is the ability to use its mobile workforce management product over multiple systems within the company. Outage management and day-to-day work management exist on different platforms within the utility. The tool transparently communicates with multiple systems (Validation, Scheduled and Emergency work). Additionally, multiple jobs of multiple types can be reported within the same call.

A joint presentation on Outage Management from the Field was given by Tim Kesler (Technical Advisor, Dominion) and Michael Hearney (VP Sales and Business Development, Waterfield Technologies) at the Chartwell's 9th Annual Energy Marketing & Customer Service Conference & Expo (EMACS) on October 4th. Kesler and Hearney shared key points from Dominion's Voice-Recognition-in-the-Field Experience:

- Find a good partner.
- Talk early and often. Stay on the same page.
- Be prepared for shifts of business and process focus along the way. Stay flexible.
- Have an Acceptance Strategy. Know your culture.
- Allow for courteous responders ("yes, ma'am").
- Incorporate local jargon/familiar terms as also-acceptable.
- Make voice recognition available to all crews; all approved contractors for every day work.
- Have the system recognize by work order # what type of work, what questions to answer and what choices to present.
- Use intelligent fail-out points to direct any issues to the persons best skilled to handle them.

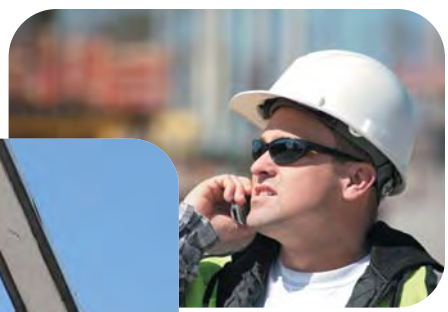
Tim Kesler and Janet Mushrush, Director of Utility Sales, Twenty First Century Communications, will give a second presentation at the 6th Annual Outage Management Solutions Conference, "Capitalizing on Operational, Customer Focused and Cost Competitive Outage Management Solutions," November 28-30, 2006 at the New Orleans Marriott at the Convention Center.

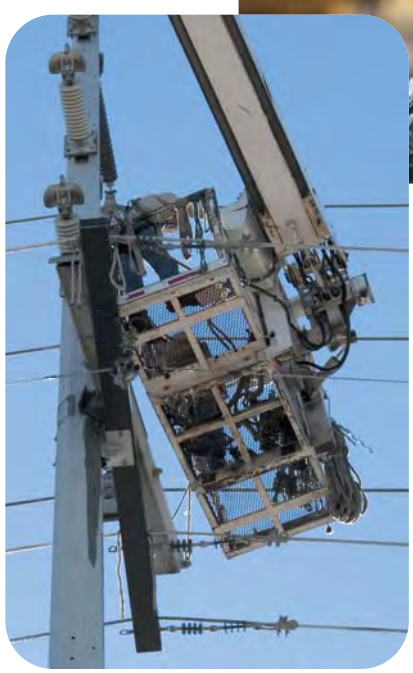
With a work management system in place, hundreds, even thousands of contractors can update an outage management system, one which has unique edits and requirements for job completion, using a tool as simple as a cell phone. Work progress and completion can be reported every day.

THE RESULTS

The Voice Recognition Mobile Workforce Management System allows both Dominion's teams and mutual aid crews to communicate via cell phone, so incompatible radio systems or mobile data terminals are no longer an issue. Advanced Speech Recognition eliminates the communication bottlenecks that occurred while field crews were waiting to reach a customer service representative. The system takes the burden off both dispatch and customer service staff.

Progress reporting through the day is a critical barometer during storms -- both for validating today's plan and for projections beyond today. Analysis without a thorough picture of events doesn't tell the whole story. Field Connect's real time interface provides immediate reporting and allows for improved in-day and post-storm analysis, actually filling in data gaps through automation. The result is work completions throughout the day with a reduced office staff, yet more complete outage reporting.





Utilities need the resources to continue to meet their customer commitments during a storm. Utilities can't just 'wait and hope,' -- they have to 'know now and adjust.' Real-time reporting through this tool provides a mechanism for that.

"Our Voice Recognition Work Management System is another tool in our toolbox for providing customers with information that lets them plan their lives. We are positioned now to turn busy signals and field frustration into valuable information for ourselves and our customers."

-- Tim Kesler, Technical Advisor, Dominion

By using integrated tools that connect their key systems, utilities can position themselves to meet increasing customer service demands – providing best in class service every day, and most importantly, during major disasters. ■

About the Authors

Tim Kesler, Technical Advisor, Dominion

Tim Kesler has worked with Dominion for nineteen years in various Emergency Preparedness capacities at the local, regional, and system levels. Recent projects within Dominion include deployment of an electronic damage collection tool and assessment process and an on-going effort to transform Dominion from semi-mobile to a fully mobile, technologically integrated workforce. Tim has served as Dominion's Mutual Assistance liaison since the late '90s and is the current Chairperson for the Southeastern Electric Exchange (SEE) Mutual Assistance Committee.

www.dominion.com

Michael Hearney, VP Sales and Business Development, Waterfield Technologies

As VP, Sales and Business Development, Michael is responsible for all sales, marketing and partnership activities for Waterfield Technologies (WT). Michael brings considerable customer service and utilities experience to WT, having previously co-founded and managed a consulting company focused on advising utilities on call center and customer service operations. Michael has also led marketing and business development activities for leading call center, business process and voice technology companies such as Altitude Software, Categoric Software and MobileAria. Earlier in his career, Michael worked for Pacific Gas and Electric Company in a variety of customer service and operations management roles.

www.waterfieldtechnologies.com

Janet Mushrush, Director of Utility Sales, Twenty First Century Communications

Janet Mushrush has been with Twenty First Century Communications, Inc. (TFCC) for the past 9 years. Her early experience as a Project/Client Manager provided her with an in depth knowledge of the inner workings of both TFCC and client utilities and enabled her to transition easily to her current position of Director of Utility Sales. She is now responsible for generating new business in the electric utility markets in the US and Canada. She also functions as primary client liaison for over 80 of the company's existing utility clients and works with them to identify new opportunities to expand TFCC's offerings.

www.tfcci.com

Conquering Advanced Metering Cost and Risk

By: Guerry Waters, Chief Technology Officer & Senior Vice President, Marketing and Strategy, SPL WorldGroup

THE PAST YEAR HAS SEEN A DRAMATIC CHANGE IN THE METERING MARKET.

Previously, utilities faced questions about cost-justifying Automated Meter Reading (AMR)—projects that reduced personnel and insurance costs by substituting drive-by or other data gathering devices for human meter readers.

Today, discussion is all about Advanced Metering Infrastructure (AMI). How quickly should utilities move forward with systems that combine time-of-use or interval meters with two-way communications, large-scale repositories, and new data management approaches? Will AMI live up to its promises to increase significantly the accuracy of load forecasting and management, extend demand/response programs to new audiences, improve outage response, and cut field workforce costs?

And how should utilities with existing AMR projects—or near-term plans to implement them—respond to this relatively sudden change in the landscape?

One prudent step is to weigh the costs of AMR and its benefits against a careful and realistic business case for moving ahead into more advanced AMI. (For a discussion of approaches to business case development, see "Coping with Smart Metering Uncertainties " in the September/October issue.)

Equally important is assessing the two major risks that lie clearly outside the utility's current knowledge and control:

- The risk that AMI technology may not be mature enough to make a significant investment appear prudent over the time period during which it is amortized.
- The risk that AMI programs cost-justified in part on anticipated consumer or business community behavior that may not occur. If cost justification relies, for instance, on consumer participation in demand-response programs or on the development of third-party energy efficiency and management services, might utilities be subjected to regulatory criticism and cost disallowances if that behavior is other than anticipated?

This article explores these risks and suggests ways that utilities might be able to minimize them while still preparing to capture AMI's many benefits for their stakeholders.

TECHNOLOGY RISK

Let's take the technology dilemma first.

Advanced metering, with customer-site costs in the range of US$ 1,000 or more, has long been a viable and cost-effective approach for large commercial and industrial establishments. It has fostered the development and dissemination of equipment like chillers that use off-peak energy for on-peak consumption. It has encouraged the growth of distributed energy. And it has enabled states like New York to establish day-ahead hourly pricing programs to ensure that the bills of the state's largest electricity users reflect actual costs.

Interval meters for residential consumers are a more recent phenomenon, made possible in part by the remarkable drop in metering technology costs—now frequently cited at US$ 150[1] or less. Further price drops are almost universally predicted. But exactly how low will they go? Some predict a 50 percent drop within the next year.

There is a danger in committing too early to today's technology. "Policy is now catching up with technology maturity," Gartner's Zarko Sumic and James Spiers noted in a presentation last September; "however, if pushed too far, it could force premature technology choices that may prove to be inefficient and ineffective for future applications and consumer welfare." They further stated, "Betting too early can lock into technology that will not serve future requirements."

Meter technology is not the only element subject to change. Software and communications vendors are scrambling to introduce new product variants that respond to the growing AMI marketplace. Products are being reintroduced with "smart metering" labels. North American and international standards[2] are emerging. Meter retrofits are being hailed as a salvation by some, pooh-poohed by others. Every week brings announcements of new advanced-metering alliances among hardware, software, and communications companies.

Product stability is not the only issue. As AMR guru Howard Scott warned last year, "[I]t is reasonable to assume that the number of auto¬mated metering vendors will shrink."[2]

Scott also warns that product footprints may change rapidly. Why, he asks, should vendors "produce multiple software packages that then need to be supported? Isn't it more efficient to build one common software package that might serve electric, gas and water AMR, and differentiate the services within the software? ... Is it a huge leap to imagine that AMR, prepay metering and subme¬tering might also be supported by the same software packages? Won't the same be true for components on circuit boards?"[3]

How best can utilities make prudent purchasing decisions given the speed and extent of current change?

THE REGULATORY DILEMMA

While the technology dilemma is a concern for all types of utilities, the regulatory dilemma is a far greater issue for electric utilities than for gas or water. That is because:

- AMI for electric utilities is far more likely to involve the most expensive form of metering—interval—for residential consumers.

[1] U.S. Federal Energy Regulatory Commission, Assessment of Demand Response and Advanced Metering, August 2006, p. 34.
[2] ANSI, for instance, is issuing C.12-22.20XX to standardize the application layer for network communications so that any physical communications medium can transport standard meter data tables.
[3] Howard A. Scott, Cognyst Consulting, "Automatic Metering is About to Undergo Explosive Growth," EnergyBiz Magazine, September/October 2005. http://www.cognyst.com/biblio/scott05eb.pdf.

- Interval metering for residentials is frequently cost-justified, at least in part, on the basis of consumers' participation in demand-response programs.[4]
- While analyses and pilot programs have been, in the words of many, "promising," there is no certainty about consumer response to long-term programs that require them to pay frequent attention to electricity prices or invest in equipment that responds to utility-generated pricing signals.

And utilities going down the residential demand-response path are caught between two distasteful possibilities:

- The program may fail, subjecting all who advocated it to criticism and possible disallowances in cost recovery.
- The program may succeed in shifting demand to lower-cost time slots or (and this is a frequent result in pilot programs) reducing demand overall. And as FERC states baldly, "Reductions in customer demand reduce utility revenue."

FERC does not refer to this problem as "Catch 22." But it does state unequivocally, "Without regulatory incentives such as rate decoupling or similar incentives, electric utilities lack an incentive to use or support demand response."[5]

INTERIM APPROACHES NEEDED

Clearly, most utilities want to address the potential advanced metering needs of all customers. Few want to risk getting seriously behind the technology-adoption curve. Yet they face an equally strong imperative to guard against financial exposure that could well be deemed imprudent.

Here are some possibilities for determining the best course of action.

Option 1: Bracket Problems with Specific Advanced Metering Solutions

Advanced metering discussions frequently lump all benefits together and end up calling for full deployment of the most sophisticated meters and networks. That may not be necessary. If your problem is outage response or preventing unnecessary truck rolls in response to consumer outage complaints, do you need interval meters, or could you solve your problem by retrofitting existing meters so that they can be "pinged" to determine whether they are on or off?

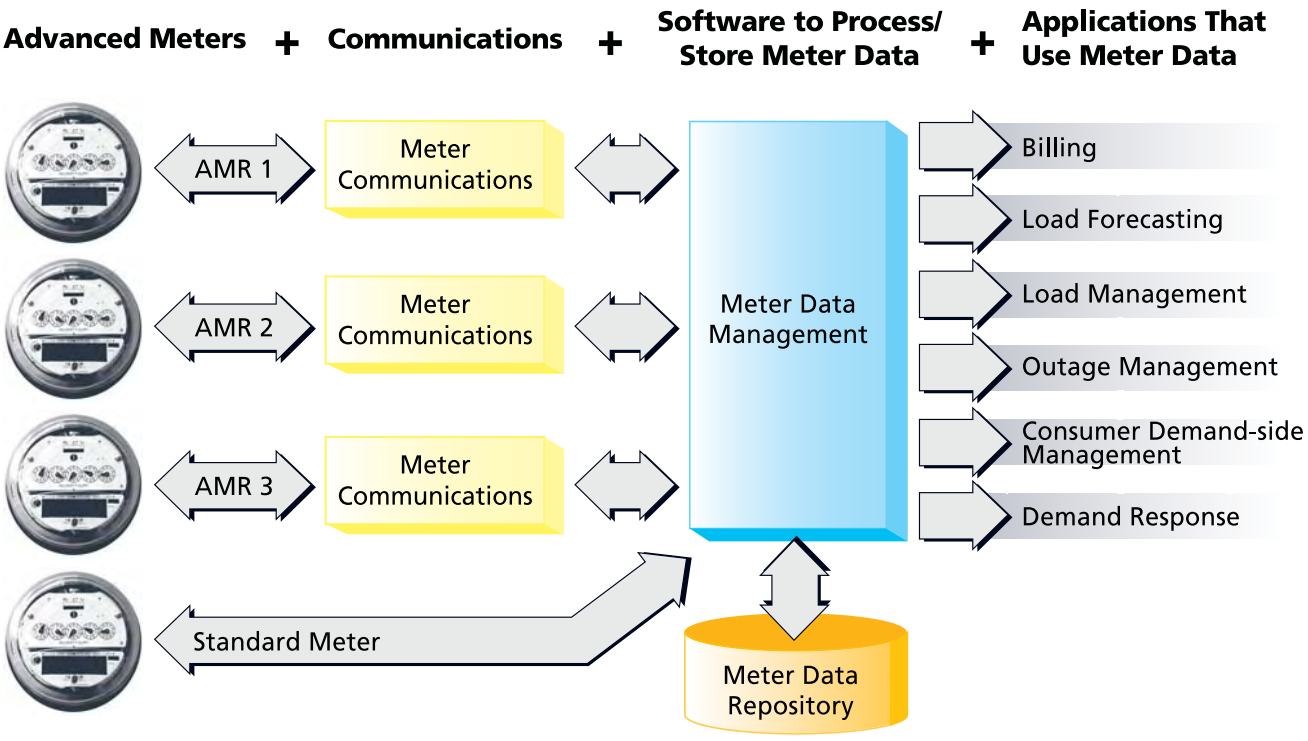
Option 2: Solicit Alternatives

Full-scale metering hardware and software replacements may not be the only solution for some advanced metering objectives. If you are trying to prevent unnecessary truck rolls, for instance, might you instead charge individual consumers for their cost? That's a solution many gas utilities adopted in the wake of false alarms from householder-installed carbon monoxide detectors.

[4] The other cost justification is load and grid analysis and forecasting. There has been little attempt thus far, however, to make the case that the analysis available from residential interval meter data justifies the hardware and software cost differential between interval and time-of-use or even single-read meters.

[5] Both quotes are from U.S. Federal Energy Regulatory Commission, Assessment of Demand Response and Advanced Metering, August 2006, p. xi.

Fig. #1: Advanced metering systems involve a range of hardware and software to facilitate cross-organizational processes involving meter data.



Alternatives are important if you are considering the most expensive parts of advanced metering, such as residential interval billing as a way to reduce peak electricity demand. Before you spend millions on this technology—and confront consumers with unpleasant alternatives costing millions more—you might try alternatives like:

- Time-of-use billing with time/rate relationships that remain constant for a year or more, giving consumers opportunities to make time-shifting a habit.
- Urging customers to use the time-shifting features on their appliances as a contribution to the environment. Most consumers have no idea that electricity goes to waste at night. Keeping emissions out of the air and transmission towers out of the landscape could be far more compelling to many consumers than a relatively small saving[6] resulting from an on- and off-peak pricing differential.
- Month-to-month rate variability. One study found that approximately a third of the efficiency gains from real-time interval pricing can be captured by simply varying the flat retail rates monthly—and at no additional cost for metering.[7] While a third of the efficiency gains might not be enough to attain long-term goals, they might be enough to fill in a shorter-term deficit, permitting technology costs and regulatory climates to stabilize before decisions must be made.
- Multi-tier pricing based on consumption. Today, two-tier pricing is common.[8] Three or four tiers might better capture the attention of those whose consumption is particularly high—owners of large homes and pool heaters, for instance—without burdening those at the lower end of the economic ladder. Tiers plus exception handling for hardships like high-consuming medical equipment would almost certainly be less difficult and expensive than universal interval metering.

Option 3: Time-Line Demand Increases

Given population growth—in both people and in energy-using equipment—virtually all utilities face an eventual need to enlarge distribution networks and build or contract with additional sources of energy. But the timing of such shortages varies. If in your particular situation there is little chance of shortage before 2015, there is little point in putting solutions in place by 2010.

Option 4: Embrace Amortization

Automated Meter Reading (AMR) has been around for two decades. And after a slow start, penetration levels have risen to almost 25 percent in the U.S.

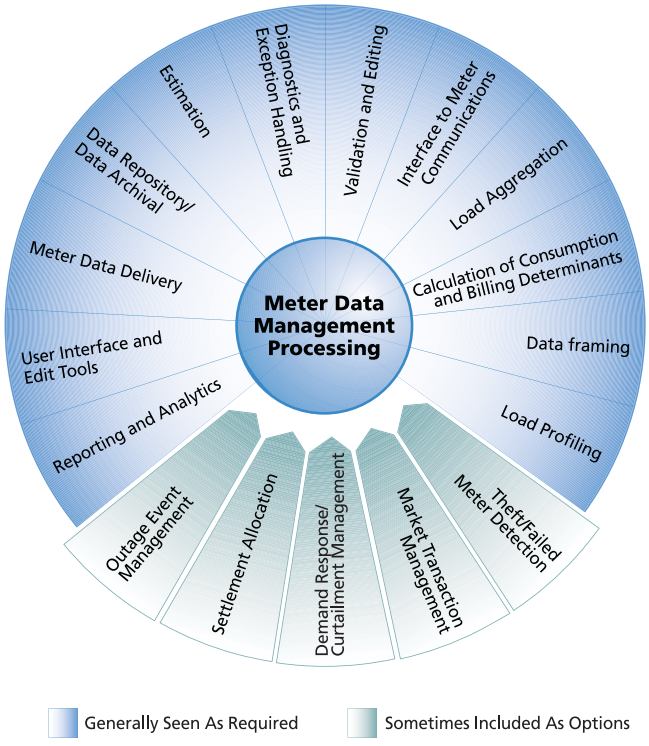
The vast majority of those meters are relatively simple devices, such as those that permit monthly "drive-by" readings. But increasingly the AMR base includes substantial numbers of meters that report daily reads, time-of-use reads, and sometimes voltage. Two-way communications systems that enable remote disconnect and meter "pinging" for outage detection are on the rise.

[6] Patti Harper-Slaboszewicz, for instance, benchmarks the amount a customer might realize from time shifting as 32 cents per month. ("AMR Business Cases Stronger with MDM and DR," UtiliPoint, 9/28/2005, http://amimdm.com/site/modules/articles-7/index.php?id=9.)

[7] Holland and Mansur, "The Distributional and Environmental Effects of Time-Varying Prices in Competitive Electricity Markets." Results published in "If RTP Is So Great, Why Don't We See More Of It?" Center for the Study of Energy Markets Research Review, University of California Energy Institute, Spring 2006. Available at http://www.ucei.berkeley.edu/.

[8] That is, a lower rate for the first few hundred kilowatt-hours per month and a higher rate for additional hours.

Fig. #2: Vendors define meter data management in different ways, but most see meter data management processing as the heart of the system. MDM systems generally include these core components--either in the product itself or through close partnerships with other vendors--in addition to a number of optional elements.



Given the rise in AMR shipments in the years since 2000, it would appear that most systems now in use are not fully amortized.[9] Few CFOs want to replace them before the anticipated end of their lifecycle. Should regulators demand residential interval metering before the end of that amortization, investor-owned utilities will have a reason to apply for stranded cost consideration. Similarly, the boards of cooperatives or the city councils that oversee municipal utilities will have to take stranded costs into consideration as part of the business case for an early move to interval metering.

Amortization periods do not, however, stretch indefinitely into the future. The end of amortization provides a convenient date by which time a utility may want to have an advanced metering plan in place.

Option 5: Adjust Software Plans to Encompass Meter Data Management

No matter what steps you take toward advanced metering, you are almost certain to generate significantly larger volumes of data.[10] You may also generate different types of data, such as voltage and outage information. Additionally, larger amounts of data will produce new demands for use by load analysts, asset managers, regulators addressing regional planning, conservation experts, and the like.

Typically, utilities keep today's meter data in the billing system. And if the system is highly scalable, that can work even when data volumes mount. But eventually, most IT analysts predict that utilities will want to move metering data and inquiries out of the billing system—where increased use has the potential to slow billing production—and into a separate meter data management application *(see Fig. #1)*.

Meter data management provides an easy pathway between data and the multiple applications and departments that need it. It can more easily consolidate and integrate data from multiple meter types. It can reduce the cost of building and maintaining application interfaces. And it provides a place to store and use data whose flow into the system cannot be regulated, such as the flood of almost simultaneous messages from tens of thousands of meters sending a "last gasp" during a major outage.

For most utilities, the move to meter data management does not have to be precipitous. It can be timed to coincide with upgrades to other applications. It is probably easiest to accommodate after the utility's advanced metering objectives are established, so that the correct functionality will be available *(see Fig. #2)* but before a major meter change-out takes place.

CONCLUSION

The advent of affordable advanced metering confronts utilities with costs and opportunities unanticipated even three or four years ago. But unless your provincial or state electricity system is reaching a crisis—as it is in a few areas—there is time to study the alternatives and evaluate the experience of the early adopters.

Establish a study group. Discuss the situation with those overseeing your direction—regulators, city councils, members of your cooperative. Provide the public with realistic estimates of the size and solution to problems presented by growing energy demand. Propose timetables. Then work carefully through the alternatives presented by meter and application vendors.

Matching real issues with workable alternatives is your best protection against the risk that the "bleeding edge" of advanced metering may prove, after all, to be a solution in search of a problem. ■

About the Author

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[9] Extrapolations from shipment data in The Scott Report indicate that less than a third of total AMR shipments took place prior to 2000.

[10] Moving from monthly to hourly billing, for instance, increases data reads from 12 to 8,760—a 730-fold increase.

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AN OVERVIEW OF ASYMMETRIC OPERATION OF AC TRANSMISSION SYSTEMS

1 INTRODUCTION

Existing AC transmission systems are operated with three physically distinct systems of conductors referred to as "phases", where sinusoidal voltages and currents in each are offset with respect to each other to exploit Nicolas Tesla's invention of the three-phase alternating-current (AC) generator and motor. A key characteristic is that they are symmetrically operated: if any problem develops on one or more phases, all three are taken out of service. Traditionally, this has been done to avoid the generation of harmful load voltages and currents which can occur when asymmetrical conditions arise.

1.1 SYMMETRIC OPERATION OF POWER TRANSMISSION SYSTEMS

When a fault occurs on either one, two or three phases of a transmission line, circuit breakers at both ends remove all three phases from operation until subsequent human intervention has resolved the situation. This strategy has significant disadvantages:

1. operating the three phases as a single organic whole increases the probability of transmission loss: any one phase affects the operation of the other two;
2. a problem with 33% of a three-phase line (the most frequent occurrence) results in the loss of 100% of its capacity;
3. after the fault is cleared, system operators must apply remedial measures, such as modifying generation to redirect power flows so that the system can sustain further contingencies: this exposes operations to potential human error and higher risk.

All of these issues influenced the Northeast U. S. and Canada blackout of August 2003 in one way or another (1).

1.2 ASYMMETRIC OPERATION OF POWER TRANSMISSION SYSTEMS

Asymmetric operation is defined as the operation of a three-phase transmission line as three independently-operated entities (2). When fault conditions occur, a three-phase line is operated with one or two phases out of service for single-line transmission corridors, or with one, two, or three phases out of service in the case of multiple-line corridors. However, to do so requires achieving three operational objectives:

a) the faulted corridor appears to operate symmetrically at both extremities;

b) the faulted corridor returns to its pre-contingency electrical state (i.e. impedances, voltages, currents, and power transfer);

c) undesirable voltages and currents are "contained" within the faulted corridor.

Since the post-contingency system is electrically identical to its pre-contingency state, there is no need for immediate operator post-fault remedial measures: they are "built-in" to the strategy (though local intervention is still required to rectify the fault condition)!

For this to occur, compensating equipment must be introduced while the faulted phase(s) is(are) switched out by means of circuit breakers. Such equipment can either be conventional, inexpensive passive devices, such as capacitors and reactors equipped with appropriate switching equipment, or more complex, rapid and expensive power-electronic devices such as Flexible AC Transmission System (FACTS) controllers (7,8). Both approaches have their strengths and weaknesses, and the final choice will depend on system-specific constraints imposed by the system planner.

2 BENEFIT OF ASYMMETRIC OPERATION

2.1 STATISTICS OF TRANSMISSION LINE FAILURES

Most transmission line faults are single-phase (varying from 60% to 97% with increasing voltage level (3,4,6)). However, the three-phase fault – often used concurrently with the subsequent loss of major transmission equipment - has long been the industry norm for establishing system performance under difficult conditions (9), even though three-phase faults have no more than a 1% probability of occurrence. Clearly, the three-phase fault criterion is limited in terms of physical significance, and one can argue that a symmetrical three-phase response is inappropriate up to 97% of the time, depending on voltage. In the past, this criterion served a useful purpose as an umbrella contingency, accounting for lack of knowledge of either operating context or system dynamics. However, asymmetric operation enables power systems to respond surgically to contingencies while maintaining symmetrical capability when required.

2.2 RELIABILITY ANALYSIS

The most frequently used reliability index in transmission planning is the Loss of Load Expectation *(LOLE)*, which is the expected mean of energy not supplied due to the failure of network components (5), quantified in either energy units or dollars. *LOLE* therefore measures risk. Here, the *LOLE* is used to compare the risk of operating a single- or multiple-line transmission corridor either symmetrically, or asymmetrically.

Fig. 1 shows the logic circuits for the reliability analysis of a three-phase transmission line under each type of operation. In the symmetrical approach, events leading to the loss of any one phase result in the loss of all three phases. In the asymmetrical approach, the three phases function independently.

Consider a corridor of N three-phase lines transmitting a total power value of T, where the probability of successful transmission of each phase is p. According to (2), the expected mean non-transmitted power under symmetric operation $LOLE_{sym}$ and the expected mean non-transmitted power under asymmetric operation $LOLE_{asym}$ are:

$$LOLE_{sym} = f_{ch}T(1-p^3)$$
$$LOLE_{asym} = f_{ch}T(1-p)^3 \quad [1]$$

where f_{ch} is a load factor which takes average load variations into account. An arbitrary load factor between 50% and 75% is typically acceptable.

The difference between the $LOLE$ of symmetric and that of asymmetric operation yields the benefit of asymmetric operation which can be evaluated at the energy generation cost:

$$LOLE_{sym} - LOLE_{asym} = \left[(1-p^3) - (1-p)^3\right] f_{ch}T = 3p(1-p)\,f_{ch}T \quad [2]$$

Clearly, equation [2] is always greater than zero for $0 < p < 1$: this means that the risk is always higher under symmetric operation.

Example 1: Asymmetric Operation of a Two-Line 400 kV, 300 km Corridor

The probability of non-transmission can be evaluated as 0.133% per 100 km of line (6). For each phase with an equivalent length of 300 km, one has : $q = 0.004$ and $p = 0.996$. The benefit of asymmetric operation is obtained from equation [2] as: $\Delta LOLE = 0.01195\ f_{ch}\ T$. Assuming a generation cost of 2500 $/kW and a load factor of 75%, the benefit of the asymmetric approach over the symmetric approach is approximately 23 $/kW.

3 IMPLEMENTATION

Two cases must be considered for implementing asymmetric operation: a) the multiple-line corridor and b) the single-line corridor. The following sections focus on the use of conventional devices due to their lower cost.

3.1 MULTIPLE-LINE CORRIDOR

A lossless, uncoupled, lumped-parameter transmission line model is used as a starting point: this simplifies the analysis while leading to a reasonable estimate of the capacity and cost of the compensating equipment.

Compensating Impedances

Consider a corridor of N lines with L individual a_i-phases out of service (for $N \geq 2$). The problem is to determine the conditions for which the power transmitted on N a_i-phases in symmetric mode is equal to that of N-L compensated remaining a_i-phases in asymmetric mode.

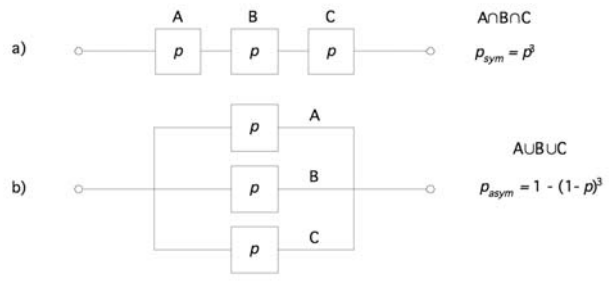

Fig. 1: Equivalent logic circuits of a three-phase line under : a) symmetric operation; b) asymmetric operation

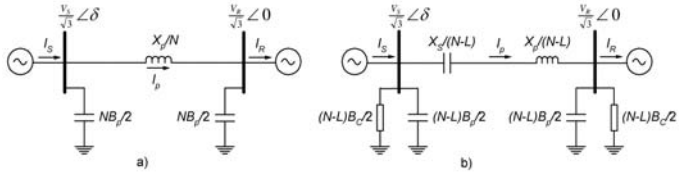

Fig. 2: Equivalent circuit of one phase of a corridor in symmetric and asymmetric operation: a) Corridor A-phase in symmetric operation, consisting of N individual ai-phases; b) Corridor A-phase in asymmetric operation, consisting of N-L individual ai-phases

Fig. 2a) shows the equivalent circuit for N parallel a_i-phases operated symmetrically. V_S and V_R are respectively the line-to-line rms voltages of the sending and the receiving ends, and X_p and B_p are respectively the series impedance and the shunt susceptance of each a_i-phase. With L a_i-phases out of service, the equivalent circuit is shown in **Fig. 2b)**. X_s and B_C are, respectively, the series impedance and the shunt susceptance of the compensating devices for each a_i-phase, defined as follows:

$$X_S = -\frac{L}{N}X_p$$
$$B_C = \frac{L}{N-L}B_p \quad [3]$$

With these compensating elements, the asymmetrically-operated compensated corridor A-phase with L open a_i-phases has the same electrical characteristics and carries the same power as the symmetrically-operated corridor A-phase with N operational a_i-phases.

Installed Reactive Power

The total installed reactive power for series compensation $Q_{Tseries}$ is calculated assuming that series-connected reactive power is available to every phase of every line. The total installed series reactive power in the $3N$ phases of the corridor is:

$$Q_{Tseries} = 3NX_S\left(\frac{I_p}{N-L}\right)^2 = -3\frac{L}{(N-L)^2}X_p I_p^2 \quad [4]$$

where I_p is the rms value of the current in the equivalent line.

The value of the total installed shunt reactive power Q_{Tshunt} is calculated based on the fact that any phase of any line can be lost. However, there is no need to compensate for particular a_i-phases as shunt compensation can be installed on the sending-end and receiving-end buses. The total reactive power installed for shunt compensation is given by:

$$Q_{Tshunt} = 3(N-L)B_C V_N^2 = 3LB_p V_N^2 \quad [5]$$

where V_N is the rms phase-to-ground voltage.

Example 2: Two-Line 400 kV, 300 km Corridor with Lossless Lines

Two 400 kV, 300 km, lossless, transposed lines loaded to their surge impedance loading (SIL = 1400 MW) are equipped to sustain the loss of any combination of three different phases in succession, on either of the two three-phase lines. **Fig. 3** shows this corridor with one phase out of service. The unit length parameters are $x_L = 0.3\ \Omega$/km and $b_L = 6.0\ \mu$S/km. Thus,

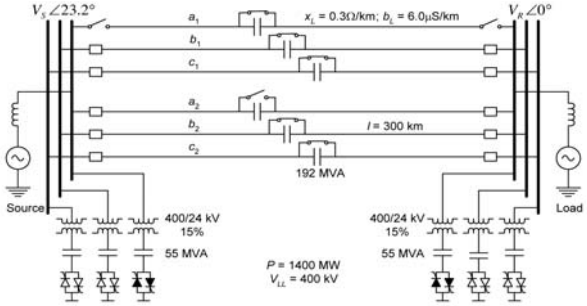

Fig. 3: Compensation scheme for asymmetric operation of a two-line 400 kV, 300 km corridor (assuming a lossless conductor model)

for 300 km, X_L = 90 Ω, and B_L = 1.80x10^{-3} S. For L = 1, a total of 1150 Mvar are required in series compensation, and the total needs for shunt compensation, including 15% for the SVS transformer losses, are 330 Mvar.

3.2 SINGLE-LINE CORRIDOR

The solution to the single-line case requires filters to eliminate undesirable negative and zero sequence currents resulting from a one- or two-phase-open situation. As the single-phase fault has the highest probability of occurrence, the loss of two phases is not considered here.

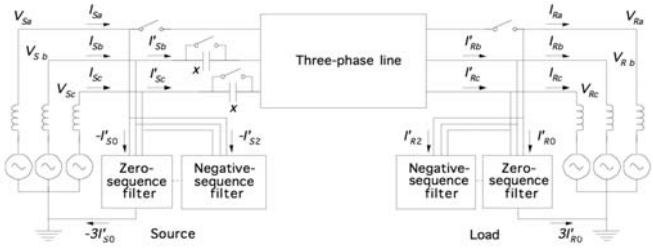

Fig. 4: Concept of asymmetric operation of a single-line corridor

Fig. 4 illustrates the asymmetric operation of a three-phase line with phase a out of service. During asymmetric operation with one phase open, three basic compensating elements must be introduced to rebalance voltages and currents:

1. Series compensation of the sound phases (phases *b* and *c* in **Fig. 4**) to lower the series reactance, maintain the same angular spread and ensure the flow of the pre-contingency power;
2. Zero-sequence filters, at each extremity, to afford a low-impedance path for zero sequence current;
3. Negative sequence filters at each extremity to eliminate negative-sequence currents. Depending on the planning criteria, the negative-sequence compensator and zero-sequence filter at each end of the line can be grouped together (2);

Example 3: Asymmetric Operation of a Single-Line 120 kV, 100 km Corridor

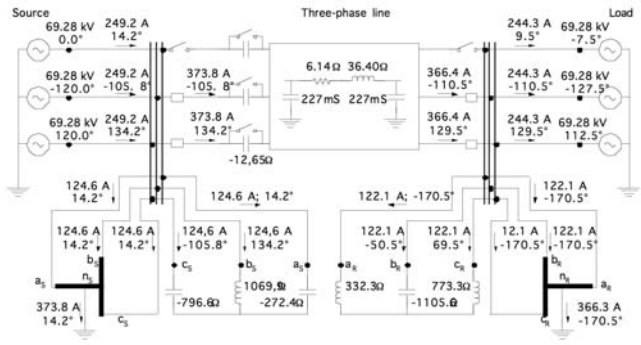

Fig. 5: Asymmetric operation of a single-line 120 kV, 100 km corridor with one phase open (assuming the use of conventional compensating devices)

Fig. 5 illustrates a three-phase 120 kV, 100 km line with parameters r = 0.061 Ω/km, x_L = 0.3644 Ω/km, b_L = 4.54 x 10^{-6} S/km with *a* phase open. The load power is 50 MW. Compensation of the positive sequence requires three capacitors of 2 Mvar each for a total of 6 Mvar. Compensation of the negative sequence requires 68 Mvar at the ends of the line. Filtering zero sequence requires 16 Mvar.

4 FINANCIAL ANALYSIS

4.1 RETROFIT OF EXISTING CORRIDORS

Table 1

		Case 1	Case 2	Case 3
Number of lines		1	2	3
Voltage (kV)		400	400	400
Line length (km)		150	150	150
Transmitted power (MW)		700	1400	2000
Probability of failure of one phase (6)		0.002	0.002	0.002
Load factor		75%	75%	75%
Cost of power not supplied: *LOLE* (M$CA)		8	16	23
Asymmetric operation with conventional devices	Investment Cost (M$CA)	48	15.0	12.1
	Payback time (years)	6.0	0.93	0.53
Asymmetric operation with FACTS devices	Investment Cost (M$CA)	70	42.8	34.7
	Payback time (years)	8.8	2.7	1.5
New line	Investment Cost (M$CA)	60	60	60
	Payback time (years)	7.5	3.8	2.6

Table 1: Cost comparison of three options at 400 kV for reducing the risk of non transmitted energy (costs are expressed in millions of dollars Canadian).

Table 1 summarizes the financial analysis for three 400 kV, 150 km asymmetrically operated corridors having respectively one, two and three transmission lines.

For a single line, the cost of the *LOLE* (excluding the larger social and economic costs) is lower than the investment cost of asymmetric operation, and much lower than the cost of building a new line: the payback period is therefore greater than one year. For two or three lines, the investment cost of asymmetric operation using conventional devices is lower than the cost of the *LOLE*, yielding a payback time of less than one year. In other words, part of the investment for asymmetric operation is already present in the case of multiple lines!

Table 2

	Scenario 1	Scenario 2	Scenario 3
Transmitted power	450 MW	1000 MW	2200 MW
Symmetric operation	345 kV;2×300 km lines	500 kV;2×300km lines	735 kV;2×300km lines
Asymmetric operation	345 kV; 1×300 km line	500 kV;1×300 km line	735 kV;1×300 km line

Table 2: Transmission system scenarios for comparing symmetric and asymmetric operation.

4.2 NEW CORRIDORS

Table 2 identifies three different transmission scenarios under symmetric and asymmetric operation for new transmission capacity. Each scenario compares the cost of a two-line, symmetrically-operated transmission corridor to a single-line, asymmetrically-operated corridor of the same capacity, both respecting an "N-1" criterion (9). For a symmetrically-operated system, "N-1" represents the loss of a three-phase line; for an asymmetrically-operated system, "N-1" represents the loss of a single phase. The capacities are considered identical as planning criteria consider the immediate post-contingency capacity as the pre-contingency corridor capacity. As the reliability of both cases of each scenario is essentially identical (they respect their respective "N-1" criterion), one must compare them on the basis of investment costs, not risk (i.e., *LOLE*).

Cost Analysis

Table 3 presents the cost summary based on the use of conventional elements, including rights-of-way. In all three, the cost of a single, asymmetrically-operated 300 km line is less than that of two symmetrically-operated lines of the same length, as the cost of the compensation elements enabling asymmetric operation is less than the cost of the additional line required for symmetric operation.

Table 3

		Scenario 1	Scenario 2	Scenario 3
	Transmitted power (MW)	450	1000	2200
Symmetric operation	Voltage level; Nb. lines	345 kV; 2 lines	500 kV;2 lines	735 kV; 2 lines
	Total cost (lines) (M$CA)	120	240	360
Asymmetric operation	Voltage level; Nb. lines	345 kV; 1 line	500 kV; 1 line	735 kV; 1 line
	Cost of the lines (M$CA) (10)	60	120	180
	Cost of compensation (M$CA)	26.8	59.2	128.6
	Total Cost (M$CA)	86.8	179.2	306.6

Table 3: Costs associated with symmetric and asymmetric operation for the three scenarios of Table 2 (costs are expressed in millions of dollars Canadian).

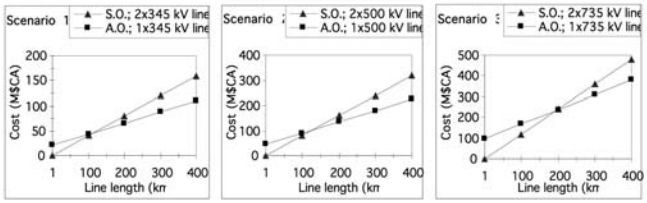

Fig. 6: Cost comparison of symmetric (S.O.) and asymmetric (A.O.) operation for three scenarios as a function of line length (costs are expressed in millions of dollars Canadian).

Effect of Line Length

Fig. 6 illustrates these same scenarios for line lengths varying from 1 to 400 km. Clearly, each scenario exhibits a point (between 100 km and 200 km) where an asymmetrically-operated single-line corridor costs less to build than a symmetrically-operated two-line corridor of the same voltage. For short lines, the cost of asymmetric operation is higher because the cost of compensation is predominant. For long lines, the cost of symmetric operation is higher because the cost of an additional line increases more quickly than the cost of the compensation added to the asymmetrically-operated line. Such cost behaviour is similar to that found in comparisons of AC and DC transmission corridors where, beyond a certain point, DC transmission is less costly than the equivalent AC solution.

5 CONCLUSION

Though asymmetric operation yields a more reliable system than symmetric operation, its key features are economy and flexibility in system planning and operations. Let us summarize the advantages:

1. the system's response is tailored to the circumstances of the moment: there is no "response overkill" resulting in weaker-than-necessary post-contingency systems;
2. the post-contingency system is "strong" : it is electrically identical to the pre-contingency system;
3. there is no need to implement immediate post-fault, error-prone, operator-driven remedial measures for maintaining security: such measures are "built-in" to the response;
4. this in turn provides precious time for prioritizing appropriate follow-up strategies for rectifying the local, physical situation; and
5. the investment in compensation equipment pays for itself in a short period of time, particularly in the case of multiple line corridors.

Clearly, asymmetric operation has the potential to redefine the reliability and economics of electric power transmission.

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About the Authors

Richard J.Marceau, Eng., Ph.D., FCAE, *obtained his B.Eng. from McGill University in December 1977 and began his engineering career with MONENCO Inc. in January 1978. In 1982, he joined Hydro-Québec as an operations engineer in Montréal, Canada and later as a researcher at the Hydro-Québec Research Institute (IREQ). While engaged full-time in his engineering career, he obtained his M.Sc.A. in Electrical Engineering from École Polytechnique de Montréal in 1983 through part-time studies. He began full- time doctoral studies at McGill University in 1990, and obtained his Ph.D. in October 1993. He then became Assistant Professor of Electrical Engineering at École Polytechnique de Montréal, obtained tenure in December 1996, was promoted to Associate Professor in 1997, was elected Chair of the Department of Electrical and Computer Engineering in 1998, was promoted to the rank of Professor in May 1999, and remained Chair until May 31st 2001. On June 1st 2001, he became Dean of the Faculty of Engineering of the Université de Sherbrooke. On January 1st 2005, he assumed the position of Provost of the University of Ontario Institute of Technology (UOIT). His present research interests are centered on power system security and reliability.*

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Donald T. McGillis, Eng., *received the B.Sc. Degree from Loyola College, Montréal, Canada, and the B.Eng. degree from McGill University, Montréal, in 1949 and 1951, respectively. From 1951 until his retirement, he was with Hydro-Québec, in Montréal initially as the Head of the Analytical Division, later as Manager of System Engineering and finally Advisor of the Vice-President, System Planning. As a member of Canadian Electrical Association, he served as chairman of the Engineering R&D Operating Division, Consultative Committee on Outage Systems where he is still active. He is a consultant for Hydro-Québec International and adjunct professor at McGill and Concordia Universities, in Montréal. His interests span the planning and design of Extra-high-voltage systems, applying power electronics to power systems, the design and use of expert systems for planning, dynamic security analysis, and power-system reliability.*

Service Transforms Business in the 21st Century

By: Steve Roth, Vice President, Marketing, Indus, Inc.

Last week, I took an afternoon off from work to do what we all dread: wait for the cable company. I'd been without Internet service for several days and couldn't survive another weekend spent offline. I made some lunch and settled in at my desk to wait for the cable technician to arrive between noon and 5:00 p.m. The afternoon slipped slowly away with no tech, so I called the cable company at five to determine the Estimated Time of Arrival.

"He's stuck in traffic," the service operator said. "He'll be there soon."
"Soon" stretched to 6:00 p.m., then to 7:00 p.m.

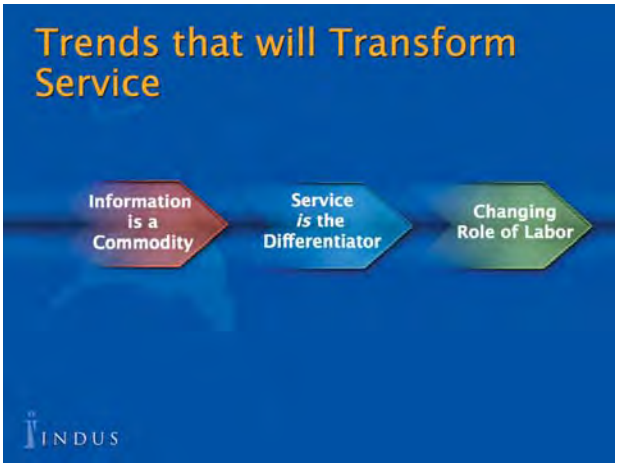
I called again. Where is he, I demanded.
"Sir, I don't know where he is. Would you like to reschedule?"

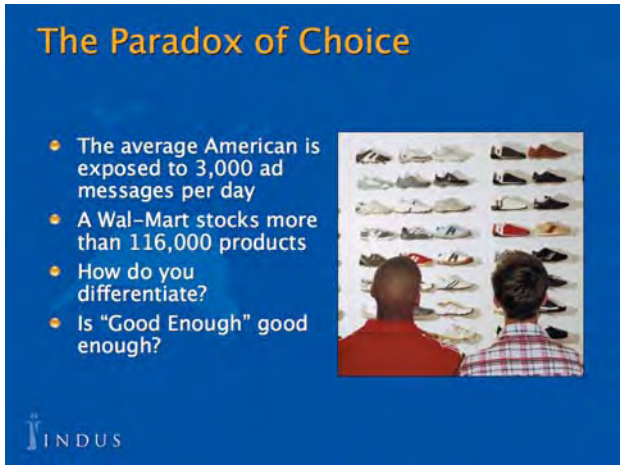
And on it goes. Whether it's cable, washing machines, air-conditioning – any kind of service or repair, customers hate to wait. And, smart businesses are beginning to realize this fact. Furthermore, they are beginning to realize that customers hate waiting so much that they are willing to pay a little extra not to have to wait. As a result, for many forward-thinking B-to-B as well as B-to-C companies, instead of a drain on company time and resources, after-sales service/maintenance is becoming a viable revenue channel.

In fact, according to Boston-based Aberdeen Group, 78 percent of OEMs currently or soon will manage post-sales service as a strategic profit center -- a dramatic shift in traditionally product-centric companies which viewed service as a "necessary evil" and an unavoidable cost of doing business. Sears Holding Corp., for example, has already seen that service, when properly delivered, can lead to additional sales, either for products or additional services. "At Sears, the field technicians are customer advocates," said Mark Vigoroso, Chief Research Officer and Senior Vice President at the Aberdeen Group. "They are adept at responding to customer needs, which increasingly translates into additional sales."

TRENDS CONVERGE

In the next twenty years, service will be the key differentiator between those businesses that succeed and those that don't. And, technology is being utilized to "supercharge" service in a growing number of industries. Three important industry and cultural trends are converging to make this a reality.





1. Aging Workforce

The aging workforce is a major driver in the advancement of knowledge management technology, a key enabler of service optimization. More than 76 million baby boomers will be retiring soon, resulting in an imminent knowledge drain that will first hit oil and gas, utilities, government, education and manufacturing industries. Frank Lambert, electrical engineer and Program Manager at Georgia Institute of Technology's National Electric Energy Testing Research and Application Center, noted this trend will hit utilities hard because of the amount of downsizing that occurred due to deregulation and the experience that was lost as a result. Among the utilities with whom the center works, Lambert agreed that a large number of experienced senior staffers are retiring, leaving a 10-to-15-year worker gap.

Furthermore, by 2010, the U.S. Department of Labor, Bureau of Labor Statistics reports that the number of unfilled skilled worker posts will reach about 5 million, ballooning to 14 million by 2015. According to the Utilities Business Education Coalition, more than 90 percent of CEOs surveyed face the difficulty of finding entry-level people to replace retirees. And, according to Forrester Research Inc., one participant at a recent event said his organization found it requires two to 2.5 new employees to replace just one highly experienced worker – partly due to education but also because attitudes about work are quite different between boomers and generation X and Y.

Les Duncan, Vice President and Chief Information Officer for Atmos Energy Corp., believes technology is crucial to capturing that knowledge. Many of the field service workers have specific knowledge about reading meters, and in particular, where many of those meters are located. One may be in the middle of a forest or tucked away on a hill and only one worker in the company knows its exact location. As Vigoroso puts it, "If historical asset knowledge is not captured in a system of record, it will disappear with the departure of the retiring worker."

2. Technological Advancements

Technology, then, is the key to capturing that data which otherwise too easily disappears. Yet even as it's becoming more expensive to hire people to perform those jobs, the technology needed to capture that knowledge is actually getting less expensive to purchase and deploy.

Like the Y2K bug, the pressure to capture knowledge forces businesses to exploit existing technology. Michael Lamb, Executive Director of Utility Innovations for Xcel Energy, believes that technology can help "retain that knowledge and make sure that we're more efficient so that we can get the same amount of work done with fewer people."

Progressive companies are instituting more automation and streamlining business processes that will reduce the number of workers needed as well as the cost of doing business.

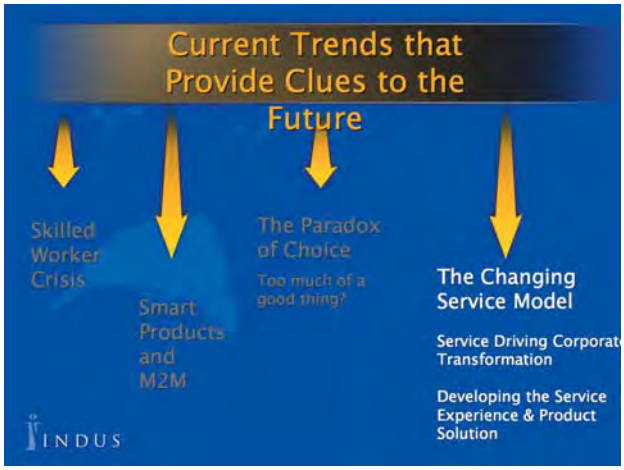
Those businesses are also implementing best-of-class service delivery management practices and software tools to drive efficiency improvements across their entire service supply chains. These advances in technology and technology deployment are the next trend to supercharge service. When the technology involved in condition-based monitoring and maintenance of a product aligns with the ability of a service provider to quickly access customer data, service parts information and service scheduling information - combined with the ability to seamlessly connect the back and front office to the field using a mobile device of choice - the result can be a level of convenience that wasn't possible until now. Imagine copiers that automatically report to the service desk that they're running out of toner or that the document feed belts will need to be replaced soon. Even better, the service tech, armed with invaluable customer data, initiates the process of selling a new copier or a service contract while he's replacing the document feed belt. Hence, service migrates from a cost center to a strategic profit center.

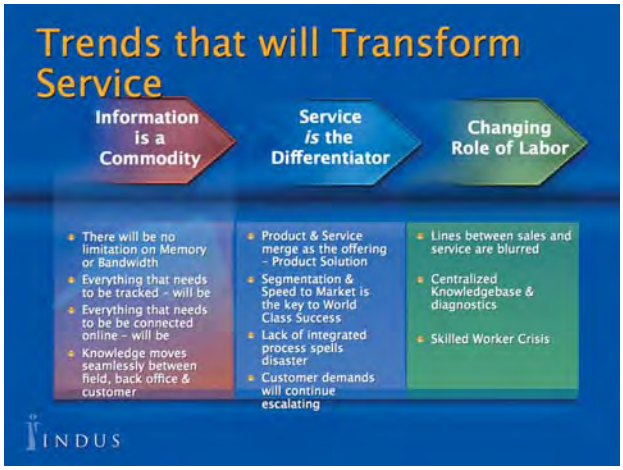
Another example of technology supercharging service is occurring right now. A local restaurant in Atlanta offers its patrons a frequent diner card. Through radio frequency identification (RFID) tags embedded in the cards, diners are identified when they arrive in the parking lot and then ushered to the front of the line to a table. Wait staff knows in advance the guest's favorite cocktail, meal preferences and even whether the steak should be rare or medium well. Once again, this knowledge – previously stored only in the mind of the worker, if anywhere – can now be accessed from a centralized database that expands and changes as the data evolves. The value of the customer satisfaction, loyalty and convenience that this service will engender cannot be overstated.

3. Paradox of Choice

The third and perhaps most influential trend that is supercharging service may appear more abstract than the other two, that of service as a differentiator. From the billboard touting a new luxury sedan to the TV commercial introducing the latest cell phone gadget to the magazine ad promoting the latest in men's deodorant, the average American encounters at least 3,000 advertisements per day. Options reflect an American right – the freedom to choose, or so the marketplace tells us. However, psychologists disagree. Instead of control over our lives because our options are limitless, we often become overwhelmed by the chaos, resulting in what social psychologist Leon Festinger coined "cognitive dissonance." The greatest dissonance occurs when the choices look equally attractive.

According to Aberdeen's Vigoroso, "Products by themselves are feeling the pressures of commoditization and competition, so it's becoming difficult for manufacturers to





distinguish their product from others. Feature-function isn't enough to win the day."

Additional bells and whistles on a product won't sell it when all the products have similar bells and whistles. What's a business to do to avoid what Swarthmore College psychology professor Barry Schwartz called "The Paradox of Choice," when "good enough" guides a consumer's buying decisions? "You have to sell an experience. It's becoming the only way to garner market share," Vigoroso added.

It wasn't always like this. Consider the evolution of the cell phone. Of the cell phones available about twenty years ago, there were only two options: an 11-pound Nokia or the 3-pound, four-thousand-dollar Motorola. Throughout the last twenty years, in order to be competitive, wireless companies focused on reducing the cost and size of cell phones while increasing the battery life. They've obviously achieved their goal. Today, according to The New Atlantis, Journal of Technology and Society, more people have cell phones than fixed telephone lines, both in the United States and internationally. In addition, there are more than 208 million wireless subscribers in the U.S. alone. With every carrier offering the latest and greatest feature and function, how's a carrier to stand out from his peers? The answer is in delivering the highest quality service.

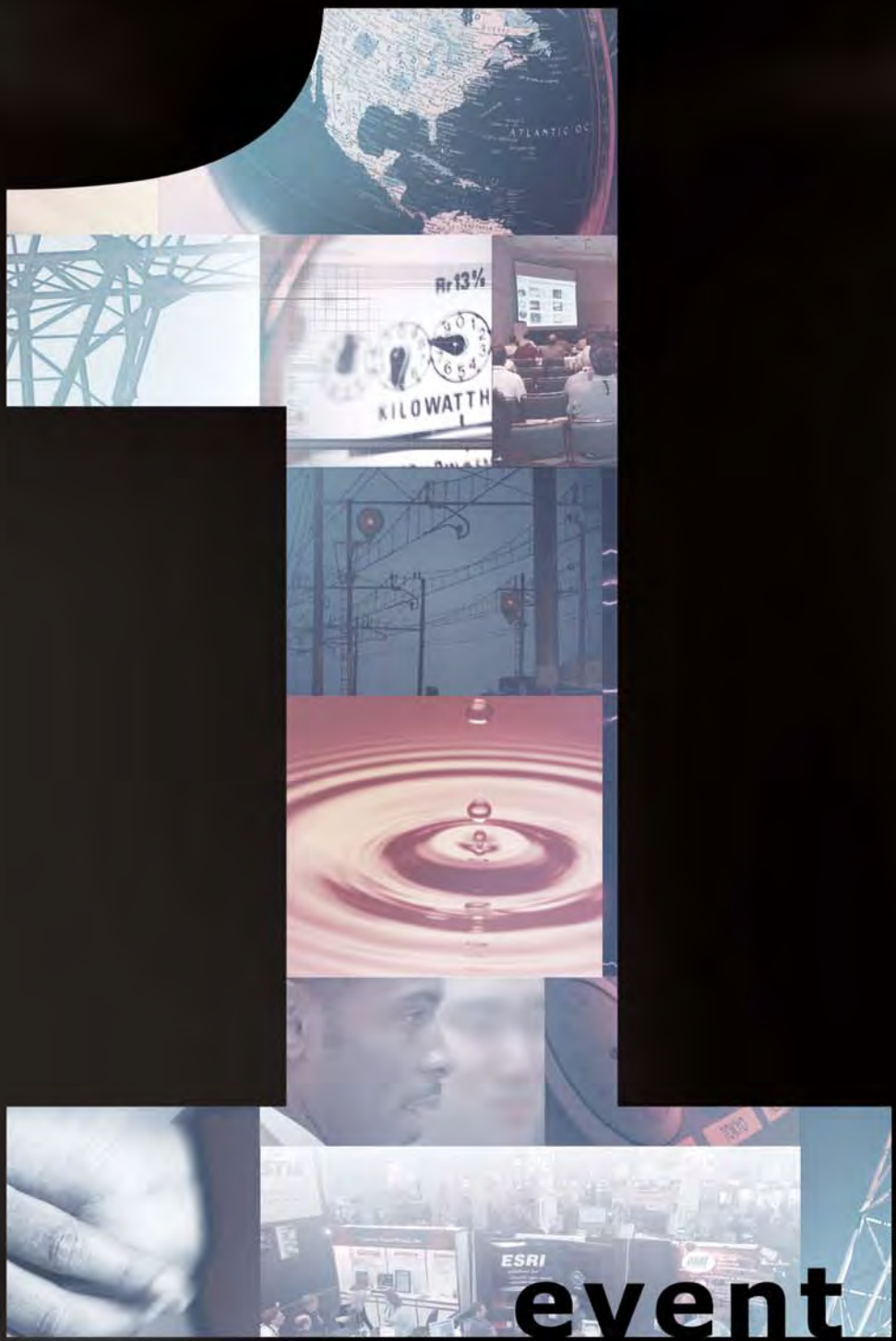
Verizon seems to understand this with their "Can you hear me now?" ad campaign. They're selling an experience – not just a product. And BMW; it's not just the ultimate driving machine, but also the ultimate service for that machine – hence, the ultimate driving 'experience'. And on the business-to-business side, service level agreements will demand 100-percent equipment availability with severe penalties for failure to perform. With the right parts, the right person, at the right place and the right time, even the cable company's promise that: "We'll be there between noon and five" will no longer be acceptable.

Businesses that want to ride the wave of change rather than sink under it will work on their business processes and examine the trends and influences that are changing the world, not just their specific dimension(s) of the industry. Smart businesses will invest in technology to supercharge service. And service will in turn supercharge their performance and their profit, helping to make them best-in-class.

[1] *"The Retiring Workforce Is Creating A Knowledge Void In Government And Regulated Industries", Forrester Research, Inc., May 2005* ■

About the Author

Steve Roth, Vice President, Marketing
Steve Roth joined Indus as vice president of marketing in November of 2000.
With responsibility for both corporate and product marketing, Steve leads the development of strategy and execution of tactics on a global basis. Since early 2003, he has also served as thought leader in Indus' Service Delivery Management (SDM) initiative, charged with researching market needs and guiding acquisition activities surrounding this crucial solution strategy.
To Indus clients, Steve brings a strong focus on delivering economic value. To our company, he brings a passion for results-oriented marketing. Roth has two decades of experience in the process industries marketplace, where he has held a variety of sales, marketing and operational leadership positions. For 10 years prior to joining Indus, Roth served as managing director of Solaronics International, a highly profitable division of Solaronics Process S.A. From the division's base in Atlanta, GA, Steve established the North American operations and managed all of the company's sales, marketing, field service and administrative resources for the Americas. In addition to this geographic responsibility, Steve was a key member of the Solaronics management team responsible for taking the company public. The company was subsequently purchased by Belgian-based Bekaert in January of 2004.
Steve has also held positions in operations, sales and marketing for IBM, Measurex-Devron (a division of Honeywell Inc.), and TechMark Corporation. He holds a Bachelor of Science degree in management information systems from the University of Rhode Island.



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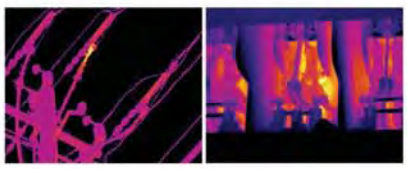

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