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October/November 1991

Professors and outside experts help PG&E create the 'utility of the future'

A think tank consisting of university professors and technical experts from inside and outside of PG&E laid the foundations for developing a "smart" electrical distribution system that will be a key piece of the utility of the future.

Steve Krein and Paul Mauldin of R&D's Energy Delivery and Control Program hosted the two-day External Advisory Group meeting in Silverado, near Napa in late September. The idea was to create a cross-fertilization of ideas and research initiatives combining micro-sized sensors, advanced computer science techniques, and PG&E's power distribution grid to transform the way electricity is distributed to homes, offices, and industries.

Basically the network of power lines, transformers, substations, and control switches are going to "get smart" in the 1990s. This will happen for two reasons: (1) it is possible, and (2) it is necessary.

North Carolina State University's John Grainger leads a workshop session on one aspect of a "smart" electric distribution system.

(1) It is now possible. Mauldin and Krein have identified several "enabling technologies" in which there have been tremendous advances over the last couple of decades: sensors, digital communications, distributed intelligence (computers), controls, and human interface technologies. These advances can be integrated into the power distribution grid in a number of creative ways to provide unparalleled monitoring and control capabilities.

(2) It is necessary. America's power needs will continue to be met by a mixture of sources, including the old standbys: fossil fuels, water power, and nuclear power. But, particularly in Northern California, that mixture will begin to include more and more elements of renewable energy sources (solar, wind, biomass), plus the saved energy from aggressive conservation programs that will generate "negawatts."

In this new energy mix, there will be many small, dispersed sources of power that will need to be integrated into the power grid. Customers' power needs must be met around the clock. Yet solar energy is available only when the sun shines and wind turbines turn only when the wind blows. Somehow all these sources need to be integrated into a system that provides steady power in just the right amounts to all customers. This can only be accomplished with sophisticated control, monitoring, and safety systems derived from advanced technologies.

If energy conservation is to work, customers need much more precise information about their energy consumption patterns (and the economic costs) to be able to use power more intelligently and save power and money.

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Spotlight

The purpose of ***Spotlight*** *is to help us get to know one individual who works at the Technology Center. PG&E employees and contractors alike may be* ***Spotlighted.*** *Carl Weinberg of R&D is in the* ***Spotlight*** *this month.*

Carl Weinberg

What is your job title?

Manager of R&D. Actually I have a second title that I use with foreign visitors — Executive Director of R&D. In other countries a manager is usually someone who reports to a director. This title says that I'm the supervisor of the directors. Many of our foreign visitors are more comfortable with that. They feel more like they're talking to somebody important.

What is it you actually do?

I run the R&D program. I give it a vision and a direction, and I try to arrange for the resources (money and people) to make it work. Sounds pretty simple, but that's basically what I do.

How long have you been at PG&E?

Since August 12, 1974. I joined the Department of Engineering Research (DER) as an engineer after I retired as a colonel in the U.S. Air Force.

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"A smart energy delivery and control system is at the core of these future systems," Mauldin pointed out to the meeting participants.

Getting people to dream

To create the vision and begin prioritizing some of the needed early research, experts from within PG&E and outside the company were brought in. "We brought in a group of experts from around the U.S.," explained Steve Krein. "The list includes Dr. Lotfi Zadeh, a professor at U.C. Berkeley who's been called 'the father of fuzzy logic,' Dr. Robert Marks, the president of the IEEE neural networks society, Dr. Roger Howe, who is co-director of the sensors lab at U.C. Berkeley, Dr. John Grainger, the director of the Electric Power Research Center at North Carolina State, and others."

"Our mission in Silverado was to create market pull for this new technology," Mauldin said. "We wanted to get company people and outside people together and get them to dream. Silverado was the coming together of a lot of experience and fresh ideas. I think it expanded the awareness of people in the company and got outside experts to start thinking about utility applications. Roger Howe knew little of utilities, their needs or technologies, but he was extremely interested."

Focus groups

About 15 PG&E departments were represented at the Silverado meeting, plus outside experts — about 40 people in all. After initial talks by Mauldin and Krein, there were several presentations to stimulate creative thinking by professors Grainger and Howe, Tom Kendrew and Wade Malcolm from EPRI, Dr. Jack Lawler of the University of Tennessee at Knoxville, and Dr. Dan March from Montana State University.

The meeting then split into three focus groups, each exploring a different area:

- communications, computing, and information systems
- controls, actuators, and sensors
- systemwide issues (such as communicating with customers)

Results

After all the smoke cleared, three hot research areas had been identified as places where resources should be focused:

1. The development of small, low-cost CTs/PTs. These are current transducers and potential transducers that measure energy flow along transmission lines. The utilities now use big bulky transformers that cost about $1,000 each to make these measurements. But, by applying the microminiature photo-etching techniques used in the semiconductor industry, a network of small sensors could be developed and installed easily and inexpensively at many points on the grid.

2. The development of advanced control algorithms and diagnostic tools. Controlling the distribution system of the future will require a sophisticated ability to diagnose and respond to developing situations. To help with this, some of the most advanced concepts in computer science will be explored. These include neural networks (computers that learn from experience) and fuzzy logic (computer programs that are more flexible than conventional rule-based programs). These advances could help to reconfigure the distribution system and optimize the system to reduce losses, providing more rapid service restoration.

3. The development of high impedance fault detection techniques. When a power line has been cut and is lying on the ground, it can create a very dangerous situation. If the conductor is still energized, touching it or even coming too near it can cause shock and electrocution. In high-impedance faults such as this, the current is not grounded solidly, which would cause a detectable fault and would trigger circuit breakers that would de-energize the line. With better sensors located at strategic spots on a feeder, this kind of fault could be detected more easily.

These research directions will be incorporated in R&D strategies and technical plans. But perhaps the real results of the Silverado meeting can best be measured in the attitudes of the participants. "Our employees were blown away," Mauldin reported. "They were very enthusiastic. One General Office manager came up to me and said 'Wow! The possibility of using these things is tremendous'."

"There have been a lot of isolated efforts to work on distributed automation throughout the company", Krein said. "I think parts of the company were dismayed because of turf issues. This retreat created—not a team—but a very strong group of advisors who are providing input on the approach and direction." ❑

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Credits

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