POWER TECHNOLOGIES, INC.®

power technology

SPECIAL 25th ANNIVERSARY EDITION

ISSUE NO. 78, JULY 1994

25 YEARS IN PERSPECTIVE

L. O. Barthold,
Vice Chairman

On Monday, July 25, 1969, seven engineers and one
secretary assembled in a dingy, second-
story office on Schenectady’s Erie
Boulevard. That was
day number one of
“Power Technologies,
Inc.” None of the
founders had any
formal business or
management training.
Why such a rash
jump from secure
careers at General
Electric? On reflec-
tion, it was probably the need to be told, not by performance
appraisals or IEEE awards, but by the marketplace itself, of our pro-
fessional worth. Now, 25 years later, our greatest gratification is
affirmation of that worth . . . the realization that PTI could not only
advance the state of the art, but could develop new generations of
experts with the same ingenuity and energy that drove the founders
to go independent.

PTI is owned solely by active employees. While earnings
wouldn’t impress most analysts, we’ve never ended a year in the
red. Growth has been less an objective than a result of struggling
to keep enough work in house. Through software, courses, and
joint ventures, we’ve constantly sought to propagate our know-
how, thus keeping pressure on ourselves to innovate. Despite our
diversification, we’re aware that our strength in all undertakings
derives from expertise in our core business — the engineering
analysis of power plants and electrical systems.

Hundreds of companies, younger than ours, have grown faster
and bigger. Some are on the Fortune 500 list. None can take more
pride in doing what they set out to do, none are more dependent on
client confidence. Thanks!

PTI'S GROWTH AS A
SCHENECTADY COMPANY

D. D. Wilson, Chairman

Although PTI has grown in staff size and client base
every year of its existence, the 1980s clearly brought the
biggest change in corporate operations. By the mid-
1980s, PTI had grown to over 70 employees with a client
list exceeding 600 companies. Since that time PTI has doubled in
size, increased its client base to well over 1000, and expanded its
scope to include services, software, and specialty hardware.
PTI’s clients represent over 60 countries worldwide. In the
early 1980s, PTI formed its first foreign affiliation — a formal, cor-
porate level agreement with an independent company to transfer PTI
technology to Norway. Others followed, and our foreign initiatives
were formally recognized in 1988 when the company received New
York State’s Governor’s Award for Achievement in Export. At pre-
sent, PTI has six non-U.S. affiliations in addition to a wholly-owned
subsidiary in the United Kingdom.

PTI has grown to be a significant employer in a city where we
have no local clients. To accommodate growth, PTI completed a
new office building in 1991 that is connected to the original build-
ing by a bridge over a main street of Schenectady — Erie
Boulevard — which earlier in the century was the site of the
famous Erie Canal. We are credited by the City of Schenectady as
having upgraded the northern entrance to the city. We have been
the recipient of several Schenectady County Chamber of Commerce
awards including “Company of the Year” in 1991. The city has
been good to us and for us, and we will continue our efforts to be
responsible members of the community.

WHERE IS PTI GOING?

W. H. Smith, President and CEO

PTI has successfully survived its infancy and adolescence, and
has clearly established its identity in the electric power industry.
We have a reputation for technical superiority and name recognition
around the world. We are financially sound, independent, and in
command of our own destiny. So what is left to accomplish?

Technological strength is the foundation of PTI’s success. We
are determined to continue as the technological leader in the elec-
tric power industry. We must continue to be pioneers and push
technology development. For example, we’re now using new
graphics and programming tools in our code development to do a
better job for our software users. Our Plant Monitoring
Workstation (PMW)™ developed for EPRI, and our Thermal
and Electrical Energy Cogeneration Optimization (TEECO) are state-of-
the-art systems that optimize power plant efficiencies well beyond
standard systems. Our Dynamic System Monitor (DSM)™ provides
previously unavailable transmission system data for utilizing total
system capability. New software to assess production costs and
transmission capability is also available to determine the value
of the transmission grid on an hourly basis.

We regard ourselves as technological allies of our clients in
meeting their customers’ needs. We will convert technological
advantage into products and services which will make our clients
the most competitive in the marketplace. Only when our
clients succeed do we succeed. We are determined to
be the best at what we do — making our clients the best
at what they do.  

This product incorporates technology developed for the electric
power industry under the sponsorship of EPRI.
THE CHANGING INTERNATIONAL ARENA

D. N. Ewart, Manager
International Business Development

The last 25 years have seen major changes in the electricity supply industry around the world. Seen from our perspective, three major trends are apparent:

1. Once-emerging nations have developed into full-blown economies with a thirst for western technologies.

2. Traditional utilities, vertically integrated and government-owned, are being corporatized, privatized, and often fragmented. A keen sense of competition has developed between former associates.

3. Industrial and private users of electricity are becoming more conscious of the cost and quality of their power supply.

PTI has responded to these changes both through the products and services it provides and in the way it interfaces with overseas utilities.

Electric power enterprises have traditionally constituted a small fraternal community. When PTI was organized 25 years ago, there were three keys to success in that community: 1) publication of cutting-edge technical articles; 2) good personal contacts; and, most importantly 3) providing consulting services and products of the very highest quality. While the elements of that formula still apply, it has been complicated by today's diverse client background and shift to a more business-oriented environment.

Strong economies have emerged from some previously less-developed regions, and they promise to emerge from others. For example, the Pacific Rim, now a major PTI market, has not been a significant client 25 years ago. The systems of the former Soviet block are now increasingly on the list of overseas destinations.

Structural changes within the utility industry are even more dramatic overseas than in the U.S. The electricity supply industry is often broken up into several deregulated generating companies, electricity providers, and regulated entities that own and control the electrical connections between generators and consumers. This both subdivides and specializes the number of potential PTI clients.

Privatized utility entities also show more business orientation. No longer regulated monopolies, the impact of our services and products on their "bottom line" is very important. A senior executive in a major utility in Southeast Asia told us recently that "he has very fussy customers." Where 25 years ago any electric supply was a luxury, there is now no tolerance for power supply interruptions.

While the fax machine and jet travel have made it "a small world" in some ways, it doesn't seem so small after 30 hours on an airplane to reach clients in Brisbane. Fifteen years ago we saw how impossible it would be for a small company like PTI to meet face-

SYSTEM STUDIES AND TECHNOLOGY TRANSFER

L.G. Barthold
Vice Chairman

PTI's original mission was the detailed analysis of electric power systems and power plants. The continuing importance of that mission can best be illustrated by considering some of the other businesses it spawned. In the 1970s and early 1980s, PTI was not looked on as a totally logical source for software. In our struggle to gain position in that market we asked the question, "Would you rather have software from a group of people who grew up dealing with the physics of detailed equipment and systems who then learned to write and use software to solve problems, or from a group of people who 'teethed' on computers and software and then learned how a power system worked?" It was more than a sales argument. It was the reason for PTI's preeminence in the software business, special purpose microprocessor-based hardware products, courses, and every other venture we've built. We are keenly aware of that.

In fact, PTI's success in those derivative businesses has had a profound effect on the system study business itself. From the first year of operation, PTI set about transferring to clients the wherewithal and experience which we ourselves brought to bear in analyzing systems. An extensive Power Technology course was PTI's first substantive piece of business in 1969. Educational programs have grown every year since. The sale of our latest software was an even more powerful client enabler. (Now over a dozen international PTI competitors license software.) Beyond that, PTI deliberately put affiliated companies in a position to do as much of what Schenectady headquarters group could do.

This was a high risk philosophy. We recognized from the beginning that it would limit our growth and stake our long range survival on the Schenectady staff's ability to move technology forward. We put a lot of pressure on ourselves to identify new client needs and to develop new methods to address them. PTI's system experts responded remarkably. Traditional load flow and dynamic analysis remained a part of their agenda, but they gave way in emphasis to more sophisticated phenomena. The progression began with subsynchronous resonance, and is now centered in complex transmission-costing phenomena. Deterministic methods have given way to probabilistic and risk-based ones. The analytical tools used in many of today's studies were unimaginable 25 years ago.

Perhaps the greatest recent change in system studies derives from institutional rather than technical changes. Utilities, once a grand fraternity in a protected environment, are now aggressively competitive and extremely protective of strategic information. In one way the change is like a breath of fresh air. Clever technical ideas (for which there's never been a shortage at PTI) now find a much more open reception. The number of direct PTI/utility joint

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For at least 10 years the electric utility industry has been driven by the need to increase generation efficiency, delivery capability, and production under the backdrop of changing government regulations. The technical response to this environment is typified by such innovations as demand side management programs, Flexible AC Transmission Systems (FACTS), series capacitors, Superconducting Magnetic Energy Storage (SMES) device, and a host of other devices designed to stretch the existing utility infrastructure through more sophisticated controls. The commercial response to these changes, such as re-engineering, non-utility generation, and power wheeling, relies on better and more timely information and the ability to process the increased volume of information in more efficient ways.

In order to realize the control strategies required by these innovations, scores of new microprocessor-based devices have been developed. In addition, many existing devices have been modernized by introducing digital technology into their designs. Increasingly, these devices play the dual roles of control as well as collecting data on control performance. This data can then be made available to planners and operators in real or near-real time to assist in the short-term operation of the system as well as in long-term planning. For example, the PTI digital power system stabilizer incorporates an internal data acquisition system which is remotely accessible via telephone modem. The data acquisition system allows the recording of internal control quantities in addition to normal input/output signals.

Digital data and the on-board processing capability of these devices also more readily allow the data to be converted into a usable form. PTI recognized this when they designed the Dynamic System Monitor (DSM) where sampled voltages and currents are converted within the device to phasor quantities in the proper format for direct comparison with simulation data from transient stability programs.

As more devices are added, we need to accommodate the interchange of data between them. Data from controllers and data acquisition systems should be directly compatible with simulation tools to facilitate the validation of system models. Figure 1 (pg. 5) shows the data interchange capability between PTI’s system simulation program, PSS/E, Power System Stabilizer (PSS), DSS, and DADISP (a commercially available digital signal processing program). This circular interchangeability of data allows PTI to offer an economical service for field-testing generators and controls and developing simulation models.

When PTI was founded 25 years ago, it was the era of 256K byte memory capacity, 1000 bus power system models, and overnight turnaround on power flow results. Over the years, many advancements have been made in power system analysis algorithms, models, results displays, and performance. Yet these impressive strides have merely kept pace with power system planners’ and operators’ needs to operate and optimize investment in increasingly complex power systems with very tight financial, reliability, and political constraints.

Today we are moving into a new era where deregulation is forcing electric utilities to compete with each other and with non-utility suppliers. As the industry continues to evolve, the tools used to plan and operate power systems will need to expand and adapt to the changing environment. The mathematics are the same, but the focus and demands are different.

Simply stated, the focus has changed from “How can I save a buck?” to “How can I make a buck?” (or a pound, or a peso, or a yen). True, a penny saved is a penny earned, but this change in focus causes a significant rethinking of the role and purpose of power system methods. In a regulated utility industry, earnings performance (or other measures of utility performance) could be improved by reducing the cost of service in balance with accept-able reliability levels. The driving objective has been to “save a buck.” In a competitive company, “making a buck” is the objective.

How can power system planning and operations analysis methods be used to make a buck? This depends upon the market forces at play and how a utility positions itself. Competitive electric utilities are turning into a combination of commodities brokers and service providers. Power system planners and operators must use their analysis and simulation tools to make a buck within these new business frameworks. Analysis methods technology does not change, but the mindset of their application and implementation does.

For a commodities business, the primary ingredient for success is cost reduction (which will also benefit a service provider’s competitiveness). Several new developments germane to this objective are:

- **System Optimization** - Optimization methods have come of age. The optimal power flow program, for instance, can explore lower cost ways of operating the existing power system and how to balance many variables at the same time.

- **Reliability** - A closer look at reliability criteria and measures can help reduce investments and shave safety margins by squeezing more out of an existing system without unduly compromising reliability criteria. Adjusting planning criteria to include probability of outages, common mode failures, and not planning for worst case conditions is an approach to saving a buck.
LIFELONG LEARNING - KEY TO TECHNICAL VITALITY

T.G. Schmehl, Manager
Educational Programs

In 1969, the year of PTI's founding, utility managers in the northeastern U.S. complained that recent university graduates in electrical engineering lacked the know-how to be productively employed without additional training. This industry need resulted in the creation of PTI's Power Technology Course, starting its twenty-five year tenure. Clearly, the necessity for continuing education beyond the college classroom was evident at that time just as it is now. Most of us are keenly aware that technology is advancing at what seems an exponential, albeit exciting, rate. Keeping pace with the latest e-mail, word processing, and spreadsheet programs is a challenge, let alone mastering the latest engineering software needed to do our work.

Obviously, graduating from an ABET accredited engineering program is only the beginning of what must be a lifelong learning process for an engineer. IEEE recently sponsored the Industry 2000 symposium to explore issues related to maintaining technical vitality through continuing education or lifelong learning. Invited to this meeting were more than one hundred representatives of leading manufacturers, consultants, and academia. At that meeting, there was an overwhelming consensus that our present educational process does not inspire students to be self-learners. One might be tempted to blame universities for not better preparing engineering graduates to serve in the real world, but many changes are going on in the university classrooms across the land. Graduate enrollment in power engineering programs that was steadily declining, has increased notably during the past several years (see Figure 1). During PTI's 25 year history, graduate enrollment of U.S. citizens has increased 250%, while for foreign nationals the increase is 550%.

Previously, a young engineer entering the work force would receive several years of on-the-job training under the tutelage of a wise and experienced engineer (complete with an odd-looking pipe, a pocket full of pens, and a slide rule). The continued downsizing of the utility industry, however, has removed many veteran engineers leaving a void in experience and a lack of mentors. In many instances today, engineers rely on computer programs instead of practical experience. The omnipresent danger here is the risk of losing objectivity and the intuition needed to question calculated results.

While many of PTI's short courses include the use of computer programs, our main focus is always to teach engineers the theory first and then introduce the software that can speed the calculations. Our instructors caution young engineers to thoroughly examine computed results to be sure the data are reasonable or even feasible.

Short courses are but one means of staying technically current in today's rapid-paced environment. Lifelong learning is a trait that must be instilled in our children and our students from an early age. Corporations must further support this concept by providing opportunities for engineers to continually attend courses, offering varied and challenging work assignments, and recognizing achievements through promotions and salary action. Perhaps more importantly, each engineer must assume personal responsibility for career planning and maintaining technical vitality.

How has the rationale for PTI's course business changed over 25 years - a generation of engineers later? The original motives remain, that is, building a bridge between basic engineering principles and advanced applications in a practical world. Add to that an acceleration in technical advances, radical changes in system structure and facilities' utilization demands, shifts to a much more competitive utility industry, and a dwindling cadre of "grey heads" to serve as technical back-up, and it is clear that PTI's educational role will become more important with every passing year.

CHANGING INTERNATIONAL ARENA
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to-face with each of our clients on a regular basis. We responded to the problem by forming "Strategic Alliances." We started an affiliate program in the early 1980s that, in turn, led to the Power Technology Interchange Group (PTIG) in the 1990s.

PTIG is a group of allied consulting companies, each providing high-quality engineering services in major international regions. Leadership is provided by PTI and open technology transfer is an important tenet. PTIG is supplemented by a network of individual and corporate representatives, each bringing local knowledge and the respect of our clients. The representatives are fully supported by PTI with regular, two-way communication. Because of these alliances, clients in Central and South America, the United Kingdom, Scandinavia, Western Europe, Central Europe, the Newly Independent States of the former Soviet Union, the Middle East, the Gulf States, South Africa, Pakistan, India, Southeast Asia, China, Japan, Korea, Australia, and New Zealand often see PTI through our partners.

Was this part of "the plan?" In a way, it was. From the beginning, PTI was dedicated more to technical leadership than to growth. The emphasis was on courses, on software, and ultimately on technical "empowerment" of affiliates rather than attempts to respond to all international study needs directly from Schenectady. And that's just the way it worked out.
NEW DIRECTIONS
(continued from pg 3)

System optimization and managed reliability are not only keys to maintaining market share, they open the door to transfer dealing that would have been set aside in a less competitive era. Nowadays, it takes a more aggressive strategy to do more than survive.

Power system analysis tools must help utilities create a competitive advantage, balance risk and reward, and differentiate their products/services. Technical insight is especially important to the “make a buck” frame of mind, for example:

**Merged Tools** - Power system analysis tools were often developed and used in isolation by different parts of a utility. As conditions change, achieving accurate, beneficial technical insights such as transmission costs and limitations requires merging or interconnecting tools such as production costing, power flow, and financial models.

**Faster Computations** - Looking at more scenarios, system conditions, and expansion options may uncover opportunities unnoticed by cursory examination or typical conditions analysis only.

**More Accurate Simulations** - More refined power system models, perhaps based on measured data, can help planners and operators achieve finer network control and informed risk-taking.

Better information means better decisions. Both planning and operations decision-makers can benefit from a broader and more precise knowledge of system conditions and alternatives. Information management itself requires more sophistication than ever before. While regulatory groups insist on total disclosure and others encourage coordination, strategic planning within utilities requires that cards be held close to the vest. This has accelerated interest in software that supplements traditional analysis tools and is geared to broader “what if” questions.

The more information that is available within an organization, the more likely it is that business opportunities will be identified and exploited. The various departments and actors in a utility need to share information more than ever before. Interfaces, databases, and software functions and performance must be redesigned and improved to provide critical data for decision-making. Modern computer concepts, especially client/server networks, can be exploited to help.

The best information and its effective dissemination is meaningless unless informed action is taken at the proper moment. To “make a buck,” the utilities need to get the right information to the right people at the right time... and then act. PTI is a major software supplier providing tools for dynamic, competitive utilities to acquire and act on improved technical insight and information.  

CHANGING ROLES
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Near-term advances in control and data acquisition will most certainly benefit from system-wide synchronization using satellite signals. Slaving or referencing data acquisition is already available, and coordinated controls, based upon satellite systems and high-speed fiber optic communications, are nearing reality.

SYSTEM STUDIES
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ventures grows by the month. Meanwhile, virtually all of our clients regard one another as potential competitors, lending new importance to a principle we've always tried to honor: that data supplied to PTI and results generated by PTI are proprietary to the client for whom we've worked. In the past six months, PTI has formalized policies and methods to ensure client protection and to train staff in the importance of those policies. We are determined to remain a viable consultant to utilities.

The market we serve will doubtless change a great deal in the next decades, as will PTI’s services and products base. For PTI, the constant in this equation will be the need to retain technical leadership in understanding the physics of system and power station operation.

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1 "Modern Analytical Tools are Changing the Way Transmission Planning Is Done"  
R. R. Austria and F. S. Prabhakara, "Power Technology" Issue No. 74, July, 1993
PTI TECHNICAL MILESTONES

Many of the rules for athletes apply to businesses as well. You win by running fast, not by preoccupation with your competition's position. Also, you do not take too much comfort from being ahead of the pack. Yet, perhaps once every 25 years it's appropriate to look at the scoreboard or the "split" in what will be a very long race. Several months ago, PTI did an internal survey just to see what technological milestones we could claim. The list doubtless misses many, and claims a few incorrectly. It was gratifying nevertheless.

1969 - Transportable Power System Analysis Course
1970 - Interactive Load Flow
1972 - Comprehensive Compact Line Research Site
1974 - HPOF Cable Forced Cooling Optimization Tests
1975 - Analytical Model & Assessment - Boiler Implosions
1975 - Interactive LF/DYN/SC Software (PSS/E)
1977 - Computer-Aided Software Engineering for Nuclear Simulators
1978 - 138 kV Insulated Conductor Research*
1978 - Power Plant Control Check-Out Simulator Product
1978 - Digital Fault Recorder*
1978 - Comprehensive Generator Parameter Measurement Program
1978 - 138 kV Bundled Circuit Research Program*
1978 - Compact Line Design Reference Book*
1979 - Diesel/Motor Sequence Study for Nuclear Plant
1979 - Application of Riser Pole Surge Arresters
1979 - Add-On Interactive Operator Load Flow (PSS/O)
1980 - Interactive Power Flow Graphics
1980 - Construction of Prototype Six- and Twelve-Phase Lines
1981 - Introduction of Rotating Reactor Concept
1981 - Video Course for Power System Operators
1982 - Digital SVC TNA Model
1982 - 25 to 60 Hz Railroad Conversion Analysis
1982 - Digitally Controlled TNA
1982 - Comprehensive Leak Location Research Program (HPOF Cable)*
1983 - Computerized Power Balance Industrial Load Shedding System
1983 - Use of DSM for Machine Measurements
1983 - Pipe Type Cable Pulling Tension Research*
1984 - Digital Power System Stabilizer
1984 - Video Course for Distribution Operators
1985 - Interactive Distribution Analysis Software (PSS/U)
1985 - Energization of Twelve-Phase Line
1986 - Comprehensive Power Plant Monitor/Diagnostic System*
1986 - Thermomechanical Bending Research for Pipe-Type Cable*
1988 - Commercial Software for Trade Off/Risk Analysis
1988 - Commercial Program for True Optimal Maintenance Scheduling
1989 - Phasor Monitoring System for Dynamics (DSM)
1989 - Practical Large-Scale Optimal Power Flow (OPF)
1991 - Multimode Power System Stabilizer
1991 - Lightning Triggered Camera Systems
1991 - Distribution Line Protection Software
1991 - Real-Time Thermal Circuit Rating*
1992 - Comprehensive Total Power Quality Study
1993 - Thermal/Electrical Optimal Dispatch for Cogenerators
1993 - Underground Transmission Systems Reference Book*
1993 - PC-Based Industrial Load Shedding System
1993 - Comprehensive Transmission Costing Model
1993 - Rocket-Triggered Lightning Research Site*
1993 - PSS/E Extension to 50,000 Buses
1994 - 250th PSS/E Program Licensed

Industry Firsts
*EPRI-Sponsored

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