INTRODUCTION
For more than 20 years, electric power utilities have actively embraced computerized project management systems. Even before that, many block project management methodologies with manual systems. This article describes how the use of project management at utilities has evolved and highlights the benefits and pitfalls along the way.

Basically, the application of project management techniques in the utility industry appear to have been driven by six dominant factors. The most visible “impact items” at utilities have been:

• The perception of outages as projects
• The transition from large base load projects to smaller projects
• The increasing need for more effective resource management
• More active regulatory agencies
• The trend toward distributed project management
• The acceptance of desktop computing

Utilities today need to be able to accommodate change, be anticipatory in developing strategy, and apply versatile tools and methodologies in response to these external variables.

BACKGROUND
Most early project management applications were focused on plant construction. During the 1960s, utilities were in the “Grow and Build Era.” As demand for electricity increased, utilities could simply build a new generating plant, apply to the utility commission, include the new plant in the rate base and collect its guaranteed profit. Many of these plants were actually designed and constructed by engineering firms and construction firms who operated their own project management systems; some had automated mainframe systems, while others relied on hand-drawn CPM networks. In either case, this was the utilities’ introduction to project management.

“Since the mid 1970s, almost all major power plants constructed have enjoyed—or perhaps been ‘inflicted’ with”—a project management system. Initially, these systems were run mostly on large architect/engineer (A/E) owned mainframes, with the project management function performed by A/E staff members. Over time, utilities such as Northeast Utilities, Arkansas Power & Light, and Florida Power & Light, formed their own project management staffs to oversee the construction of large base load facilities; particularly nuclear power plants.

Typically, the nuclear division of a utility was the first to use automated project controls. As time passed, managers found that many of the same benefits were available to the fossil side of the house. For example, in 1987 computerized scheduling guided a $1.6 billion, two-unit 761 MW, coal-fired generating station to completion; on time and under budget. The project management team from Los Angeles Department of Water and Power setup an integrated cost/schedule database which computed contract progress payments based on reported progress. This is a perfect example of the traditional use of automated scheduling tools-specifically, an application of the time-honored CPM scheduling concept.

OUTAGES AS PROJECTS
In the late 1970s utilities began to use project management techniques to control nuclear refueling outages. This was probably the first widespread non-traditional use of project management techniques in the utility industry, even though it is now considered a routine way to use project management.

Florida Power & Light is one of the most visible utilities in this area. They have published several articles on their successful use of project management techniques and the PROJECT/2 project management software package to control outages at their nuclear power plants. FP&L has documented:

• Cost reductions or avoidance (replacement power, additional labor cost, etc.) of 2.6 million dollars during two outages
• 1.3 million dollars of out-of-pocket savings during two outages
• An average four-day reduction in outage durations
• Timely execution of all scheduled work both on and off the critical path.

FP&L also expects that overtime the use of project management techniques will reduce their average outage durations from approximately 70 days to approximately 51 days.

Looking back, Frank Ponzio of Bechtel Power Corporation, summed up the change in perception of outages that occurred after Three Mile Island this way:

“Prior to the TMI accident, planned nuclear refueling outages were typically scheduled for a routine of core refueling and general maintenance work. Plans were developed to accomplish as much plant maintenance and betterment work as possible while the refueling activities controlled the overall outage duration... Following the accident at TMI, the nuclear power industry found themselves in a totally different environment. Efforts were initiated to improve nuclear power plant effectiveness, resulting in significant plant modifications. This period of regulatory con-
Scissorness created a new trend in nuclear outage management.

Throughout the 1980s, mandated backfits and the aging of operating nuclear plants has reversed outage scope priorities and methodologies. Often the refueling activities are no longer the critical path in an outage. Outages can now be perceived as backfit shutdowns that occur on a refueling time cycle.

Significant activities during an outage include:

- Refueling operations
- Plant betterment
- Preventive maintenance
- Corrective maintenance
- Technical specification requirements for inspections or surveillance

No longer was the shortest outage duration the overriding goal of the outage team. Now the most cost effective use of resources is often just as important as producing the shortest outage duration. The entire process must be carefully documented for operating plant prudence reviews. Utilities no longer have the luxury of “unlimited” resources to direct at problems. The cost of adding resources to shorten the outage by a day must be weighed against the savings generated by trimming a day from the outage schedule.

The concept of the “outage as a project” means that there is a project life cycle for the outage. This includes pre-outage planning, set-up of a process to control work and monitor trends during the actual outage, and finally, post-modification testing and paperwork closeout. The Institute of Nuclear Power Operations (INPO), an industry-funded group, has studied reactor availability and ways to improve it in the United States. Major recommendations by INPO include improved pre-outage planning, long-range planning (multiyear), detailed craft planning, and integration of work activities. Each of these recommendations can make use of automated scheduling tools.

Fossil Plant Overhauls

In the early 1980s, fossil-fueled power plants began to receive the same detailed computer schedule modeling once reserved only for nuclear plants. These efforts have rewarded nearly every utility who has applied them; including Los Angeles Department of Water and Power, Pennsylvania Electric, Public Service of New Hampshire, and Arkansas Power & Light. Outage management is quite similar in fossil and nuclear facilities. The major difference is in scope development. At a nuclear unit, about 75% of the scope is identified prior to the start of the outage; with a fossil unit this number is about 30%. This is primarily due to inspection-related activities, which may or may not require additional scope. Once in progress, a nuclear outage typically has a few complex schedule changes, whereas the fossil unit typically has many simplistic changes. The end result of applying automated schedule modeling to fossil fuel power generation is the same; however, clearer mission statement, shorter outage durations, better resource usage, reduced costs, and improved communication between all players on the outage team, from executive management to shift supervisors.

TRANSITION FROM LARGE, BASE LOAD PROJECTS TO SMALLER PROJECTS

Today, utility companies are at the end of a transition that has profoundly affected project management. Simply stated, the transition is from large projects to small projects.

Utilities have seen the end of the era of rock-steady growth, in which A/E firms could always see the next plant on the drawing board, and utility management talked of growth in terms of positive, unending, escalating demand. Utilities with nuclear projects were questioned about the wisdom of building the plants. Rate-payers and public utility commissions began to question the need for newer, bigger power plants. And, large base load projects in the nuclear, coal-fired, and hydro worlds were delayed or canceled.

In the new era, cost containment, aging plants, tough regulatory environments, and competition are the topics utility executives discuss. Projects are smaller in this new era. They tend to be short-duration projects, such as life extension, plant betterment, transmission and distribution projects. Just because these projects are smaller than projects in previous eras, they are no less important.

In order for utilities to maintain visible service to their customers it has become necessary to rejuvenate older plants with retrofit projects that upgrade equipment, improve heat rate, and bring emission into compliance. With no new nuclear construction projects and few new large fossil projects on the drawing boards, the focus of electric utilities has shifted to operational reliability and cost effectiveness of existing generating plants. Generating technology, developed in the baseload, multi-generating-unit era, must now be updated, modified, or even scrapped for plant betterment and life extension mini-projects. Cost containment and time constraints are the prime movers of utility betterment projects.

Utilities are finding that the collective financial risk of a group of capital expenditures is still quite large, although it is spread over a number of projects, rather than one or two large ones. According to Electric World’s Annual Statistical Report for 1989, the capital expenditures were over $23.3 billion for the total industry, with $11.2 billion being apportioned to transmission and distribution facilities.

Managing Smaller Projects

“So what’s different about project management systems applied to a retrofit project versus a large project?” There are several key differences. The effort to manage a small project is often more intense; management requires analytical data faster; the work is forced into a smaller window of opportunity; the project controls tools need to be sophisticated, fast and efficient.

Most retrofit projects take place during a plant outage, and the project control systems may appear similar to those used for outage management, but there are differences. Normal outage activities tend to be maintenance-oriented, with soft logic ties. In contrast, retrofit projects tend to be construction efforts, with hard logic and a concern for material delivery, engineering drawing, and contractors. Retrofit projects have a much greater
need for trend analysis and “what-if” scenarios.

Other areas affected by smaller projects are the organization of the projects group, the supporting cost/schedule staff and computer systems. With a large project there typically comes a strong project manager. Although it may not be the best practice, the project manager can “bulldoze” through problems. With a smaller project, a utility may have 200-500 individual mini-projects, without the benefit of a single project manager. Therefore, the project control group must be able to set priorities and guide the total group of projects through to completion. To be successful, the utility must have a continuous stream of successful projects.

“Why not use a smaller computer to manage a smaller project?,” is another question project controls personnel often hear. As we have seen, the project controls required of smaller projects are often collectively very large, making PC-based systems inappropriate. On the other hand, there are many situations when a PC-based system offers a very cost effective solution. In fact more companies use both. This allows data integration to take place on the mainframe for corporate reporting, while giving the cost/schedule personnel in the field the power and flexibility of the project management tools under their control.

Transmission and Distribution

Transmission and distribution (T&D) projects typify the “smaller” project that now benefit from computerized project management. As “small” projects, T&D has been around for years; but as a percentage of corporate annual budget, they were so small that no one paid special attention to managing them. This has changed. Not only are utilities using project management techniques to engineer, design and construct substations and transmission lines; they are also using them to resource constrain crew sizes and track new customer installations.

Electric Substation Construction

Substation construction is another area of change and growth in use of project management systems. Whereas many think of building a substation as simply a matter of pouring a slab of concrete and mounting a transformer, Boston Edison reflects today’s more complicated scenario. When a new substation was required in Boston’s historic Downtown Crossing district, the utility found they had to meet local historic preservation codes. Boston Edison had to build a substation and then enclose it in a reproduction brick townhouse. This required high temperature transformers and special air handling equipment, and a tight construction schedule—a perfect assignment for a project management system.

PCB Transformer Removal

PCB transformer removal represents another critical power delivery area. Removal of all transformers containing polychlorinated biphenyls (PCBs) located in high fire risk areas has been mandated by the Environmental Protection Agency (EPA). Utilities must have a viable removal plan, and implementation is monitored by the EPA. At one large utility in the Northeast, a PCB Transformer removal project was budgeted at $40 million. Using scheduling tools, a utility can track and record progress in this vital area.

A NEED FOR MORE EFFECTIVE RESOURCE MANAGEMENT

With the transition from large to small projects came an increase in the complexity in resource and scope management. There were more players, more complicated project relationships, organizational complexities, coordination complications, confusing work priorities and decentralized information.

The need for better resource management seems to be intertwined with other major concerns, such as cost containment, prudence reviews, long-term planning, and smaller project trends. Major areas where project management techniques are being used for resource management include: in-house engineering staffs, mobile maintenance forces, general outage support services, transmission and distribution.

In 1987, the Pennsylvania Power and Light Company set cost and schedule objectives for major refueling and inspection outages at their Susquehanna Steam Electric Station. Their managers recognized that planning and controlling key resources are critical to meeting these objectives. Resources considered in the program are direct labor, selected support group labor, key equipment (such as polar cranes and lifting rigs), and work documents. By integrating data from several existing databases, PP&L implemented a resource planning program which could provide reliable manhour estimates and was compatible with both the work groups’ crew planning criteria, such as critical skills and key tasks, as well as the schedule structure (system available, etc.). The resulting system was adapted to PP&L’s management process and provided an integrated outage resource planning, analysis, and control system for outage management.

Another key resource planning area is in engineering management. Many utilities now maintain their own engineering and design staffs, sometimes quite large. As the trend toward many smaller projects grows so does internal competition. The separate engineering disciplines find themselves competing for support on projects. The various operating stations, fossil and nuclear, find themselves competing for engineering resources. In order to deal with this internal competition and remain outwardly competitive, managers need a common method of long-range planning for projects and resources. They need a system with the ability to compare planned to budgeted or actual manhours, and with enough flexibility to handle the day-to-day dynamics of the workload. And they need a true commitment to these small projects from senior management.

At Northeast Utilities, there is a central staff of 700 devoted to engineering, construction and project management. This group serves all the NU sites, including four nuclear plants and a variety of fossil and hyd-
eluding a trash-to-energy plant and a unique pumped-storage hydro facility. The NU project management staff was faced with managing the engineering resources for 760 projects.

An INPO symposium on outage management concluded that the best way to improve outage (and therefore plant availability) at nuclear plants was to improve the engineering effort before an outage. This was true during a Millstone 1 outage, where 30 projects were planned during a tight outage window (11 weeks). Ninety percent of the Plant Design Change Requests were approved 30 days before the start. All pre-outage construction activities were started on time, and two planning engineers helped develop and monitor all engineering schedules for the outage.

Similar efforts are taking place at GPU Nuclear, Pennsylvania Electric, and Boston Edison.

**Work Management Systems**

Although project management systems continue to be at the heart of the work management process, some utilities are now formally expanding the Work Management System (WMS) with automated tools. These WMSs are generally found in the utility engineering organizations where not all work is project-related; in fact, non-project-related work often consumes a significant amount of resources. This "baseload" work was typically managed independently with a variety of non-integrated tools and systems. The utility WMS approach focuses on having the right tools to support individuals while still being integrated into an organization-wide information network. This allows the engineering organization to address individual management information needs, while engineering project control organization captures data required for use in planning, resource management, performance measurement, and scope control.

Work management within utility engineering organizations is a complex process. The work management process is continual, with no defined beginning or end to scope accomplishment. It is difficult to ensure that corporate goals and objectives are represented in day-to-day decisions and strategy development. In addition, management must respond to an ever-changing political, economic, regulatory and social environment which requires managing resources within the confusing, and sometimes conflicting, framework for balancing project life cycles, and budgets.

Advances in information management, like relational technology, allow project management systems to serve as the centerpiece of centralized engineering control and work management.

**MORE ACTIVE REGULATORY AGENCIES**

The effect of regulatory agencies, both state and federal, has been ever increasing. Two of the hottest topics for the 1980s were prudence audits, or prudence reviews, and the concept of the Integrated Living Schedule or Integrated Implementation Schedule. These topics have primarily affected nuclear operations, but the public utility commissions are now looking at fossil operations with a critical eye, while stack emission and other environmental concerns further impact these fossil utilities.

Dramatic rate increases have put both the utilities and the public utility commissions in the spotlight and under the microscope. No longer is it a simple procedure to be granted a rate increase. No longer are rates of return guaranteed. In fact, in one decision, the Massachusetts Public Utilities Commission cut back the rate of return to which Boston Edison was entitled. Public utility commissions are looking at a variety of factors when evaluating a utilities rate increase request. The "prudence audit" is one method of determining which costs a utility is allowed to recover through its rates.

**Prudence**

A key factor in promoting good project management, in general, is the prudence audit. Almost all nuclear power plants have had some kind of prudence audit performed regarding cost and management decisions. Increasing numbers of public utility commissions are using prudence audits to identify improper costs and to disallow them from being passed on to the ratepayer.

The prudence audit is being used by public utility commissions to investigate utility management decisions with respect to new power plants and outages which are extended because of some problem. The outcome of the audit is used to determine what costs the utility is allowed to recover through its rates.

Some utilities have been faced with large rate base disallowances due to prudence audits. Two examples of utilities that have had large rate base disallowances are LILCO and Philadelphia Electric. A $1.4 billion disallowance was recommended on LILCO's $4.7 billion Shoreham Nuclear plant, and $369 million was disallowed at Philadelphia Electric's Limerick 1 plant. Obviously the real question is, who pays?—the ratepayer through higher utility bills or the utility's shareholders through writeoffs of a portion of the investment.

Project management systems can help utility managers show schedules, costs and the process by which decisions were reached. In order to be "prudent," a utility must have prudently and reasonably managed the project's schedule and costs both in the conception of the project and during project delivery. Increasingly, public utility commissions are conducting "operating plant reviews," which are basically prudence reviews for plant outages. Outage management personnel use project management system reports to show prudence in decision making.

**Rate Justification**

Because of the financial risk involved, utilities are under much more pressure to ensure that their rate case hearings go smoothly and quickly. This has prompted several utilities to use project management techniques to schedule all work related to a rate case. Scheduling the rate case work ensures that all work is done in a timely fashion, thus increasing the utilities' chances of having the request approved quickly.

**Integrated Living Schedule Concept**

Underlying nearly every Integrated Living Schedule is a computerized project management system working
in conjunction with other utility systems. The Integrated Living Schedule (ILS) or Integrated Implementation Schedule is a long-term plan (five years or greater) often negotiated between a utility and the Nuclear Regulatory Commission (NRC). The ILS schedules nuclear power plant maintenance and retrofit activities over several refueling cycles. Refueling cycles are generally 12-to-18 months. The ILS is the product of a dynamic process which recognizes the needs and limited resources of the NRC and of the electric utilities operating nuclear power plants. The ILS uses an ongoing process of identifying, integrating, prioritizing, selecting, and scheduling plant betterment activities. Early ILS programs were often the result of the NRC’s efforts to “help” a utility manage a large regulatory backlog. In more recent times, the process has a broader perspective and is concerned with the needs of all the stakeholders. To sum up, the ILS process is just plain good management practice. Not all utilities believe in incorporating those concepts in the operating license, but nearly all implemented some type of long-range plan, regardless of what it is called.

As its basis, the ILS considers safety, regulatory, reliability, operability, and economic factors, with the dual goals of optimizing resource allocation and assuring the protection of public health and safety. The ILS process is a comprehensive program for the allocation of resources to support the most cost and safety beneficial activities. “It integrates utility needs and limited resources with regulatory requirements to arrive at completion dates for both utility-initiated and NRC-imposed projects.”

The ILS is integrated because it combines cost, manpower, budgets, and schedules within a single database. The ILS further integrates corporate goals and business strategy, and typically segregated types of workscope (e.g., operations and engineering, maintenance and modifications). It is “living” because it is not “cast in concrete,” but changes as conditions warrant.

A number of utilities have embraced the concept of the integrated living schedule. The first was Iowa Electric Light & Power. In May 1982, Iowa Electric Light & Power submitted a five-year living schedule for the Duane Arnold Energy Center. In May 1983, the NRC approved Iowa Electric’s ILS amendment. Later that year the NRC issued Generic Letter 83-20 endorsing the Iowa Electric living schedule as an industry standard program that they (the NRC) would like to see implemented. There is more significant history to the NRC’s attempts to regulate the ILS process. In general, the industry’s response to a regulatory ILS was “thumbs down,” but their response to strategic long-range planning was “thumbs up.”

Utilities have recognized a long list of benefits derived from implementing an ILS. Tops among them are: optimal resource usage, objective comparison of regulatory and plant betterment issues, objective prioritization of proposed modifications, long-range financial planning, objective basis for negotiation with the NRC, management review and support, meeting commitment dates, availability of planning information to all departments, etc. The list goes on. Clearly there are also many benefits to the utility beyond simply dealing with the NRC. In fact, no utilities have any desire for increased active involvement in company business by the NRC.

In an era of increased regulatory awareness and cost containment it is not unreasonable to expect the concept of the Integrated Living Schedule to be applied to fossil units. After all, it is the prioritization process used to allocate limited resources that makes the concept of the Integrated Living Schedule almost universal in nature.

Commitment Tracking

Another area where project management systems help managers affected by regulations is in commitment tracking. Utilities frequently commit to the NRC or other regulatory bodies to take a specific action by a specific date. If this date is missed, the company faces a deficiency report or, worse, a monetary fine. In nuclear organizations it is possible to have a number of people making commitments. Therefore makes good financial sense to use the scheduling system to track these key dates and avoid further deficiencies and possible fines.

THE TREND TOWARD DISTRIBUTED PROJECT MANAGEMENT

Distributed project management puts project planning, scheduling, and cost control in the hands of line personnel. Utilities were implementing this in a variety of ways in the mid-1980s. Some were putting project control tools directly in the hands of engineers and supervisors, and giving them responsibility for generating schedules and budgets. In its most extreme form, this approach signaled the end of the project controls staff focused on one project.

On the other hand, in many cases, distribution of project management tools is combined with the development of an overall project management department. In this scenario, project management tools are distributed to engineers, but their plans, schedules, and budgets are submitted to a central project controls staff who manage diverse projects. This ensures that projects and budgets are monitored from a corporate management perspective, and minimizes the risk of costs or schedules getting out of hand.

Some utilities put the project controls tools in the hands of supervisors and then reduce the project controls staff to one or two individuals. This was exactly the situation in 1987 with Combustion Engineering, who was working closely with Korea Electric Power Company to engineer and design a new power plant. The Koreans were working side-by-side with the CE employees. The project controls staff was very small. Each of 20 supervising engineers were provided a PC-based project management software program. Each supervisor built his own network. The project controls staff loaded these networks to CE’s scheduling software on the corporate mainframe for consolidated reporting. The total network of 17,000 activities, constraints, and resources was maintained by the limited project controls staff. The benefits of the distributed system included some pleasant surprises. In addition to reduced training time (PC programs tend to be user-friendly), and the obvious staff reduction savings, the project manager has found a real pride of ownership among the
engineer supervisors. No longer do they feel the schedule was imposed by “someone else” for them to meet. Rather it is their schedule. They have a greater awareness of how the various disciplines interact and affect each other—a major step forward. This leads into the last “impact item.”

ACCEPTANCE OF DESKTOP COMPUTING

Personal computers have had a major impact on project management in the utility industry. In the years since IBM introduced their Personal Computer, the use of computers in business has changed dramatically and more than 50 project management packages for personal computers have come to market since 1984, priced from $100 to $5,000 or more.

In addition to cost, the main advantages of PC-based project management packages are ease of use, computational speed, and the perception that they are putting control of the project right in the manager’s hands.

Today’s high performance workstations have also eliminated most objections relating to smaller project capacity, both in the size and length of the project, and relative inflexibility in the options.

One utility that is committed to using PCs for project management is Pacific Gas and Electric Company (PG&E). PG&E was one of the first utility companies to take this approach on a corporate scale. PG&E is interesting because they were using mainframe project management software to manage their large projects (over $50,000,000) and PC project management software for small and medium project ($500,000 to $50,000,000) planning. They are now committed to using PC-based project management software on all of their projects with a value of $50,000 or more whether they are large, medium, small, or staff projects.

PG&E has three standard reports that everyone is committed to using: schedule bar chart, cost plan, and resource plan. Without these, no project over $50,000 is approved. PG&E is a very large utility company, with nearly 30,000 employees located at 120 different sites or offices which uses PC-based project management on projects ranging from design and construction of power plants to load forecasting, environmental studies and research and development efforts. PG&E is committed to the project management concept and is a driving force in the industry for bringing new and better computer tools for project, program and functional managers.

Hardware Advances

Hardware advances in the area of LAN (Local Area Network) has removed one of the last objections to the use of PCs for project management: if the data is on a lone PC, it is difficult to share that data with others or interface with corporate systems;

LAN networks typically link many users together and have links to the company mainframe. Southern California Edison, for example, has 800 users on LAN. This also illustrates how corporate MIS and EDP managers have seen these PC LANs as a low-cost/high-productivity solution.

CONCLUSION

A number of factors have driven utilities to change the way they manage projects:

- The need to improve plant availability and reduce costs has forced utilities to manage outages as projects.
- The transition from large base load projects to smaller life extension and plant betterment projects, with a focus on the effective use of resources and dollars, has forced utilities to use more sophisticated and efficient project control systems.
- Prudency reviews and the possibility of resulting disallowances are forcing utilities to manage projects in a reasonable and prudent manner.
- Additional regulatory demands make it essential for a utility to optimize the use of resources to ensure timely, cost effective completion of utility-initiated and regulatory agency-imposed projects.
- Since distributed project management has been found to be the most effective way to manage multiple small projects, it is causing utilities to rethink and restructure their project controls staffs.
- The advent of desktop computing and LANs allows cost effective application of project management practices to small and medium-size projects and is driving down the level at which project management is performed.

All of these factors are putting increasing pressure on utilities to be better managers. As a result, there is an ever increasing need to employ the best people, the best processes, and the best tools. Utilities must first ensure that they employ the best people—highly trained and dedicated project control people. Second, they must ensure that processes and procedures are in place to smoothly and effectively monitor and control projects. Finally, utilities must always have the appropriate tools available: state-of-the-art systems, both in hardware and software. Without these three things in place, no utility can hope to successfully manage their projects in the future.

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