EPRI

Asset Management Technology Update

Strategic Asset Management – Solutions for Deregulated/Re-regulated Industry

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MM&T
MAINTENANCE MANAGEMENT & TECHNOLOGY

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Technical Update, March 2004

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ABSTRACT

Over the past five to ten years, US Electric Power Companies have faced many challenges brought on by such changes as deregulation, restructuring, and in some instances, re-regulation. Industry CEO's and CFO's must meet a myriad of regulatory and safety requirements while, at the same time, meeting shareholder expectations and customer demands for reliable electrical energy at affordable rates. In this new business environment they [CEO, CFO] now find that their business operations are on center stage.

Power Producers, regulated and non-regulated alike, now require, as never before, access to accurate, real-time, and forward-looking knowledge about their physical assets, their markets, their inputs, and their impact on their organization's core business and how their business affects the public - Customers and Investors alike.

This Technical Update takes an objective look at the evolution of Asset Management from the days before computers through the advent of Computerized Maintenance Management Systems (CMMS), to Enterprise Asset Management (EAM) solutions, to the emerging technologies that enable Performance-based Strategic Asset Management. Though this journey, we examine how outside influences such as deregulation, re-regulation, the aging workforce and aging infrastructure, and investor/SEC expectations affect how asset management will be carried out in this decade and beyond.

Although this report is focused primarily on Power Generation, its contents are applicable to Transmission & Distribution and Retail operations.

CONTENTS

1 BACKGROUND

Deregulation, restructuring, and in some cases, re-regulation, is changing the rules by which US Power Companies have been operating under for years. These changes place new pressures on producers and distributors alike, while offering up new opportunities as never before. Competition with independent power producers and merchant generators is now the new business environment in addition to Public Utility Commissions.

Electricity has become a commodity business requiring new operating strategies focused on cost reductions while, at the same time, improving plant availability and reliability. EPRI and its Family of Companies is working with its Members to help them achieve their business objectives by:

- Leveraging Technologies and realigning business process
- Lowering the cost of production
- Increasing Plant uptime

Proprietary networks no longer dominate industrial automation. The rising availability and declining costs of Internet Protocol (IP)-based Ethernet, Transmission Control Protocol/Internet Protocol (TCP/IP) and related technologies have paved the way for open standard Internet protocols to make their way to the factory floor. The technological convergence between traditionally separate domains such as plant automation and enterprise information systems is enabling breakthrough applications that optimize the entire enterprise[1]. As stated in the National Energy Policy, the " challenge is clear – we must use technology to reduce demand for energy, repair and maintain our energy infrastructure, and increase energy supply[2]."

> "Operators need access to accurate, real-time, and forward-looking knowledge about their physical assets, their markets, their inputs, and their impact on core business. Not only within a single plant, but also across a portfolio sometimes geographically dispersed plants. Operators must create an environment by optimizing and integrating all the physical and business processes impacting their business objectives, so operational decisions can be made. Our bottom line is that generators must plan for increased investments in real-time analytics and decision support systems to maximize their economic value."
>
> — Terry Ray, Vice President, Energy Information Strategies, META Group, Inc., January 29, 2003

This report is intended to provide our members with a current appraisal of where the Asset Management application industry is headed and how their technological innovations might be employed. In assessing the current direction that these solutions seem to be headed we have elected to discuss them as three distinct configurations: Computerized Maintenance Management Systems (CMMS), Enterprise Asset Management (EAM) solutions, and the emerging application of Performance-based Strategic Asset Management (PSAM).

Additionally, in the current Governmental oversight environment arising out of the Enron and MCI collapse we also elected to discuss what the potential impact of the Sarbanes-Oxley Act of 2002 might have on our member organizations and how Asset Management technology might be employed to meet new reporting requirements.

2 COMPUTERIZED MAINTENANCE MANAGEMENT

2.0 Overview. During the past thirty years technology has provided power plant maintenance departments with an ever-increasing capability to manage the maintenance activity and contain those costs associated with plant maintenance. The most fundamental approach to managing maintenance activity through the application of technology-based tools is Computerized Maintenance Management Systems (CMMS). In this report we classify a CMMS as a maintenance planning and management application used by a single plant to manage their maintenance activities. Our definition does not mean that the same CMMS would not be found at multiple plants within a company, but it does imply that these separate instances of the application are not normally integrated with each other or with other ERP and MRO management applications.

The care and support of plant and equipment assets requires a complex system of suppliers, parts inventory, business processes, technology tools and information flows. Add to the mix several different functional areas with different agendas and the need for clear and coordinated goals becomes a "critical success factor" when trying to improve asset performance.

In the ensuing paragraphs we will discuss a CMMS solution in both generic and specific terms. We'll also present some points for consideration that should be taken into account when selecting a CMMS. Our discussion will also touch upon a very small segment – the *Home Grown*, or in-house developed, CMMS.

2.1 Selecting a CMMS Solution.

Understanding and selecting the right CMMS can make the difference between "just another program" and a meaningful and lasting improvement. Care and support of power plant assets requires a complex system of suppliers, parts inventory, business processes, technology tools and information flows. Add to the mix different functional areas with different agendas and the need for clear and coordinated goals become *critical success factors* when trying to improve asset performance. In today's ever changing business environment, managers need to develop a clear vision of what their objectives are and search for a CMMS solution that best meets their vision. Care must be exercised so as not to select a solution that fits today's requirements, but fails to consider other factors such as a growing electronic performance support system (EPSS) capability. Additionally, attention should be directed toward understanding the total life-cycle cost, an area traditionally overlooked. For instance, what are the costs associated with integrating a new CMMS into the existing, or planned, enterprise business systems? Costs associated with personnel on CMMS operations, etc.

Appendix A provides additional insight into the CMMS selection process[2].

2.1.1 Your Maintenance Objective.

In selecting a CMMS solution for your organization one of the first questions that needs to be asked is this: What are our Maintenance Objectives? If the answer is simply to allow for work order planning and general inventory control at a single plant, then Tier 1 CMMS solution is probably all one needs. On the other hand, if the answer involves a most intense maintenance planning activity such as part of a plant optimization initiative coupled with the desire to interface with corporate business systems and even third party vendors then a higher end Enterprise Asset Management solution.

2.1.1.1 [Streamlined] Reliability Centered Maintenance. Maintenance program design, implementation and continued optimization (see Sections 4.2.2. and 6.2) are the cornerstone of plant maintenance performance. Success in this area can be measured by total maintenance cost and overall equipment availability and performance. Selecting the right solution for your business objectives is crucial.

One strategy used commonly within the area of maintenance program management is that of Reliability Centered Maintenance (RCM). With RCM, maintenance scheduling is based on actual equipment reliability and performance data rather than arbitrarily established time-based intervals. In addition, RCM seeks to prioritize equipment based on failure consequences and incorporate condition-based and predictive capabilities along with run-to-failure (RTF) data.

2.1.1.2 Total Productive Maintenance. TPM is a total quality approach to maintenance that seeks to encompass process and asset ownership with Prevention-At-The-Source techniques to improve Overall Equipment Effectiveness (OEE). The direct results include extensive OEE improvement and reduced cost of maintenance for plant equipment and processes.

2.1.2. MRO and ERP Integration. The maintenance, repair, and operating (MRO) supply system is part of the life blood for power plant operations and maintenance. Such a system can have enormous leverage for improving asset performance and reduce maintenance costs. The opportunity lies in streamlining, automating and improving the reliability of this complex system. Integrating all departments and functions across your company, or even your plant, onto a single computer system that can serve all those different departments' particular needs is the objective of an enterprise resource planning (ERP) system. A CMMS solution, as opposed to an EAM solution, may not allow for a seamless MRO/ERP integration, but can allow progress toward seamlessness to be realized. Again, as we discussed in paragraph 2.1, such an outcome should be considered when making your CMMS selection.

2.2 In-House CMMS.

Some organizations have discovered that it is simply easier to design their own maintenance management system. One such EPRI member to do so is Northeast Generation Services Company (NGS) of Rocky Hill, CT[3].

The primary objective of the NGS Plant Manager (NGSPM) is to efficiently and effectively manage maintenance activities at fossil and hydroelectric generating facilities. Accomplishment of this objective required the development of "systems" and subsystems to document, control, monitor, store, and retrieve, on demand, production maintenance related information. The magnitude of this effort, coupled with the desired manipulation capabilities of the associated systems and components, requires the use of automated techniques and the availability of computerized support systems.

The NGS Maintenance Manager provides the following basic features:

- Extensive capability to capture and track engineering, equipment name plate, location, spare parts, maintenance and historical data
- Extensive planning capabilities from basic ‘fix it now’, problem identification and collection through detailed planning and scheduling features
- Collects and tracks detailed historical data, maintenance experiences, and resources required to maintain equipment
- Capable of operating on data it has collected to do statistical and trending analysis
- Up to date open 3-Tier architecture technology.
- Scalability from 1 to hundreds of simultaneous users
- Basic functions can be Internet enabled.

As with commercially available applications, In-House systems rely on a standardized equipment identification protocol, have the ability to log reported problems and create and track work orders and support some form of historical record analysis.

3 ENTERPRISE ASSET MANAGEMENT

3.0 Overview. Enterprise Asset Management (EAM) allows companies to define and monitor their equipment, hardware and software and the human capital required to operate and maintain it. Figure 3-1 provides a graphical representation of an enterprise's operations and the role of an EAM solution in it.

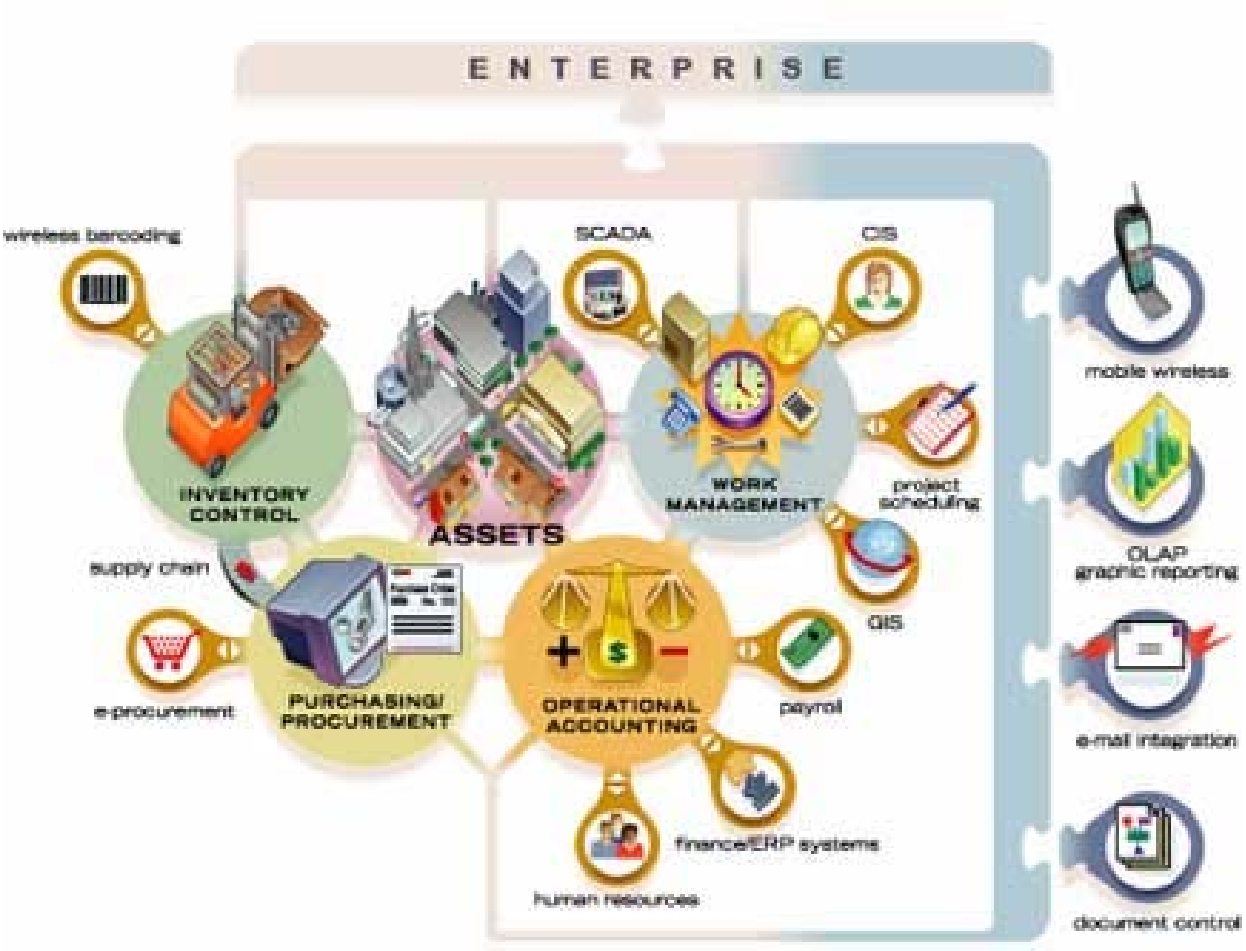


Figure 3-1. Source: Synergen, Inc. (© 2003 Illustration courtesy of Synergen, Inc.[4]**)**

3.1 Asset and Resource Management. A well designed CMMS can have applicability in areas other than maintenance planning and scheduling. For instance, recent advances in technology and systems integration interoperability not only allow plant maintenance and operations managers, but corporate and plant executive management alike, unprecedented real-time access to information about a plant's, and subsequently, a Corporation's (The Enterprise), assets and resources, through an electronic view, or portal, commonly referred to as a Digital Dashboard. In other words, for the first time, multiple layers of management can view the organization's health as a pre-defined graphical representation unique to an individual manager's domain or sphere of influence.

3.1.1. Digital Dashboard. Perhaps the best known and most widely used digital dashboard is MS Outlook. Outlook users can customize their digital dash board to display their calendar, e-mail previews, and selected tasks. Similarly, an EAM Digital Dashboard can be customized to present the viewer with a view of just the right combination of information that they need to perform their job. A maintenance craftsman dashboard might display their day's assignments and links to such performance support applications such as work orders, user and procedure manuals (organized with the work order), parts ordering, special tools check-out, and Just-in-Time (JIT) Training to name a few. Similarly, a maintenance planner, maintenance supervisor, and operations superintendent digital dashboards might display information about planned outages, equipment down-for-maintenance, estimates-to-completion timeline for out-of-service equipment, load management, etc., while plant managers and corporate executives would have access to such enterprise-wide business drivers as grid loads, unit output, cost of replacement power, plant resource availability, load demand, vehicle fleet resource availability, worker/staffing status, and so on.

Additional information about digital dashboards and how they can be used can be found in an upcoming EPRI report about Electronic Performance Support Systems (TR-1004877) scheduled for release in March 2004 by the Simulator and Training Center and in Section 5 of this report.

3.1.2. Workflow Management. An integral aspect of an EAM solution is workflow management through accurate and timely management of craft's skill levels, predictive and preventive maintenance activities, internal and external resource scheduling and integration with third-party applications such as MS Project and Primavera, time-keeping, and safety/compliance tracking.

3.1.3 Inventory Control and Material Management. Today's operating cost management practices demand that maximize the benefits derived from just-in-time parts and supplies stockage and material accountability.

3.1.4. Procurement. Reduce the overall cost of procurement by allowing department and project managers to purchase parts and supplies through such technology-based applications as EDI and B2B (business-to-business) to maximize business supply chain business needs.

3.1.5. Accounting. From General Ledger (GL) integration and conformity while providing information accessibility down to the lowest work level.

3.1.6. Analysis and Reporting. Provide on-line, real-time reporting of standard and ad-hoc reporting tailored for the level requesting the information. Seamless interfacing to standard reporting tools such as HTML, Excel, Word, Crystal Reports, Oracle Discoverer, and graphical OLAP format, etc.

4 FORCES OF CHANGE

4.0 Economic Conditions

Since 2000, US and World economic conditions have forced energy companies in general, and US electric power companies in particular, to focus on their assets as never before. Mergers and acquisitions, consolidation of operational business units, and government regulations have driven some companies to explore what it takes to maintain and report on their assets.

4.1 Trends and Business Drivers

In the old world, connection distance mattered. Today, increasingly, it doesn't. The enabling technology of the Internet is equally applicable to a one-inch connection or a 1,000-mile connection. As a result, factory floor device information can now be widely leveraged throughout a plant, site, enterprise or extended enterprise—including trading partners.

Today, power-producing enterprises are focused on operational and procedural efficiencies that will make them more competitive and responsive in a deregulated business environment. They require business systems that will address their business needs efficiently and adapt to changes as their business needs or their environment changes. This requirement, known as Interoperability, allows them the ability to collaborate within their enterprise and with their partners and customers.

In today's environment, collaboration requires the integration of multiple business systems within your own company and with business systems and process of your partners and, in some cases, with your customer's systems. Companies that look for a single solution may find that the Internet will not be so accommodating as to allow, or support, the desired results.

> *Customers, suppliers, manufacturers, governments, and marketplaces will have their own favorite systems. Efficient collaboration in today's business environment requires companies to integrate with their partners, suppliers, manufacturers and customers. Very likely, they will be integrating their internal business processes at some point or another as newer processes are introduced that is not supported by their existing systems. Integration requires the coordination of multiple autonomous business systems within their organization, their partners, and customers. Interoperability is inevitable. It is best to have a well-implemented universal strategy addressing interoperability across the value-chain to establish and maintain your competitive advantage*[5].

Internet based technologies are having a tremendous impact on business and the field of Enterprise Asset Management. One such area that is beginning to benefit from these technologies is condition-based maintenance (CBM). Integration of condition monitoring and analysis tools with enterprise asset management solutions and other enterprise business applications a network-centric system can be achieved. Such an integration of plant floor asset management information throughout the enterprise can be a key step for organizations seeking operations and maintenance (O&M) improvements to remain competitive.

4.1.1 Business Process Improvement

Operator Excellence.

Recent restructuring of electric utilities and the advent of increased operator certification requirements have directed attention toward power plant operator training. Companies are examining the strengths and deficiencies of their programs and frequently request models for comprehensive operator training. In addition, they are investigating ways to incorporate awareness of maintenance planning activities and

plant efficiency into their existing training programs. As a result of these initiatives, many power plant operators have implemented an Operator Excellence program built upon the following four training elements:

- Technical Training Elements. Technical training for power plant operators is divided into self-study, on-the-job training (OJT) (that is, "hands-on" training), classroom, demonstration of technical competence, and mentored training. Operator certification preparation is also part of a comprehensive training program in facilities where certification is required.

  Technical training often overlaps and interfaces with regulatory and safety training because correct operation of the equipment is an important part of working safely and protecting the environment.

- Regulatory Training Elements. Regulatory training elements consist of environmental training, Occupational Safety and Health Administration (OSHA) training, and emergency response/hazardous materials training. This type of training is required, and documentation must be maintained on file for presentation to environmental auditors.

- Pre-Qualification Elements. Pre-qualification elements consist of "bridge" courses for persons who have had little or no previous technical education. These courses help the candidate to prepare for an entry-level operator position and the position's training requirements.

- Post-Qualification Elements. Post-qualification elements consist of operator certification outside the candidate's company. Technical training elements can be designed to help the candidate to prepare for operator certification examinations.

A common thread found within all four elements is the importance of understanding the day-to-day business drives controlling and influencing the Plant's power generating capabilities, and within this is the need for plant operators to have an appreciation for the role they plan in plant maintenance. Therefore, increasingly, one will find that plant operators have a need to interface with the CMMS.

Plant Maintenance Optimization. Plant Maintenance Optimization (PMO) designed to integrate Maintenance Strategies, Work Identification Methods, Work Control Processes, and Continuous Improvement. EPRI's Model is the basis for leading power production organizations into the competitive environment. Electric power producers can achieve lower operating costs and higher asset reliability and availability by optimizing their overall maintenance program.

MRO Supply Chain Optimization. The maintenance, repair, and operations MRO supply system is part of the lifeblood for plant operations and maintenance. This system has enormous leverage to improve asset performance and reduce maintenance costs. The opportunity lies in streamlining, automating and improving the reliability of this complex system.

Cost, complexity and poor coordination has led, and continues to lead, to poor overall business performance. Annual MRO expenditures for a typical company can exceed 15% of total purchases[6], or more. A power plant's supply chain is complex, with many, often thousands of parts, pieces, suppliers and inventory stockpiles. Across an entire power company such complexity can be enormous. There are many decision-makers in maintenance, engineering, operations, procurement, internal audit, accounting, etc. with different agendas, who often don't communicate well with each other. Such complexity and coordination means higher costs, service gaps and lost capacity. MRO Supply Chain Optimization could be a solution, but how?

- Analyze total spending
- Rationalize the supply base
- Redesign business processes
- Use appropriate technology to automate as much as possible

- Measure and sustain the gains

Condition-Based Monitoring[7]. Systems and processes that predict the failure of machinery on the plant floor and provide months—rather than seconds—of advance warning of potential failure, and then make that information available throughout the enterprise, can spell the difference between minutes of planned maintenance and hours of unexpected, costly downtime.

Much development work remains for this model to truly become viable. Just because the communication infrastructure is becoming much more universally available doesn't mean that all the pieces are yet in place for network-centric condition-based monitoring (CBM). Information standards are critical to allowing interoperability between multi-vendor equipment suppliers, plants with global locations, and even operations and maintenance organizations within a company who must cost-effectively interoperate in a systematic fashion.

Information standards are consolidating. A consensus for an open operations and maintenance information standard is developing around the OpenO&M initiative led by two non-profit organizations—the OPC Foundation (for OLE for Process Control) and the Machinery Information Management Open Systems Alliance (MIMOSA).

The OpenO&M initiative leverages the broad support of OPC and the information depth of MIMOSA to enable open, Extensible Markup Language (xml)-based integration for O&M applications including those associated with CBM. Collectively, OPC and MIMOSA bring together leading companies with extensive experience in CBM and enterprise applications integration.

The OpenO&M information standards combine the platform, vendor- and product-neutral power of XML, OPC Foundation's XML for data access (XML-DA) standards and MIMOSA's Open System Architecture for Enterprise Application Integration (OSA-EAI) standards. These standards enable a bi-directional flow of information between operations, maintenance and emerging industrial decision support systems.

In the future, CBM may be implemented as a Web-services model, truly leveraging the full power and convenience of the Internet. For today, an increased amount of CBM is migrating online through secure and robust virtual private networks.

The combination of CBM, communication and information standards and outsourced service management culminates in a model that allows the health of assets to be managed with Internet-based information flow. This allows early warning of asset problems and cost-effective corrective actions to be put in place—ultimately giving users the higher uptime and lower costs needed to compete effectively

4.1.2 Asset Portfolio Management

Enterprise asset management is emerging as a critical capability for utilities and energy related companies of all sizes. With the capital intensive nature of the energy production and delivery infrastructure, the ability to extend the useful life of power plants and transmission & distribution assets through improved asset tracking, replacement planning and more effective preventive maintenance delivers a very robust return on investment (ROI).

Enterprise-wide Asset Portfolio Management (APM) is about aligning people, projects and organizational priorities. It's about regaining the wasted resource effort applied on work that adds no business value. APM is also about selection and prioritization, with the ultimate goal of sustaining a steady maintenance workflow micro level and a coordinated business plan at the macro level. By controlling how your business spends its capital and people resources, and identifying which to invest those resources in, APM becomes a method by which an enterprise operationalizes its business strategy.

Relying on technology, an APM program is normally administered through a Digital Dashboard (Section 5.1.2), placing a tremendous management resource at one’s fingertips. Users begin by reviewing their portfolios from various perspectives. Bubble maps, scorecards, multidimensional OLAP pivots and reports

combine to set new analytical standards in Portfolio Management and Governance. Through the use of graphical displays and pivot tables, key decision-makers, maintenance planners, plant operators, and others can visualize and achieve the desired balance of workflow and people, tightly aligning portfolios with business goals and ensure the entire organization remains in sync with its strategic objectives.

Although not specifically addressed in this report, a separate aspect of APM has taken on a whole new dimension in today's volatile business climate of mergers and acquisitions (M&As). That is, the APM process can pay huge dividends when used to track and manage capital and intellectual assets.

4.1.3 Regulatory & Environmental Pressures

Sarbanes-Oxley Act of 2002. In 2002 the Sarbanes-Oxley Act of 1934 was modified and enhanced by the Congress to include new accounting requirements for publicly traded companies. Of particular importance is a relatively sanguine one-sentence section – ***Section 409: Real Time Disclosure***. *Issuers [of common stock] must disclose information on material changes in the financial condition or operation of the issuer on a rapid and current basis*.

What, on the first reading, might appear as a new requirement that only the CFO might need to be aware of, on retrospection has considerable more of an impact to power producers who rely on the business practice of Planned Maintenance.

To effectively meet the challenges of this Act, companies must reduce risk, enable compliance, and implement best practices. Section 409 requires real-time reporting which can only be achieved by improving visibility, control and efficiency of plant operations. Because the condition, or status, of plant material assets constantly change, they can affect the financial conditions of the Company as well. This potential must now be reported as they happen. Business systems, including Asset Management systems, must be capable of supporting a real-time view of the Enterprises financial condition.

Compliance Challenge	**Strategy**	**Enabler**

CEO and CFO personally certify financial reports	• Complete & Accurate information
	• Address Issues as they arise
	  ○ Real-time Access
	  ○ Proactive
		Visibility
		• Enterprise-wide transparent, integrated process
		• Executive access to relevant and timely information (Digital Dashboard)

Disclosure of internal process and controls for financial reporting
• Auditors must verify
	• Set up better controls that work
	• Make audit fast and easy
		Control
		• Centralized enterprise-wide audit processes and controls
		  ○ Documented
		  ○ Secure
		  ○ Accessible
		• Training employees and monitor skills
		  ○ Maximize compliance with policies & procedures

Aggressive reporting deadlines	• Close books quickly	Efficiency • Reconcile financial data quickly & accurately • Implement error-reducing processes • Ensure consistent, error-free data enterprise-wide

Adapted from An Executive's Guide to Sarbanes-Oxley[8]

Government Accounting Standards Board (GASB) Statement 34 (GASB 34). In June 1999, the GASB issued *Statement 34*, containing the most substantial governmental financial reporting change in history. In addition to government agencies, *Statement 34* applies some public utilities such as Power Authorities. Thusly, *Statement 34* might be looked at as the Sarbanes-Oxley Act for government entities. For this reason, we've elected to view potential Sarbanes-Oxley reporting requirements and *Statement 34* requirements, as they might be addressed through an EAM as one and the same.

From this prospective, this report addresses regulatory reporting through a process we call Condition Assessment (see Section 5.0).

4.1.4 Aging Workforce

Former treasury secretary and current Harvard University president Larry Summers regards a skilled labor shortage as all but inevitable. Economists like former Deputy Secretary of Labor Edward Montgomery and Sigurd Nilsen, the director of education, workforce, and income security in the General Accounting Office, have issued warnings to the same effect. And in April 2002 the country's largest and most influential industrial trade group, the National Association of Manufacturers (NAM), added its voice to the chorus. The association released a white paper based on research by labor economist Anthony Carnevale, former chairman of President Clinton's National Commission for Employment Policy, which forecast a "skilled worker gap" that is beginning to appear and grow to 5.3 million workers by 2010 and 14 million 10 years later. (Including unskilled workers, the gaps will be 7 million in 2010 and 21 million in 2020.) "By comparison, what employers experienced in 1999 and 2000 was a minor irritation," Carnevale says. "The shortage won't just be about having to cut an extra shift. It will be about not being able to fill the first and second shift too." This will occur, he adds, without any heroic growth rates or bubble like economic anomalies; all it will take is a return to the economy's long-term growth rate of 3 to 3.5 percent a year[9].

The cause of the labor squeeze is as simple as it is inexorable: During this decade and the next, the baby boom generation will retire. The largest generation in American history now constitutes about 60 percent of what both employers and economists call the prime-age workforce -- that is, workers between the ages of 25 and 54. The cohorts that follow are just too small to take the boomers' place. The shortage will be most acute among two key groups: managers, who tend to be older and closer to retirement, and skilled workers in high-demand, high-tech jobs.

To see the demographic time bomb in microcosm, just count the gray heads around your own plant. In 2000, EPRI conducted an informal assessment and found that as many as 75 to 80 percent of our member's workforce could retire between 2004 and 2010.

What employers will have to do, of course, is not difficult to predict: bid up wages, hire employees from other power producers, seduce older workers to stay on the job, develop new training partnerships with community colleges and high schools, and transition from a business model that relied upon the worker's knowledge of *how the plant* works (Knowledge-based workforce) to one that relies on technology to assist the worker (Performance-based workforce).

Outsourcing. As the workforce ages and retires, more and more maintenance organizations are relying on in-house traveling work teams or third party vendors to perform non-standard maintenance activities that might normally be associated planned outages. This process, or trend, is referred to as outsourcing; the financial benefits of outsourced service management can be greatly increased through the application of internet technologies, Condition-based Maintenance, and interoperable EAM solutions. Rather than having highly specialized and costly maintenance personnel dedicated to individual plants, the outsourced model places them in a centralized location, where their talents can be leveraged across multiple sites, or multiple customers. Any EAM solution should consider incorporating, or interfacing to, third party business processes, thus allowing the Enterprise maintenance planners access to the outsourcing vendor's business information and, conversely, allowing the vendor access to some of the Enterprise's information required for seamless execution and job performance.

Within the context of EAM functionality, Outsourcing should also be seen as a way in which the enterprise can implement non-personnel related cost saving measures. Specifically, one such area gaining wide acceptance in the power industry is just-in-time inventory management. Borrowing from the retail industry, most notability Wal-Mart, this business practice shifts the primary responsibility for parts inventory to the vendor through an e-Commerce conduit commonly referred to as B2B (business-to-business). In this

business relationship, the vendor, or supplier, as ready access to the maintenance planning process and can manage parts and supplier delivery to the strategic maintenance plan.

4.1.5 Aging Infrastructure

Occurring in parallel with the aging baby boomer workforce is an aging plant and T&D infrastructure. Half of the fossil power plants in the United States were built before 1965. and by 2010, over 60% of the nation's power plants will be over forty years old. Although recent changes to the Clean Air Act have been proposed that would relax Government mandates for plant upgrades, the fact remains that the infrastructure is aging and with aging comes the increased cost of maintenance. Better ways to contain cost almost dictate heavy reliance on automated systems and a trained workforce. This reality will force power producers to turn to newer technology and business processes that includes newer asset management solutions and the appropriate changes in the way maintenance is performed.

4.1.6 Continually Evolving Technology

Enterprise Asset Management (EAM) systems have driven waste out of business operations over the years by automating and optimizing the way in which companies procure, track, manage, maintain and dispose of capital assets. Even small improvements in capital asset management can have a dramatic impact on corporate earnings.

The first generation of EAM was client/server-based. These solutions were a dramatic improvement over paper-based processes, but they were designed for a world in which deployments were limited to individual locations. They were not designed for today's networked world, in which companies seek to deploy EAM solutions across multiple locations by installing a single instance of server software, and then enabling all locations to access it via their intranet. Additionally, power companies are discovering that standalone client/server implementations are difficult to integrate with other systems, such as ERP or automated procurement, because there is usually a different version of the EAM software running in each location, each with its own integration requirements.

EAM Meets the Web. The Internet-based EAM model can provide breakthrough cost-savings for companies while delivering capabilities that are far more powerful than anything that was available in first-generation client/server systems. There are other benefits as well. For example, because the server software is kept in a single, central location, any upgrades made to that software are instantly available to all companies and end-users. Compare this to client/server, where companies have to wait for the next version of the software to be physically delivered and installed on every desktop before they can benefit from upgrades and updates.

A potential trend in internet-based application implementation is to allow a *third party* (normally the provider of the application) to *host* the application on their server. This approach is also known as an *application service provider* model. Under this model end-users access the application over the Internet. This model can drastically reduce the total cost of ownership for enterprise applications, because it eliminates the hardware and software costs associated with maintaining a server in house, while also eliminating the personnel costs associated with installing, administering and maintaining the application. So, in effect, companies are able to gain the benefits of the application, without incurring the costs and effort associated with hosting it in-house.

There are two ways in which software vendors can go about making their applications available over the Web: they can either *Web-enable* existing client/server applications, or they can redesign their application architecture so they're optimized for the Web.

Web enabling does have its drawbacks in that it may force additional technology requirement on the enterprise. In this model, a third party hosts server software, but end-users must install special *enabling* technology in order to access the application. This adds cost, slows application deployment, and

compromises the business decision that drove the Web-based solution in the first place. Web-enabled client/server applications tend to have relatively poor performance and scalability. This requires customers to install special high-speed Internet connections in order to make the application useful, and to purchase additional hardware when new sites and end-users are added to the application, which further increases the total cost of ownership and complicates deployment.

Web-architected EAM solutions are those that have been "built-from-the-ground-up" for the Web. They are based on Web technologies (not client/server technologies), they perform well across regular Internet connections, and they require nothing more than a Web browser on the desktop to access the application.

4.2 Looking Ahead

The Public Utility Holding Company Act of 1953 (PUHCA) remained virtually unchanged for 50 years until enactment of the Public Utility Regulatory Policies Act of 1978 (PURPA), P.L. 95-617. PURPA was, in part, intended to augment electric utility generation with more efficiently produced electricity and to provide equitable rates to electric consumers. Under this Act, utilities were required to buy all power produced by qualifying facilities (QFs) at avoided cost.

Electricity regulation was changed again in 1992 with the passage of the Energy Policy Act (EPACT), P.L. 102-486. The intent of Title 7 of EPACT is to increase competition in the electric generating sector by creating new entities called "exempt wholesale generators" (EWGs), that can generate and sell electricity at wholesale without being regulated as utilities under PUHCA. This title also provides EWGs with a way to assure transmission of their wholesale power to its purchasers.

In response to EPACT, on April 24, 1996, the Federal Energy Regulatory Commission (FERC) issued two final rules to encourage wholesale competition (Orders 888 and 889).

Comprehensive as well as stand-alone PURPA and PUHCA reform legislation to reduce electricity regulation and encourage the development of retail competition, currently under state jurisdiction, was been introduced in the 106th Congress. Proposals to increase competition in the electric utility industry involve separating three functions - generation, transmission and distribution.

All of the changes to public law and the ensuing changes to regulations place a unique burden on power producers unseen in US business. As electric power producers scramble to become more efficient they are also faced with a second issue – integrating their IT infrastructure, management structure, and workforce with that of another company. This is the reality of Consolidation.

4.2.1 Consolidation

Today’s power generation managers are now required to monitor both tactical and strategic constraints while managing their business objectives as conditions change. And change they do. New plant owners must react quickly to implement their business practices and processes and integrate their enterprise-wide systems into the acquired plant’s infrastructure so that the plants continue to operate safely and efficiently and within required regulations. Only through optimization can such efforts be accomplished.

4.2.2 Enterprise Optimization

As the workforce ages electric power producers, and US manufacturers in general, will face a need to transform their organizations from one relies on their worker’s knowledge to one that relies on their worker’s ability to perform at a level that allows the organization to not only maintain current levels of performance, or productivity, but even experiences continued improvements in productivity. One way to achieve this continuation is through business process optimization across the enterprise – *Enterprise Optimization*.

There are two components of Enterprise Optimization that we believe can be realized through the application of technology through the next generation of Enterprise Asset Management solutions, one at the plant level and one at the worker level.

Plant Performance Optimization. Plant performance optimization has its roots in the integrated application of technology and process improvement such as that found in EPRI's Plant Maintenance Optimization process model. Utilizing such technology as described in this report and in Electronic Performance Support Systems (EPSS) in general, electric power producers begin to optimize all aspects of their enterprise's business process.

Worker Performance Optimization. Worker performance optimization address the educational and training aspects of plant optimization as it relates to, and interfaces with, plant automation and management optimization, or the business process side. By addressing the *people* part of the optimization equation, management *literally* sets about changing the work culture. Using the automation tools, the new worker, following *optimized* business practices are enabled to perform more efficiently and unencumbered. Michael Hammer[13] describes this process quite effectively in his land book, *Reengineering the Corporation*.

4.2.3 Driving Corporate Performance

Asset Performance Management. The ability to use current available data to drive business decisions is the promise of Asset Performance Management.

5 CONVERGENCE OF TECHNOLOGIES

5.0 Overview. As CMMS, CRM, and communications technologies converge a comprehensive approach to asset management that will enable companies to maximize the performance of critical capital assets that have a direct and significant impact on achieving corporate objectives begins to form. This emerging approach includes all types of corporate assets, i.e., Human Capital, Physical Capital, etc., and the business processes associated with their acquisition, up-keep, and optimization. These technologies, for the first time, give corporate executives, plant managers, Operations and Maintenance department supervisors, and workers alike, the ability to view and manage their assets for the benefit of the corporation as a whole. Employing analytics to data retrieved from such transaction-based systems as the plant CMMS, financial and HR systems, and client resource management (CRM) systems, along with similar systems belonging to suppliers, contractors, and other third-part vendors can present managers with unprecedented information from which to make informed decisions based on business rules. We call this new capability Performance-based Streamlined Asset Management (PSAM).

Our basis for PSAM is derived from an emerging concept rooted in asset analytics often referred to as Asset Performance Management. With integrated analytics based on an organization's actual asset and maintenance transactional data now readily available in real-time or near real-time PSAM can provide managers with answers to their needs through tools that analyze trends and anomalies, forecast performance issues, and model *what if* scenarios through simulation, thus allowing them to take appropriate corrective often before a problem surfaces.

Enterprise Asset Management. Being a transaction-based system, the enterprise asset management (EAM) system contains a wealth of information about the plant's actual asset and maintenance history. Using tools to analyze this data trends and anomalies can be identified and compared to forecasted performance issues allowing managers to make forward looking decisions and take appropriate action.

Key Performance Indicators (KPI). KPI's are used to measure the performance of those "critical elements" that impact asset performance and maintenance cost. Most significantly, they also create alignment across the entire interconnected plant support system.

Benchmarking. This process can be a powerful tool, allowing maintenance organizations to learn from others and to discover new possibilities. It can also confirm that improvement is possible even in the most difficult circumstances.

One excellent way to conduct benchmarking is through participating in and attending conferences and workshops. For instance, in a span of just two weeks in January 2004, two workshop conferences focusing on energy utilities were conducted. The first – Strategic Supply Change Management for Utilities[10] provided a forum for understanding how other power producers are addressing logistics, supply management, outsourcing, and so on to optimize their operations. The second – Portfolio Optimization for Electric Utilities Conference[11] included a session on "Apply Portfolio Optimization Techniques and Technology to Resource Planning."

Analytics. Business intelligence (BI) software and ***analytics***, grew up in the 1990s as companies began wondering what to do with the huge quantities of data they were accumulating from their ERP systems, call centers and the Internet. is a broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions. BI applications include the activities of decision support systems, query and reporting, online analytical

processing, statistical analysis, forecasting, and data mining. Examples of business intelligence software would be software that does multi dimensional analysis. A business intelligence tool, transform data into information and presents that information to end users in a meaningful and usable manner. Most products in this class also support advanced analytical techniques and free-form exploration of data, thereby converting raw data into information, and information into knowledge. Business intelligence tools are now central technology for e-commerce customer analytics, information portals, ERP enhancement, and myriad other roles.

Many people believe that BI refers to the analytical environment only. This perception may be shaped by the fact that the only thing business users manipulate to access data and obtain answers to their questions is the analytical tool installed on their desktop or accessible from a Web browser. They don't necessarily see the data warehousing environment behind the analytical tool. However, BI is much bigger conceptually and architecturally than query-and-reporting and other analytical tools. Business intelligence systems create a learning environment that enables smart organizations to run their businesses more intelligently.

Evolution of Analytics. Nevertheless, a sea change has happened in the analytical environment that is worth noting. Analytical vendors have evolved considerably in the past decade. Many now offer suites of tools designed to serve every type of analytical need within an organization. Many also have embedded these tools within *packaged analytic applications*—pre-built solutions geared to address the analytical requirements of a specific business area such as procurement or supplier performance. Others have focused on delivering vertically integrated suites that combine data integration software with analytical tools and applications. Still others emphasize analytic development platforms for rapidly building custom analytic applications[12].

Power Producers are discovering what scientists and engineers have known for years: that computer graphics speed and enrich the process of understanding large, diverse and complex data.

The purpose of business intelligence tools is to allow business users to analyze, manipulate, and report on corporate data using familiar, easy-to-use interfaces. Obviously, information should be presented to the user in a way that conforms to a businessperson's understanding of the data. Unfortunately, in relational database management systems, data is structured in rows and columns that run across multiple tables. Also, the data is highly normalized to prevent redundancy, guarantee integrity, and provide for data access flexibility.

Each analytic application should contain prepackaged metrics and analysis techniques, allowing the organization to better understand trends and business drivers such as worker availability, inventory, production schedules, outage planning, etc.

Condition Assessment. Condition assessment programs must address all areas of power plant. For instance, assessment of the boiler must be sure to include the critical pressure components. Generally, the critical components are those whose failure will directly affect the reliability of the boiler. These components -- which can be prioritized by the impact they have on safety, reliability, and performance -- include:

- drums-steam, lower
- headers-both steam and water
- tubing-superheater, generating, waterwall, economizer
- piping-steam and feedwater
- deaerator-may have special safety concerns and
- attemperators.

The need for Condition Assessments has arisen because existing assets are now required to last longer as demands for capital and maintenance money are reduced or directed elsewhere. A condition assessment is a systematic and flexible approach developed to provide plant owners with accurate and up-to-date knowledge on the condition of their assets. This allows plant owners to make informed decisions on where is best spent to provide safe assets and extend operating life.

A condition assessment should consider the following key areas:

- safety
- structural behavior (consequence of failure)
- structural exposure (likelihood of failure)
- level of inspection
- function of the structure
- deterioration of the structure

With this information, an organization is able to assign a “Risk Rating” to an asset, which then allows the plant managers to prioritize their repair, and maintenance needs.

5.1 Leading Edge Technologies.

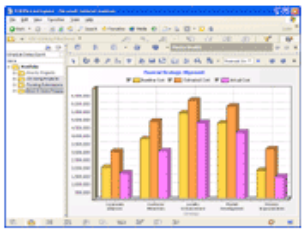
Several leading edge technologies are beginning to find their way into CMMS and subsequently EAM solutions. Most notable technologies include geographic information systems, business intelligence applications such as the digital dashboard, and mobile technology.

5.1.1. Geographic Information System Integration.

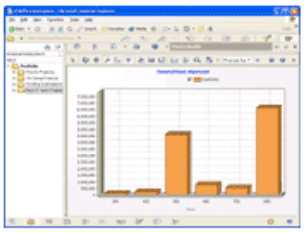
Geographic Information Systems (GIS) are beginning to be integrated into Enterprise Asset Management (EAM) Systems. Perhaps the most common application of GIS technology has to do with configuration management of assets within the EAM and its integration with workflow planning and execution. A maintenance crafts person, armed with a mobile computing device, perhaps a Personal Digital Assistant (PDA), or tablet PC, which contains a GPS (Global Positioning Satellite) receiver can instantly access information about an asset.

5.1.2. Data Visualization.

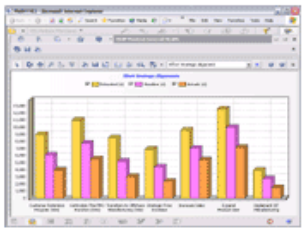
The Digital Dashboard, or at it is sometimes called – The Executive Dashboard, has its roots in distributed control systems (DCS) whereby plant control room operators can few critical perimeters on computer screens in configurable formats. Users begin by reviewing their portfolios from various perspectives. Bubble maps, scorecards, multidimensional OLAP pivots and reports combine to set new analytical standards. Through the use of graphical displays and pivot tables, key decision-makers, maintenance planners and control room operators can visualize and achieve the desired balance of workflow and people, tightly aligning portfolios with business goals to ensure the entire organization remains in sync with strategic business objectives.



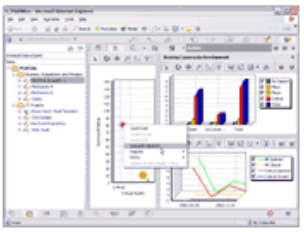
Financial Strategic Alignment



Budget by Project Rank



Effort Strategic Alignment



Portfolio Exceptions

The Digital Dashboard is the technology enabler for Asset Portfolio Management, or APM (Section 4.1.6). The entire enterprise, and the business environment it operates in, has grown so complex and integrated that even frontline managers next to be "plugged in" into the enterprise business model in such a way as to be able to modify their performance, and that of their department (equipment and personnel) in an almost real time, or instantaneous, means. The Digital Dashboard promises to allow for this responsiveness. As the ageing workforce retires, this technology will be used more and more as the new worker, unaware of the corporate knowledge possessed by the current generation of worker, will rely on the Dashboard for the performance of their duties and responsibilities. (See **ELECTRONIC PERFORMANCE SUPPORT SYSTEM**: *An Application Guideline, Solving Power Plant Workforce Management Issues with Electronic Performance Support and Knowledge Management Solutions* – TR 1004877).

5.1.3. Mobil Computing.

Although most mainstream EAM vendors have been touting mobile, or wireless, computing for several years, only within the past year, or so, has the technology begun to mature enough to allow true mobility. In fact, if the 2004 Comdex trade show is any indicator of what lies in store in this area, then 2004 promises to be a very good year for technological advances.

Perhaps the most recognizable mobile computing platform during the past few years has been the Personal Digital Assistance (PDA). Two technologies are commonly found in PDAs. One is based on the Palm OS (Operating System) while the other is based on the Microsoft Pocket PC OS. A third OS based on Linux has begun to emerge but only on a relative few hardware platforms. Of these three operating systems, the Pocket PC seems to be the most universally accepted, perhaps because is seamlessly integrated with common desktop computing applications such as Microsoft's Office suite.

5.2 Service Networks.

As EAM solutions become more interoperable, many organizations are beginning to require their suppliers, vendors, and contractors to interface with their systems. First observed in the retail business environment with such companies as Wal-Mart, service networks allow a third party to view, and in some case, even interact (update) the enterprise's EAM systems.

In such an application of the technology a supplier can monitor the consumption rate of certain consumables, or access the maintenance planning activity, and ship those consumables and parts so

that they arrive at just the right time. Such an approach shifts the supply responsibility to the third party and reduces cost to the enterprise. This approach to changing business processes is a fundamental tenet of Business Process Reengineering (BPR).

Similarly, an outage contractor with access to the plant's maintenance planning activity can manage its workforce more efficiently, thus becoming more responsive to the plant's requirements. Likewise, the plant can gain access to the contractor's planned outage workforce credentials, thus ensuring that only qualified works report for work when the outage begins.

5.2.1 e-Business/MRO Infrastructure. Strategic sourcing of supplies and parts required to maintain, repair, and operate a power plant has been shown to be a cost savings process.

- How to Optimize Your Inventory within the Supply Chain System
- Strategic Inventory Planning, Management and Reduction
- Consigned Inventory vs. Vendor-Managed Inventory
- Inventory Standardization - How to Overcome that Challenge and Maximize the Benefits
- Nuclear Plants - Solutions to Replacing Parts Unavailable from the Original Source of Supply
- Replicating Inventory Processes and Systems after a Merger or Acquisition
- Adding the Reverse Auction to the Sourcing Toolkit
- Utility Vegetation Management (UVM) - How Does it Work and What are the Procurement Challenges
- A Strategic Sourcing Initiative - Utility Vegetation Management
- UVM Supply Chain Issues and Trends
- The New Competitive Advantage - Supply Chain Entrepreneurs
- Case Study: Strategies to Acquire Initial or Additional Investment to Implement or Upgrade your Electronic Supply Chain
- Transforming Supply Chain Management through ePurchasing Technology - Costs and ROI
- The Move to Electronic Procurement - Making the Vision a Reality
- Project Finance
- Req to No Check - A Payment Process to Match eProcurement
- Benefits of Successful Utilization and Execution of Online Auctions for Both Buyers and Suppliers
- Strategies to Train Employees on Electronic Technical Tools - Online Auction, Online Procurement
- Online Auction - Pros and Cons from Suppliers', Buyers' and eCommerce Service Providers Perspectives
- Creating a Supply Chain Organization While Merging Two Companies -Twelve Months Later
- Outsourcing - An Opportunity for Supply Chain Efficiency
- Building Synergy Between Materials Management and Field Operations
- The Journey and End Game of Alliance Management
- Supply Relationship Management (SRM) to Increase Value in Supply Chain
- New Technologies and The Future
- Experiences from Incorporating a High Share of Wind Power to Transmission System

6 CONCLUSIONS

As technology continues to march forward power plant maintenance organizations are presented with new capabilities not even envisioned just a few short years ago. As with any new technology, care must be given on how to best exploit it. In most cases, it is the business processes that require modification while the technology is merely the enabler of the change. This fact became highly publicized in the early 1990's by Michael Hammer, PhD in *Reengineering the Corporation*[13].

Today's maintenance organization must look outside its confines within the plant to the enterprise as a whole when considering an upgrade to their current CMMS and replacing it altogether. The corporation's business environment is not, perhaps more that ever, a major driver in defining a CMMS solution. This new reality requires that the maintenance management process be fully integrated with enterprise resource planning, customer resource management, human resource and vendor/supplier capabilities and that information derived from data collected must be readily available to managers and worker alike in real-time.

As the workforce ages, US Power companies will be faced with an unprecedented change in how the new workforce performs its assigned tasks. The workforce will transition from one that possesses the historical knowledge of how and why things are done a certain way to one that must rely on accessing repositories of that knowledge. We call this a transition from a knowledge-based workforce to a performance-based workforce. The key to success will be how well an organization's electronic infrastructure is designed, how well their business processes are defined, and how well its applications are engineered.

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[14] Bryan Weir, Copyright 2002 by Perspective CMMS, 32 Beaton Road, Balloch, West Dunbartonshire, Scotland, G83 8QQ www.pemms.co.uk. Used by permission.

A Choosing your CMMS[14]

Introduction
Maintenance software selection is a daunting task that can involve lots of head scratching by the participants in the process. There are two main reasons for this. Firstly, it is likely that the engineers on the project are involved in a major software selection process for the first time. Secondly, a CMMS implementation can affect everything that is done in a maintenance department such that it may require involvement from just about member of that department.

Software selection is normally the domain of IT people but with CMMS software it is essential that they take a back seat. *Engineers* must define the requirements since they are the only ones with the knowledge to do so. Many people make the mistake of entering the selection process without really thinking about what they need. This can result in them purchasing a software package that may never be fully implemented. A year or two down the line it is not unknown for expensive CMMS software to be sitting on a shelf in an office, never having seen the light of day. Also, the maintenance and installation of software applications has become much easier over the last few years. Often the IT department need not be involved at all, more so with the introduction of web based software that is rented by the client and hosted on remote servers

So What's the First Move?
First of all you *must* ensure that you know why you want a CMMS and also what you require it to do for you. In other words create a definition of requirements. This can be a problem when you have never used maintenance software and don't really know what it offers. Your first step should therefore be a discovery trip. Study the information provided on the vendors' websites. Look at the functionality that each of their packages has to offer. You don't necessarily have to talk to anyone at this stage, just familiarize yourself with CMMS system features and functionality. With this new knowledge you will be better placed to compile a formal list of the particular functions that you need.

You should never approach a vendor if you do not know what you want! We all know that when you are buying a car the salesman will try to talk you up to the limit of your budget and beyond. You won't fall for this because you are probably quite streetwise when it comes to buying cars. Can you say the same about CMMS software?

Your Requirements
So what do you need? Your maintenance function can be broken down into the following ten major factors. These are in no particular order so have a look at them and decide what software functionality you require in each. Bear in mind that some of these may not apply.

1. *Management of your maintenance services*: This may involve organizational factors, personnel and training.
2. *Management of your Asset or Equipment register*: This will include the ability to handle items such as your asset management, locations, identification and history. This is important because it is the hub of your CMMS.
3. *Spares Inventory*: What functionality do you require with respect to stock control, inventory and purchasing?

4. *Methodology*: What maintenance methodologies are in use in your plant? (These may include TPM, RCM or FMEA initiatives.)
5. *Reports*: What statistics and reports do you require from your system?
6. *Documentation*: What are your document control requirements? For example, do you have any compliance issues? What other maintenance documentation do you require the system to store?
7. *Management of Work Orders*: How do you require the system to handle the control, generation and scheduling of your planned and unplanned work orders?
8. *Budgets and Finance*: Do you need the system to document and control costs, budgets and maintenance department finance?
9. *Environmental and Safety Issues*: What are your requirements with respect to the control of environmental and safety issues?
10. *Standards and Quality*: Does your CMMS have to support or comply with any standards or quality systems?

Your Budget

Be realistic about what you can buy with the budget you have available. Software is not cheap and if you want a state of the art package be prepared to pay a realistic price for it. It is also worth mentioning that the top tier companies tend not to publicize their prices. There is a good reason for this - they often charge what they think you can afford, so be prepared to bargain with them. I was recently involved in a quotation process where the bottom quoted price was £26K and the top was £80K, all for the same software specification!

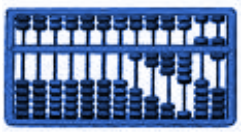
Be Flexible

If your requirements are too closely defined you will probably have to get involved in bespoking your software. This can be expensive and may lead to ongoing charges as the vendor upgrades the software in the future. During selection, a very specific definition of requirements can often lead to the elimination of perfectly good packages that fail to meet your requirements by a whisker. In these cases you should be prepared to compromise.

In conclusion, be prepared to spend a significant amount of time defining your requirements and selecting the package that best matches your needs. It is crucial that you source software that will work for *you*. Consider using weighting factors when comparing packages and score systems higher for their ability to match your main requirements and finally, best of luck with your implementation!

ROI Calculation for CMMS Projects

A Return on Investment (ROI) calculation results in a value that represents the benefits received from a project against the total costs of the project. That's basically all there is to it, but if you ask ten different accountants how to calculate ROI the chances are that you would get ten different answers. A certain amount of "poetic license" can also be evident, depending on whether the person crunching the numbers is "for" or "against". This does not mean that it is impossible to arrive at a reasonable and sensible ROI figure.



If you search around for information on ROI calculation you will find many examples of "Calculating ROI for IT projects/engineering projects/training/asset acquisition, etc." You will be seeking to justify a *CMMS* but what must not be forgotten is that the principles for building a business case for *any* project are broadly similar. The standard ROI calculation can be simply expressed as follows:

$$ROI\% = \frac{\text{total benefits - total costs}}{\text{total costs}} \times 100$$

If you need to calculate the annual percentage savings over a period of years the original calculation can be developed further. Let's say,

$$B = (\text{benefits year 1} + \text{benefits year 2} + \text{benefits year 3})/3$$

$$C = (\text{costs year 1} + \text{costs year 2} + \text{costs year 3})/3$$

$$ROI\% = \frac{B - C}{C} \times 100$$

In this example the sum of the benefits and costs for each year are divided by the number of years used in the calculation, (three).

OK - we now have our formulae, but the overriding problem is that some of the benefits of a CMMS may be intangible. Calculating the *costs* should be relatively easy, the clever part is in being able to determine or forecast what the tangible *benefits* will be. Many maintenance departments will not be able to provide an accurate figure for their total annual maintenance budget. If this total is not available you will have to use what figures you do have.

For example most departments have a good idea of what they are spending specifically on overtime. The introduction of a CMMS usually leads to better planning of work and the subsequent reduction of planned versus unplanned jobs should lead to a reduction in overtime levels. You can then look at the projected ROI on your overtime component alone.

Example
A small maintenance department spends £40K per annum on overtime. With a goal of halving this, it is estimated that the CMMS implementation can reduce it to £31K in the first year, £23K in the second year and £20K in the third year. Implementation and software costs are 18K for the first year, 8K for the second year and 4K for the third year.

The benefits are thus (9K + 17K + 20K) / 3 = 15.333K
Versus the costs (18K + 8K + 4K) / 3 = 10K

$$ROI\% = \frac{15.333 - 10}{10} \times 100 = 53.33\%$$

Assuming that the estimated overtime savings are met this means that you can demonstrate a 53.33% ROI per annum for the first three years on overtime savings alone. Savings on other costs such as headcount, inventory and production downtime can be calculated in a similar way. Ultimately, using this model, the cost of a CMMS is fairly easy to justify.

B Interviews

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