ABB Review

The corporate technical journal of the ABB Group

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Special Report

Process Automation Services & Capabilities

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ABB Process Automation – your productivity partner

ABB is the world's largest supplier of process control systems. With this title comes an awesome responsibility: ensuring that every one of our customers reaches their full potential in productivity and energy efficiency.

Most customers achieve this peak efficiency long after the initial automation system is installed, following months or even years of fine tuning and optimization. In many instances, this work is done by the customers' own staff of automation and maintenance specialists.

In recent years, customers have become much more focused on their core competencies of making, distributing and selling products. Production plants still need to be optimized, but customers often no longer possess the internal manpower to do it. This means they increasingly turn to third-party suppliers like ABB for process automation support, since plant optimization and maintenance is one of our core competencies.

To stay competitive in a global economy, many companies are improving their operational excellence by identifying, sharing and implementing the "best practices" in their businesses. "How can we do more with less?" and "How can we do it better?" are phrases commonly heard in boardrooms throughout the world.

It's a daunting task to keep a plant's automation system and electrical equipment in peak operating condition, made even harder if a site is understaffed. It is estimated that industries like oil, gas and petrochemicals spend up to half of a plant's profits on maintenance. If the plant shuts down unexpectedly, it can have disastrous effects on revenue, profits and even safety. Many customers are recognizing that maintenance is not their core competence, but see no other option but to continue doing it themselves.

Outsourcing specialized functions like plant appraisal and maintenance is a way to gain access to a vast pool of expertise and experience, which is focused full-time on improving the efficiency of installed assets.

To keep their plants or mills reliable, many manufacturers are setting up optimized maintenance programs to improve their overall equipment effectiveness (OEE). Many customers now realize they don't have to wait until a plant is built and running to improve reliability. Early collaboration between customers and automation suppliers means reliability improvements can be designed into a plant before it is even built.

ABB has over 20,000 service engineers and consultants worldwide who are trained to help "optimize" plant processes and equipment. This *ABB Review Special Report* focuses on just a few of the services and capabilities we can offer our process automation customers. It contains examples of ABB's offerings in operational excellence, outsourced performance services, reliability, and project services.

I hope you find these articles informative and interesting. Most importantly, I invite you to explore the many products, services and solutions we can offer you to improve productivity. Let ABB be your productivity partner!

Veli-Matti Reinikkala
Division Head, Process Automation
Member of the Executive Committee
ABB Ltd.

The perfect storm

New business opportunities in services are changing the automation world

Larry O'Brien

The services market remains the fastest growing segment of the automation business today. Automation suppliers are offering an ever-increasing scope and breadth of services designed to improve the bottom line for manufacturers – spanning from the front-end engineering and design process through operations, outsourced maintenance and performance improvement. This leaves end users with a wide range of service choices from automation suppliers, many of which can provide real cost benefits and fill an increasing skills gap.

Industry insight

The growth in automation services is a relatively new phenomenon. Going back 10 years, most of the growth in the automation business was centered on hardware, which in most cases was highly proprietary and therefore highly profitable for automation suppliers. The influx of commercial off-the-shelf components and technologies, from microprocessors to operating systems, eroded the price of hardware and even software. Naturally, the automation suppliers increasingly turned to their service offerings as a way to drive growth and profitability.

The services market did grow for several years, and automation suppliers did a good job building their vertical industry, applications, project execution and outsourced maintenance capabilities. In the past three or four years, however, a perfect storm has formed that has driven growth in the services business to unprecedented levels that show no sign of stopping any time soon. According to a recent ARC study on services provided by automation suppliers, the market reached $14 billion in 2006 and will grow at an average annual rate of more than 12 percent through 2011. This is almost as big as the market served by third-party systems integrators and engineering and construction firms, with one exception – the suppliers and automation vendors are experiencing a lot more growth.

So what is this perfect storm and why is it resulting in such a big opportunity for both suppliers and end users? It really comes down to the convergence of three things – the shrinking pool of highly qualified labor worldwide, the booming market for new plant construction in Asia and other parts of the world, and the need for manufacturers to drive ever-increasing levels of performance from their plants and factories to remain competitive.

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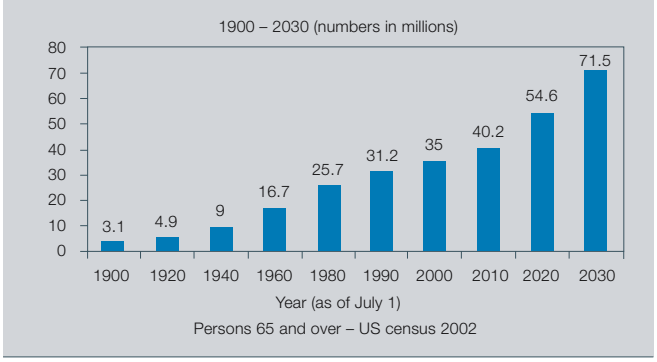
Labor – a global issue

The primary contributor to growth in services over the next few years is the continuing shortfall of skilled labor among end users. “Baby boomers” – children born after the Second World War and into the boom years of the 1960s – are starting to reach retirement. Many of them are now, or soon will be 60. This is starting a wave of retirement that will see the number of people aged 65 and over in the United States alone exceed 70 million by the time the last boomer retires in 2030 1. The average age of workers in the manufacturing industries of developed countries is already over 50. Companies have downsized, right-sized and re-engineered their workforces without apparent thought for the consequences of this upcoming retirement tidal wave. The paradox is that although workers are getting older on average, the average retirement age has dropped to 58 years, in many cases due to the re-engineering process of the past couple of decades.

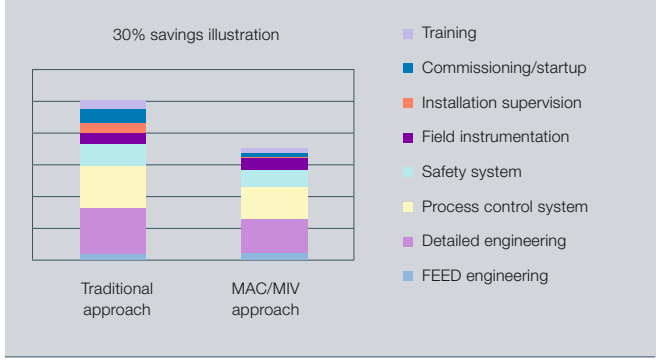
Data from the U.S. Census Bureau shows that, as a percentage of the world population, the largest growth area in the next 50 years will be in the ranks of the elderly. Several governments have responded by increasing the statutory age of retirement, in the case of Germany, for instance, to 67 years. In a recent interview, a major refining company stated that they lost 2,500 years of experience in 2006 when 100 operators retired at one site, each with an average of 25 years’ experience. As further evidence, a major chemical company said they analyzed their plant demographics and found one of their largest plants would lose 75 percent of its operating staff to retirement by the end of this decade. The same is also true of many discrete manufacturers.

The potential resource pool is diminishing too, as today‘s youth has little or no interest in studying traditional engineering subjects and following a manufacturing career. Currently, no universities in the United States offer process automation as a major. Younger people are interested in computers, but want careers in Internet and computer gaming related areas. The manufacturing industry has failed to show young people that most plants are computer controlled today, and computer skills are as necessary in a modern manufacturing facility as any other skill.

1 US population forecast for persons 65 and over



2 The MAC/MIV approach can result in project cost savings of up to 30 percent.



Younger workers no longer feel loyalty to a company, as many companies have not returned that loyalty in recent times. These younger workers will gain the needed experience and then start looking for a better opportunity in a five-year timeframe. The onus will therefore be on manufacturers to return to older traditions of treating employees with fairness and respect, giving them good and adequate training and a challenging working environment. In recent research by ARC Advisory Group, several manufacturers told us that tomorrow's operators will be much more than "valve turners", they will be challenged with continuously improving the plants they operate and provided with the skills and training they require.

MAC/MIV/MICC cost benefits

Large grassroots projects are ubiquitous in the developing economies of the world, and there is an unprecedented demand for system integration and project management services. End users are increasingly constrained by personnel issues, diminishing capital budgets and shrinking timetables. Aside from grassroots construction activity in emerging markets, end users are also faced with the task of executing multiple projects simultaneously in disparate geographic regions. With many of the world's large engineering and construction firms paring down on their automation departments, end users are increasingly looking to suppliers to take on the role of a main automation contractor (MAC) to assume responsibility for all automation related aspects of a project.

According to a recent ARC study on services provided by automation suppliers, the market reached $14 billion in 2006 and will grow at an average annual rate of more than 12 percent through 2011.

Many of the world's leading end users, particularly in the process industries, are applying the MAC/MIV/MICC (main automation contractor/main instrument vendor/main instrument controls contractor) concept to all of their capital projects. The benefits can be considerable. One major end user in the hydrocarbon industry, for example, has reported up to 30 percent savings on projects compared to the traditional approach. Costs are reduced in nearly all areas of the project, from training to commissioning and installation.

The 3PM boom

ARC defines 3PM (third-party maintenance) services as value-added supplied services that utilize vertical domain expertise, specific asset knowledge and diagnostic technologies to provide efficient maintenance of critical automation and production assets 2. Automation assets typically include hard measurement assets such as pressure transmitters, flow meters and control valves. Production assets include all other equipment, which varies greatly and is vertical industry specific. Asset classes include vessels, pumps, heat exchangers, rotating equipment, etc. 3PM contracts vary greatly with each service supplier, with the scope dependent upon the resource knowledge of the provider. ARC research has confirmed that the fastest growing segment of 3PM services is provided by automation suppliers. These suppliers have gained the trust of many users and have won 3PM contracts for all assets, regardless of manufacturer.

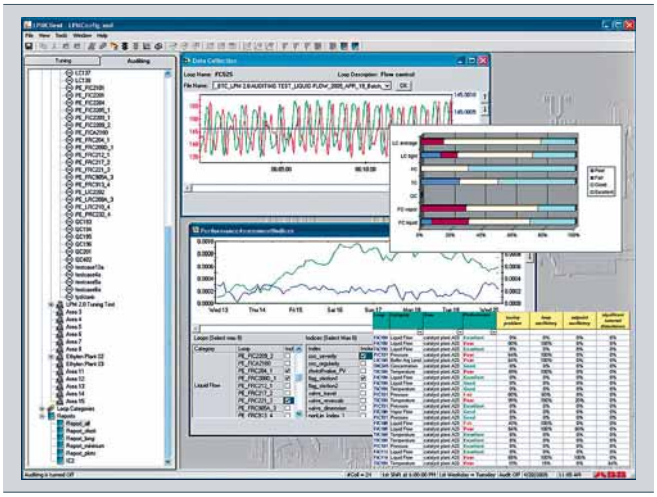
Essential to improved ROA

Within the process industries there are literally millions of control loops in use that reduce energy consumption, raw material usage and work force requirements. In addition, they form the foundation for safe and reliable operations. However, in a typical plant more than half of all loops are actually increasing variability, thus negatively affecting quality, throughput and return on assets (ROA). Even if a process is running at optimal economic conditions, performance deterioration

occurs from numerous sources such as changes in business strategies, modifications in operating conditions and ageing equipment.

Operations must be constantly vigilant to ensure that control loops operate at peak performance, since they are essential to operating the plant safely and efficiently. Typically, however, this is beyond the capability of most manufacturers given their resource constraints. To create a strong foundation for all operations, manufacturers must adopt a comprehensive monitoring and continuous improvement program targeted at optimizing the performance of control loops. Preventing deterioration of control loop performance is imperative to securing the stable and robust conditions necessary for higher-level optimization functions offered by model-based predictive multivariable control and plant optimization.

3 Screenshot of ABB's Loop Performance Monitor



One major end user in the hydrocarbon industry has reported up to 30 percent savings on projects compared to the traditional approach.

Control loop performance monitoring not only helps identify faulty control values, it also provides an indication of properly functioning valves that may have to be targeted for maintenance through a preventive maintenance program 3. The cost of not performing maintenance can be significant. Control loop performance maintenance, tuning and optimization are a balancing act: do too much and you are wasting time and money, while doing too little causes poor performance, unscheduled downtime or catastrophic failure. Since control engineers typically are responsible for hundreds of control loops, it is not possible, or even advisable, to attempt to have all loops running optimally, since the time, effort and expense are excessive. The key is to locate the few loops that will have large paybacks. Finding these key loops is difficult without the aid of sophisticated analysis tools. Automation suppliers are finding great success in offering a suite of services around their control loop monitoring applications to help users identify underperforming loops and develop an ongoing strategy for monitoring loop performance. Loop monitoring requires continuous monitoring and tuning to maintain control loops functioning at maximum performance because of the degradation and operational changes that occur over time.

The way ahead

End users should consider automation suppliers to fill their increasing list of skills gaps and as training and education providers. Many end users are outsourcing more and more of the functions they previously performed in-house to automation suppliers and have reaped considerable benefits. Outsourcing these functions to automation suppliers, however, requires a substantive selection process that should take into account elements such as the supplier's vertical industry knowledge and other factors.

Larry O'Brien
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Dedham, MA, USA

Footnote

[1)] Founded in 1986, ARC Advisory Group is a research and advisory firm in the manufacturing and supply chain sector. See www.arcweb.com

Operational excellence

Ensuring consistent, high-quality service delivery in process automation

Jarmo Heinonen

Operational excellence is not just a buzz word at ABB – it is a globally implemented initiative that provides value to its customers. As a supplier, ABB must meet the increasing expectations of customers to provide better quality, improved process performance and reliability at lower prices. To fulfill these requirements, ABB Process Automation Service and its 20,000 service and maintenance specialists around the world have been implementing an Operational Excellence Program.

Operational excellence

At ABB, there is a global team dedicated to the operational excellence initiative that works closely with the local service organizations. This program is based on the European Foundation for Quality Management (EFQM) Business Excellence Model, which is used by thousands of organizations worldwide to drive business improvements.

ABB strives to optimize its service delivery by offering customers standardized offerings, consistent quality and global processes. This is especially critical for global customers, so that they can expect and receive the same service, quality and price regardless of their plant location.

While operational excellence can refer to just about any tool or process that is implemented to improve business performance, here the focus is on those tools and processes that directly impact customer operations 1. These include common processes, site assessments and knowledge sharing. Above all, customer satisfaction management and people satisfaction management are essential parts of delivering first-class service to the customer Factbox.

Common processes ensure consistency
When a company operates in 100 countries, it is only natural to assume that there are 100 different ways to do business. That is why ABB has developed global processes that ensure consistent delivery of services to its customers in any country 2. How can ABB guarantee that a customer's production will increase by 15 percent? Or how can ABB ensure that its customers take advantage of the latest maintenance technology, whether they are a paper plant or a stainless steel producer? These are the kind of questions ABB considered when developing its common processes.

ABB's global processes are essentially the way its employees work and speak "one language" in the many countries in which the company and its customers operate. ABB has identified and developed a set of common management and support processes as well as business-related core processes 2. Each process consists of multiple phases that are described in detail, with tools provided to implement the processes at customer sites.

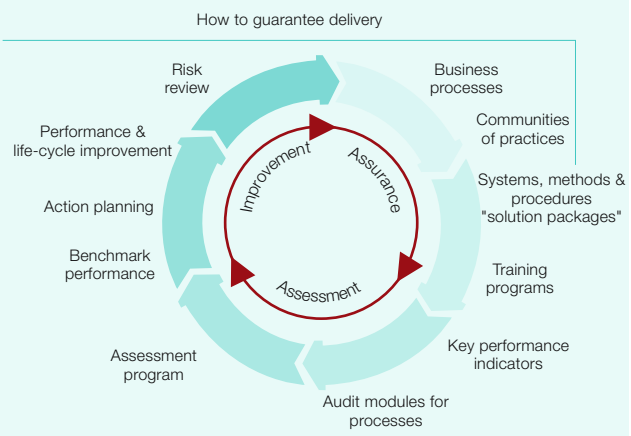
Factbox Satisfaction

Customer satisfaction management
The ultimate measure of service quality is a customer's perception of the service. Therefore, ABB has developed a global customer satisfaction survey program that provides a proactive way to understand and manage customers' needs and satisfaction. The high-level reporting is designed to track development trends, show performance levels against customer expectations and track customer loyalty. The focal points of customer satisfaction management are target setting, managing actions and communicating improvements to the customer.

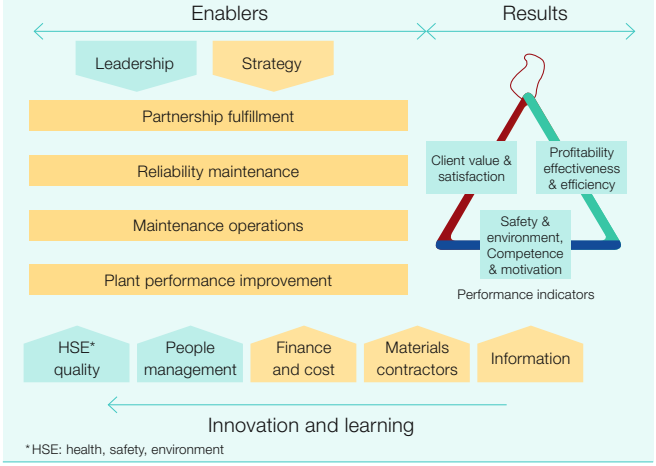
Besides the customer-specific results, global customer satisfaction reporting includes country-, regional- and global-level analyses, providing valuable insight to ABB management. 4 shows the ABB Full Service® customers' satisfaction level by region. Globally covering all Full Service sites, the results are an excellent source for benchmarking and marketing purposes. Special analyses about production effectiveness, occupational health and safety issues, and the like also can be tailored for local and global specialists.

People satisfaction management
In the service business, the workforce is the most valuable asset. Keeping people motivated is an essential part of operational excellence. ABB has developed a systematic way of continuously improving people satisfaction. The global people satisfaction survey maps both people's expectations and satisfaction, providing a progressive way to focus on the areas that are most important to its staff. In addition, a typical survey provides valuable insights about the strengths and development areas at country, regional and global levels. 5 shows the global people satisfaction trend in ABB Process Automation Services.

1 ABB's Operational Excellence Program is a continuous improvement business circle that helps to guarantee that service delivery fulfills expectations.



2 ABB's consistent process model for development and implementation of Full Service and Life Cycle Services concepts: The excellence of operation is then assessed against the same model.



Operational excellence

Over the years, ABB has continuously improved its tools and processes, which have now reached a sophisticated level of detail. People management is one example. When ABB implements a maintenance strategy at a customer site, an extensive people-competence mapping is also performed. A lack of competent personnel can threaten the availability of a plant's production due to the increasing technology advances and the fact that the Baby Boomer's generation is approaching retirement. As the average manufacturing worker is 50 years old, and with many companies having downsized their work force, the consequences of the upcoming wave of retirements could be detrimental.

When ABB's site management team systematically reviews the maintenance competencies at a plant, the customer is given a long-term plan to ensure the availability of qualified personnel. This plan outlines any type of training needs and training schedules, and oftentimes early recruiting is done to develop certain capabilities. This people-management process, as well as many of ABB's common processes, was developed by utilizing leading practices implemented at one or more ABB sites around the world.

At ABB, service goes hand in hand with maintenance. Thus reliability maintenance is one of the company's core processes. It includes general and industry-specific approaches on how the reliability and life cycle of plant equipment can be improved. Drawing on the experience of ABB's benchmark data, it is possible, for example, to easily identify industry-specific fault trees, develop preventive maintenance plans or feed the right instructions into the Computerized Maintenance Management System (CMMS).

Partnership fulfillment is another valuable process that refers to ABB's goal to act as a partner in the customer-supplier relationship. This means working together with the customer to jointly develop a maintenance strategy that addresses the customer's targets and production strategy. For example, the desired key performance indicators (KPIs) are identified and captured. ABB then provides the customer with access to relevant industry trends and benchmark data in order to create a common strategy to reach a world-class level.

Fact-based decision making

Many customers outsource their entire plant maintenance functions to ABB so they can focus solely on the core task of making quality products. With these ABB Full Service® arrangements, ABB assumes responsibility for the people and processes that influence customer profits.

Full Service sites are required to undergo site assessments, which are necessary for continuous improvement of business performance and customer relationships. This operational excellence technique provides on-site managers with the information needed to make fact-based decisions. The site assessments are conducted by an ABB team that includes a global senior assessor supported by local service employees who are invaluable in achieving an understanding of the local business environment and culture. To ensure use of the right benchmarks, an industry expert is also present to assess the reliability and performance improvement activities as well as industry-specific metrics.

With each site assessment, ABB provides a comprehensive review of a Full Service site's approaches and KPIs compared to best-in-class practices. The assessment starts with proper planning and the preparing and collecting of data, followed by the actual site assessment. Afterwards, feedback and leading practices are collected and incorporated into ABB's benchmark database.

An important part of the site assessment is the customer interview. For optimal facilitation, the interview is conducted by an external site assessor. This promotes an objective discussion of the most important topics related to maintenance execution and fulfillment of expectations with the customer in an open and constructive atmosphere. This approach is critical to ensuring that customer requirements are properly addressed and future challenges anticipated.

The site assessment report contains observations and recommendations for improvement and is shared with the customer. ABB then discusses the plant's maintenance operations with the customer, and, as a result, the findings and action plans are incorporated into the Maintenance Management Master Plan (MMMP), which integrates the customer's industry-specific targets with the systematic ABB Full Service® concept.

Site assessments are conducted annually, and between the assessments ABB regularly reviews the follow-up actions to ensure that improvement activities are implemented at customer sites. A certification program in conjunction with the site assessments is based on customer satisfaction, people satisfaction and financial results, and identifies maintenance excellence at its Full Service sites.

The usefulness of site assessments was demonstrated at the Vale Inco Labrador Ltd.[1)] in Canada. ABB has a Full Service operation at this remote mining plant and performed a site assessment there in late 2006. Today, the site has implemented most of the resulting recommendations, including common KPIs and reporting of partnership values, systematic reliability engineering functions, and structured preventive maintenance using a CMMS system. ABB's Optimize^{IT} Asset Optimizer is implemented at the site, with remote diagnostics of the main production equipment 3. The implementation was swift, which helped the site attain an all-time high production

Footnote

1) See also "A head start to profitability" on page 88 of this *ABB Review Special Report*.

3 ABB's Optimize^{IT} Asset Optimizer helps to monitor and improve the condition of critical equipment at customer sites

Operational excellence

level in 2006 and achieve 15 percent above the Overall Equipment Effectiveness (OEE) targets in the third quarter of 2007. This led to an ABB Full Service® Silver Certificate accreditation for the Vale Inco Full Service site.

Sharing the assessment findings with the customer enables a common understanding of the levels achieved in a particular process or results area. It is a way of identifying the current status compared to best-in-class and allows both parties to set targets based on the recommendations that best support the customer's production strategy.

Knowledge sharing

In the past, it was common for employees not to share their knowledge or experience with their colleagues, as being the sole point person for specific information areas was seen as job security. Today's workforce is much more team oriented, and ABB has undergone a cultural change in this direction as well. Now a job actually requires every employee to share his or her knowledge.

As part of ABB's common processes, the company has developed a knowledge management tool to collect and share information. This Service Knowledge Portal allows ABB to capitalize on the knowledge of some 20,000 service employees worldwide. The portal allows a quick response to customers' problems and challenges. Information in the portal is organized around relevant topics and allows employees to connect and collaborate with others in their field. For example, a section called "Failure Museum" includes a series of topical failures and recommended solutions to prevent recurrences.

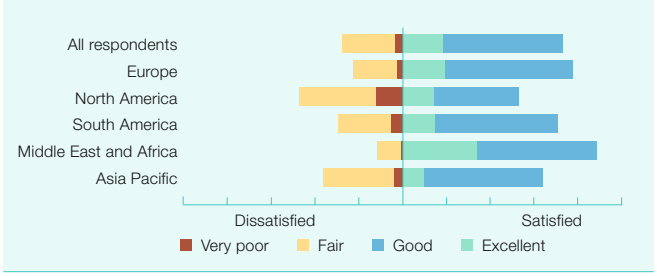
A specific area of knowledge sharing is the leading practices section that helps identify innovative solutions and good workmanship at maintenance operations. The leading practices are categorized by the different processes and associated activities, so the process area specialists can easily track relevant information. The goal is to share information from one site with others around the world, thus providing customers with the best possible process or solution. This global network is a competitive advantage for ABB and its customers. Companies who perform solely in-house maintenance would not have access to this kind of expertise.

The benefits of the portal are illustrated in a real-life example using the section of the portal called "Emergencies": A piece of critical equipment at a customer's plant in Australia broke down. Unfortunately, the part required to make the necessary repairs was no longer manufactured and there were no spare parts available. The ABB site manager posted an emergency notification in the Service Knowledge Portal explaining the situation. A reliability engineer in Brazil read the emergency post and was able to find the spare part at his maintenance site. Within days, the part was sent to Australia and installed. What could have taken four months of delivery time and expensive shutdown time was resolved in only four days thanks to ABB's global network.

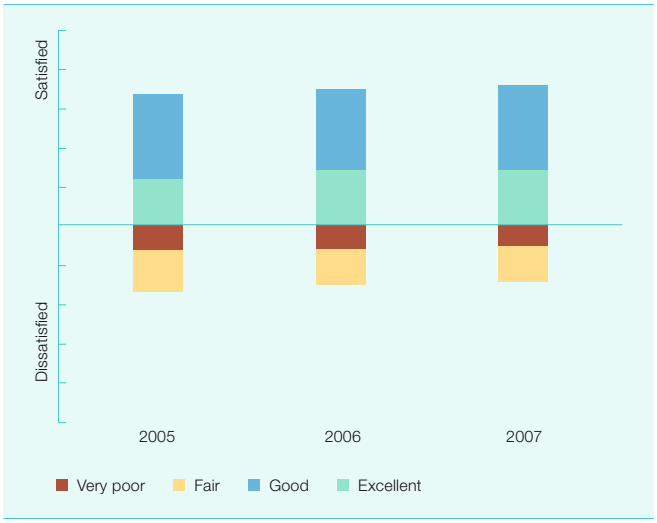
Operational excellence

ABB's Operational Excellence Program provides value to ABB, its customers and people 6. By using a structured approach, ABB is able to deliver standardized services, consistent quality and global know-how. A common language helps ABB serve its customers consistently no matter what country they operate in.

4 Service excellence means high customer satisfaction. The customer satisfaction measurement covers all countries and provides the best service quality measure globally with 47,000 customer opinions.



5 People value is measured globally through the people satisfaction survey. Improved trends are achieved by identifying three main improvement areas after each study.



6 Operational excellence principles can be summarized with the values triangle: Customer, ABB and people value are in balance.

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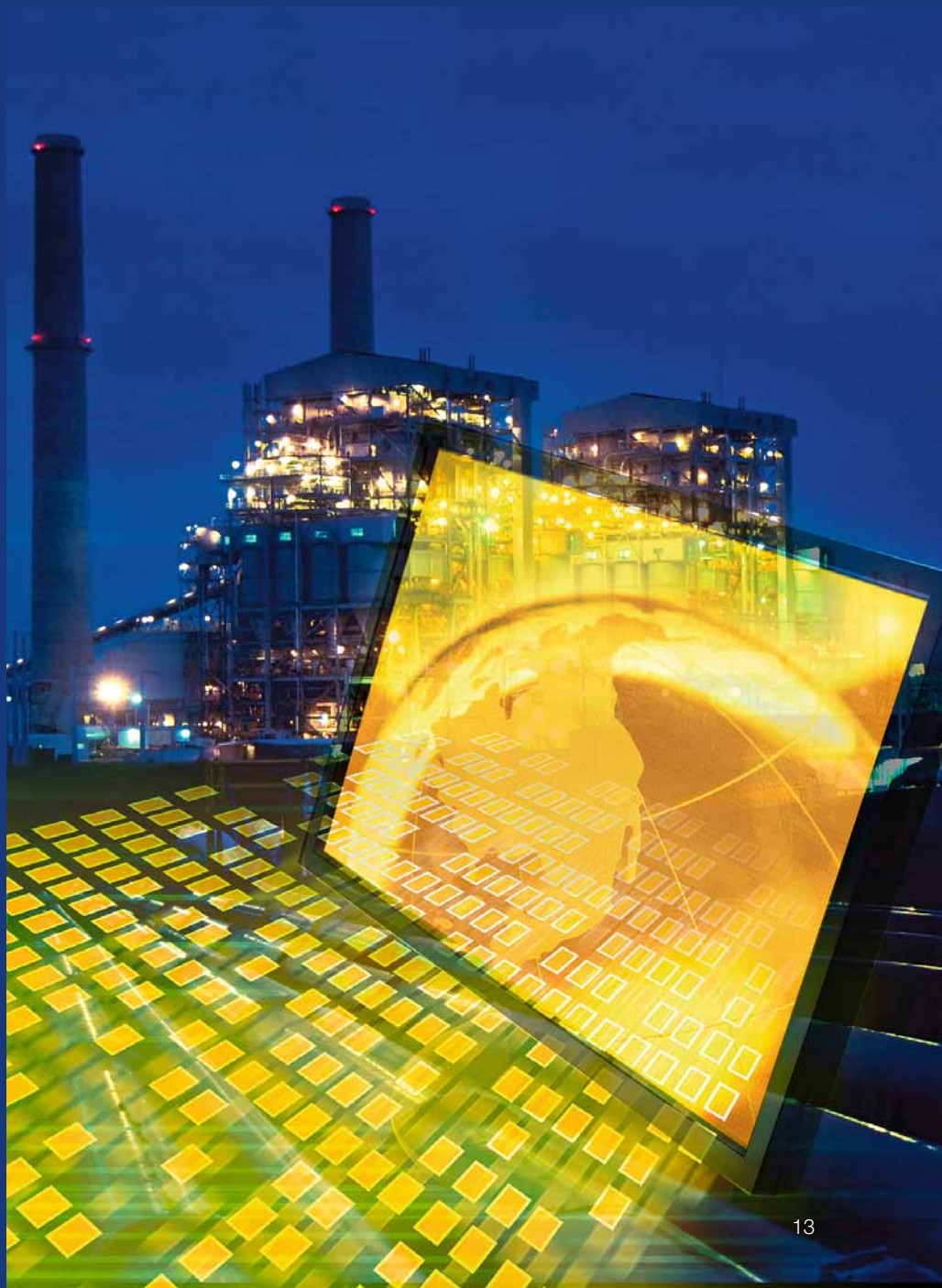
Remote optimization

Increasing profitability and improving organizational efficiency

John Schroeder

Manufacturers face the pressures of global competition more than ever today. They are expected to maximize production output while keeping costs at the minimum. Whereas some plant managers are tempted to reduce maintenance expenditure to gain an immediate improvement in bottom-line profitability, the long-term effects can be the exact opposite. Spending less on maintenance means that plant equipment will suffer, leading to poorer equipment performance and ultimately to reduced productivity and product quality.

A better solution would be to maximize the effectiveness of maintenance and process control organizations. Combining the best of maintenance practices with optimization processes will result in even greater benefits of increased production and improved quality.



Operational excellence

Process industry companies are turning increasingly to their suppliers for remote services that supplement internal and contractor on-site support and improve the effectiveness of their maintenance and process control programs. Remote services allow suppliers like ABB to provide their expertise in a cost-effective and efficient way. Having these services available 24 hours a day, 7 days a week is hugely beneficial to manufacturers, who are facing the dual challenge of a lack of expertise and rapidly advancing technology.

ABB has developed a remote service solution called Remote Diagnostic Services (RDS) that provides its customers with the right person and the right skill-set from its more than 20,000 service personnel worldwide. The solution utilizes state-of-the-art technology to ensure the security of the remote connection as well as the safety of the remote site.

ABB's Remote Diagnostic Services has helped manufacturers to improve the performance of their products and systems by providing troubleshooting and proactive and predictive services. The following examples illustrate how RDS has helped customers to quickly identify and correct problems that have resulted in tangible benefits:

Remote Troubleshooting Service

A paper manufacturer experienced a situation where a paper machine was shut down due to equipment failure. After spending more than 35 hours troubleshooting the problem internally, the company contacted ABB. An ABB expert remote-connected to the system and after 30 minutes identified and corrected the problem, which was caused by a missing machine interlock input. ABB's knowledgeable and fast service prevented greater production losses, thereby saving the customer several hundred thousand dollars.

Process industry companies are turning increasingly to their suppliers for remote services that improve the effectiveness of their maintenance and process control programs.

Remote Predictive Service

An ABB Continuous Remote Monitoring Service was installed on a control system at a power utility company. Soon after the monitoring began, the CPU (central processing unit) loading on one of the controller modules was found to be exceeding an upper limit. In addition, problems with network communications were identified that were considered to be significant and could cause a system failure in the future. Corrective action recommendations were determined and presented to the customer. After receiving authorization, ABB performed the corrective actions on the control system. ABB then verified that the problems were resolved using the Continuous Remote Monitoring Service. In this case, downtime would have caused losses of many $100,000's.

ABB's RDS solution has been well received by customers because of the significant benefits it provides in equipment performance and overall productivity, while at the same time being a very cost-effective approach. ABB provides remote services to all industries that it serves.

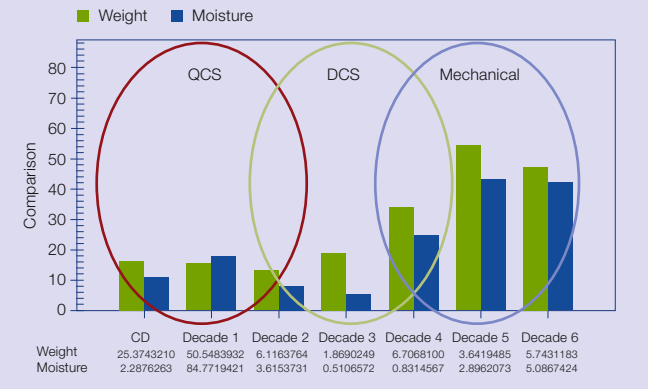
Optimizing plant processes by remote

ABB is extending its Remote Diagnostic Services offering by providing Remote Process Optimization Services as well. This advanced solution requires specialized expertise that ABB has access to via its worldwide service network:

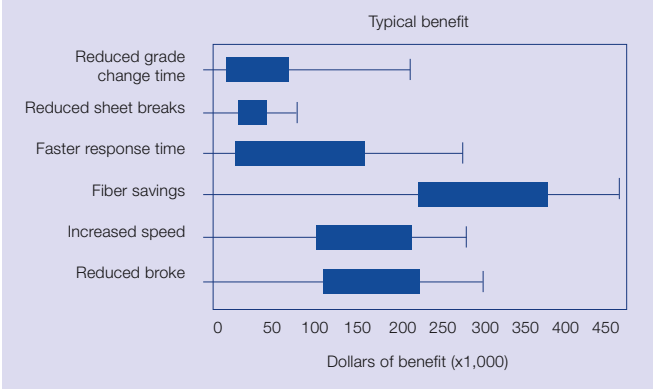
Process expertise is based on detailed knowledge of the production process. There are many barriers to achieving process optimization. These barriers reduce production efficiency and result in lost profits, but their source can be difficult to identify. ABB has world-leading authorities in this field and has developed an approach to identify barriers, implement corrective actions and provide continuous improvement services.

Equipment and system expertise is required to achieve an optimized production process, as the equipment and systems producing the products must be well maintained. ABB is the leading process automation service provider in the world[1)] with proven, in-depth service knowledge to ensure that plant equipment and systems

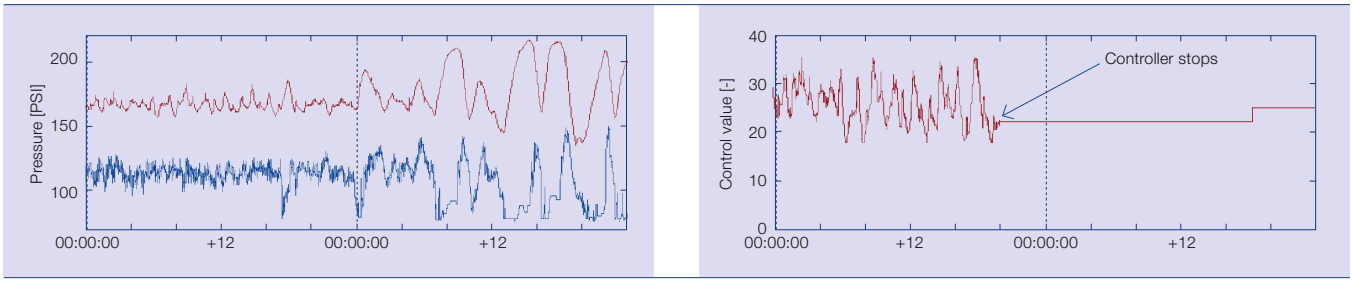
1 Summary of the cyclic energy in the paper sheet over a corresponding frequency band



2 Typical benefits achieved from implementation of ABB Process Optimization Services in pulp and paper



3 When the controller (Active Flowline Control) is switched to manual, the system (oil flow from a well) becomes unstable and oil production decreases.



perform at high levels.

Maintenance expertise is required to detect weaknesses in maintenance programs that can lead to under-performing equipment and reduced plant performance. ABB's maintenance consulting services provide a wide range of value-enhancing services that improve maintenance effectiveness by optimizing management practices. These result in lower unit production costs and reduced operational expenditure.

ABB's Remote Process Optimization Services utilize the RDS infrastructure already in place to effectively make use of ABB experts worldwide. The solution features both an onsite and a remote service element.

It begins with ABB experts visiting the customer site to become familiar with the plant and the unique characteristics of the process. Data is collected so that an initial assessment can be performed and process problems identified. Then a root cause analysis is carried out and recommendations for corrective action are made to the customer. Once the improvement recommendations have been implemented, subsequent periodic audits are performed to ensure that the desired results have been achieved and to allow for continuous improvement. Data for subsequent assessments is gathered automatically with data collection tools or with the assistance of ABB field service personnel. ABB experts remotely analyze the data and provide status reports containing additional corrective action recommendations to sustain the process improvements achieved and enable future improvements to be made.

Specific solution for pulp and paper

ABB has created a unique customized process optimization service for the pulp and paper industry. The service was developed to overcome the frequent barriers that prevent effective optimization of paper production processes. The solution utilizes both onsite and remote services to provide proven value with the following three-step process:

ABB is the leading process automation service provider in the world, with proven in-depth service knowledge to ensure high-performing plant equipment and systems.

1. ABB Paper Machine Fingerprint provides a set of unbiased surveys that analyze product variability, machine response, fiber and steam stability, and profiling capability. The fingerprint is an industry-specific diagnostic methodology that provides the most comprehensive machine study available. It delivers a complete machine analysis and provides data vital to identifying and achieving higher productivity and improved profitability 1.

2. Implementation provides the follow-up services to implement the corrective action recommendations determined during the fingerprint phase. This step applies people, processes, and proven troubleshooting techniques to locate and solve problems in the following areas:
   - Stock approach system from the high-density storage tank
   - Steam pressure system related to paper drying
   - Paper machine direction controls
   - Paper machine cross-direction controls
   - Operator usage of paper machine controls

3. Sustained equipment performance is achieved using ABB automation services such as:
   - Remote data analysis of control performance
   - Remote data analysis of production efficiency and quality
   - Remote monitoring of system and equipment performance
   - Onsite consulting services
   - Onsite maintenance services

Factbox ABB Remote Diagnostic Services

ABB's Remote Diagnostic Services (RDS) provides predictive and diagnostic capabilities for all aspects of a plant including automation, equipment performance, equipment health, mechanics, electrification, electronics, production and quality.

RDS combines secure remote connectivity with ABB's global technical support network and enables real-time visibility of asset information. Asset specific diagnostic applications perform condition-based monitoring and real-time alarming. The ABB global support network of industry and product experts coupled with immediate availability of critical asset information significantly improves diagnostic and response time.

ABB provides remote services to customers in all regions of the world.

Footnote

[1] ARC Advisory Group, Automation Supplier Provided Services Worldwide Outlook: Market Analysis and Forecast through 2011, 2007.

This three-step approach provides customers with increased production, reduced maintenance costs and improved return on assets. Typical returns have generated customer agreed upon returns on investment ranging from $250,000 to $1,000,000 a year. Payback is frequently within six months. The sustained or continuous improvement phase helps to ensure that benefits will continue to accrue in subsequent years, with further improvements leading to additional profits 2.

Typical returns have generated customer agreed upon returns on investment ranging from $250,000 to $1,000,000 a year. Payback is frequently within six months.

Specific solution for oil and gas

With most oil and gas fields in the Western world reaching maturity, the industry is facing the difficult challenge of not only maintaining production targets but of increasing them to meet ever-growing demand. ABB has developed Active Flowline Control and Active Well Control to help accomplish this difficult task. The solutions utilize dynamic active feedback control to both stabilize and increase production in mature oil and gas fields. Instead of manually controlling the production choke in wells with natural flow or manually controlling the input gas pressure in gas-lifted wells, automatic feedback control is implemented to make fast and precise adjustments to optimize overall production 3.

Since the characteristics of these wells can frequently change, and tuning of the Active Flowline Control and Active Well Control requires a high level of expertise, ABB provides a remote service to enable its control experts to both monitor and adjust the controls as needed to maintain their effectiveness. This remote service allows ABB specialists to provide more frequent monitoring and adjustments than if they had to travel to the site to perform these same tasks. It includes the following steps:

- Periodic audits – An ABB specialist periodically connects to the remote control system to assess the performance of the well or flowline control. Variability and production levels are analyzed to determine if optimum performance is being achieved.
- Control optimization – Based on the results of the audit, the control tuning will be remotely optimized if improvements in overall productivity can be achieved.

An additional benefit of this remote service offering is that it eliminates the high cost of traveling to an offshore oil platform.

ABB's Active Well Control and Active Flowline Control have achieved significant production increases at mature oil and gas fields. ABB's Remote Optimization Service offering, which provides periodic performance audits and control optimization, enables these solutions to continue to operate at optimum levels 4.

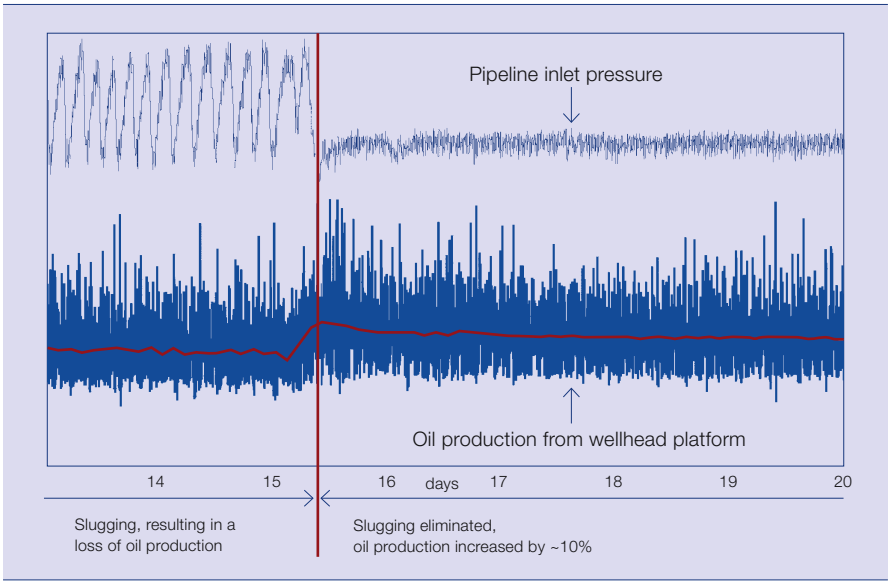
The multiple benefits of remote services

ABB's complete portfolio of remote services provides significant benefits to customers. Many cases have been documented where production downtime has been reduced or prevented altogether as a direct result of ABB Remote Services, resulting in hundreds of thousands or even millions of dollars in savings. In addition, ABB's Remote Process Optimization Services increase overall productivity and improve product quality.

Remote services are also valuable due to the dwindling amount of expertise available for the ever increasing complexity of technology. Experts can support more customers in a timely and cost-effective way.

Finally, today's remote connectivity technology makes remote services both secure and safe. Data security is ensured with state-of-the-art encryption techniques, safety is provided through customer control of remote access, and data integrity is maintained by utilizing existing customer firewall configurations and other security measures.

4 Successful results achieved by Active Flowline Control



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Evolving automation systems

Automation systems discover the meaning of life

Denis Harding

According to the leading research and advisory firm, ARC, a staggering $65 billion worth of installed automation systems in the process and utility sectors have reached the end of their life cycle. Unfortunately many companies have failed to put any form of automation system migration plan in place, and could face an expensive upgrade bill that is further compounded by the need to close plants and processes for long periods to carry out the necessary upgrade. In the few cases where a migration plan exists, extensive and expensive rework, automation application redevelopment and disruptive “rip and replace” of existing equipment is often required just to return functionality to current levels of performance.

It is against this backdrop that ABB has developed its Six-Stage Automation System Management Program. The program is aptly called Evolution for Life, and aims at avoiding the last minute panic and excessive costs of a failing automation system by providing a clear roadmap to maintain, repair, upgrade or replace the existing system and its component parts over an agreed time frame; usually the lifetime of the system.

Operational excellence

For numerous chemical and pharmaceutical companies – especially in the developing world – where the threat of lower cost operations is ever-present, staying in business can be a daily challenge. However, sooner or later automation plant equipment and systems need to be changed or modified. Unfortunately, for many companies there may be limited scope for investment in new systems, and for those companies that can afford the capital expenditure involved, the disruption, retraining and snagging that comes with it is undesirable.

To help companies avoid reaching a point where major investment in their automation plant is the only way of ensuring their survival, ABB has developed a Six-Stage Automation System Management Program called Evolution for Life. This program provides a cost-effective path to enable a company's automation systems to evolve through a series of small, manageable and affordable steps on an ongoing basis to meet their changing business, legislative and operational needs within agreed financial and operational restraints. By extending the life cycle of existing systems and adding new functionality at the right point in the life cycle, significant savings in operational and capital costs, as well as optimized production, can be attained 1. Evolution for Life goes beyond traditional maintenance and migration programs to include techniques that optimize the performance of the control system and extend its operating life and benefits beyond the norm 2.

The program initially targets ABB's own installed base, with a commitment to support its previous generation of control and automation systems until at least 2025.

ABB's Six-Stage Evolution for Life

The Evolution for Life program comprises the following stages:

- *Stage 1:* Identify customers business goals
- *Stage 2:* Analysis of installed systems and how they are affected by business goals
- *Stage 3:* Assess ABB's system and services offering
- *Stage 4:* Develop long- and short-term technical and commercial plans
- *Stage 5:* Develop and implement an agreed Evolution schedule
- *Stage 6:* Continuous re-evaluation of business needs and solutions

Stage 1: Identifying business goals

ABB has put together an Evolution core team whose role is to work with customers to identify the key business drivers that are likely to impact on the automation system. This team, together with the customer's business and operational/technical management, carries out an all-encompassing business review that considers activities such as:

- Environmental effects including carbon footprint analysis.
- Energy saving and energy measuring opportunities.
- Legislation, regulations and directives. In other words, a review of what is currently in force, what is changing, and how these may effect the automation system.
- Productivity programs such as overall equipment effectiveness (OEE).
- Asset, production and information management issues such as plant life and usage changes.
- Plant and system maintenance schedules.

This review provides the customer with a firm commercial rationale for engaging the Evolution for Life plan.

Stage 2: Analysis of installed systems

ABB audits the installed automation systems using tools and techniques to ascertain:

- Current configuration and status of the systems
- How well the systems are currently performing
- The current and future life cycle of the installed base

This information, together with the findings of Stage 1, provide a roadmap that identifies the impact of the business goals on the existing automation system functionality.

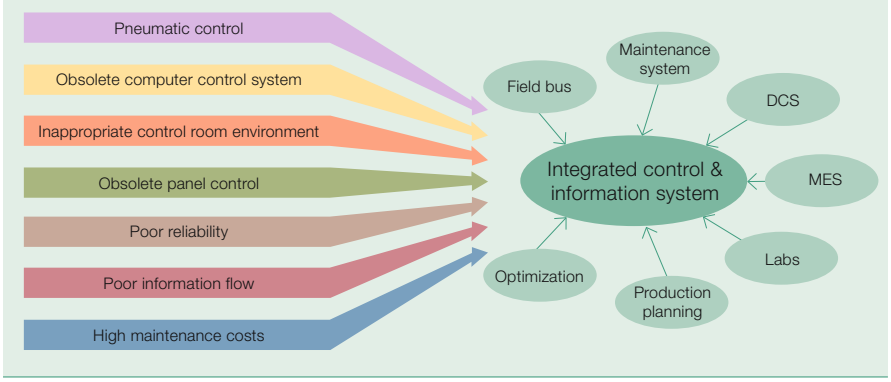
The findings of Stage 2 provide the customer with a firm technical rationale for engaging the Evolution for Life plan.

Stage 3: Assess ABB's offering

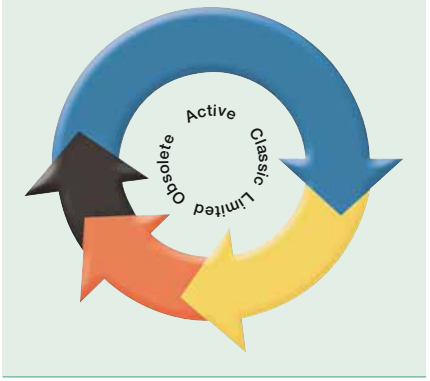
A review of ABB's existing technology is undertaken to identify products, systems or services which could provide immediate and long-term benefits to the existing installation. The customer receives an initial plan plus an audit report detailing the technical steps recommended and a summary of the commercial consequences.

This assessment drills down to the sub-system module level and identifies areas where the final Evolution

1 ABB's Evolution for Life addresses the key issues in control system life cycle and operation.



2 The "cradle-to-cradle" life-cycle concept



for Life plan can be implemented in small or large increments. This ensures that an informed plan-of-action is agreed.

Stage 4: Develop long- and short-term technical and commercial plans

Armed with the findings of Stages 1 to 3, ABB produces a recommended Evolution for Life plan for the existing system to meet the agreed business goals over an appropriate time frame. This plan is typically based on the "risks and consequences" to the customer's business if any part of the system or the business goals change status during its life cycle. Facilities at greatest risk that need be considered in the short-term are identified and targeted.

The steps within the plan are carefully scheduled to maintain the integrity and minimize interruption to production during the various stages. The plan contains details such as:

- Scope of supply
- A program of maintenance solutions targeting:
  - System life cycle in terms of functionality, hardware and software
  - Software revisions
  - Operational enhancements
  - Obsolescence
- A breakdown of the above into stages with:
  - Planned timings
  - Commercial effects
  - Responsibilities

The customer now has a mutually developed, business and technical risk/consequence plan that meets current and future needs. With it, a schedule with small or large steps is drawn up to meet production and financial strategies.

Stage 5: Develop and implement an agreed Evolution schedule

Every plant is different. As such, the collaborative evolution team agrees a detailed implementation plan for each stage.

ABB's Evolution for Life program provides a cost effective path that allows a company's automation systems to evolve through a series of small, manageable and affordable steps on an ongoing basis.

Stage 6: Continuous re-evaluation of business needs and solutions

Stage 6 is the crux of the evolution plan. It aims to support the production process throughout its life-cycle whatever the status of the commercial, legislative and technical environment, and as such the plan is regularly updated by the customer and ABB. Thus the plan is adapted as the business or technical environment changes to ensure that the system remains current, with the required functionality. This ensures a plan based on commercial, production and technical requirements that are centralized around the customer's business priorities, and avoids the issues highlighted by ARC[1]. Evolution for Life, therefore, eliminates Automation System surprises – a fundamental benefit in the current business environment.

Evolution for Life in practice

During 2007, 43 customers in the UK made a financial commitment to ABB for an Evolution for Life program. One of the early adopters of the program has been British Gas (BG) and its North Sea Armada platform, which produces 300 million cubic feet of gas per day.

Together with the customer, ABB has developed a comprehensive five-year evolution plan that will upgrade and extend BG's ICSS (Integrated Control and Safety Systems) to monitor and control every aspect of the Armada platform's process and safety systems. This will deliver increased reliability, improved asset integrity and enhanced performance. Furthermore, the scope of the ICSS will be extended to incorporate additional sub-sea tiebacks. Modernizing and extending the system will be carried out without disrupting production. The plan is reviewed every six months by BG and ABB as business and production priorities change and the implementation is fine-tuned.

Footnote

[1] Companies have made a massive investment in automation systems. It is not just financial but extends into intellectual property and the general experience gained by their workforce.

In the oil and gas sector, the priority is to ensure safe, reliable production with no disruptions. Therefore plant integrity is essential. While repair and maintenance may be covered by conventional service plans, the Evolution for Life program goes further to provide for the planned modernization of equipment and base control software. In this way companies like BG can be sure they are operating at the same high level of productivity as they would if they invested in the wholesale installation of new plant equipment.

A second North Sea operator investigated the option of replacing their existing control system. They were told by another supplier that nine weeks of production downtime would be required to install and commission a new system. As the value of oil production is about £500,000 ($985,200) per day, the economics showed that evolution rather than "rip and replace" is the way to go.

Chemical and pharmaceutical sector

For chemical and pharmaceutical companies, the Evolution for Life approach not only assists with the long-term challenge of staying in business, but it also ensures that the customer's organization has confidence in ABB's long-term support of all facets of its automation plant. This support even extends to older components in a system, such as the core components belonging to a previous generation of systems, that are performing well.

In addition to supporting these core components, ABB has committed to provide a minimum of 10 years continuing support to any such product that is removed from active sale.

To illustrate this, a chemical plant in the north of England installed an ABB distributed process control system in its main plant in the early 1990s. Due to the low investment capacity of this manufacturer, the system has had minimal modernization and is therefore no longer suitable to provide all of the functions required for a modern world-class manufacturing facility. Some parts of the system are reaching the end of their life cycle, and legislative changes mean that new features are necessary over the next several years. The capital investment needed for a new control system is simply not available.

The Evolution for Life program differentiates itself from others by focusing on preserving the production process stability.

ABB and the customer have agreed a six-year evolution program to support and modernize the existing system in small stages, thereby keeping the investment within the customers budget. As part of the program, automation functions that are currently in third-party systems will be moved into the ABB system, thus significantly improving plant operation and support needs. In addition, this will also provide improved and consistent functionality, as well as a reduction in support costs and production disruption.

For this customer, the advantage of implementing the evolution program is that he now knows his technical and commercial solution for many years to come. This will be reviewed each year to ensure continued stability and suitability of the plan for a similar period of time ahead.

Keep on going

In high performance process and utility industries, the need to keep abreast of industry-leading performance is vital. Falling behind can reduce margins, reduce throughput and build a gap which ultimately becomes economically unbridgeable.

ABB's Evolution for Life program differentiates itself from others by focusing on preserving the production process stability. The integrity of the customer's existing installed base is preserved by providing a "hot cutover." This results in the seamless implementation of modern, robust and supportable equipment and eliminates the need for costly interruptions to production.

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Taking control of the human element

A proven approach to control room performance assessment

Tony Atkinson

The importance of the control room operations team can never be overemphazied. This team needs to be alert, informed, supported and motivated at all times if dangerous, costly and reputation-damaging situations are to be avoided. The obligation then is on organizations and their management to ensure that control room operators are equipped to respond correctly to all conditions. This involves much more than just training and guidelines; the entire professional, physical, managerial and working environment needs to be looked at. In the long run, these are the things that make the difference between safe shutdowns and a potentially serious situation.

To help industries achieve the optimum control room environment, ABB Engineering Services has developed what is known as the Control Room Ergonomic Review. The purpose of this review is to examine and report on the factors that affect the performance of the control room operations team. The review is suitable for all control room environments and is applicable to control rooms in a wide range of industrial sectors, including oil and gas, chemicals and utilities.

Even though it is obvious that good working conditions bring out the best in people, it is often a forgotten or overlooked fact. While it is very important in all working environments, nowhere does this matter more than in the control of hazardous processes. When things do go wrong, very often it is not the people who are at fault, but rather external factors that affect their responses and lead to mistakes.

Control room operators need to be properly equipped if they are to respond correctly to all conditions, and this encompasses much more than training and guidelines. The entire working environment, both physical and professional, needs to be scrutinized. Every organization in the process industry needs to pay full attention to the human element, especially in control room functions. It is essential that managers, engineers and financial people inform, support, motivate and communicate with these key members of staff if disasters are to be avoided.

ABB's Control Room Ergonomic Review

To help companies create the right control room environment, ABB has developed a Control Room Ergonomic Review to examine and report on the factors that affect the performance of the control room operations team. The review conforms to internationally recognized standards and guidelines, as well as regulatory "best practice" guidance. Its role is not just to highlight areas that need attention, but to also provide an action plan that offers a clear way forward for the customer. The review is suitable for all control room environments, both legacy panel-based layouts and more modern screen-based designs. It is also applicable to control rooms in a wide range of industrial sectors.

The Control Room Ergonomic Review helps companies create the right control room environment by examining and reporting on the factors that affect the performance of the operations team.

A typical review involves a two-day site visit followed by a report which is delivered within a two-week period. The report highlights good practices as well as areas where improvements are needed. It can also be used to provide a baseline for improvements and further benchmarking. The review takes a disciplined look at eight main areas:

- Control room environment
- People/machine interfaces
- Alarm system performance
- Safety-critical communications
- Operational procedures
- The operators' physique and ergonomic needs
- Alertness and fatigue
- Training and competence

Each of these areas is scored to produce a visual model that shows compliance with what is considered best-practice 1. This not only gives an easy to understand picture of performance, it also provides a benchmark against which all the control rooms in a company can be monitored.

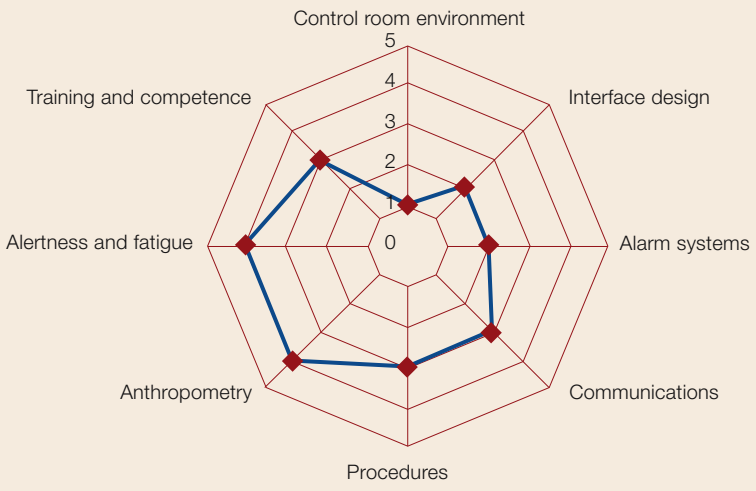
This structured approach involves all personnel directly involved in control room activities. These include the operators, operations team supervisors, health, safety and environment managers, plant engineers and operations management. The required data is obtained through questions and observations as well as a review of site information including design, procedures and guidelines. Participants in the survey must answer a series of questions that highlight their awareness and understanding of the main issues. These cover everything from management commitment to processes, performance, improvement strategies and routine performance.

The ABB approach is to consider the control room by its actual performance rather than as an abstract theoretical model. This ensures that the outcome is relevant to improvement and upgrade projects because it addresses real-world topics like performance targets and regulatory requirements.

Control room environment

At the heart of the ergonomic review is the physical layout and operation of the control room. The ABB consultant assesses the age, format and organization of the room; how it has changed over time and what other purposes it has to fulfill, such as meetings and relaxation. Because they tend to evolve over time, control rooms can easily accumulate a range of redundant equipment, unsuitable fittings and unnecessary functions, all of which need to be considered in the review. This might even extend to whether the area is tidy, hygienic,

1 The eight key elements in ABB's Control Room Ergonomic Review are assessed on a scale of 0 to 5 based on a word model



well cared for and comfortably furnished. Assessors will observe the subtle but notable impact of long established habits on the performance of the people and where necessary, recommend changes.

Management commitment

A key element in a successful and efficient control room is the commitment of management to continuous improvement throughout its lifetime. Unfortunately, it is very easy for a state of benign neglect to set in which, in turn, results in a slipping of standards. A feeling that there is a lack of interest by senior management in their workplace conditions can easily be reflected in a workforce's own attitude and commitment to their job. Therefore any changes in the plant that impact the control room and its staff need to be properly managed at higher and local levels. For any improvement or life-cycle plan to succeed, a number of elements need to be in place. These might include an integrated plan (with performance targets and purpose), a responsible nominated engineer, a budget and a communication program.

Lighting

Control room lighting makes a big difference to the performance and comfort of operators, as does screen glare. Lighting is not only necessary for the more obvious tasks (ie, reading), but it also affects operator alertness. This becomes especially important when people must work long hours and are subject to fatigue and pressure. Simple steps, like adding desk lamps can make a real difference.

Noise is another factor that affects comfort and performance. It is important to get the balance right by avoiding sounds that distract as well as low sleep-inducing sounds. An example of a distracting sound is voices and this leads indirectly to yet another area that ought to be considered: whether the control room should be allowed to become a thoroughfare with a constant flow of people dropping in to chat or simply passing through. While a punitive regime is not at all desired, it is important that operators remain focused and alert with the least possible distraction.

It should not be assumed either that air conditioning systems are necessarily performing adequately. ABB has found situations where additional heating or cooling devices have been installed, producing atmospheres that are too cold or too hot, neither of which will keep people at their peak.

Man/machine interface

A key part of any process overview is the "big picture" which enables the operator to keep tabs on all the main variables and statuses at all times. This is why the ergonomics and ease-of-use of primary DCS (Distributed Control System) equipment is critical. To be able to monitor key plant performance in normal, and more importantly, abnormal situations, such as start-up and shutdown, enough screens should be available, minimizing the need to switch between them. Consistent presentation of graphics across the systems is both good practice, and essential for ease-of-use and the avoidance of errors. This makes it easier for users to interpret new or unfamiliar situations quickly when they arise.

It is not unusual for significant gains in operator performance to be achieved through the creation of "task-based" graphics, thereby making it simpler to manage the tasks and integrate them with specific procedures. Setting key performance indicators (KPIs) and measuring the performance and effectiveness of communication is a vital success factor. This is not a once-only function but a continuing ongoing requirement. ABB can help by identifying best-practice indicators against which each installation can be compared.

At the heart of the ergonomic review is the physical layout and operation of the control room.

Efficient handover

Communication is the key to so many aspects of control room safety and efficiency. One area where this can be clearly seen is in the handover between shifts. This should involve all concerned and include operators and team leaders passing on information to each other. This communication should follow a proper format and be formally recorded. It not only makes good sense, it is one area where in

the UK, for example, the Health & Safety Executive is prepared to consider enforcement if an effective procedure is not in place and being followed.

Proper communication extends not only to the control room team but also to other operators in the plant with whom the team must work. ABB reports occasions when the basics of this process, reliable phone and radio systems have not been in place, making it virtually impossible to achieve the necessary degree of communication.

It is important to ensure that written and actual procedures for start-up and shutdown operations are the same. It is easy for these procedures to change over time and for these changes not to be recorded. ABB has discovered situations where different shifts have different ways of performing the same tasks, something that should not be allowed to develop. This is another area where firm management and clear communications are vital. The teams concerned should also be required to confirm their receipt of new instructions.

Anthropometry

Anthropometry involves relating the physical layout and organization of facilities to the people that work in them. Physical characteristics, such as size and mobility, of the control room staff need to be taken into account. In the end, anthropometry is a matter of personal comfort and convenience, and getting it right can significantly affect working efficiency. Anthropometry is particularly relevant to the layout of workstations in the control room. As well as covering furniture and screens, it also looks at the availability of artificial and external light. For example, the ISO standard recommends that the operator is approximately 900 mm from the screens he is using.

The real secret of safe, efficient control room operation is understanding and managing the human element.

The control room layout design affects many aspects of performance and no single design is perfect for all circumstances. Screen layouts arranged in an arc formation facilitate performance from a single operator, but impede communication with other operators. Linear layouts improve communications, but present difficulties in reaching multiple interfaces, while stacked screens can aid issues of reach, but block line of sight.

Clearly the design of the control room cannot be considered separately from the tasks undertaken and the necessary team dynamics within that control room. And, of course, all systems should be adequate in an emergency and not just under normal operating conditions.

Alertness and fatigue are other important issues that need to be actively addressed. Factors affecting these issues, such as the physical environment, and work patterns and hours must be closely examined.

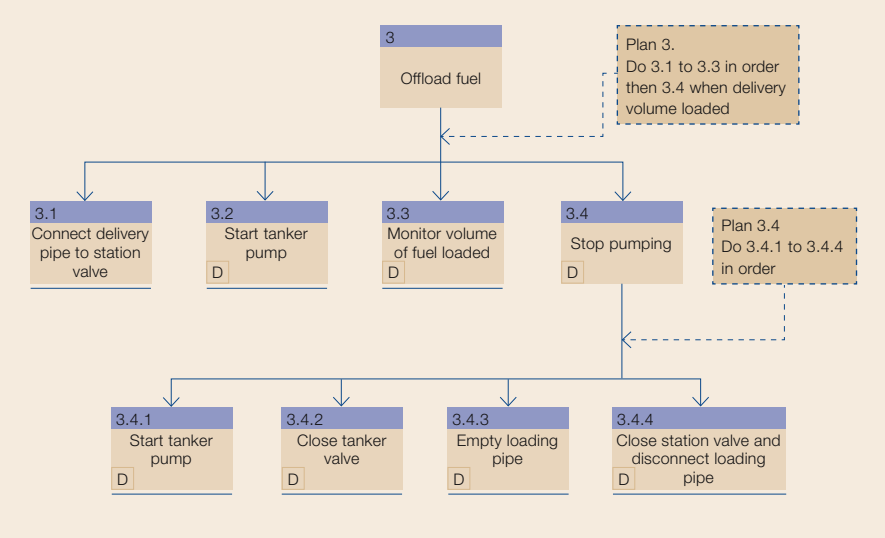
Control room technicians are required to be competent in the individual areas of a process plant prior to being trained and assessed for their role in the control room. Achieving and demonstrating this competence requires more than just training. Issues of job design, experience and assessment are key to ensuring competent staff in this key role 2. Competence extends beyond the technical, and may include the ability to manage diverse and conflicting data and to take complex and critical decisions. Therefore, like many of the issues previously mentioned, training and competence must be constantly monitored, reviewed and recorded and not allowed to drift over time.

Managing the human element

The real secret of safe, efficient control room operation is to understand and manage the human element. The way people are managed and motivated can make all the difference to the success of an operation and this is never more true than when an emergency arises.

ABB expertise in understanding and working with the human element in process industries is reflected in its Control Room Ergonomic Review. The consultant's role is not just to review and comment on the existing environment and procedures but to deliver an action plan as a way forward. This enables customers to make quick and informed decisions to meet all the issues raised in the review.

2 Hierarchical Task Analysis (HTA) can be used to assess the role of an operator's job



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Unlocking potential

Industrial energy saving – an untapped opportunity

Jim McCabe

The International Energy Agency estimates that the world's manufacturing industries could reduce their energy consumption by 600 to 900 million metric tons of oil equivalent a year. This represents a potential reduction in total annual global CO_2 emissions of between 7 and 12 percent. Why is this opportunity still being missed? After all, it could be a relatively "quick win" for many companies and also deliver considerable cost savings.

For energy intensive industries, greater energy efficiency is vital to improving competitiveness, security of energy supply and environmental protection.

Given these strong action imperatives, it is surprising that many energy savings opportunities remain untapped. They can provide "quick wins" for business, often with short payback times and long-term benefits.

In many cases, organizations are unable to respond to opportunities due to lack of time or personnel to implement the savings projects, difficulty in raising finance or the perception that implementing such projects will compromise customer service or product quality.

For many organizations, energy is one of the top three production costs.

ABB's Industrial Energy Efficiency program is designed to address these factors, securing the management commitment needed to unlock the required resources in a structured and long-term approach to continuous improvement 1.

Starting with a structured process to identify savings, ABB develops an Energy Management Master Plan which details all that is needed for the successful delivery of improvement projects. This plan is then carried through as part of an energy performance contract, with savings shared between the customer and ABB over the life of the contract.

Energy audits gathering dust

The most troubling fact is that many of the recommendations made in energy audits are never carried out.

Of the 844 variable speed drive energy saving assessments undertaken by ABB in the United Kingdown. from June 2004 to October 2007, only about 20 percent of the improvements identified were implemented. These missed opportunities represent a potential annual energy saving of 350,000 megawatt-hours and an emissions reduction equivalent of 154,000 metric tons of CO_2. What is more, the average payback period for these investments was just over 12 months.

A recent report by the International Energy Agency estimated that the opportunity for energy efficiency in the global manufacturing industry alone is equivalent to 600 to 900 million tons of oil [1]. The corresponding emissions reduction potential is 1.9 to 3.2 metric gigatons of CO_2 a year, about 7 to 12 percent of today's global emissions of the gas.

These savings contribute to future revenues by enhancing a company's environmental brand, improving profitability and reducing its vulnerability to future energy shortages or price increases.

From plant room to boardroom

One part of the problem is that too many energy efficiency initiatives are driven from the plant room rather than the boardroom. In these cases investment opportunities are often tactical, fragmented and perceived as small and unambitious. They fail to catch the attention of the people responsible for creating future business value. Instead, capital flows to higher profile strategic investments for expanding capacity, especially when market prices are high. When prices are low, managers opt for no investment at all rather than making what they see as marginal efficiency improvements. Under these conditions, energy efficiency investments often fail to attract managerial commitment and time at a high enough level [2].

Delivering the full potential of energy efficiency improvements requires energy to come out of the plant room and secure a seat in the boardroom. This is the key step to achieving management commitment to a structured and long-term approach to continuous energy efficiency improvement.

ABB assessments regularly identify savings opportunities of 5 to 20 percent of a site's utility consumption.

Delivering sustainable improvements

How can a company organize itself for sustainable energy efficiency improvement? What is needed is clear leadership and an empowered, well-motivated and competent workforce. Energy savings targets should be clearly communicated, ambitious and achievable. The organization must allocate sufficient resources to deliver the improvements and to deploy energy efficient technologies effectively.

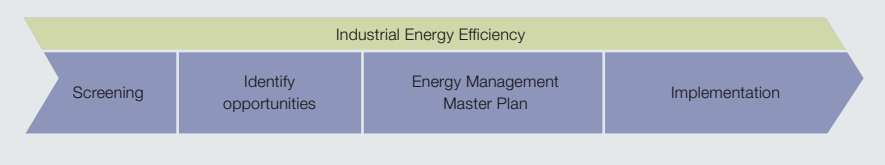
Fundamentally this calls for leadership commitment in five key areas: setting policy and direction, establishing an effective energy management organization, identifying and selecting energy saving improvement projects, action-planning for targeted improvements, and implementing an efficient management control and reporting system.

Setting policy and direction

A clear and widely communicated energy strategy is a way of coordinating such activities, either within a single site or across a multi-site enterprise. 2 describes the components of an energy strategy in varying stages of maturity.

For example, ABB recently helped a division of a major metals producer develop a strategy to meet corporate energy efficiency objectives. The corporate objective was ambitious and required the divisional managers to address the issue strategically rather than tactically.

1 ABB Industrial Energy Efficiency program



In this case, the energy policy sets out the guiding principles for managing energy across the organization, in particular the focus on continuous improvement in energy consumption per unit of production (specific energy). The policy also provides guidance for considering investments in energy efficiency, including life cycle energy costing. It also sets out individual responsibilities for energy conservation in the workplace.

2 Evolution of energy strategy from tactical to strategic

	Policy	Structure	Resources
Strategic	Formal energy policy and implementation plan; commitment and active involvement of top management	Energy management fully integrated into management structure and systems from board level down	Full-time staff and budget resources related to energy spent at recommended levels
↑	Energy policy set and reviewed by middle management	A management structure exists but there is no direct reporting to top management	Staff and budget resources not linked to energy spent
Tactical	Technical staff have developed their own guidelines	Informal and unplanned	Informal allocation of staff time and no specific energy budget

The divisional objectives were clearly articulated, ambitious and achievable. The corporate targets were devolved to individual sites, taking into account the particular conditions of each and focusing on those sites or operations where the maximum energy savings or emissions reductions would be obtained. The strategy included a description of the mechanism for measuring and reporting energy efficiency performance and how the performance indicators would link between corporate, site and project levels.

The ABB Industrial Energy Efficiency program is a structured methodology with proven tools to identify and deliver real energy savings to process plant operators.

The strategy also defined the organizational structures needed to deliver the desired improvement. This included the mechanism for managing and monitoring the direction of the improvement program, reviewing performance and adjusting targets, as appropriate. In each plant clear responsibilities for energy management, particularly within the production units that consume energy, were recommended. The enabling works and budget requirements necessary to deliver the defined improvements were also detailed. After all, the strategy can only be delivered if adequate resources are available.

Establishing an effective energy management organization

For many organizations, energy is one of the top three production costs, along with labor and raw materials. Yet all too often it attracts little management attention. What interest there is, is usually focused on procurement policy or on energy plant operations (steam raising and other plant room or power house activities).

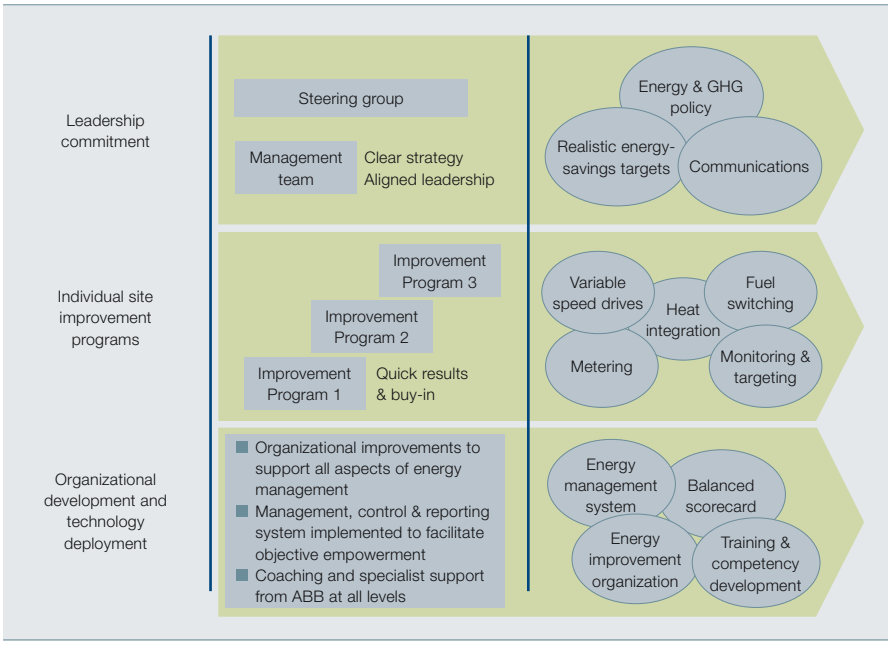
Effective energy management requires careful oversight of the full energy value chain from procurement and generation, through distribution to point of use in the production process. 3 shows the structure of an effective energy efficiency improvement program with governance activities, organizational development and site-based improvements.

An energy steering group or task force, with members drawn from production units as well as utility operations, should be set up to oversee the energy efficiency program. This group will have unambiguous corporate sponsorship.

Within the plant, energy efficiency experts or champions should be trained in energy saving techniques, from auditing to data analysis. Their role is to coach and support individual production units or departments and help them make the needed improvements in energy efficiency. Where established initiatives exist, for example in continuous improvement processes, energy efficiency can be co-opted into the existing structures.

Efforts should be coordinated across sites in order to share knowledge and promote good practices. Economies of scale may be realized where multi-site cooperation provides a bigger benefit than individual tactical interventions. Networks or communities of practice

3 Leadership, organizational development and individual site improvements in the ABB Industrial Energy Efficiency program



provide a valuable means of sharing good practices, benchmarking performance and piloting specific improvement opportunities.

Identifying and selecting energy saving projects

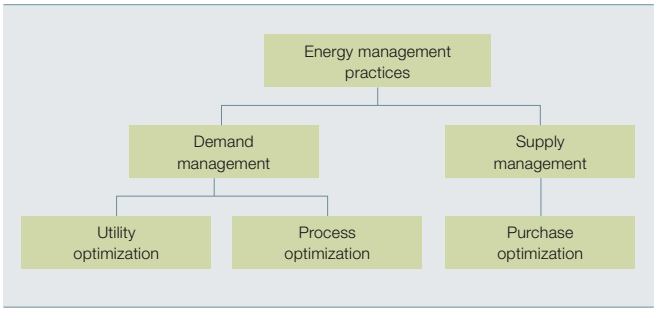
The starting point of the ABB Industrial Energy Efficiency program is the "Identify Opportunities" phase. This process identifies existing energy usage and highlights the potential areas for savings. It not only shows the environmental benefits, it also reveals the potential cost savings and the likely payback period.

A structured process is essential in order to identify and evaluate energy efficiency improvement projects. It should start with a high-level overview of energy management practices, demand management and supply management. This approach will focus effort on those areas that deliver the most value to the business. Expert intervention at this stage can accelerate the identification of savings opportunities and provide an unbiased appraisal of individual projects. It is important that decisions are based on data rather than opinion and address the requirements of the whole energy value chain 4.

In particular, process optimization is an often overlooked area where energy inefficiencies can be generated from poor plant reliability, excessive variability on product grade or production rate, and inherent inefficiencies in steady state production.

Benchmarking energy consumption at plant level or for individual unit operation can help to quantify savings opportunities and prioritize efforts in those areas that will offer the greatest returns. Such benchmarking can be carried out against nameplate performance (ie, what the plant was designed to achieve), best achieved performance (for a particular product grade or production volume), best available technique (what the world's best producers are able to achieve) or minimum practical energy (what is the minimum energy consumption that should be required to make the product?).

4 "Identify Opportunities" considers all aspects of energy supply and demand on the plant



Improvement projects should be identified and ranked according to their expected benefits (energy saving, improved reliability, reduced maintenance) and cost or difficulty of implementation (project costs, implementation time, risk to production, technology risks). At this stage a payback criterion can be applied so that only projects paying back within a particular timescale are considered.

The most troubling fact is that many of the recommendations made in energy audits are never carried out.

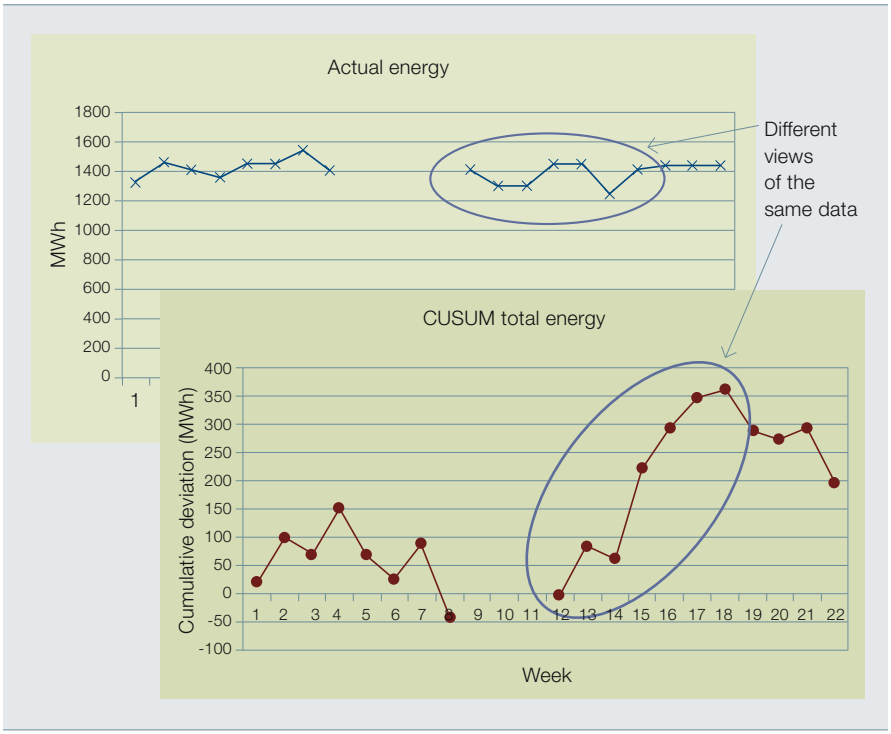
Assessments on pulp and paper mills, primary and secondary metals processing, chemical process plants and pharmaceutical facilities regularly identify savings opportunities of 5 to 20 percent of the site utility consumption. For a summary of some of these, see *ABB Review* 4/2007.

Action-planning for targeted improvements

A targeted improvement plan is essential to determine resource requirements and provide a mechanism for reviewing progress towards the energy strategy objectives. This plan will include detailed execution strategies for the selected improvement projects.

In the ABB Industrial Energy Efficiency program, this improvement plan is documented in the Energy Management Master Plan. For an individual site, the targeted improvement plan defines the local energy management structures, the competency and train-

5 Simple statistical techniques such as CUSUM (cumulative sum) detect trends and can be used to trigger corrective actions or monitor improvements



ing requirements for local energy champions and any required awareness training for the workforce at large. It also documents any required metering and measurement upgrades to support the improvement plan.

Specific improvement projects will have detailed execution strategies to define the scope of the project, the baseline performance (before implementation) and the expected benefits after implementation (including the mechanism for verification). They will also set out what activities are to be delivered, by whom, when and at what cost. If the improvements are to be implemented as part of an energy performance contract, the mechanisms for sharing savings will be defined at this stage.

Energy management control and reporting system

It is highly important that successes are visible and communicated widely throughout the organization. Energy efficiency improvements are a valuable tool for engaging a wide community of stakeholders, including employees and customers. It may be necessary to install meters to measure improvements – these should be specified as part of the implementation plan.

An energy management system can be used to collect and analyze data as well as provide the real-time performance information that allows operators to respond quickly to changes in conditions. Many energy management systems report monthly, perhaps based on billing data. However, this is too infrequent to be useful as it is difficult to connect perceived anomalies with actual plant conditions when looking back over three to four weeks. Any system used should be flexible enough to allow analysis based on product grade, batch, shift or specific time period.

Energy savings contribute to future revenues by enhancing a company's environmental brand, improving profitability and reducing its vulnerability to future energy shortages or price increases.

Statistical techniques such as CUSUM (cumulative sum), are useful for detecting small changes that appear insignificant in absolute data but accumulate over time [5].

Site energy champions will be trained in these techniques and supported with tools to collect and analyze data from the major energy consuming processes on the plant. If site resources are not readily available, then it is possible for energy data to be analyzed remotely.

Value from energy savings – delivered!

The ABB Industrial Energy Efficiency program is a structured methodology with proven tools to identify and deliver real energy savings to process plant operators. Energy efficiency and emissions reductions are recognized as drivers of value, supporting profitable and sustainable growth. Ambitious improvement targets can be set, together with the required management commitment and resource allocation to deliver. By engaging with ABB, plant owners gain the benefits of a greener brand and reduced energy consumption while continuing to maintain their primary focus on their customers and core business.

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Safe and sound

Achieving organizational functional safety certification for IEC 61508 and IEC 61511

Stuart R. Nunns, Roger W. Prew

Statistics relating to the performance of major manufacturers are published internationally and incidents, especially those causing injury or death, make headline news. Safety is a major issue and with heightened awareness of contractual rigor and the potential for litigation should something go wrong, organizations need to demonstrate that their functional safety capability is seen as best-in-class.

With this in mind and the increasing globalization of markets, it becomes more and more important to have uniform international safety standards. The IEC 61508 and IEC 61511 international standards are now increasingly used as a measure to demonstrate compliance with legal requirements and justify that the required functional safety has been achieved.

As one of the largest suppliers of safety-related systems to the oil and gas, petrochemical and power industries worldwide, ABB recognizes the importance of compliance. Two years ago, the company embarked on a program to achieve third-party accredited certification in accordance with with the requirements of IEC 61508 and IEC 61511 for 18 of its system integration centers around the globe. This article illustrates the process that the company followed.

Recent inquiries into major industrial incidents [1, 2] reinforced the importance of the international standards IEC 61508 [3] and IEC 61511 [4] and their use as a benchmark of acceptable good practice. In today's world, manufacturers and producers face significant liabilities if they are in breach of or fail to apply required regulations. Such liabilities include direct financial costs arising from the incident itself or from legal costs and fines if found guilty of breaking the law, damages paid to injured parties and a damaged reputation, which can have far-reaching implications on the business. The result is that safety and profitability are inextricably linked.

For ABB, compliance is not only about minimizing liabilities for both the company and its clients, but it is also about leading by example and achieving engineering efficiencies through company-wide common practices and procedures. To explain further, safety systems, like many other automation technologies, are undergoing a revolution. Process protection relies increasingly on networked "smart" equipment, integrated control and safety systems, reprogrammable components and subsystems with automated configuration tools. The application of such technology offers significant economic and safety benefits. However, to exploit this potential the technology must be applied in a compliant and competent manner, and this means the adoption of relevant standards such as IEC 61508 and IEC 61511. In any case, the requirements of these standards cannot be ignored, especially as many major clients are specifying them as a functional safety benchmark and a contractual requirement.

To meet this requirement, the company embarked on a program to achieve third-party accredited certification in accordance with the requirements of IEC 61508 and IEC 61511 for 18 of its system integration centers around the globe. The benefits of certification are outlined in the Factbox.

Establishing the basics

ABB responded to the strategic objective of third-party certification by establishing a Safety Lead Competency Center (SLCC). The SLCC was charged with ensuring that safety applications implemented within ABB Safety Execution Centers (SEC) complied with IEC 61508 and IEC 61511.

For ABB, compliance is not only about minimizing liabilities for both the company and its clients, but it is also about leading by example.

One of its first tasks was to develop a set of core principles for functional safety and a program of work to achieve accredited certification for all the system integration businesses in ABB wishing to achieve SEC status. These core principles, called strategic competency principles, define the minimum requirements needed to demonstrate a commitment to (functional) safety within the businesses. There are four strategic competency principles:

- *Benchmarking current practice* undertakes and documents a "gap assessment" of the existing functional safety management system against IEC 61508 and IEC 61511 to establish the scope of work required.
- *Implementing safety standards* species and implements a work program to achieve accredited certification for each potential SEC's functional safety management system.
- *Establishing individual competency* encourages safety engineers to achieve "certified functional safety engineer" status through the TÜV Rheinland Functional Safety program. Additionally, it ensures that lead and safety engineers working on safety projects have previously attended all the relevant safety system training courses.
- *Managing third-party integrators and channel partners*. Third-party companies invited to carry out safety-related activities for an ABB company will be assessed and approved by the SLCC in the same way as an ABB integrator.

Factbox The benefits of certification

- Limiting exposure to potential liabilities
- Demonstrating due diligence
- Establishing an efficient, repeatable safety management system (procedures, techniques, tools, etc.)
- Reducing unnecessary pre-contract discussions (a benefit to both ABB and client)
- Cost-effective proposals
- Reducing requirements for bespoke project safety procedures
- Gaining a competitive edge
- Being seen as best-in-class

Defining the boundaries

Prior to the gap assessments, a core set of prerequisites[1)] was agreed for all potential SECs. These provided a clear understanding of the organization's safety systems supply chain responsibilities, and mapped the organization's generic functional safety management system against IEC 61508 part 1, clause 6 and IEC 61511 part 1, clause 5 (Management of Functional Safety).

A Safety Requirements Specification (SRS), based on a Process Hazard and Risk Assessment and developed in a systematic way by the Engineering Procurement Contractor (EPC)[2)], is essential before a project can begin. Even though there are significant variations in the quality and contents of the SRS within the industry, the fundamentals are for a clear specification of what safety functions are required and their target Safety Integrity Level (SIL). This information is critical as it enables a definitive proposal to be prepared against an enquiry, and when the contract is won, it provides the full definition for the safety functions to be engineered.

The prerequisites are also required to define the scope of the certification and how it applies to the SEC. For ABB, the certification scope covered:

- IEC 61508 E/E/PE safety-related system integration and IEC 61511 Safety Instrumented System (SIS) integration

Footnotes

1) These prerequisites detail the activities specifically associated with the logic solver subsystem as part of the overall end-to-end Safety Instrumented System (SIS).

2) The benefits to all parties involved (ie, the system supplier, contractor and end-user) by engaging in dialogue at an early stage to establish a quality SRS are immeasurable.

- Applicable phases – IEC 61508 phase 9 and IEC 61511 phase 4. Specifically:
  - Management of functional safety
  - Documentation
  - Functional safety assessments

Specifying competency requirements

The need for formal evidence of the competency of providers of safety-related products and services is increasing. However, in many cases it is clear that there is little understanding of what competency means. Against this background the SLCC has established processes for both organizational and individual competence. These demonstrate that the organization has competent functional safety staff as part of a functional safety competence scheme. This competence scheme is based on four attributes: knowledge, experience, training and qualifications, which are addressed through the development and introduction of a Competence Management System (CMS).

The CMS introduced additional competences specific to functional safety, over and above the requirements of ISO 9001. It is based on the UK IEE/BCS "Competency Criteria for Safety-related System Practitioners" [5].

1 A TÜV Rheinland certificate showing that ABB Limited (UK) has successfully introduced and applied a Functional Safety and Management System (FSMS) in accordance with the requirements of IEC 61508 and IEC 61511.

The CMS ensures that all personnel having responsibilities for safety-related project tasks are equipped with the correct training, knowledge, experience and qualifications appropriate to the tasks for which they are responsible.

A competence database is used to record the technical capabilities of all personnel and provides data for personnel selection. Project managers consult the database when assigning resources to a safety-related project, to ensure that candidates for the roles have the necessary experience and qualifications appropriate to the task and technology, in addition to the legal and safety regulatory framework. The competency level achieved by an individual is classified as follows:

- *Level 1:* Indicates implementation experience of the system safety platform and/or appropriate training. This is the minimum level required for system implementers and testers.
- *Level 2:* Indicates experience and training to the level required for specifying/designing solutions for the system platform. This is the minimum level required for system designers.
- *Level 3:* Indicates a recognized expert in a specific aspect of the systems platform, demonstrated through appropriate combination of experience, application and training. This is the minimum level required for the reviewers of the system.

Benchmarking current practice

The first of the four strategic competency principles described earlier ("Benchmarking current practice") calls for a gap assessment of the Functional Safety Management System (FSMS) against the requirements of IEC 61508 and IEC 61511 for each SEC. To perform this task, a gap assessment methodology, based on a Conformity Assessment of Safety Systems (CASS) [6] scheme was used. This was developed to align with part 1, clause 6 of IEC 61508 and part 1, clause 5 of IEC 61511.

IEC 61511, rather than IEC 61508, was used to develop the detailed gap assessment methodology because its terminology was more relevant to companies like ABB that operate predominantly in the process sector. The gap assessment methodology was aligned to the following phases of IEC 61511, and mapped to the core set of prerequisites defined earlier:

- *Phase 4:* SIS design and engineering
- *Phase 9:* Verification
- *Phase 10:* Management of functional safety and functional safety assessment and auditing
- *Phase 11:* Safety life-cycle structure and planning

A gap assessment module was developed specifically for each of these phases. For completeness, each module was reviewed against all relevant clauses of both standards, and a series of gap assessment tables were developed, which included:

- Targets of Evaluation (TOE)
- A summary of the clause
- A sub-clause reference identifier
- A supplementary assessor guidance (assessor prompt list)
- Assessor findings

By performing the gap assessment in a number of ABB integrators, common areas for improvement were identified, which helped to prioritize the development of the generic FSMS.

Selecting the certification body

Accredited third-party certification – ABB's goal from the outset – provides transparency, credibility, international recognition, objectivity and independent scrutiny. A shortlist of accredited certification bodies, compiled by the SLCC, were invited to participate in a pre-qualification exercise to demonstrate their capability and competency. A panel from within the SLCC reviewed the responses and selected TÜV Rheinland as being the most appropriate third-party accredited certification organization 1.

Model and function

Developing the safety life-cycle model and FSMS was the most significant activity undertaken. It followed the gap assessments and entailed defining a comprehensive safety life-cycle model by mapping the requirements of each phase of the project to the relevant clauses defined in IEC 61508 and IEC 61511. This safety life-cycle model 2 is fully supported by procedures, framework documents (basic

default information for a safety project to be customized to meet any specific project variations) and skeletons (a template consisting of all necessary headers to be completed) – collectively known as the FSMS.

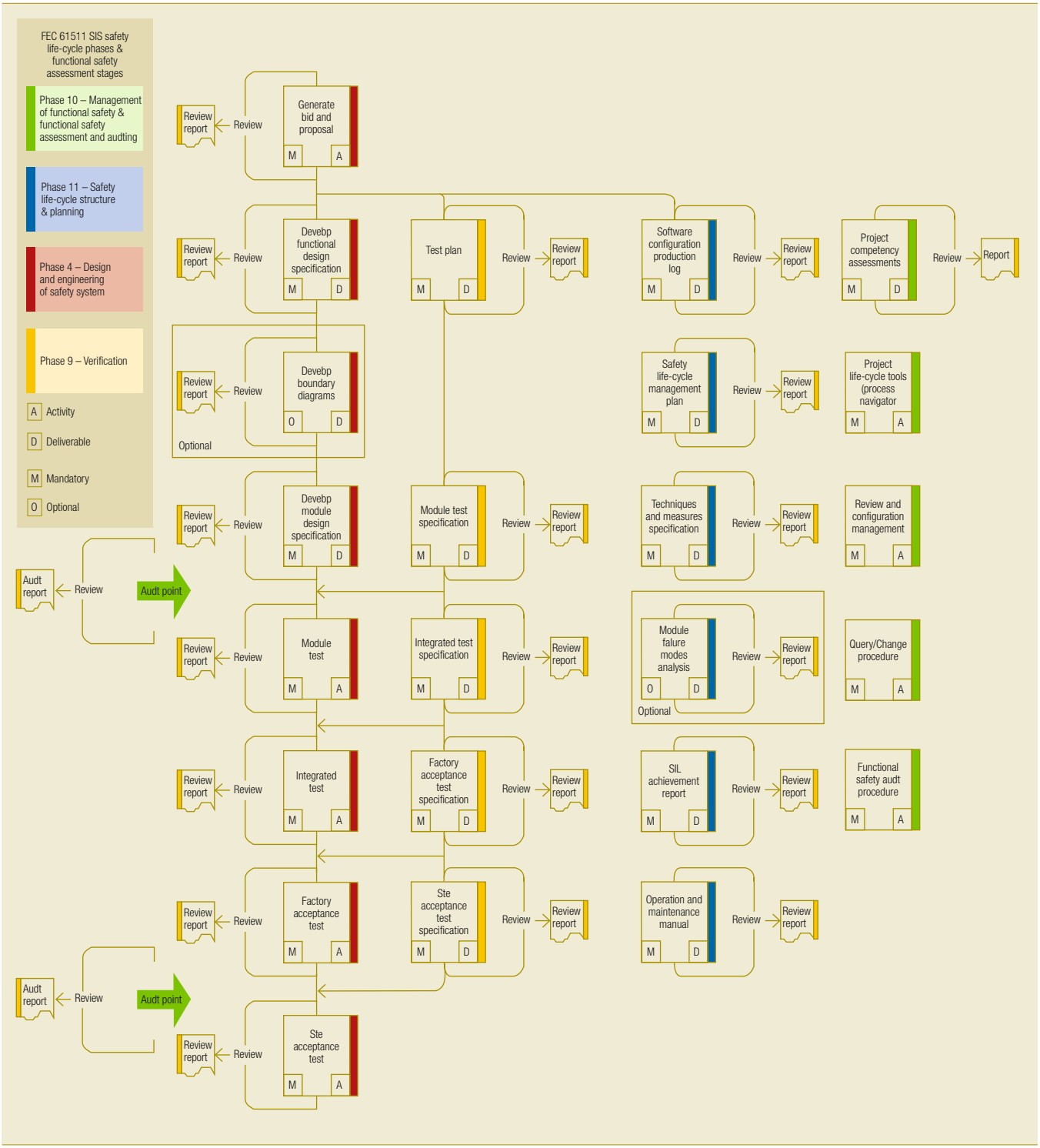
In addition, the FSMS documentation covers all aspects of the life cycle, including the management system, policy, competency, assessments and audits, modification and impact procedures, verification procedures and reporting. It also includes skeleton documents for all the main working documents such as FDS, SDS, Testing, FAT, SAT and operational manuals.

The development of this safety life-cycle model also had to make full use of the existing quality management processes and procedures.

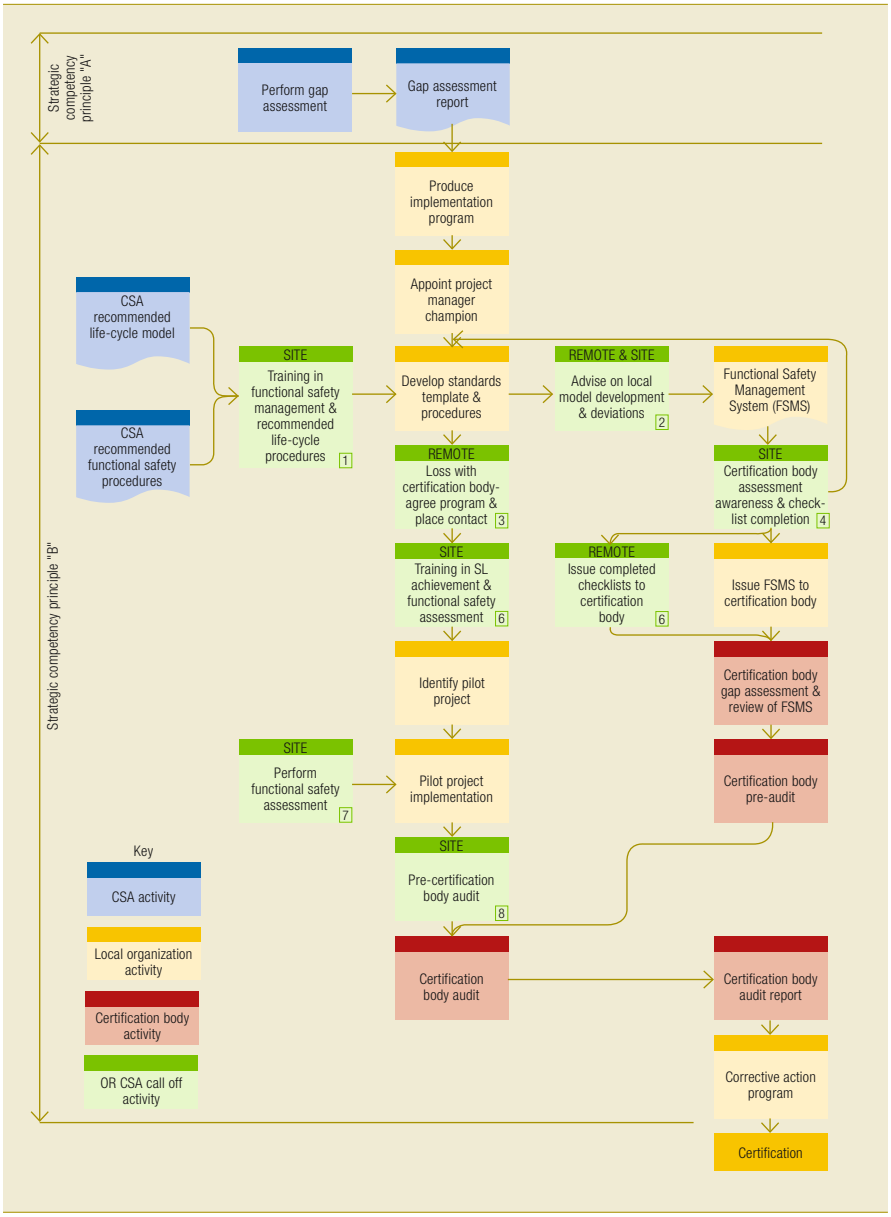
Executing the certification process

A generic certification process model is necessary for the SEC to identify the roles and responsibilities of all the

2 Safety life-cycle model



3 A generic certification process model



parties concerned 3. It is also used by the SLCC to provide assistance in achieving certification.

Establishing supporting activities

Prior to the global certification program, ABB had a large internal network of safety practitioners with different objectives and operational safety standards. Some businesses had already developed plans for certification that had not been completed. Consequently, it was important to establish, early on, a common repository for information exchange. This repository came in the form of a safety database containing the following information:

- Third-party certificates of safety products
- Lists of certified functional safety engineers and functional safety technology engineers
- Improvement themes
- Technical papers and articles
- The latest FSMS procedures
- External functional safety standards
- Sales and technical product material
- Case study progress and program updates

Partners and integrators

To minimize company liabilities, the same rigorous approach to functional safety must apply to any third-party integrators using ABB products. A program of work is required to perform a gap assessment of third-party integrators and to work with them to develop a compliant functional safety management system, preferably in line with that of the main system vendor. This process benefits the third parties in that they can also achieve certification and thereby gain all the advantages.

A move in the right direction

The international safety market is undergoing many changes driven by technology, standards, legislation and incidents. Those organizations working in this demanding and highly competitive arena seek to differentiate themselves, secure market advantage and demonstrate competence and due diligence. Many organizations see accredited certification as a positive step forward.

Accredited certification for an organization is a significant undertaking. It requires management commitment at the highest level, as well as a comprehensive work program involving not only that part of the organization selected for certification, but other groups within the organization itself.

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Governing energy

An all-in-one energy management solution

Bashir Ahmad

An ABB energy management system is helping Public Works and Government Services Canada – one of the largest owners and managers of office space in Canada – to improve energy efficiency in its real estate portfolio. When complete, the solution will be one of the largest energy management installations in the country.

High energy cost is a global reality. Bulk energy users are striving to minimize their energy costs in all avenues of energy consumption. Typical measures include reducing overall energy consumption, improving the efficiency of plant processes, installing variable speed drives and implementing a comprehensive energy management system.

ABB helps its customers in all aspects of energy conservation and consumption optimization by providing unique products and services. The benefits to customers include operational cost (OPEX) savings, energy consumption optimization, asset optimization, integrated energy information systems, and reduced emissions of greenhouse gases.

This article describes how Energy Management and Optimization, ABB's comprehensive energy management solution, helped achieve the energy management goal of the Public Works and Government Services Canada (PWGSC).

PWGSC, a bulk energy user, wanted an up-to-date energy management system that would improve their ability to gather, control and understand their energy data. With better data, they could implement appropriate consumption reduction strategies to lower their energy costs and actively participate in improving the environment. They found what they wanted in ABB's Energy Management and Optimization (EMO) tool. They recognized that EMO was the one "commercial off-the-shelf software" that could give them a unified approach to energy conservation across their facilities Factbox 1.

EMO analyzes energy consumption and helps determine the right energy conservation schemes for different buildings, so they can be operated at maximum energy efficiency while reducing greenhouse gases.

ABB's EMO provides comprehensive energy management, reporting and analysis. It replaces multiple independent systems with one unified system. Because EMO is fully modular, it can respond more quickly to future expansions and changes across PWGSC. A wide range of options provides scaleable functionality based on the customer's goals and objectives.

In November 2004, PWGSC ordered a small EMO system designed for only 500 data points and 10 concurrent users. This was PWGSC's "system on trial." They wanted to explore its different features to determine if EMO could be implemented at the organizational level.

By the end of 2005, PWGSC had ordered the first extension and by November 2007 several extensions were incorporated to include various National Capital Region[1)] complexes and facilities in the EMO. Most recently, PWGSC ordered another extension to include the utilities management operations of the Nunavut Territories[2)].

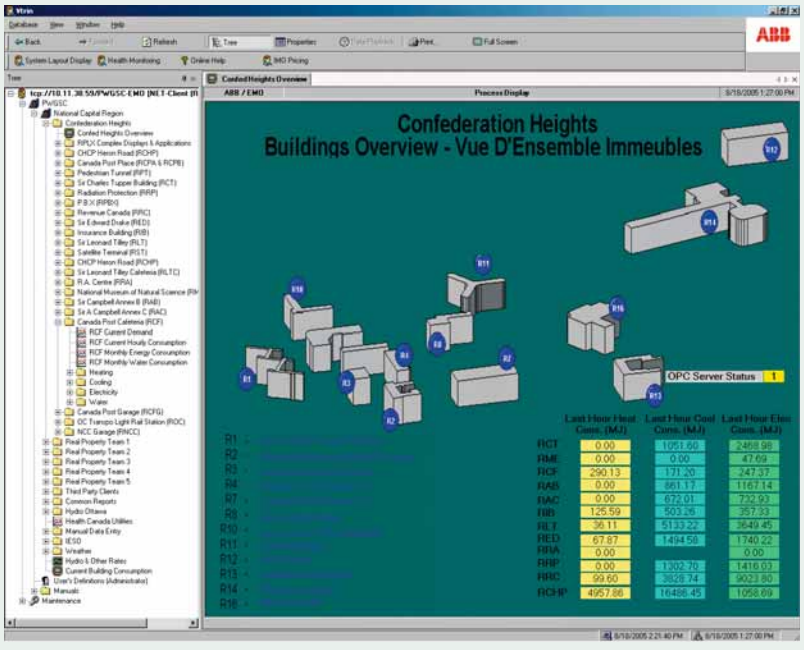
At present, the PWGSC EMO covers the National Capital Region and has 35 concurrent clients. In the future, when it expands to other regions of Canada, it will be one of the largest energy management installations in the country, with 125 concurrent clients across the nation.

Ineffective multiple systems

There are 11 branches in PWGSC that are responsible for providing and managing services for the Government of Canada and for other internal departments. PWGSC is divided into five regional operations – Atlantic, Quebec, Ontario (excluding the National Capital Region), Western and Pacific.

Real Property Branch (RPB), within the PWGSC, is responsible for property management services. It provides work environments for approximately 241,000 federal public employees (in 105 departments and agencies) and manages an inventory of approximately seven million square meters of space. Included in this inventory are national

1 Overview of the Confederation Heights federal building complex in the Canadian capital, Ottawa. Managed by PWGSC, the complex consists of 17 office buildings on a 107-hectare site.



Footnotes

1) National Capital Region is an official federal designation for the Canadian capital of Ottawa, the neighboring city of Gatineau, and the surrounding area. It has a total population of 1.13 million.

2) Nunavut Territories is the largest of Canada's provinces and territories, with a land area the size of Mexico.

treasures such as Parliamentary Precinct and heritage assets across Canada.

In the National Capital Region, Utilities Management Services (UMS), a sub-group of the RPB, is responsible for energy management services for all the central heating and cooling plants and their associated high-voltage, water, storm and sanitary sewer systems. UMS is also the custodian of all utility accounts for federal complexes and other government departments managed by the PWGSC 1 2.

UMS is responsible for delivering, verifying, forecasting and reporting on utilities for all these facilities, and for the following management functions:
- Providing data to assist in the analysis of building energy consumption
- Forecasting and reporting utility consumption

EMO's energy management modules are designed to support both operational and economic perspectives.

These tasks are complicated by the need to deal with different energy suppliers, different energy commodities (such as electricity, natural gas, water and different grades of fuel), and many internal departments and other government departments. UMS found that the multiple budgeting, reporting, billing and forecasting systems in place could not effectively manage all the energy and asset management activities. So UMS put together comprehensive system specifications for a new energy management system.

UMS decided to replace their many different budgeting, reporting and energy forecasting tools with a single state-of-the-art energy management system that would provide conventional energy management features and analyze the total energy consumption data, which were collected from different buildings to determine if those buildings were within expected ranges.

A single ABB system

Instead of using multiple independent systems to perform standard forecasting, budgeting and reporting functions, PWGSC gets all these functionalities from one EMO system. EMO also has the analysis tools and a rich report facility to handle energy consumption and minimum load requirement studies for multiple buildings.

EMO helps optimize energy costs by providing "what-if" scenarios and contract management. It analyzes the cost impact of different combinations of electricity and natural gas purchased from different sources, and provides the information needed to negotiate and purchase various energy commodities directly from the main suppliers and markets. For example, PWGSC can purchase electricity directly from the main electricity market operator Independent Electricity System Operator (IESO) or natural gas directly from the wellheads in Alberta.

EMO analyzes energy consumption and helps determine the right energy conservation schemes for different buildings, so they can be operated at maximum energy efficiency while reducing greenhouse gases.

The EMO interface server collects real-time data from different energy markets (such as IESO, and Environment Canada). An audit-trail feature tracks changes in the EMO server database. PWGSC users do not have any language constraints because EMO switches from English to French following the language setting of the user's login station.

EMO system overview

EMO's energy management modules are designed to support the energy business from both operational and economic perspectives. The system has been developed to:
- Forecast electricity, steam and fuel consumption

2 The C.D. Howe Building, Ottawa, is one of the buildings managed by ABB's EMO system

Factbox 1 Energy Management Optimization (EMO)

ABB's Energy Management and Optimization solution aims at improving energy efficiency and keeping energy expenses under control. This is achieved by providing planning tools that:
- Forecast energy and other utility consumption based on production schedules
- Plan and optimize the scheduling of energy supply
- Simulate alternative operating and price scenarios

and by offering monitoring and reporting tools that:
- Control the energy balance between supply and consumption in real time
- Set targets for energy efficiency, energy consumption and costs, and monitor and report the actual performance against the targets.

Introduced in 2000, EMO is currently running at more than 40 installations. Examples of EMO users include UPM-Kymmene (pulp and paper), Mayr-Melnhof Karton (carton board), Swiss Steel (steel manufacturing), Giga Energy (foundry), Neste Oil (oil refinery), Helsinki Energy (power utility) and PWGSC (buildings). The aggregate amount of electric power managed in existing EMO installations is approximately 50 terawatt-hours a year, equivalent to more than half the electricity consumption of Finland.

- Manage electricity and natural gas purchase and sales transactions
- Monitor and control peak loads, energy balance and efficiency
- Support decision-making with simulations and "what-if" analysis scenarios

EMO analyzes energy consumption and helps determine the right energy conservation schemes for different buildings.

PWGSC's EMO comprises the following modules: Forecast, Energy Contract Management, What-if Scenarios, Calculations, Reports, Statistical Analysis, and Revenue Meters & Settlement Statement Verification. Additional modules can be added in the future as needed.

In addition to providing energy management functions, EMO also provides statistical tools for detailed energy consumption studies.

Results of different analyses (eg, benchmarking, data normalization, base-load analysis and load forecasting) are presented in reports 3. These reports can be modified, copied and transferred to various departments. Additional reports can be generated using the predefined report templates.

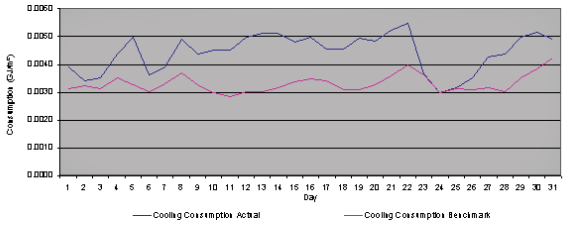
At present, PWGSC's consumption, energy, load, financial and administrative reports include the items listed in Factbox 2. Additional reports were developed for:

- Benchmarking
- Normalization of building consumption against its characteristics
- Peak demand and base-load analysis

3 Sample benchmark report on cooling consumption at an office building in Ottawa

Public Works and Government Services Canada | Travaux publics et Services gouvernementaux Canada

Cooling Consumption Benchmark
July 2004
Sir Edward Drake Building



	Cooling Consumption		
	Actual GJ/m²	Benchmarking GJ/m²	Difference %
1	0.0039	0.0031	19.72%
2	0.0034	0.0033	4.96%
3	0.0035	0.0031	11.44%
4	0.0044	0.0035	19.40%
5	0.0050	0.0033	34.44%
6	0.0036	0.0030	17.55%
7	0.0039	0.0033	15.98%
8	0.0049	0.0037	24.47%
9	0.0044	0.0033	24.84%
10	0.0045	0.0030	34.21%
11	0.0045	0.0029	36.54%
12	0.0050	0.0030	39.27%
13	0.0051	0.0030	41.32%
14	0.0051	0.0032	37.96%
15	0.0048	0.0034	29.79%
16	0.0050	0.0035	30.53%
17	0.0045	0.0034	24.45%
18	0.0046	0.0031	32.22%
19	0.0049	0.0031	37.34%
20	0.0048	0.0033	32.42%
21	0.0052	0.0036	31.34%
22	0.0055	0.0040	27.23%
23	0.0037	0.0036	0.99%
24	0.0030	0.0030	0.73%
25	0.0032	0.0031	0.55%
26	0.0035	0.0031	11.89%
27	0.0043	0.0032	25.41%
28	0.0044	0.0030	30.42%
29	0.0050	0.0035	29.45%
30	0.0052	0.0039	25.30%
31	0.0049	0.0042	13.54%
Total	**0.1377**	**0.1026**	25.49%
Avg	**0.0044**	**0.0033**	

Building Profile		
Building Name:	Edward Drake Building	
Project Number:	830960	
RPT:	4	
SIT:	1	
Portfolio:	140104	
Asset Type:	Crown-owned	
Asset Code:	C	
Province:	ON	
Region:	National Capital	
City:	Ottawa	
Address:	1500 Bronson Avenue	
Complex:		
Property Manager:		
Inside Gross Area:	11579.9	m^2
Rentable Space:	10024	m^2
Usable Space:	8529	m^2
Number of Floors:	8	
Building Age:	44.3	
Major Client:		

Normalization Parameters	
Balance Point	0.793957061
Slope (m)	8.8
Intercept (b)	918.6559296

Benchmark Based on the Following Buildings
Four Year Average

Sir Charles Tupper Building
Sir Leonard Tilley Building
Insurance Building

See Appendix 1 for building profiles

Factbox 2 Reports for PWGSC

At present, PWGSC's consumption, energy, load, financial and administrative reports include:

- Consumption report for all utilities per day/month/year by individual meter and by aggregated meters
- Average energy used for all utilities per day/month/year
- Energy used per m^2 for all utilities per day/month/year
- Total energy cost per m^2 per day/month/year
- Temperature and weather correlation report
- Energy use per building and cost by building
- Peak load reports for all utilities per day/month/year
- Average electrical demand per day/month/year by individual meter, multiple meters or building
- Average daily profile – shows average pattern of demand over a specified period by individual meter, multiple meters or building
- Aggregate analysis report – totalizes data points and determines peak, minimum and consumption to determine demand-limiting options for all utilities
- Billing reconciliation report

Effective energy management

ABB's Energy Management and Optimization (EMO) solution is helping PWGSC establish standardized processes for the life-cycle administration of energy management information and move towards an operating environment that supports data sharing and e-commerce. With the help of EMO, PWGSC will also be able to focus on achieving customer satisfaction based on valuable services that are timely, responsive, affordable and aligned with the private sector.

The unification of multiple systems (ie, budgeting, reporting, billing and forecasting) improves the energy-management-related functions and helps reduce overall energy consumption and greenhouse gas emissions into the atmosphere.

Langevin Block, Ottawa, is the main headquarters of the executive branch of the Government of Canada.

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Putting people in control

Investing in workforce is imperative to a successful business strategy

Lori J. Molinari

Much has been written about the challenges many worldwide organizations face in sourcing, retaining and developing their talent in today's fast-paced and competitive market. This is a significant and often underestimated contributor to plant-performance issues and to the high costs that most industries face. In an environment that emphasizes the importance of return on investment, surprisingly few companies recognize that the return on investment in people can easily outstrip returns from investing in equipment.

The best processes in the world are of limited value if adequate skills are not available to implement them, or if resources are continually absorbed in the training of new employees. The key is not just to hire and train, but to retain and continually develop the available talent.

Operational excellence

While many hours and resources are spent on the continuous development, refinement and updating of business strategies, quite often the same energies and focus are not placed on the critical players that are responsible for its execution – the people. It takes many more people to execute a strategy than it does to develop one, and it is its successful execution that drives people and value. In ABB's Process Automation Services, the criticality of execution is clearly recognized and people management is not only a common support process in its service business model but is also heavily embedded in its overall business strategy 1.

With ABB's customers as the focal point of its people-management initiatives, the company's success is derived from maintaining strong customer–supplier relationships and making its customers more profitable. ABB contributes to the success of its customers through its people's knowledge in knowing what, when and how to most effectively and efficiently improve customer plants. In recognizing the influence of people, ABB places equal importance on satisfaction as a key metric alongside issues such as safety, environment, overall equipment effectiveness and cost.

The fostering of people and drive for maintaining and building a high-performance culture throughout ABB Process Automation Service starts at the top with the management team and cascades down throughout the entire organization.

Putting people-processes in place, sharing the strategy in a way that everyone can understand and buy into, and showing how their roles relate in the "big picture" has enabled ABB Process Automation Service to transform strategies into operational realities. The results of investing in people have proven to be major success factors in attracting and retaining top talent as well as maximizing performance, building employee engagement, and achieving innovation and motivation – the prerequisites of operational excellence.

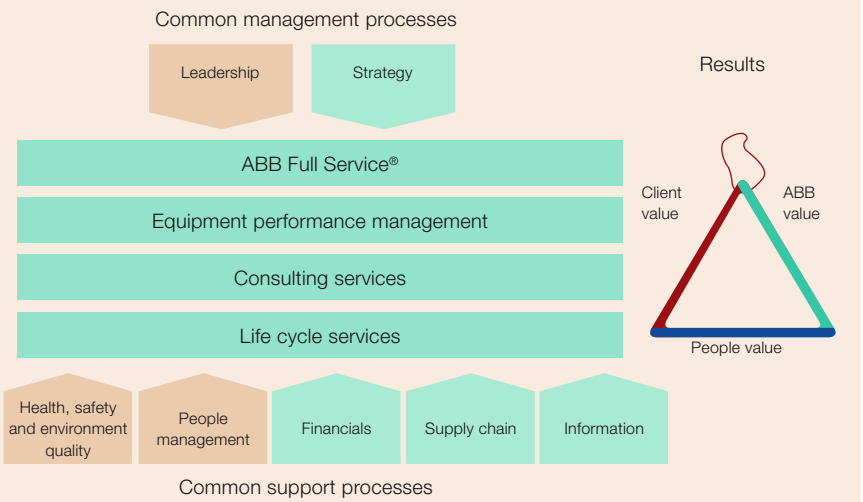
One of the notable strengths that ABB brings to its customers lie in the people management programs that are run worldwide to continuously develop, build and monitor the company's workforce. A wide range of comprehensive programs are available to employees and customers around the world. Besides the broad range of courses available through the ABB Universities and local country organizations, ABB Process Automation Service has developed a specialized suite of learning events tailored specifically to its products and service businesses. The relationships and networks derived from these events have drastically improved employee performance, engagement and motivation.

Two such global programs are Site Management Training and Maintenance Training, both of which are week-long intensive classroom and example-based learning events. This type of focused training gives new employee's rapid and broad understanding of the practical standards, methods and support that is available to them, permitting them to efficiently deliver value to ABB's customers. Existing employees are kept up-to-date on best practice methodologies, latest technologies and tools. These trainings are continually improved through global learning and the anonymous attendee feedback assures honest and constructive critique.

The value of these trainings 2 is reinforced with full attendance and feedback such as shown in Factbox. The training courses are followed up with options such as specialized local training, site specific plan development, internships and cross-border job rotations to reinforce ABB processes and continually develop the company's global workforce.

The loop is closed by ensuring that employees have the ability to execute and deliver results through annual employee satisfaction surveys to mon-

1 People-management is an integral part of the overall business strategy of Process Automation Services



Factbox Sample feedback from employee training courses

"A very good selection of topics addressed to actual and future site managers, combined with the presence of relevant business professionals resulted in a serious and very important training inside ABB."

"This course was superior to my expectations! It was excellent and well proportioned to help us succeed in maintenance."

"The Reliability maps, information and knowledge is fantastic! Many good and new tools, I can compare my site activities with the presented material."

(Site Management Training
Maintenance Training – Belgium, October 2007)

itor workplace environment, employee performance/engagement/motivation and overall functionality of the organization. Over the years, the results have shown common improvements in the areas of career development, connectivity and communication. ABB has listened to its people and used their valuable feedback to identify innovative solutions for continuous improvement in these areas.

Career development

For career development, an employee self-service (ESS) talent management system is in place globally. This system catalogs the skills and experiences of ABB Process Automation Service's global workforce and allows employees to define their own value proposition to the business. The ESS system is integrated with ABB Group's people-management systems and gives other management groups the ability to efficiently manage their talent worldwide (eg, recruitment, succession planning, leadership development, training and certifications). The effective management of talent has not only allowed Process Automation Service to maintain its competitive advantage, but also to showcase its global talent to customers as one of the company's value propositions.

Connectivity

For connectivity, it was realized that people need and want to become more connected with networks and tools to collaborate in areas relevant to their work. ABB Process Automation Service has diligently worked on breaking down the country and departmental "silos" and has developed its service knowledge portal (SKP). This portal provides a global platform for standardizing processes and tools across the company's various service offerings and industries.

For example, in the maintenance outsourcing offering, ABB Full Service®[1)], where reliability is one of the principal core areas of competence, the SKP has an extensive maintenance library and communities of practice (CoPs), consisting of experts from all around the world. Because ABB is uniquely positioned to develop and evaluate emerging technologies and due to its large customer base, the company has the systems in place and talent to globally maintain and implement industry-specific solutions.

2 Focused training programs permit ABB employees to better deliver value to customers

The SKP enables the company's country organizations to leverage this standardized content, while developing their own localized content to enhance their support and service offerings to global customers, manage projects and build customer relationships more effectively.

One of the notable strengths that ABB brings to its customers lies in the people management programs that are run worldwide to continuously develop, build and monitor the company's workforce.

Communication

The third and most fundamental element is communication. No matter how talented a company's global workforce, without proper communication, people will not have the ability to execute and deliver their projects. Communication is one of the main drivers for providing people the ability to perform, and is a single tool which assures the cohesion of the ABB Process Automation Service organization while at the same time building and enhancing employee performance and engagement. From using tools such as the SKP, to creating virtual communities of practice, where topic specialists from around the globe collaborate and improve processes, to detailed implementation plans on how to improve communication at the site level, ABB recognizes the value and impact of leveraging the knowledge of its people. Significant investments are continually made in enhancing and integrating systems to ensure the efficient delivery of messages in a directed and coherent manner throughout all levels and countries.

In the case of ABB Full Service®, where both ABB and the customer work together to maintain and improve equipment performance and reliability for the entire facility, client value is the ultimate objective. ABB has clearly paved the way and has differentiated itself from its competitors by having a solid and proven foundation of systems, tools and programs that not only embrace its global workforce, but also aid in ensuring that the greatest value is delivered to every customer anywhere in the world.

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Footnote

[1)] See also "A head start to profitability" on page 88 of this *ABB Review Special Report*.

Steeling the show

IBM and ABB are raising the bar in steel manufacturing excellence

Jose R Favilla, Jr., Clive Colbert

The steel industry of today faces multiple challenges: Some of these are due to the recent rejuvenation of the industry, with consolidation and expansion occurring around the globe. Companies in developing nations are building new mills, while more developed countries are modernizing their existing mills. World steel production has climbed 50 percent since 2001, and world usage is following closely with 50 percent growth expected between 2001 and 2010 [1].

The rash of consolidations and expansion shows an industry trying to reconcile its costs and market share. Labor and other operating costs still account for about 27 percent of steelmaking costs (on average). The drive to get bigger and better is felt throughout the industry. CEOs and their teams know that they need to improve operationally, defining a major part of the operational agenda for steel manufacturers as: “How can we improve core processes using advanced technology to increase competitiveness and better serve our customers?”

While steel companies have invested billions of dollars in new mill equipment and modernization, many of the core manufacturing processes are left to simplistic planning systems and outdated shop floor applications that don't provide the capabilities required to run the plant in the most efficient way.

There has been some ad hoc creation of systems to attempt to improve this situation, but most companies still conduct in-house operations through simple tools, spreadsheets, or applications that are not integrated. These approaches still rely largely on the operator's experience and require considerable manual intervention. The reliance on these simple tools characterizes a peculiar weak link or gap in the management of steel manufacturing operations – the lack of integration of business systems with the automation and process control systems. This results in inherent barriers and challenges that steelmakers experience daily. These include:

- Disconnect between the plan and execution
- Operations in silos
- Complexity of steel manufacturing

These are discussed in the following.

Disconnect between the plan and execution

Putting together a plan or schedule requires significant effort to generate a single feasible solution. Manufacturing variability, such as quality problems, equipment breakdown and changing business conditions – such as the need to process a rush order – demands continuous adjustments in the schedule. This means that production personnel are left to struggle to overcome these variables.

Operations in silos

While everyone is trying to optimize his or her part of the process, the overall throughput of the company requires:

- A broader view of the production constraints
- Coordination between upstream and downstream operations
- Full visibility of the entire order book and available inventory, including the specifications of each order and actual characteristics of each piece of metal

When companies lack global visibility and properly synchronized operations, this typically leads to inflated lead times. This lack of vision and integration also affects on-time delivery and drives operational costs up.

Complexity of steel manufacturing

The scheduling of melting shop operations is a critical task for any steelmaker, and it directly affects how well the facility is operating. Companies need to consider several optimization objectives simultaneously – for example:

- Maximize caster uptime
- Maximize tundish[1)] life
- Minimize grade transition
- Minimize width changes
- Maximize on-time delivery

The schedule should consider the balancing of the pig iron supply from the blast furnaces with a large number of physical and metallurgical constraints and other business rules.

Failure to manage these processes effectively results in poor operations performance. From a revenue perspective, these shortcomings can cre-

Factbox 1 IBM and ABB Strategic Alliance – a brief background

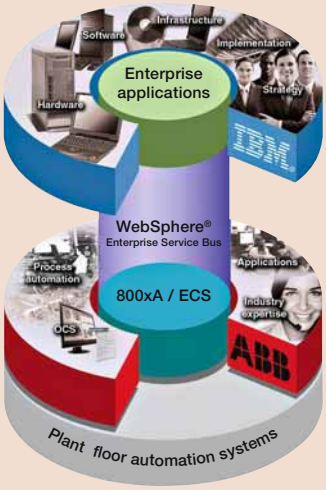
People know they can expect a lot from an industry leader. Now imagine what they can expect when two global industry leaders get together.

IBM has long been both a supplier to, and customer of ABB. Historically IBM has supplied various products and components for ABB's process automation systems. In turn, IBM was a significant customer of ABB's power business. Both companies have similarities in terms of organization and global presence, and complementary services and products. This led to a deepening of cooperation between the two companies, resulting in ABB outsourcing much of its IT support to IBM.

In 2004, a Strategic Alliance was formed between ABB and IBM, focused on developing "vertically integrated" solutions for industry. The joint solution for steel is one of the latest evolutions. The combined business and industry expertise and product portfolio of ABB and IBM provides manufacturers in the process industries valuable partners to achieve the next great leap in productivity.

The ABB and IBM alliance delivers solutions aimed at improving plant performance and integrated business processes by integrating strategy, people, business process and technology components to deliver new capabilities for process manufacturing business transformation.

1 IBM and ABB have combined their strengths as industry leaders



IBM strengths:

- Enterprise application expertise
- Open standard middleware integration
- Proven, scalable and flexible integration platform
- Advanced optimization and analytics
- Industry experience and service capability

ABB strengths:

- Industry automation expertise
- Industrial[IT] System 800xA
- Standard-based integration
- Proven, comprehensive and configurable plant floor applications
- Industry experience and service capability

Footnote

[1)] A tundish is a receptacle used in metal foundries to hold molten metal, typically in a continuous flow process.

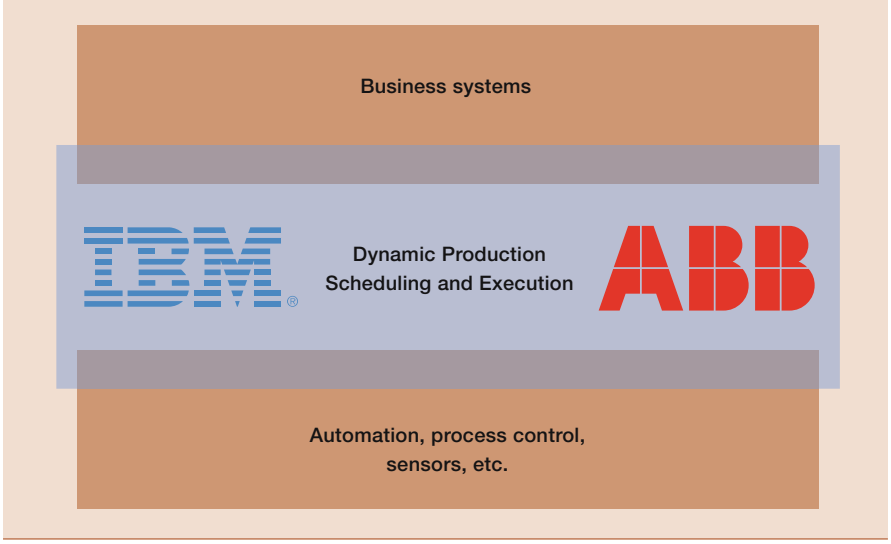
ate customer satisfaction issues, such as delays in delivering orders as promised, decreased flexibility or even affect the quality of the products. In the worst-case scenarios, plants can suffer production standstills and gross under-utilization of high fixed-cost assets and resources. From the market's perspective, the worst case might include higher product prices, reduced competition and profit reduction.

IBM and ABB have combined their strengths 1 to create a unique offering that adopts the latest software technology and the extensive industry experience and services of both partners to help steel companies overcome challenges and achieve levels of efficiency not previously thought possible Factbox 1.

The IBM and ABB combined solution

The combined solution of the two companies leverages the capabilities of ABB's Collaborative Production Management (CPM@Metals) [2] and IBM's Production Design and Operations Scheduling (PDOS) solutions [3,4]. This collaborative offering, called Dynamic Production Scheduling and Execution (DPSE) [5,6], helps bridge the gap between business systems and automation or process control systems 2.

2 Dynamic Production Scheduling and Execution (DPSE) is a collaborative solution by IBM and ABB



The solution is designed to address the needs of all or part of the steel value chain in integrated steel plants and mini-mills – including:

- Primary yard
- Coke plant
- Sintering plant
- Blast furnaces
- Steelmaking shops
- Hot and cold rolling mills
- Finishing lines
- Shipping yards

DPSE uses advanced optimization algorithms that were designed by IBM Research Labs, working with leading steel companies around the world. The solution generates optimized production designs for slabs, coils and plates, as well as detailed production schedules for the entire mill. Companies can implement the optimization modules gradually, reducing time to value and enabling the steel producer to move toward global optimization.

The solution also delivers information that helps improve production activities, from order launch to finished goods. It provides:

- Timely order and inventory data
- Short-term detailed order (piece by piece) sequencing and material allocation capabilities
- Manufacturing instructions
- Production supervision and pacing
- Process optimization
- Information about the actual production status and product quality results

DPSE is designed to enable users to achieve high efficiency in the production process. Its functions support the individual needs of the planners, mill management, operators, quality inspectors and process engineers in carrying out their operational tasks.

DPSE is composed of a comprehensive and configurable suite of modules covering all steps needed for efficient scheduling, rescheduling and manufacturing during steel production. It leverages IBM's extensive experience in implementing business systems (using SAP, Oracle Manufacturing and others) and leverages ABB's automation process control expertise. It enables the constant monitoring of all the critical key performance indicators (KPIs).

DPSE complies with industry standards – for example, OPC and ANSI/ISA-95 – in order to allow the system to operate with multiple existing systems. It supports ISO 9000 compliant manufacturing and is adaptable to individual plant equipment and operation practice. In addition, DPSE is operator-friendly and reliable.

Making the transformation

In building best-in-class manufacturing enterprises, the aim is not to relieve experts of decision making, but to provide them with tools that supply them with accurate information. This allows them to better use their time and expertise to analyze different alternatives and business scenarios. It allows them to come up with the best alternative for their operations as quickly as business need dictates.

IBM and ABB have combined forces to help steel companies overcome challenges and achieve efficiencies not previously thought possible.

However, technology can only take an organization so far. The adoption, training and use of software, as well as its integration into the organization (both technologically and culturally), determines its overall success. Specifically, the success of such a system depends on how it is supported, including its accessibility, its usability, the quality of the data it uses, and the processes it enables. The supporting resources and infrastructure must be responsive to the new system so that better schedules and coordination can be implemented successfully on the plant floor.

Steel companies considering adopting advanced technology to increase competitiveness and better serve their customers should undertake some critical activities. This will ensure that their initiative becomes a strategic and valuable productivity enabler and not an underused software launch that is never properly adopted. These activities include:

Align the project with company's business goals as they are directly related to the internal and external drivers for the companies. Companies need to make sure the goals defined for the project support their objectives.

Develop an understanding of the current state of operations, including the level of maturity of the "intangible" practices and their relative cost to the organization.

Evaluate the current expertise and skill sets of key operators to understand how they perform their jobs, how skills and knowledge vary across units, and how their participation affects the greater productivity of the plant or plants.

Understand the capabilities of the software for production design, operations scheduling and operations management. Decision makers need to take a complete view of the software capabilities available. However, it's important to focus on business results rather than on implementation of a specific feature or function.

Develop an operational blueprint and road map that show the operational vision for improvement and a practical, multiphased approach for achieving it. This is a valuable tool for bringing the organization on board.

Building a numbers-driven business case that shows projected costs and benefits. This involes using qualitative as well as quantitative measures. Comparing the current state to the desired state might be tricky, as many of the displaced or mitigated costs will be non-system attributes. Also, it is important to calculate the entire cost of ownership for the new system.

Build consensus and advocacy for making the change among key operational leaders. Organizational commitment is necessary to see the improvement through to the end.

Understand and plan for training and knowledge management programs to

support the shift. Communications and change management are necessary for the program to be adopted and successful in the long run.

Reaping the rewards

The ability of any innovation to achieve manufacturing excellence ultimately comes as much from the bottom-line benefits it delivers as from the problems it solves.

In the capital-intensive arena of steel manufacturing, return on capital employed (ROCE) can be one of the most valuable measures of success. Considering a typical (and hypothetical) steel manufacturer with a five-million-ton capacity, $750-per-ton average sales price, $3.75 billion in revenue and $3 billion in asset investment. Such an operation spends 16 percent of its costs on operations. By relying on simple tools or spreadsheets, they could be missing opportunities to reduce operating costs by two to 20 percent, reduce inventories by five to 40 percent, increase production throughput by two to five percent, and increase revenue by two to five percent. For example, a reduction of four percent in operating cost to produce slab can result in a $3-per-ton benefit, helping our hypothetical steelmaker to save $15 million per year in added margin. An $8 per ton improvement is $40 million in new margin. ROCE is directly affected.

Leaders in steel production understand that they must look for new levers when it comes to getting more from their steel-producing fixed assets. These levers can include the adoption of advanced software tools supported by the experience of global technology leaders such as IBM and ABB to allow these companies to exploit their improvement potential fully. Ultimately, a better approach means better ROCE and better business: more productivity, better margins and improved competitiveness.

Factbox 2 exemplifies some of the key enablers of IBM and ABB joint offering.

Factbox 2 Steelmakers' challenges and the key enablers of IBM and ABB joint offering

Increase productivity	Increase revenue and market share	Reduce operating costs	Reduce inventories
Better utilization of capacity	Reduced number of lost sales through better inventory search	Minimized rework considering route compatibility	Reduced unused weight and waste
Maximized average slab weight	Higher flexibility to handle smaller orders	Higher manpower productivity	Reduced slab inventory due to better designs
Minimized number of slab and coils to fulfill orders	Improved ability to fulfill high-priority orders	Minimized cutting waste and surplus	Reduced inventory of slabs and coils due to better designs
Higher caster up time	Faster responsiveness to customer inquiries	Minimized waste due to grade transitions	Reduced surplus due to better cast and charge design
Higher hot charging ratio	Higher quality due to less radical gauge and grade changes	Reduced hauling costs for the slab yard and hot mill	Reduced work in progress due to better synchronization
Better production flow due to higher synchronization among facilities	Improved on-time delivery	Higher flexibility to cope with unexpected situations	Reduced finished goods inventory due to better delivery performance
Reduced downtime, and improved yield	Improved quality due to better process control	Better utilization of production assets and reduced maintenance costs	Reduced scrap due to lower deviations and higher consistency

Maximized benefits

As the steel industry has rejuvenated, steel producers have been investing billions of dollars in building new mills and modernizing the existing ones. IBM and ABB have combined their complementary expertise to create a comprehensive offering to enable steel producers to operate at levels of efficiency not thought possible before, maximizing their return on investment.

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Factbox To learn more …

For additional details and to further understand how the joint solution – Dynamic Production Scheduling Execution – can help customers achieve levels of performance previously not thought possible, please contact either IBM or ABB. Experts throughout the Centers of Excellence of both companies around the globe can show it in action and work with customers to tune these solutions for their clients on an engagement-specific basis.

The right part at the right time

ABB is helping customers develop a comprehensive storeroom management process

Richard R. Rosales

The main reason for the existence of a storeroom is to supply a maintenance team with the parts and materials necessary for them to ensure that all plant equipment continues to operate at its maximum design capacity. In fact, Material, Repair and Operations (MRO) storeroom personnel state that their deliverable is "to provide the right part at the right time at a cost-effective price." Yet, in many MRO storeroom operations, customers complain that the right part is never in stock when needed, or there aren't enough parts, or that original parts were replaced with cheaper parts due to a price reduction effort. Having to fly a missing part in from anywhere is very costly, especially at today's oil prices.

To help customers develop a comprehensive storeroom management process, ABB provides the professional services needed to ensure the expected MRO storeroom deliverables. ABB is acutely aware that the establishment of a sound MRO storeroom operation is one of the key requirements of an effective equipment reliability program.

Problems in a Material, Repair and Operations (MRO) storeroom usually occur from a lack of maintenance support and management focus, and an ineffective operating process[1]. To tackle these problems and fulfill the MRO storeroom deliverable of providing the right part at the right time at a cost-effective price, it is necessary to understand the specific areas related to such a deliverable.

"The right part"

What is meant by "the right part" and who determines what this should be? The process of determination begins at the engineering design stage where all equipment and component parts are identified. The decisions made on equipment selection are typically agreed to and approved by representatives of the production, maintenance and engineering functions, and are based on experience with similar equipment, operating parameters and engineering specifications. During the later phases of a project, the detailed equipment and component part information is transferred to equipment records in the site's CMMS (Computerized Maintenance Management System). This information is typically available to those who work with or support the equipment.

A typical Maintenance, Repair and Operations (MRO) plant storeroom

The establishment of a sound MRO storeroom operation is one of the key requirements of an effective equipment reliability program.

The next step, carried out immediately prior to equipment installation, is to determine if the equipment or spare component parts need to be kept in the MRO storeroom. The decision for storing these items is made through the combined efforts of the production, maintenance and purchasing functions. The resources typically used to help make this decision include OEM recommendations, prior history of repairs on the same or similar equipment, the number of items of equipment at the site utilizing the same parts, and part availability from the local vendor. At this point all equipment and associated component parts have been identified using engineering specifications, and only those parts that have meet these specifications are locally stored.

If the process is followed correctly, the organization can be assured that the selected parts stored in the MRO storeroom will be the right ones. To maintain this assurance, any part being reviewed as a potential replacement for an existing storeroom part must be approved by the same cross-functional group that determined the need for storing the original part and current users of the part. These processes must be in place to ensure that the "right part" is in the MRO storeroom.

"At the right time"

This element of the MRO storeroom deliverable has somewhat of a twist. What exactly is the "right time?" Does the "right time" mean "anytime?" If "anytime" is the "right time," then this implies a reactive mode of operation in the field because it is not known when the spare part will be needed since it could be anytime. What is needed for "the right time" to materialize is an organized or scheduled time. A scheduled time implies that the need for a spare part was predetermined, and ideally this would have been identified with enough time to communicate this need to the MRO storeroom personnel. Therefore, a proactive rather than a reactive response requires that a system or pro-

Footnote

[1] http://www.mrotoday.com/mro/archives/uptime/StoreroomJJ04.htm (December 2007)

Decisions regarding equipment selection, ie, "the right part," are typically approved by representatives of the production, maintenance and engineering functions.

Ensuring the right part is available "at the right time" requires a proactive response in which a system or process is in place to properly identify spare part needs along with a scheduled date for future use.

cess be in place to properly identify spare-part needs together with a scheduled date for future use. A well established work management process will provide the necessary information along with a scheduled need date for the equipment spare parts. Once the work management process has been established, then it can be said that the processes are in place.

To be cost-effective does not necessarily mean purchasing cheaper parts: it means the total cost of ownership during operational life.

Being cost-effective does not necessarily mean purchasing cheaper parts. It means the total cost of ownership during a component's operational life.

Cost-effective price

One possible reason for equipment failure is the price of spare parts. To begin with, equipment spare parts play a critical role in ensuring reliability. The function of engineering is to provide the specifications for equipment and associated parts used in the manufacturing area. These engineering specifications account for operating conditions and ensure safe, environmentally sound and reliable performance. Deviations from engineering specifications can potentially do more harm than good. Although vendors and parts manufacturers may claim their parts are just as good, this must be verified by involving those functions that originally defined the specifications for the equipment during the design phase. Less expensive parts sound like a bargain but the consequences of using them may yield very negative results, including environmental breach or serious injury, or both. To be cost effective does not necessarily mean purchasing cheaper parts: It means the total cost of ownership during operational life. In other words, a cost-effective price is what matters, not the cheapest price.

Cost-effective ownership encompasses a number of areas. The first concerns the overall performance of the product throughout its operating life. Spare part performance can be verified if historical experience with the product is utilized and if it is determined that the manufacturer employs proven quality manufacturing techniques along with performance tracking of the product. In short, product verification can only be assessed by involving the engineering, maintenance and production functions.

Another area related to cost effectiveness is the vendor service provided for the product. Vendor service can include technical assistance as needed, introduction of higher quality, more reliable parts along with stable pricing for extended periods of time. In this area the purchasing function takes the lead role in building long-term alliances with vendors and manufacturers to ensure consistent product performance with stable pricing. Purchasing must include the engineering and maintenance functions in qualifying vendors as preferred providers of goods. Additionally, a goal for the purchasing function would be the establishment of long-term itemized priced contracts for all stocked parts. Electronic transmission agreements could be utilized to minimize the costs associated with order placement, receipts and the payment of goods.

Having these processes in place will help provide assurances that the right parts being stocked were purchased at a cost-effective price.

Who can help?

ABB offers consulting services to help companies develop a comprehensive storeroom management process that includes all of the elements of storeroom deliverables – "the right part at the right time at a cost-effective price." Additionally, ABB offers services to develop and implement a robust work management process.

ABB consultants work with company representatives to identify the "as is" process and to develop the "to be" process. ABB's approach includes the development of an implementation plan, execution of this plan and process review at completion. All the while, ABB[2)] will work side by side with company representatives to train, coach and mentor company employees involved in the processes described above.

The establishment of a sound MRO storeroom operation is one of the key requirements of an effective equipment reliability program.

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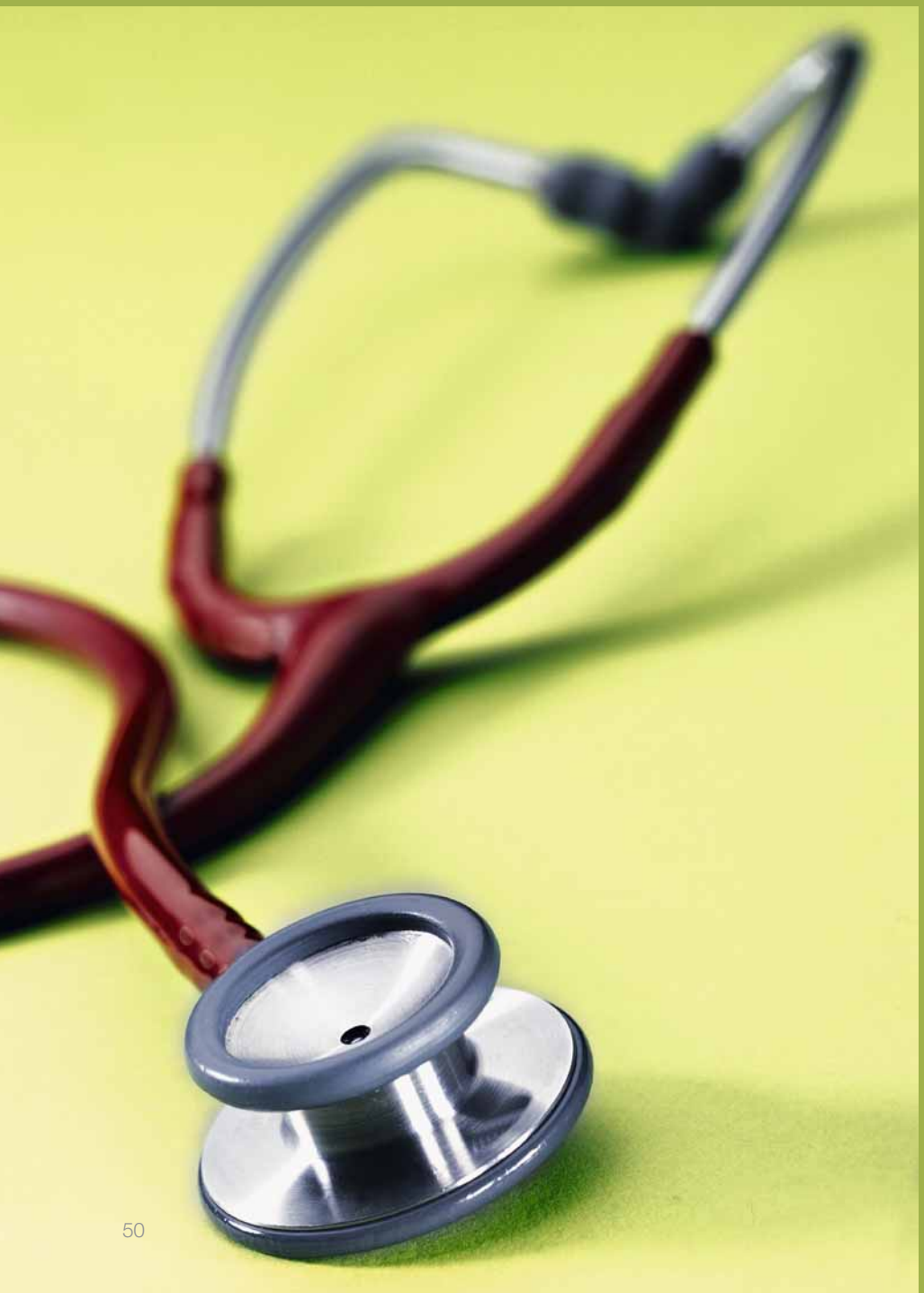
Footnote

[2)] ABB personnel are trained and certified by the global inventory and logistics organization, APICS.

Prevention is better than cure

Reliability Centered Maintenance (RCM) reduces the risk of equipment failure to a more than satisfactory level

Richard R. Rosales



Most people, especially those who come from a family in which there is a history of a particular illness, ensure that regular checkups are scheduled throughout the year. Knowing the weaknesses in one's system means that certain measures can be taken to prevent the occurrence of serious and possibly long-lasting human "down-time." Even if something does go wrong, a well-documented patient history may mean the difference between life and death.

In many industries, managers work hard to reduce equipment downtime. What better way of doing this than by ensuring their plant equipment, like people, are subject to regular "check-ups." Some equipment may be prone to more problems than others and so will require greater attention. To help them determine what must be done to ensure that any physical asset continues to do what its users want it to do in its present operating environment, managers utilize a process called Reliability Centered Maintenance (RCM). RCM enables the definition of a complete maintenance regime and is a process that can form a vital part of a company's preventive maintenance program.

Reliability Centered Maintenance (RCM) is a term that is widely used in industry today. However, it is not always well understood. RCM requires plant personnel to monitor, assess, predict and generally understand how their physical assets work. By doing this, certain failure modes can be identified, thereby enabling appropriate maintenance tasks to be established. In [1], RCM is described as "a systematic approach to defining a routine maintenance program composed of cost-effective tasks that preserve important functions."

RCM history

The RCM process has its roots in commercial aviation, and the acronym was first coined in a 1978 report titled "Reliability Centered Maintenance," which was authored by F. Stanley Nowlan and Howard Heap – two employees of United Airlines – and sponsored by the US Department of Defense (DOD). This report embodied the latest technologies developed and utilized by commercial aviation over a period of time dating back to the early 1960s.

The commercial airline industry worked closely together with the Federal Aviation Administration (FAA) to establish a well structured RCM process, which was necessary to meet the FAA requirements of ensuring more reliable commercial aircraft and better safety performance. Until then the performance records of the commercial airline industry were poor. However, their involvement in the development of the process demonstrated a clear understanding of the consequences[1)] of not using a sound approach such as RCM.

The results of their efforts are evidenced by the fact that commercial airline travel is now a much safer mode of transport than driving on a public road. The commercial airline industry continues to use the RCM process to ensure the continued safe and reliable performance of their aircraft.

RCM is described as "a systematic approach to defining a routine maintenance program composed of cost-effective tasks that preserve important functions."

Verifying a true RCM process

Since the late 1980s and early 1990s, there has been a move by many companies to utilize the RCM process for their own assets. In answer to this demand, a number of RCM derivatives, each claiming to be as good as or better than the original RCM process, have materialized. Unfortunately, some of these have modified the process to such an extent that it no longer provides the same benefits as the original version of RCM.

As a result and in an effort to verify a process as an RCM process, the Society of Automotive Engineers (SAE) was asked to develop a standard that would verify if a process was truly an RCM process. This standard was published in 1999 as SAE standard JA 1011 and is now used by many companies. It requires that for a process to be considered RCM, it must satisfactorily answer a set of seven questions in sequential order. In addition, it must provide the basis for satisfactorily answering these questions.

The main players

The classical RCM process begins with a review of the individuals involved in an RCM analysis. To effectively conduct an RCM analysis, the participants must have knowledge about the system or equipment under review. In other words, participants are those who work with the system on a daily or frequent basis, such as operators and those who maintain the system. In addition, front-line supervision in both the operating and maintenance areas, ie, the individuals who work with the system from a managing perspective, would also be involved in the RCM process. Others, such as OEM representatives and subject matter experts, are brought into the analysis as needed. The subject matter experts may not have in-depth knowledge of the system but are typically experts in areas such as engineering, safety and quality management. A key player in an analysis is the RCM facilitator who orchestrates the group during the analysis.

ABB has experienced RCM practitioners available to conduct training at a client site. This training is conducted

To conduct an effective RCM analysis, all participants must have knowledge about the system or equipment under review.

over a three-day period during which attendees participate in practice exercises and case studies. ABB also offers a 10-day RCM facilitator course for companies who wish to have their own internal RCM facilitator resources. In the facilitator course, candidates learn how to guide a group in the application of the RCM process, as well as enhance their own knowledge of the subject. Under the guidance of an ABB RCM practitioner, candidates work as a group on a series of exercises. They each take turns acting as a facilitator by conducting an RCM analysis. The exercises include a case study of an actual system selected from the client's facility where the course is held. Upon completion of the facilitator training, the participants are further supported with an additional one to two weeks of mentoring and coaching provided by ABB practitioners. ABB also provides RCM facilitator services to conduct an analysis at the client site.

The RCM process

The cornerstone of the RCM process is the understanding that there are six different failure patterns to be considered when defining maintenance strategies for physical assets 1. When the commercial airline industry conducted an extensive analysis of failures, it determined that 20 percent of equipment failures are a result of time-based failure patterns (as seen in the three graphs to the left in 1) while the remaining 80 percent are not time-dependent (right three graphs). Even though the majority of maintenance work was primarily performed after a set number of run hours – where typically 85 percent of components were taken through overhauls – the failure issue was not solved since the majority of failures were not time dependent. As a result infant mortality was introduced as components were overhauled, leading to the realization that condition-based maintenance was the best solution to a company's asset failures.

The commercial airline industry determined that 20 percent of equipment failures are a result of time-based failure patterns.

The RCM process begins with an understanding of how the system under review is being used, or in other words, what is the operating context of the system. This is followed by the seven questions:

- What are the functions and desired standards of performance?
- In what ways can it fail to fulfill these functions?
- What can cause each function failure?
- What happens when a failure occurs?
- In what way does each failure matter?
- What should be done to predict or prevent the failure?
- What should be done if a suitable proactive task cannot be found?

The RCM process – analysis meetings

A typical RCM analysis meeting lasts around four hours, and five to 15 meetings are required to complete an analysis. To be more specific, conducting an RCM analysis requires a significant commitment of resources. To illustrate this point, consider doing an RCM analysis of a pump station where there are two identical 50 HP centrifugal pumps, one duty and one stand-by pump. A typical analysis would require approximately seven days plus or minus a day. In performing such an RCM analysis, the functions, functional failures and likely failure modes that could cause some of the system functions to fail would be reviewed. Some examples of function statements for the pump station include:

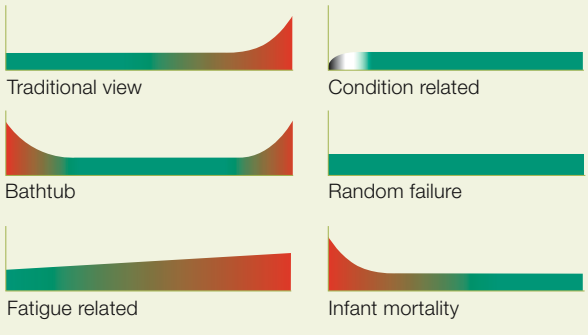
- To supply oil to the generator bearings and gearbox at a minimum pressure of 50 psi and temperature between 15 and 50°C
- To contain the oil
- To be capable of supplying oil to the generator bearings and gearbox in the event the duty pump fails
- To be capable of redirecting the oil back to the suction line in the event the oil pressure exceeds 90 psi
- To maintain the oil at a temperature not exceeding 50°C

However, time is needed to identify the functions and functional failures,

Footnote

[1)] These consequences included unreliable equipment with the possibility of a catastrophic failure while in the air, resulting in multiple fatalities.

1 Failure patterns: The commercial airline industry determined that only 20 percent of equipment failures are a result of time-based failure patterns.



As well as providing participants with a better understanding of how critical assets within an organization operate, the RCM process can be a vital part of a company's preventive maintenance program.

followed by a listing of the likely failure modes – for this example there could be as many as 100 failure modes.

Why perform an RCM analysis

An RCM analysis requires resource and time commitments if it is to be properly conducted. If a typical pump RCM analysis needs approximately seven days to complete, the time and resources required to conduct an analysis for all on-site systems and equipment is enormous. So the question centers on whether the benefits are really worth the effort.

One way of answering this question is to ask if the failure of any system or equipment can result in either serious injury to people or a breach of environmental regulation. Failures that result in negative safety consequences are simply not an option. If there is a risk, no matter how small, then the RCM process should certainly be considered. Even systems or equipment covered by protective devices or controls should also be considered for RCM analysis since the RCM process can then verify if these devices or controls will eliminate or mitigate the consequences.

In all cases where ABB practitioners conducted an RCM analysis, several participants expressed their appreciation of the knowledge gained, and the safety and environmental solutions developed to mitigate the consequences of failure. It can be said then that the value an RCM analysis brings to a company cannot be overstated.

Benefits of performing an RCM analysis

There are a number of benefits of performing an RCM analysis:

- Development of a comprehensive equipment maintenance program; in this program, maintenance strategies with defined tasks and frequency are evaluated against technical feasibility and cost effectiveness
- Identification of physical and procedural redesigns
- Greater maintenance cost effectiveness
- Identification of assets that will be allowed to run to failure
- Identification of key training opportunities
- Improved process knowledge across an organization
- Ability to generate troubleshooting guidelines

The RCM process can be a vital part of a company's preventive maintenance program, and it can provide participants with a better understanding of how critical assets operate.

An additional benefit to the process is the gathering and documenting of the knowledge and experience gained by those who participated in the process. This in itself could be a means of capturing information from those within an organization who may be retiring but whose knowledge remains undocumented.

Preventive maintenance component

The RCM process can be a vital part of a company's preventive maintenance program. In addition, it can provide participants with a better understanding of how critical assets within an organization operate, and an understanding of the necessary tasks to ensure reliability by migrating failure consequences associated with the safety of people and/or breach of environmental regulations.

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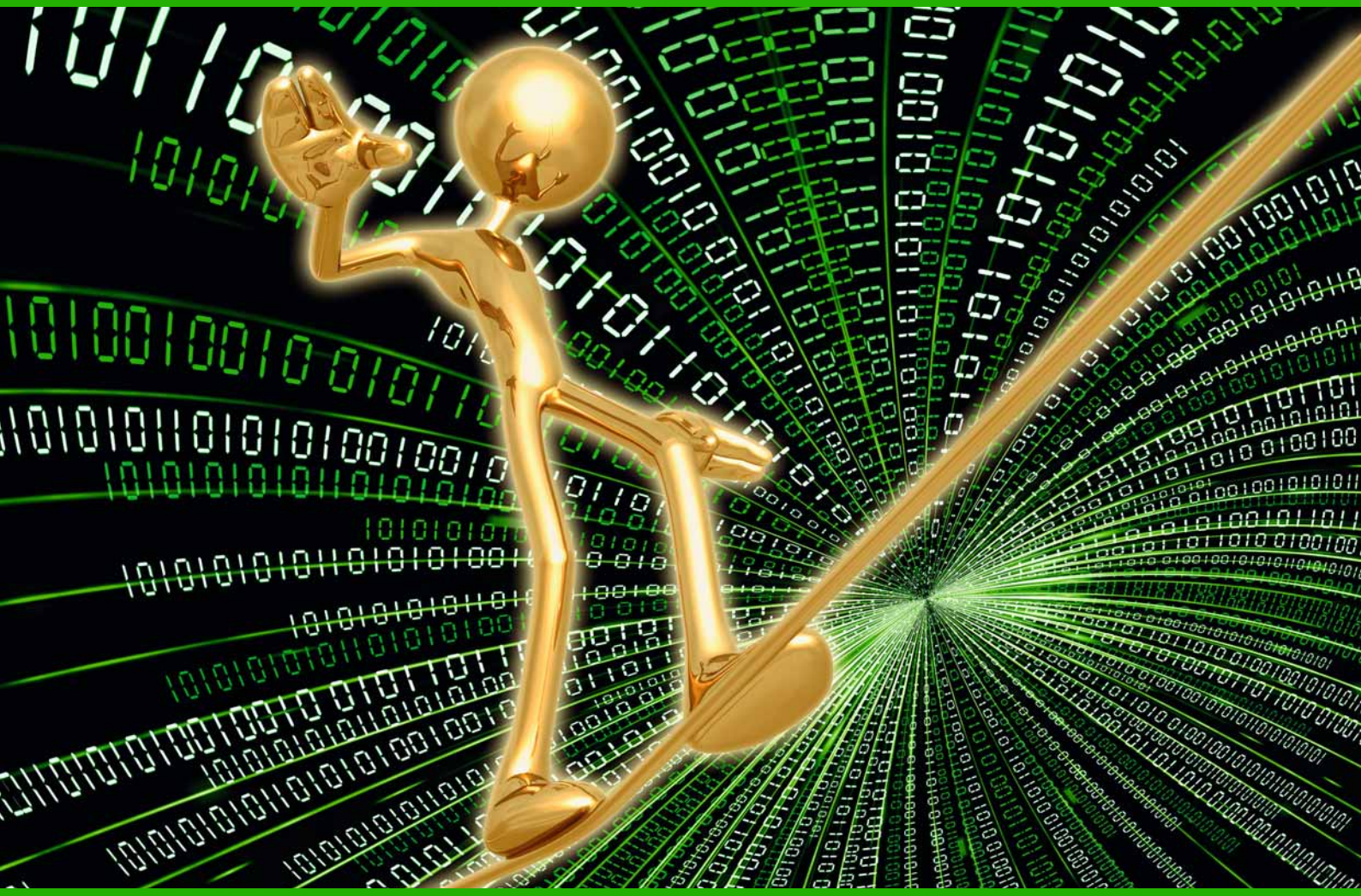
Reference

[1] http://en.wikipedia.org/wiki/Reliability_centered_maintenance (January 2008).

Making reliability sustainable

A long-term solution for process and equipment reliability

Andy Ginder



“Make our reliability process self-sustaining!” How often has that request been heard from executives over the years? The answer is, “too often.”

With competitive pressures surging in recent years, corporate leaders now recognize that equipment and process reliability is critical to operational excellence. Companies depend on their ability to start up equipment on demand, complete scheduled production runs without failure and shut down production without incident. And they need to do it in a cost-effective manner. That requires excellence and consistency in applying reliability and maintenance practices.

ABB Reliability Consulting has been working with companies for more than 40 years to build sustainable reliability and maintenance processes. Building a solid reliability process is a major undertaking, and making it sustainable is no less challenging. The idea that a best-practice reliability process is going to take off and sustain itself (like perpetual motion) is a fallacy.

In a consulting career spanning 30 years, the author has witnessed numerous companies undertake initiatives with the intention of dramatically improving their reliability and maintenance practices. In many instances, they attempted this solely with their own internal resources. In other cases, they drew on the capabilities of consultancies like ABB. Post-analysis of their endeavors shows that the results achieved fall into one of four categories:

1. A percentage of the companies' programs implode before they ever get off the ground. Due to organizational difficulties and lack of commitment, no significant changes are ever achieved.
2. Another group of companies achieves changes during a defined period of time, but as soon as the formal phase of the process ends, things quickly revert to their historical norm. It is equivalent to filling a bathtub with water, then watching the water disappear after the plug is removed.
3. The third group of companies makes changes during the formal project phase and actually maintains the gains thereafter before leveling out onto a plateau. Too frequently, when discussing reliability best practices with employees, the author has been told that they used to do the right things in the past but for some reason – personnel changes or cutbacks – those practices were not maintained.
4. And finally, the fourth group not only makes gains that are sustained, but improves upon them in coming years. The formal project phase lays a strong foundation for future, additional improvement. Even in this fourth group, the reliability gains are not self-sustaining. A structured series of elements, activities and interventions is a necessity for sustaining continuous improvement.

The idea that a best-practice reliability process is going to take off and sustain itself (like perpetual motion) is a fallacy.

Executives are perplexed that once employees are introduced to best-in-class practices, they don't automatically embed them in their daily routines. When the benefits of applying proactive reliability practices are so clear, why don't people grab onto them?

Escaping the comfort zone

When speaking recently at a conference about sustainable reliability, the author asked a simple question of the audience: How many of them were aware that if they exercised four to five times a week for 60 minutes, they would improve the probability of their living longer, healthier lives? There was a unanimous show of hands. The follow-up question was: Knowing the benefits of regular exercise, how many of you religiously work out four or five times a week? What a surprise! Only five percent or less of the attendees raised their hands. Even knowing the benefits accruing to our personal lives, few of us embark on or apply best practices for healthy living. In fact, medical studies show that the vast majority of people who lose weight through diet or exercise regain those lost pounds within two years. So aren't we a bit naive to expect that people are going to embrace over the long term best practices in reliability without a formal support structure?

Just as we know that daily exercise promotes good health, the vast majority of personnel in manufacturing sites know that certain practices (ie, reliability-centered maintenance, planning and scheduling, preventive and predictive maintenance, etc.) promote equipment reliability and the attainment of production goals. Most companies do not apply these reliability practices in a high-quality and consistent manner, despite numerous initiatives intended to embed them in the organizational culture. Improvements are made in the short term but are not sustained.

What lies behind this regression? People have a natural tendency to revert to their norm. And the norm is the comfort zone they have evolved and settled into over the years. Despite their best intentions, people easily fall back into their past practices. Even though we know that we should apply good maintenance planning and scheduling or preventive/predictive

maintenance practices, we relapse into the comforting routines of the past.

One of the conference attendees responded with an appropriate question: If people know what good practices are, whether they relate to our lifestyle or the life cycle of our plants, how do you motivate them to apply those practices? Unfortunately there is no silver bullet, but there are a number of things that can be done to encourage people to take the first step and continue on that path. The reality is that the majority of people want to improve their health and personal appearance, just as the majority of people want to excel at their jobs. The underlying desire or motivation already exists. People just need ongoing support and reinforcement. ABB Reliability Consulting has identified and applies a significant number of tools and activities that help companies achieve sustainable changes in reliability processes. Among them are the following.

Benchmarking

It is generally recommended that people seek guidance from their physician or other qualified personnel prior to starting an aggressive diet and exercising regimen. This provides them with an intelligent, objective opinion on what it is possible to achieve and where they should focus their efforts. Similarly, companies should critically evaluate and benchmark their reliability practices to determine what they want to achieve and what they should do to get there. ABB Reliability Consulting has benchmarked hundreds of manufacturing companies across multiple industries to obtain an objective overview of reliability performance levels. This initial benchmarking supports ABB's work with the customer in developing and implementing a strategy that drives practices and performance metrics in the desired direction.

Executives are perplexed that once employees are introduced to best-in-class practices, they don't automatically embed them in their daily routines.

Leadership structure

To drive processes forward in a sustainable manner, companies need to develop a reliability leadership structure. This typically mirrors the traditional management structure, but supports reliability activities with designated sponsors and/or champions, facilitators, subject matter experts, and consultants. 1 shows a sample leadership structure that has been applied to sustain the change process of many of ABB's customers. The structure identifies reliability-oriented roles, responsibilities and accountabilities, with ABB providing the external consulting staff.

Champion succession plan

Too often reliability processes lose their impetus due to a change in personnel. Frequently the plant, production, or maintenance managers who championed reliability are either transferred or promoted. Their replacements, wanting to make their own mark on the organization, promote new initiatives without ensuring that they are integrated with the established reliability best practices. Companies overlook the need to proactively identify people who can step forward to become the new reliability champions when others depart.

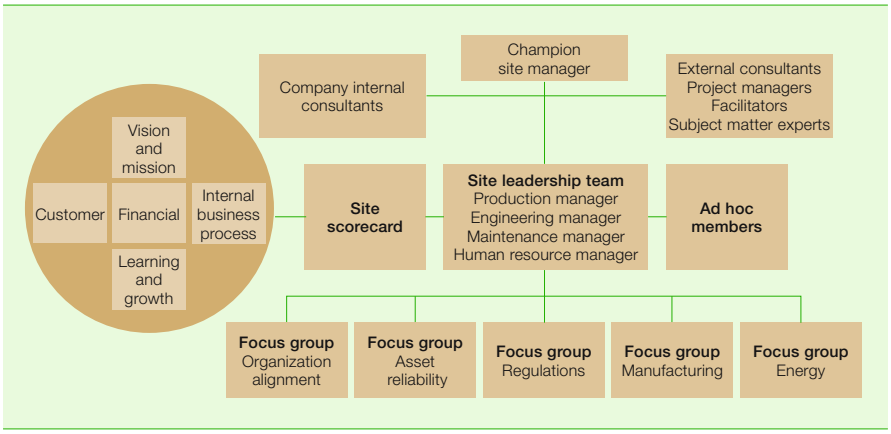
Best practices

Many companies are overambitious or overzealous in their objectives. How many people quit exercising because they overdo it in their first training sessions, leaving their bodies so sore that their resolve to continue falls by the wayside? Companies need to define a core group of best practices on which they are going to focus initially. They can expand the group later. The practices need to be well defined and supported with appropriate procedures, process maps, and training of personnel. A company doesn't have to be the best at everything. If it excels in a few reliability practice areas and is a good, solid performer in others, it will be among the leaders in reliability. ABB Reliability Consulting has developed theoretical models of reliability business processes. By analyzing and contrasting those models with customers' current practices, the change process is accelerated and documented in a manner that supports sustainability after implementation.

Metrics

The benchmarking activity mentioned earlier identifies potential metrics against which companies can track performance. Studies have shown that people who weigh themselves daily are more likely to control their weight successfully. Plants are similar. Tracking specific indicators sends a message to employees regarding what is important. The most successful organizations, though, establish an environment that requires cross-functional teams to regu-

1 ABB employs a leadership structure that mirrors the customer's work teams. The ABB consultants play a dual role of process facilitators and subject matter experts. This enables site personnel to gain ownership of the improvement process, while avoiding possible barriers and roadblocks to change.



larly review the indicators and implement actions to drive them in the proper direction. ABB Reliability Consulting applies a methodical trademarked process (Reliability Balanced Scorecard™) to ensure that customers have an integrated performance system that ties together strategies, metrics and practices, and implements them throughout the organization vertically and horizontally. Just as importantly, ABB aids the customer in implementing a structure and assigning roles that ensure indicators are analyzed and acted on.

Communications

Organizations must continuously communicate what they are doing, why they are doing it, and the successes they are achieving. This communication must be formal (newsletters, town meetings, etc.) and informal (MBWA – management by walking around). Employees base their actions on what they believe is important. And what they consider important is influenced greatly by what their supervisors and managers discuss with them. Regular, consistent communications on the value of reliability are critical to sustain gains.

Periodic audits/interventions

Whether companies use outside or internal consultants, or a combination of the two, regular audits need to be performed to assess the health of the reliability process. Just like an annual physical, these audits identify a company's strengths and areas of opportunity, thereby keeping employees focused on what is important. Slippages are identified along with new areas of opportunity.

ABB Reliability Consulting has identified and applies a significant number of tools and activities that help companies achieve sustainable changes in reliability processes.

Continuous education

Finally, a company needs to establish an educational process that reinforces consistent, quality application of best practices for long-term employees, while introducing new employees to the company's reliability culture. That education needs to be reinforced by supervisors and managers in on-the-job situations.

Yes, reliability improvements are sustainable, but they don't just happen by themselves. The proper building blocks need to be put in place, and continuous support and reinforcement is necessary. It takes effort and discipline to rise early every morning for that three-mile run or to push yourself away from the table before dessert. That same discipline and effort is required in our reliability endeavors. Whoever claims it is easy (or self-sustaining) is selling you something you really don't want to buy.

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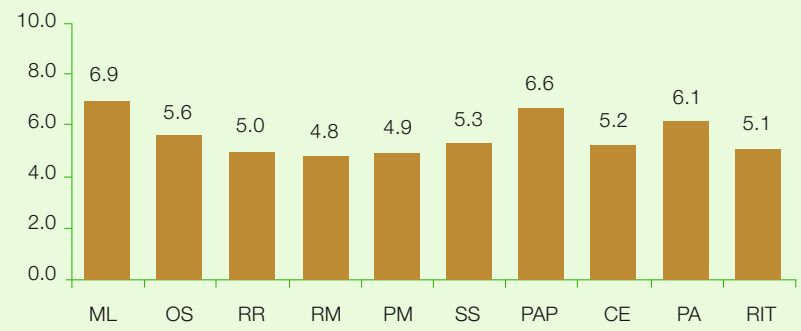
Factbox ABB Reliability Consulting

ABB Reliability Consulting has been helping major corporations drive sustainable improvements in reliability and maintenance for more than 40 years. Companies typically achieve a return on investment in excess of 5:1, as measured in improved equipment performance (availability, run rate and quality) and optimized costs. ABB Reliability Consulting helps customers in all industries, from oil and gas, pulp and paper, and steel to food processing and automotive components.

In a typical project, ABB Reliability Consulting initially conducts a detailed assessment of the client organization using its proprietary World Class Reliability audit 2. Based on the assessment findings, a structured improvement plan is then created and implemented with the support of ABB.

ABB Reliability Consulting provides a multitude of products and services to drive customer performance. These include assisting customers with the implementation and use of maintenance management systems such as SAP PM or MAXIMO, helping to develop or implement performance measures or scorecards, aiding in the application of RCM2 (reliability-centered maintenance) or RCFA (root cause failure analysis), and improving the management of maintenance parts.

2 ABB's World Class Reliability audit: 10 criteria

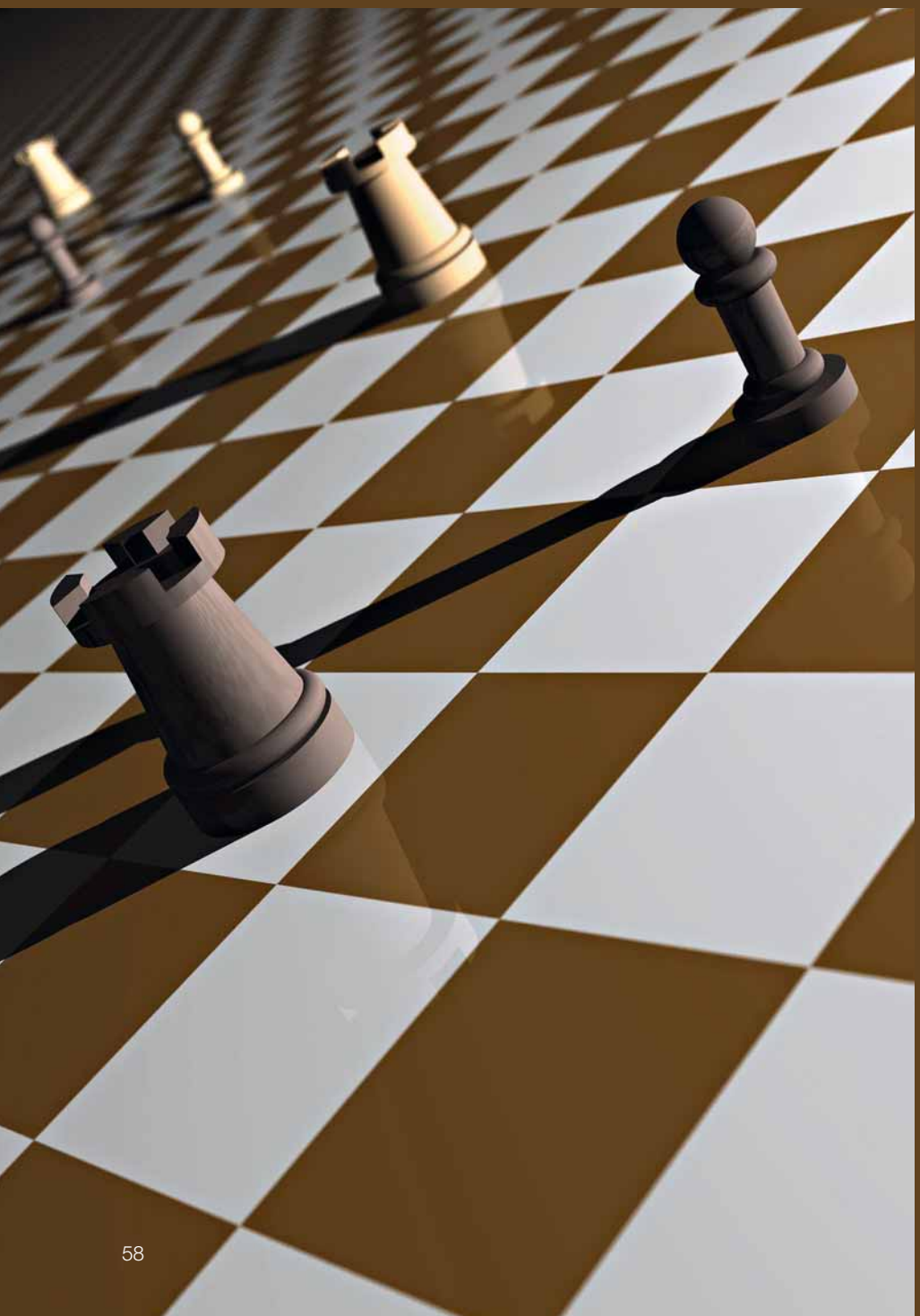


ML Management leadership
OS Organizational structure
RR Roles and responsibilities
RM Responsive maintenance
PM Preventive and predictive maintenance
SS Supplier and services – stores
PAP Physical assets program
CE Continuing education
PA Performance assurance
RIT Reliability information technologies

RIS: The right move

Reliability Integrated Solution: The strategy for getting the most out of assets

Bert Mijten



Strategic thinking when facing a tough challenge requires recognizing how to make optimal use of all available assets. A chess player, for example, who chooses to exclude some of his chessmen from his strategy, is inherently disadvantaging himself. This is no different in manufacturing processes. No matter how good a company's other strategies are, it cannot, for example, afford to ignore the consequences of unplanned equipment downtime when it is seeking to maximize efficiency and productivity.

Companies are dealing with global competition, rising energy prices, fast-changing market requirements, shorter lead times and a shifting labor pool. Market dynamics mean they must make optimal use of their installed base. Although automation is a high contributor to increased plant profitability, the return on investment (ROI) of the installed assets has yet to achieve its maximum. ABB's RIS helps plant operators achieve this optimization by making better use of their assets.

Unavailable and underperforming assets are production drains and missed profit opportunities and often lead to a lower quality product. Unscheduled and often unnecessary maintenance leads to the underutilization of operational assets; and moreover limit the life-cycle profit and financial returns of the installed capital.

To tackle these losses, a balancing act between high asset availability and low-cost demand is required, supported by a proactive business strategy with clearly defined metrics.

ABB's answer is Reliability Integrated Solution (RIS). RIS delivers the path to implement a successful asset optimization strategy using advanced technology. It uses a consultative maintenance and production-oriented approach to drive sustainable results Factbox 1.

Positioning

ABB's Reliability Integrated Solution (RIS) is a package providing the technical, managerial and service components that a company needs to successfully define and implement its asset optimization strategy.

The introduction of an asset optimization solution into a company is more than a one-project exercise, and can certainly not be achieved overnight. Consequently, executive commitment is crucial in bringing the various maintenance and production teams to adopt the common goals and metrics required.

RIS's asset stewardship focuses on cost reduction, productivity and several aspects of the asset life cycle:

- Increase and ensure asset availability
- Reduce the life-cycle cost and extend the asset's life span
- Drive productivity by advanced maintenance strategies
- Aligned business and production goals through improved usage of installed base

To achieve these targets, RIS is built on a combination of ABB's asset optimization automation solutions and extended industry knowledge, expertise and maintenance methodologies. RIS is deployed in both a focused and continuous way. Three main phases are distinguished:

- Allocation of critical assets under assessment of the actual situation with a focus on lost opportunities. These are then benchmarked against the performance indicators of the world's best reliability performers. Further implementation of asset optimization strategies are deployed from these findings.
- Introduction, implementation and integration of real-time asset optimization technology to support advanced maintenance strategies.
- Sustainable profit growth by cross-functional and continuous improvement strategies.

RIS in action

ABB's RIS is applicable in a wide selection of industries, ranging from chemical plants to mining, and presents a scalable and incremental solution for asset optimization.

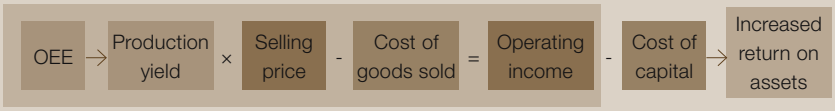
As a starting point in the implementation of RIS, a process, an item of equipment or a group of assets is selected. Within any such selection, the components to be focused on when seeking improvements are those that have an impact on the plant's productivity as reflected in key performance indicators (KPI) such as the overall equipment effectiveness (OEE). The expansion of this process area and the inclusion of additional assets can be engineering in an efficient way using ABB's System 800xA platform as a backbone.

Phase 1: Criticality analysis, benchmarking and assessment

A criticality analysis, benchmark and loss-opportunity assessment are critical process steps in the successful selection of the best asset optimization strategy. These steps all deploy technical and service-oriented components of RIS. The criticality analysis is performed to prioritize the assets that affect the major asset life-cycle costs and productivity. This classification of critical assets also forms the basis for defining loss opportunities and potential OEE improvement.

The plant-performance benchmark focuses on a series of maintenance KPIs, reflecting the actual situation, and comparing these against "world class" standards. This positions the company or process relative to the globally best maintenance and pro-

Factbox 1 Benefits of Reliability Integrated Solution (RIS)



The target of RIS is to enable maximum production at minimum cost. The production yield of sellable products is represented as overall equipment effectiveness (OEE) and is one of the main key performance indicators (KPIs) that reflect the real utilization of production and automation assets. OEE is not only limited to the shop floor but is an important KPI for all levels of the company from operations to plant management. Availability and performance of the installed assets and their resulting product quality have direct impact on the ROI of assets. When these assets are not operational or not contributing to the production of a sellable end product, capital is being wasted.

An increased OEE also opens the opportunity to reduce maintenance cost because higher asset availability results in a better control over the assets and production process. The use of advanced maintenance practices can drastically reduce unnecessary and unforeseen maintenance activities and optimize workforce utilization.

RIS combines OEE improvements with reduced maintenance expenses to provide a solid return on assets by:

- Extending the useful life and reducing total life-cycle cost of plant assets
- Increasing plant asset availability and performance while reducing maintenance cost
- Mitigating downtime, risks and consequences
- Reducing time to achieve operational results
- Converting data to decision-making information for continuous improvement
- Evaluating the financial impact of maintenance

duction performance metrics and sets a baseline for improvement targets. The performance of most companies falls well short of this "world class" level, presenting considerable potential for improvement. OEE is thus the main reference KPI[1].

The loss-opportunity assessment is built upon the findings of the plant-performance benchmark and reflects the targeted business value of this performance gap. The basics for deploying the asset optimization strategy are technology, maintenance, change-management processes, and continuous improvement programs.

Phase 2: Implementation

The technology as well as change-management processes are driven by findings of the criticality analysis, benchmarking and assessment phase. Both are essential in enabling a culture of reliability in the company.

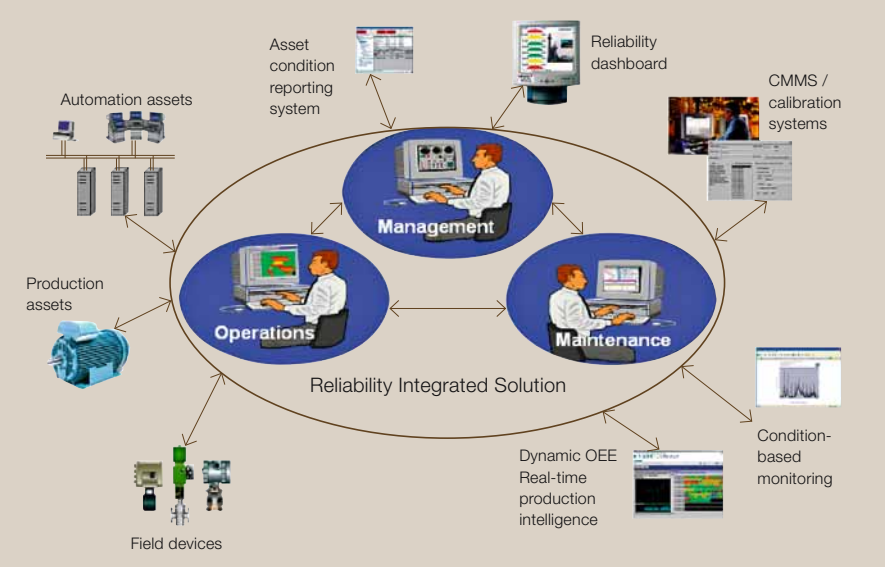
Horizontal integration of technologies and solutions is a prerequisite in enabling real-time and closed-loop operations. Therefore, ABB's 800xA platform is the backbone of the technological part of RIS. Its interoperability, the openness to integrate brand-independent solutions, the suite of asset optimization solutions and the extended library of asset monitors creates a scalable platform for the implementation and successful expansion of asset optimization throughout the enterprise.

The common 800xA platform takes care of real-time data consolidation and access to historical asset data. Besides being accessible through the standard 800xA workstation, these data are also accessible through a web-based application from ABB: the Reliability Dashboard.

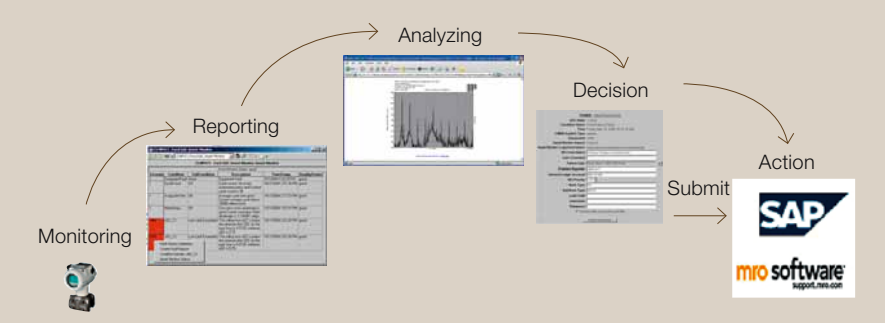
These technologies and solutions cover automation and production assets, intelligent devices and calibration solutions. They include condition-based monitoring solutions, dynamic KPI-measurement solutions and a Computerized Maintenance Management System (CMMS) 1. A selection of applications is presented in Factbox 2.

Not all asset information may be available in electronic form or based on laboratory results, and hence cannot be integrated in the RIS in an automated way. Asset footprint data, for example oil analysis, thermo-graphical results and environmental data, can be entered in a manual way. Using CMMS connectivity solutions, such as Maximo, SAP and IFS, work-order information is natively linked to the specific asset. The same assets are often named differently in operational and maintenance environments; consequently, to avoid confusion and misinterpretation, all information is linked to the same asset. Work orders are sub-

1 Conceptual view of RIS (Reliability Integrated Solution)



2 Avoiding downtime, the information flow from the asset to CMMS



Footnote

[1] See also "Making reliability sustainable" on page 54 of this *ABB Review Special Report*.

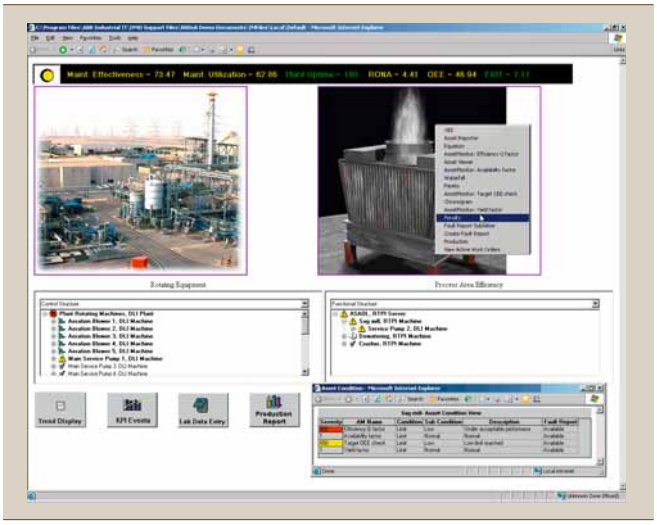
Factbox 2 A selection of applications

- Real-time asset health evaluation by using standard, device- equipment- or processes-specific asset monitors to trigger maintenance alarms for upcoming issues. These asset monitors rely on continuous condition monitoring. Fault condition reporting with suggested actions and asset data are electronically fed to the CMMS to assure a consistent data flow.
- Dynamic on line OEE with real-time production intelligence will track equipment events, downtime reasons and KPIs such as OEE. Deep root cause analysis (RCA) focuses on the problematic elements responsible for the performance losses.
- Condition-based monitoring applications such as ExpertALERT from DLI Engineering report concise vibration analysis results with severity classification and detailed narrowing-in possibilities for equipment fault analysis.
- Calibration device management solutions such as Asset Master and process control loop monitoring such as Loop Performance Panager (LPM).

mitted, accessed and overviewed in a consistent way. This horizontal integration creates an automated workflow, from the problem detection by asset monitors over the analysis to actionable decisions, resolving or preventing failure of equipment and avoid upcoming downtime 2.

As a single point of access, the Reliability Dashboard provides web-based access to real-time and historical asset information such as the maintenance history of KPIs, work-order details and entry (through CMMS), alerts and many other asset-related aspects. This dashboard is available across the site and delivers actionable asset intelligence for operations, maintenance and management staff. For each of these three groups, specific information is available by the ability to "drill down" for in-depth root-cause analysis and decision making. The Reliability Dashboard is not intended as a replacement of the process workstation but as a dedicated maintenance practice oriented, and customizable access point to support advanced maintenance strategies 3.

3 The Reliability Dashboard is a dedicated and customizable access point to support advanced maintenance strategies.



Phase 3 : Continuous improvement

The implemented technology comes to full play when applied in conjunction with a dedicated and advanced continuous maintenance program. This can be equipment-oriented like an equipment performance maintenance program, or a focused support on the equipment asset life cycle. Operational maintenance programs can include, for example, workload balance, implementation of an advanced maintenance program such as Reliability Centered Maintenance[2)] or Total Productivity Maintenance. Also, specific expertise of equipment may not always be available in the plant[3)]. The Remote Diagnostic Services application uses the RIS technology to remotely support, evaluate and troubleshoot equipment at anything from periodic time intervals to round-the-clock vigilance.

For companies that focus on production as their core business, ABB's Outsourced Performance Services (Full Service) is a viable solution in which ABB takes care of all maintenance operations.

An advanved solution

The Reliability Integrated Solution includes technology supported by advanced maintenance strategies to fully deploy a successful asset optimization strategy. Equipment availability and production rate improvement is achieved by providing insight into the asset health and the related actions.

Throughout the enterprise, accurate and actionable information on critical assets is made available to the right people at the right time. Operations and maintenance people can thus work together to maximize productivity – basing their decisions on common goals. The target is to provide maximum production output at minimum cost. By combining OEE improvement with reduced maintenance expenses, the primary benefit of RIS is the achievement of a solid and sustainable ROI.

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Factbox 3 A remote mine in Canada

RIS is applied in a remotely located mine in northern Canada – Vale Inco Labrador Ltd.* – in combination with ABB's Outsourced Performance Services (Full Services).
Due to the harsh environment and remote location, the electrical rotating equipment requires a proactive maintenance approach to guarantee its reliable operation in critical processes.

The RIS application is integrated with the distributed control system and constantly collects data from the prioritized and critical rotating equipment. Vibration data is periodically collected with portable devices supplied by DLI Engineering. The vibration analysis results are then automatically linked with the associated asset and evaluated in the 800xA asset optimization solution. Thermal imaging footprint data are added manually.

This integrated solution fully supports the condition monitoring of the rotating equipment. In this arctic climate, the rotating equipment calls for special lubrication processes to be run at cyclic intervals and requiring close monitoring. When this data is combined with vibration and thermal imaging, a total hierarchical asset-health overview of this equipment becomes available. Instead of performing traditional cyclic and time-based maintenance, maintenance schedules are planned around the equipment whose chances of failure are found to be most critical. In this way, the use of health information as a consolidated and concise asset leads to an optimized and continuous condition monitoring program. The different levels of actionable intelligence, from asset health KPIs to lubrication-related failures, form the cornerstone of the reliability program for the rotating equipment.

Footnote
* See also "A head start to profitability" on page 88 of this *ABB Review Special Report*.

Footnotes
2) See also "Prevention is better than cure" on page 50 of this *ABB Review Special Report*.
3) See also "Remote optimization" on page 13 of this *ABB Review Special Report*.

References
[1] **Wilson, A.**, 2002, Asset Maintenance Management, Industrial Press.
[2] **Reierson, B.,** April 2006, "Myths and realities of asset optimization," Plant Engineering.

Mapping production losses

Exposing true problems and setting correct priorities with ABB Loss Map

Barry Kleine

As process automation plants evolve and the equipment and technology becomes more complex, the number of problems that can occur in production escalates. Even with the best intentions of achieving world-class standards, progress towards best practice targets can be impeded or brought to a halt by plant personnel being overwhelmed by operational and maintenance problems. This is not an issue that affects just engineers or technicians – managers at all levels can become frustrated at the time it takes to achieve the benefits they are targeting.

Industry knows that firefighting – addressing problems as they occur – is very time consuming and costly. Not only is there a risk that the actual root causes are not addressed, but there is simply not enough time to fix problems one by one. Prevention is the only method to get long-term sustainable improvement. But before the prevention program can start, time has to be created.

ABB has investigated the reasons why customers run out of time and money when implementing proactive action plans at their plants, and has found two of the major contributing factors to be:

1. Not knowing what the real problems are – you can only address what you can see, so the problems that are not obvious remain unsolved
2. Insufficient or incorrect data on a problem – so plant personnel have to speculate what the true underlying issues are

By not having accurate information on production losses and how those losses are interconnected, a lot of time is wasted addressing the wrong or low-impact issues. This applies to all levels of the workforce, from managers to technicians and operators. For instance, maintenance personnel who are working on a particular machine may be focusing their efforts on, say, a scanner instead of the motor, without realizing that although the motor is not of great importance on that particular machine, motors are significantly more important across the site as a whole – they should postpone their work on the scanner and work on the motors instead. Similarly, management may be pushing plant improvements without understanding how much time is lost due to issues such as communication. A method is therefore required to identify and compare losses from different sources.

Loss mapping – a unique ABB tool

One of the solutions offered exclusively by ABB is the "loss map," which draws on ABB's extensive industry expertise to determine which factors affect each of a plant's key performance indicators (KPIs). The method enables those KPIs that are critical to plant performance and business objectives to be detailed and understood in depth. It allows the KPI (or "branch" of the map 1) with the largest potential improvement to be identified and focused on at an early stage of the loss review. As each branch is opened, a list of factors with the capability to cause poor performance of the KPI is revealed. Site data will identify which of these factors is contributing the most to losses at the site. When the data is compared to benchmark figures, plant personnel will be able to focus on those factors that will deliver the fastest returns to the business.

The "loss map" draws on ABB's extensive industry expertise to determine which factors affect each of a plant's key performance indicators.

2 shows the branch for overall equipment effectiveness (OEE). The first question would be whether the underperformance of OEE is caused mainly by the availability of equipment, production rate (speed) or quality of the product manufactured. Hard data must be obtained to show which factor(s) should be focused on first. If the underperformance of OEE was caused mainly by availability, it would then prompt the question of which factor(s) of availability were causing the largest loss – equipment failure, the time spent setting up and adjusting, or planned shutdowns. Again, data must be obtained to show the contribution of each factor to loss at the site. In time, all branches should be investigated as each may be contributing to the loss in plant performance

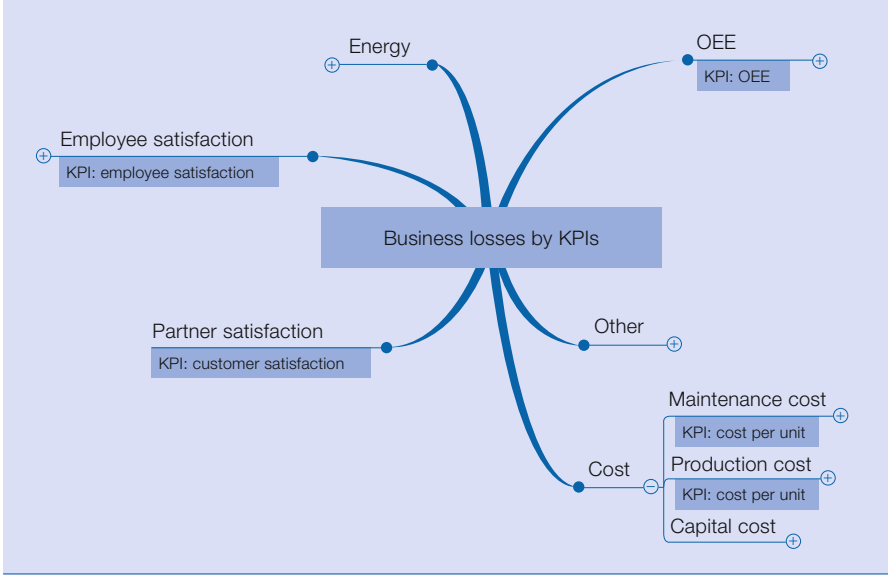
Importantly, a list of "counterbalances" is provided for each branch to prevent one KPI from being improved to the detriment of another. For instance, OEE should not be increased if it leads to a significant rise in costs, or reduces safety or impacts the environment.

Contributing to plant strategy

Loss mapping is not just about identifying sources of loss, it also helps to determine plant strategy. Traditionally, maintenance is linked with availability, but if the plant data reveals KPIs such as production rate or quality to be the largest source of loss, it is in the customer's interest for its maintenance and operations department to focus on them instead. Plant action plans should not just be a set of generic tasks, but rather a maintenance and operations program to address specific plant losses.

At each level, the map continues to challenge understanding by prompting

1 Loss map separating business losses into key performance indicators (KPIs)



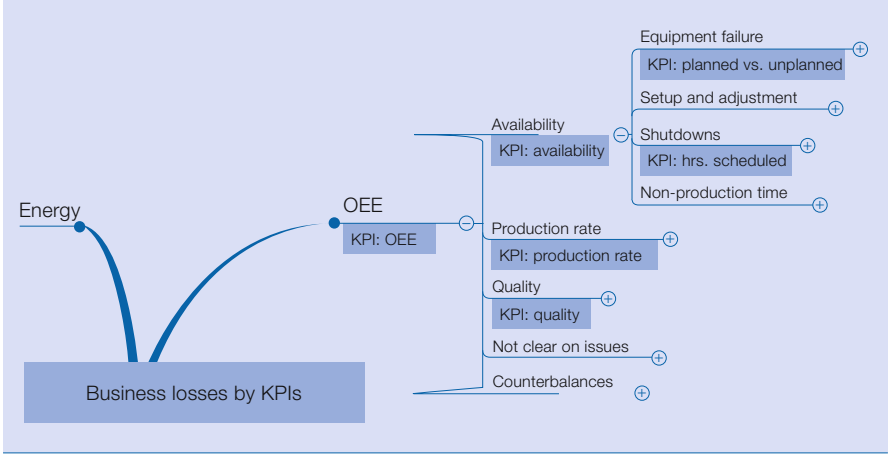
questions such as "If equipment failure is significant, is it the frequency of failure (mean time between failures, or MTBF) or the duration of repair (mean time to repair, or MTTR) that contributes the most?" Different losses are addressed by different tasks 3.

While "reliability" is a good catchword, improving the operating life of something that has little impact on OEE or cost (current or future), or reducing the repair time of something that rarely fails, is not making good use of personnel's time. Not only does the loss map encourage personnel to look for frequent, high-impact losses, it suggests the contributing factors behind those losses so that personnel can assess the most cost-effective measures to take.

Each branch in the loss map enables personnel to drill down to the problem's roots – the fundamental issues that cause the plant's losses. Identifying the root issues for each branch enables fast progress to be made. Any tasks or planned investments at the plant that are not shown to be a major source of loss on the map should be postponed. This will create time to address the root issues.

Loss mapping is not confined to equipment; it focuses on loss, wherever it may reside. Efficiency of people, for example, plays a significant part in the performance of the plant – and this includes everyone from the plant manager down. It poses questions like: Are issues of communication slowing down personnel? Are people being distracted from their main tasks? Are management and personnel procedures adequate for efficient and quality work? Would addressing any of these give greater or lesser returns than addressing a particular equipment issue at the plant 4?

2 Contributing factors affecting overall equipment effectiveness (OEE)



Loss mapping is not confined to equipment; it focuses on loss, wherever it may reside.

Often it is problems not recorded by maintenance or production databases that cause the greatest losses. Communication problems, for example, may add several minutes to a downtime repair but go unnoticed; in the long term, those several minutes will be added to every downtime incident, shutdown or refurbishment, leading to substantial accumulations in delays and losses. The map allows personnel to understand the issues that can slow their performance and highlight the ones most applicable to them. For instance, addressing a 10-minute-a-day problem for one employee creates one extra week of work time for that employee over the course of a year. A site improvement plan should not just include equipment improvements, but should prioritize and include these "soft" issues.

While the map is remarkably comprehensive in size and content (more than 1,500 factors are detailed), it

Factbox The ABB loss mapping process

The ABB loss – mapping process allows plant management to understand all the factors limiting the achievement of their business objectives. It considers equipment as well as personnel factors and is used across all industries. Sites using the tool rapidly recognize that the issues they are focusing on are not necessarily the most important sources of loss at the site. ABB Loss Map has been rolled out in more than 20 countries and at every site has resulted in a better understanding of plant issues by personnel and a refocusing of the site improvement plan to achieve faster gains.

should never be allowed to overwhelm personnel; it is a tool to understand losses and create a dialog about what is really causing problems at the plant. As a result of this dialog, plant management should select as many or as few tasks that can realistically be implemented. In addition, the map provides a simple and clear means to compare and prioritize future losses as and when they arise, providing essential detail and guidance for years to come.

Quantifiable benefits

Jacques Vosloo, improvement manager at Kinleith pulp and paper mill in New Zealand, found that the loss map was the best way to focus the site resources.

"By comparing the original plant action plans to the ABB Loss Map, we found that half of process improvement projects had no bottom-line impact and another 25 percent had a negative impact on the plant's overall productivity. The ABB Loss Map helped to identify the major loss makers in the manufacturing process. Thereafter, it was just a matter of aligning maintenance, operations and engineering to eliminate or reduce the loss."

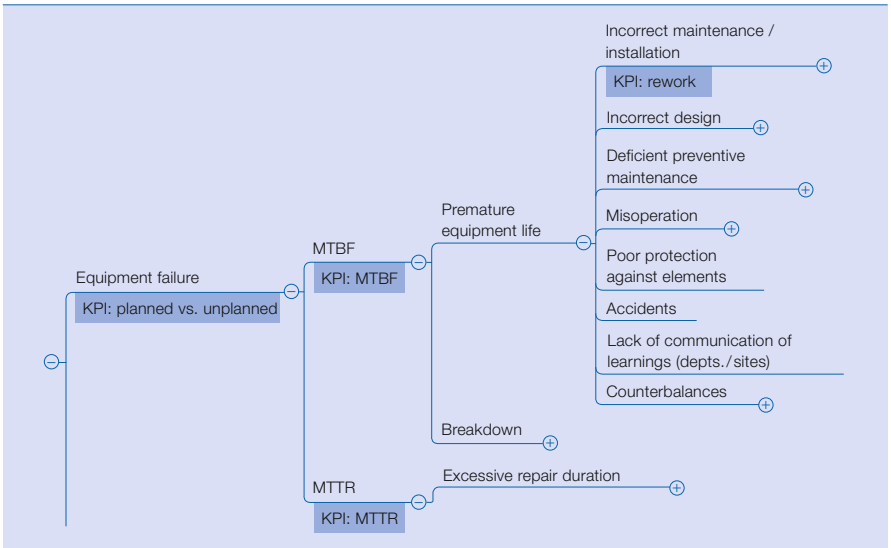
Over the last four years, Kinleith has enjoyed substantial improvements, including an increase in overall equipment effectiveness of 22.4 percent, a reduction in maintenance cost per ton of paper of 35 percent, and an increase in employee satisfaction from 66 percent to 78 percent.

Jose Baptista, ABB Full Service® regional manager for North America agrees. "I think the use of this methodology is crucial to leverage the plant-performance improvement, helping to identify 'the hidden plant.' Mind mapping is an important technique that enhances creative problem-solving by identifying and understanding the structure of a subject and the way that pieces of information fit together."

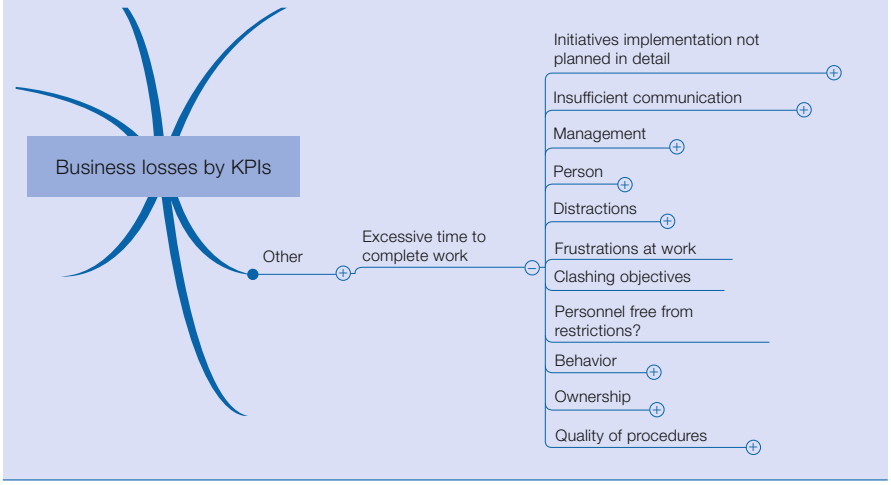
ABB Loss Map has helped Kinleith increase OEE by 22.4 percent, reduce maintenance costs per ton of paper by 35 percent and increase employee satisfaction from 66 percent to 78 percent.

Rapid and sustainable improvement of business objectives can only be achieved when all influencing factors are understood and compared. ABB provides the process and tools necessary to evaluate and prioritize site-specific losses that need to be addressed. The ABB Loss Map enables not only better understanding of what is happening at the site, but compares factors such as equipment losses with personnel losses. The agreed maintenance and operation plan that results has the additional benefit of achieving better teamwork and improving the level of confidence between disciplines. The loss mapping process is just one example of the global support our customers enjoy by choosing ABB.

3 Contributing factors to equipment failure that require different tasks when addressed



4 Non-equipment-related factors that contribute to KPI losses



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Flawless project execution

ABB is the main automation and electrical contractor for large industrial projects worldwide

Mike Connolly, Josh Caglar

As the pace of technology development increases and the demand for increased plant efficiency and improved power consumption drives the design of industrial facilities, manufacturers and plant operators are turning to automation and electrical product developers like ABB to provide industrial solutions that meet the technical and execution requirements of these complex facilities.

This approach moves the product developers from their traditional role of vendor/equipment supplier – providing equipment to a customer-developed specification – to that of an independent contractor performing the role of an engineering, procurement and construction (EPC) contractor and provider of engineered solutions 1. ABB defines this role as that of a main automation contractor (MAC) or main electrical contractor (MEC). In making the transition from vendor to contractor, the MAC/MEC is required to adopt a more proactive approach during the execution of the work. This requires close cooperation with the client organization and other contractors and suppliers to develop best-in-class solutions, as well as to implement those solutions across the facilities and manage the interfaces with other participants to ensure effective integration of all components and systems.

This EPC approach is distinguished from the traditional vendor/supplier role in three significant ways:

1. The scope of supply involves services and products, with the emphasis on the ability to provide the services element 2. The scope of work requires participation of the MAC/MEC throughout the full project lifecycle, from front-end engineering and design (FEED) to completions and startup.
2. The work requires significant coordination and information exchange between multiple project participants.
3. The MAC/MEC is responsible for coordination of the overall systems and manages the interfaces to facilitate integration.

There are also significant differences from a project execution perspective where these types of projects involve multiple participants including process designers, construction contractors, utility providers, regulatory authorities and government agencies.

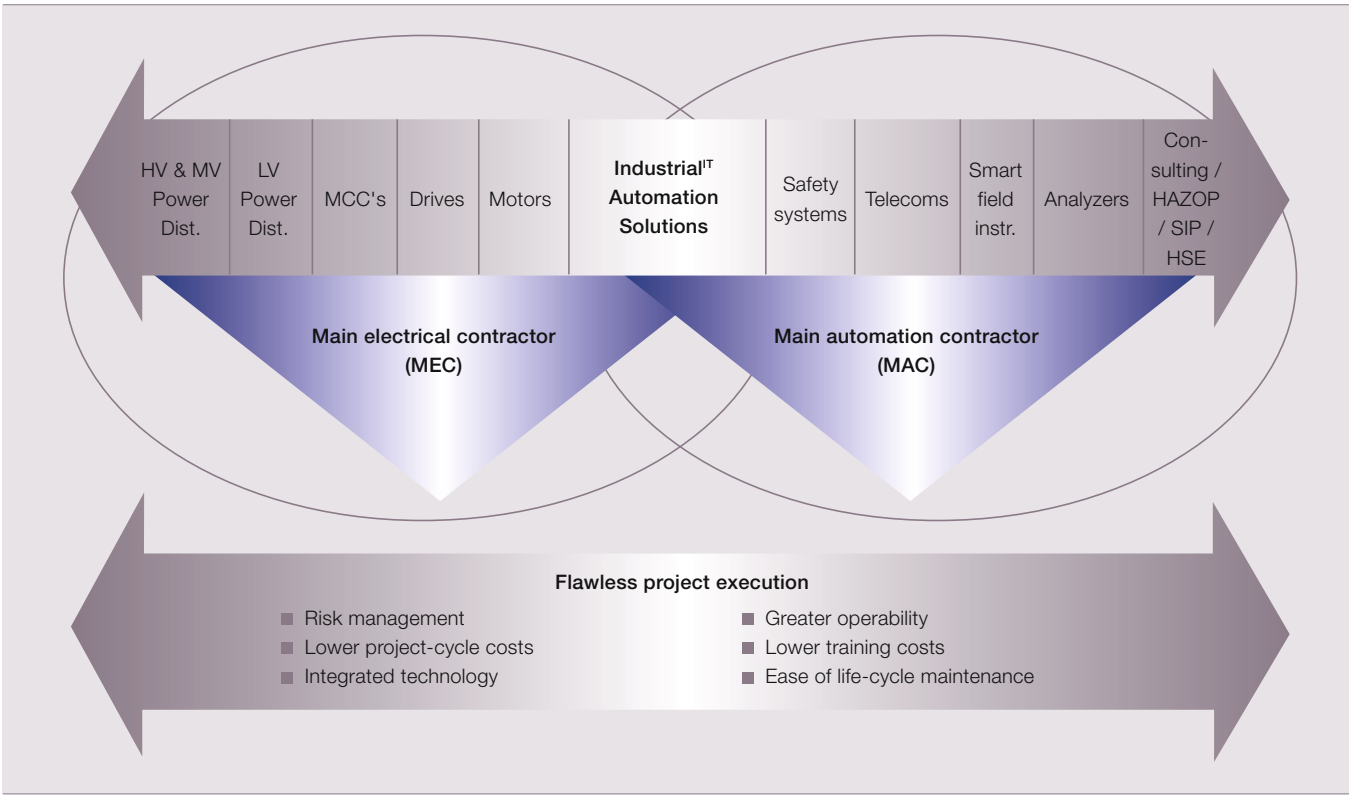
First, the scope of work is broader than a conventional vendor/supplier scope and is focused on the overall solution and not the products that make up the solution.

Second, it requires participation in the FEED phase where the MAC/MEC works closely with the customer and overall plant designers to develop the system concept and basic operational specifications.

Third, once the project moves into the full execution phase, the MAC/MEC has the responsibility, in addition to providing the product solution, to provide coordination and interfaces between the major EPC contractors. This ensures that the concepts and requirements developed during the FEED phase are implemented effectively and that design standardization is achieved across the facilities.

Fourth, the MAC/MEC provides the product solution utilizing its own products in combination with third-party products, integrates these with the process and utility equipment provided by the EPC contractors, and as-

1 ABB's comprehensive product and systems offering in power and automation technologies covers the entire spectrum of an integrated scope of supply



sists with the installation of the completed systems under the direction of the EPC contractors.

Finally, the MAC/MEC has responsibility to work under the direction of the EPC contractors at the construction sites to achieve final commissioning and startup of the facilities.

ABB has developed a robust project execution methodology that provides customers with a level of service not available from the traditional EPC contractors.

As a global leader in the design and supply of process automation and power systems for a broad range of industries, ABB has easily made this transition from main product vendor to overall solutions provider. Leveraging its expertise around the globe, ABB has developed the "Book of MAC/MEC," a robust project execution methodology that, combined with extensive product and industry knowledge, provides customers with a level of service not available from the traditional EPC contractors.

Project execution

ABB's execution methodology is based on modern project management techniques supported by well-trained and qualified professional resources and proven systems and tools. The focus of the approach is ensuring that the project scope is well defined at the outset, that the work is planned well in advance of execution activities, that execution responsibilities are identified and agreed upon between all participants, and that detailed project-specific plans covering all aspects of the work are established, implemented and followed.

To support the project management process, ABB has developed the MAC/MEC Project Execution Map. The map outlines the structure and scope of a typical automation or electrification project from the FEED phase through to completions and acceptance. The map provides information on the primary execution processes and the various project plans needed to support flawless execution during the various project phases. The map portrays the relationships between the internal execution processes of the customer, MAC/MEC and the EPC contractors, and how these processes interact and integrate in order to achieve a common approach for project execution. The map also indicates the high-level technical interface points that exist between the MAC/MEC and the EPC contractors during each major project phase. The map depicts the four main project phases:

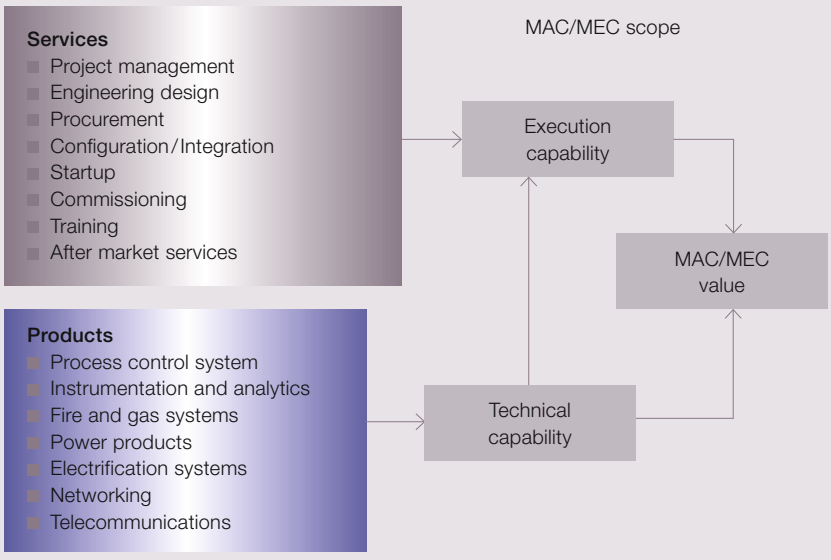
- FEED
- Detailed design, engineering and manufacture
- Construction/installation
- Completions and closeout

FEED participation

Early involvement in the development stage of a project has a tremendous impact on the overall effectiveness of the final solutions selected. The long-term benefits achieved by "getting it right" early in the project yield results in total cost of ownership savings.

The MAC/MEC participation in the FEED phase of the project lays the foundation for the development of a best-in-class solution for the project. The FEED phase has two basic elements: a technical aspect and a work process aspect. Working in cooperation with the plant owner and process designers, ABB utilizes its unique combination of technical expertise and detailed product knowledge to provide the technical concept definition, project standards, common functional design criteria and generic equipment specifications. The FEED phase is also the period when the management systems and specific project plans to be employed during

2 A MAC/MEC approach provides value to the owner/operator in all phases of a project



Factbox ABB MAC/MEC projects

ABB has implemented numerous projects as the main electrical and automation contractor on behalf of many of the world's leading hydrocarbon companies in onshore and offshore locations all over the world. Applications include gas distribution pipelines, gas processing plants, offshore oil and gas platforms, onshore oil production facilities, and oil refineries.

ABB is a leading supplier of power and automation products, systems and solutions to the oil and gas industry, with a complete and integrated scope of supply capability that ranges from plant electrification to control, optimization and safety systems, smart field instrumentation, analyzers and telecommunications systems.

project execution are defined and developed. Each organization (owner, designers and ABB) has its own internal standards and requirements for executing its work. These internal processes reflect the basic tenets of the respective organizations and are the foundation for how each of them approaches the various execution phases. A balance between the project-specific requirements and the basic work processes of each of the participants must be achieved. Basic integration of the respective work processes is necessary to make the transfer of critical engineering data and documentation possible. This integration of work processes and establishing a common approach to execution are key elements in achieving flawless execution. To facilitate this, ABB utilizes the Interface management[1)] process.

Interface management

Interface management is one of the most critical processes in achieving flawless project execution. It involves identifying and controlling the flow of critical information between major project participants. For complex industrial projects there are multiple project participants, each of whom will require data (technical, schedules, etc.) from other participants in order to perform their work. The timely identification, development and exchange of this data are crucial to project success. The interface management process facilitates this through early identification of the data required and by establishing formal agreements between the supplier and receiver on the required data and when it is to be delivered.

The process utilizes formal, documented interface agreements created between ABB and the other project participants. Agreements are also created internally within the various units of the ABB organization to provide visibility of critical data and information. Each interface agreement has an information owner (the sender) and an information recipient (the receiver), and lists the specific information required and the delivery requirements for it. Each interface agreement is given a unique identification number and is logged in the interface database. The status of all agreements is monitored and reports produced on a regular basis indicating the overall status. Constant monitoring highlights areas of criticality that can be quickly addressed and brought under control.

The long-term benefits achieved by “getting it right” early in the project yield results in total cost of ownership savings.

Interface management is just one of a complete suite of processes employed by ABB in the overall execution model. The processes have been developed as a result of participation in major projects around the globe covering a wide variety of customers and industrial sectors. These processes are the foundation of flawless execution. They are based on the premise that the work to be performed is fully defined and responsibilities for execution are agreed and allocated. Goals and objectives for success are established and strategies developed to achieve success. The strategies form the guidelines for action planning. Creation of the detailed plans, implementation of the plans and constant monitoring of actual performance towards achieving the defined objectives are the keys to successful execution.

The ABB execution model has been developed using project management best practices and is implemented globally. The model structure is very flexible, allowing its elements to be tailored to reflect local practices, local regulations and regional variations in approach while maintaining a common execution framework. This provides ABB with the ability to execute on a truly global basis making full use of its regional centers of excellence, high value engineering centers and global execution centers. It also provides a common execution language, allowing ABB to make full use of its global resource pool to match the “on demand” resource requirements of complex projects.

The ABB execution capability, coupled with ABB’s broad products portfolio, technical expertise and global manufacturing facilities, offers customers a range of project services that provide predictable and consistent results and help customers deliver their business objectives.

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Footnote

1) See “Information exchange” on page 70 of this issue of *ABB Review Special Report*.

Information exchange

An effective interface management program that creates communication excellence

Josh Caglar, Mike Connolly

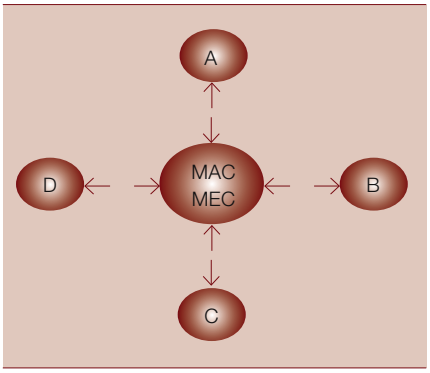
Large industrial projects usually involve a multitude of companies from all over the world who have to collaborate across several different time zones and cross cultural and language boundaries. As a leading automation and electrical contractor for oil and gas projects, ABB has developed an interface management system to ensure that communication and data exchange between suppliers is fast and efficient, and that the ultimate objective of flawless project execution is achieved.

In today's flat world, many major oil and gas projects involve multiple project participants from different geographic locations. A typical project would include one or more engineering, procurement and construction (EPC) companies performing process and facilities design, a variety of third-party suppliers providing products and services, and a broad array of external and internal customers needing to exchange information between themselves and other project stakeholders.

Critical elements in the successful operation of major oil and gas facilities are the automation, control and electrical power systems. For these systems to have a common "look and feel" throughout the facility, owner-operators are increasingly adopting the concept of main automation contractor (MAC) and main electrical contractor (MEC), where major vendor/equipment suppliers take on an expanded role in the design, manufacture, installation, commissioning and initial operation of the facilities. An important aspect of the MAC/MEC role is to promote effective and timely communication and the exchange of information between participants, since this is a prerequisite for the ultimate success of a project 1.

MAC/MEC brings value to the end user by providing advanced technology solutions and integrated products. In order for the solutions and integration to be implemented successfully, it is essential that a common framework of communication is established to permit the timely exchange of relevant and accurate data between the parties involved. To achieve this, ABB employs interface management, a key process within its project execution model and an essential element in delivering flawless project execution.

1 Interface management



Project requirements

A major factor impacting the exchange of information is the contracting structure employed on the project. There are a variety of different contracting models that can be used, ranging from direct contracts with the owner to various prime contractor/subcontractor/supplier relationships between the owner, engineers and other project participants.

Owner-operators are increasingly adopting the concept of main automation contractor (MAC) and main electrical contractor (MEC).

Irrespective of the contracting model used, large projects usually involve multiple participants who are based in different geographical locations, do not share the same culture or language, and have to collaborate over multiple time zones. In situations like this, it is essential for the MAC/MEC to be able to interface with others and coordinate information in order to minimize risk during design development and prevent the delivery of late or erroneous data. This requires the creation of a process to coordinate activities directly with other project participants to ensure an effective exchange of critical information.

The process must be robust and it must be managed. It requires a management structure that can cross the relevant participant boundaries without impacting contractual relationships. The nomination of an interface representative within each participant's project organization achieves this. The project interface manager has overall responsibility for implementation and maintenance of the interface management process throughout the project's lifecycle. This is achieved by developing and implementing project-specific interface management work processes, as well as by capturing the necessary interface agreements, monitoring progress, ensuring that schedule requirements are maintained and identifying or initiating any requests for change that may arise from the interface requirements. Depending on the size of the project, the MAC/MEC project interface manager may also assign a project interface contact (technical liaison) to each of the other participants. That person is the interface liaison officer with the owner and the EPC's interface representative, as well as other persons or departments stipulated by the owner.

Defining roles and responsibilities

The objective of the interface management process is to facilitate agreement between stakeholders regarding roles and responsibilities, the provision and timing of interface information and the identification of critical interfaces early in the project. The overall goals are to quickly identify issues that have the potential to impact costs or schedules and to minimize or eradicate their impact; and, to promote the clear, accurate, timely and consistent communication and exchange of interface information with other participants.

Large projects usually involve multiple participants who are based in different geographical locations, do not share the same culture or language and have to collaborate over multiple time zones.

Interface agreements enable the exchange of project information that is generated by one party and needed by another party for it to implement its scheduled project tasks. This may include, but is not limited to, engineering drawings, specifications, design reports and calculations, equipment details and project schedule information. There is no limitation on the source of interface agreements. They can be initiated by members of the project team or by contractual requirements, responsibility matrices,

customer requirements, third-party vendors/suppliers or project stakeholders.

Whatever the source, requests for information in an interface agreement should follow two basic rules:
1. They should be very specific and not open to further breakdown into additional items.
2. They should be given a specific date for completion.

To simplify the process and make tracking and monitoring efficient, all interface agreements should be unidirectional from the first party (receiver) to the second party (supplier) 2. If the second party requires the data to be returned, it should be the subject of a separate interface agreement from the second party to the first party.

The receiver is the party that initiates the request for information and the supplier is the party that is responsible for providing the requested information. During project execution all participants are likely to adopt the role of receivers and suppliers at some point in time.

The interface management process

The interface management process is a method for formally documenting and tracking the exchange of information between project participants and for monitoring their performance in supplying the required information. The process involves:
- Identifying and recording an interface
- Creating an interface agreement
- Agreeing/resolving conflict
- Monitoring the status
- Reporting the status
- Closing the interface agreement 3

Information required by the receiving party is identified and the interface manager is informed of the request. The information manager creates an electronic register of all identified interfaces, usually in a database. Each interface agreement is given its own identification code to enable easy identification of the receiver and supplier. For example, in the case of an external party, MAC/MEC-EPC1-001 reveals an interface agreement that MAC/MEC is requesting from EPC1.

A formal interface agreement document is generated from the interface management database by the interface manager and is signed by the receiver. It is issued to the supplier via a formal document management process that contains essential data such as the interface agreement identification number, priority (whether it is highly critical or information only), date raised, supplier organization and interface contact, the date the information is needed by the receiver, the date agreed by the supplier and the status of the interface agreement as either "open" or "closed."

Interface management allows early identification of critical interfaces through a structured process leading to the definition of issues that have the potential to impact costs and schedules.

Once the created interface agreement is issued by the receiver, the supplier will either accept it or ask for further clarification. The interface agreement is then discussed with the supplier and is accepted, modified, or deleted. If there is a dispute over the legitimacy of an interface, the interfacing parties will make every effort to resolve the issue. The customer may intervene to provide final arbitration of any unsettled issues. The supplier then signs the interface agreement and returns it to the receiver. The database is updated as required. To keep the process as simple as possible, an interface agreement may be revised only once.

Each project interface manager monitors the status of the interface agreements on a regular basis by holding periodic meetings or teleconferences with the relevant parties to review progress on the interface registers. Interface agreements with "critical" status are prioritized and contingency plans are developed by the respective project managers to minimize the impact of critical data that is not delivered on time.

The interface manager is responsible for producing regular reports on interface progress from the electronic log. The frequency of status reports will depend on project reporting requirements, but should at least be generated once a month and included in the monthly project progress report. Reports are made in either tabular format as an interface register or in statistical format as a high-level report.

When the receiver receives the requested information by the required date and judges it acceptable, the interface agreement can be signed off as "closed" and returned to the supplier. In turn, the supplier also signs off the interface agreement as "closed" and the document is recorded as such in both the supplier's and the receiver's interface databases. "Closed" interfaces are omitted from future interface agreement reporting.

The benefits

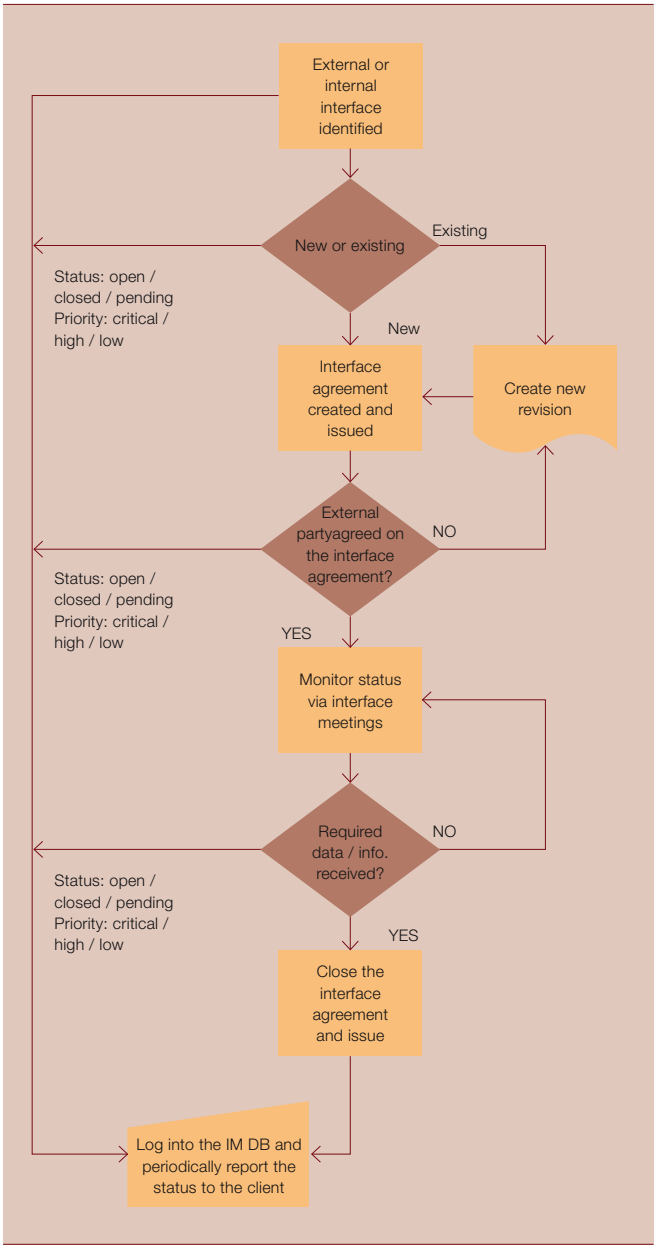
The interface management process has many advantages, particularly when there are numerous participants and stakeholders involved in a project. A structured process for the exchange of information means that performance in satisfying requirements can be monitored in detail and any shortcomings highlighted and addressed immediately, should they become apparent. A secondary benefit of implementing the process is that it encourages meaningful communication between the supplier and receiver. The requirement to provide specific, detailed requests that cannot be

2 Interface agreements are unidirectional

broken down into smaller parts means that the party making the request must give careful thought to the detail of the information requested and to the timing of its delivery. The requirement that both parties sign a formal agreement means that a dialogue regarding the information and its delivery must take place between the parties for agreement to be reached. If the receiving party asks for too much too soon in the data generation cycle, agreement with the supplier party is unlikely to result. The supplier party will require the data to be broken down into more precisely defined parts, resulting in detailed discussions between the parties regarding the information required. The formal interface agreements are the product of this communication process.

Fostering this communication between project participants early in the design cycle is an important factor in achieving execution excellence. Very often, the information a participant requires is either ill-defined (resulting in confusion and lack of focus) or is all-encompassing (resulting in non-delivery). This leads to conflict within the team and gives rise to unproductive finger-pointing instead of cooperation to ensure that work progresses to meet the scheduled objectives. Examples of this are the MAC requesting delivery of the AFC P & IDs (approved for construction piping and instrumentation diagrams) from the process designer by a certain date. This is an ideal situation, but in today's fast-track projects the process designer is often unable to deliver all P & IDs at the same time. By focusing on the actual data needed, the MAC and the process designer can reach agreement on an acceptable timeframe for delivery of the data. The use of the interface process captures the details of these agreements, makes them visible to all participants and tracks them to a successful conclusion.

3 Process flow for interface management (IM)



Fostering communication between project participants early in the design cycle is an important factor in achieving execution excellence.

Flawless project execution

Effective exchange of information is crucial to the successful execution of any project. The larger the project and the more participants there are, the more difficult it is to achieve this. Interface management allows early identification of critical interfaces through a structured process leading to the definition of issues that have the potential to impact costs and schedules. Once identified, action can be taken to minimize impact and, through constant monitoring, any critical areas that deviate from the plan can be quickly addressed and brought under control.

Interface management also encourages communication between the participants. It provides each participant with an understanding of the constraints inherent in their respective data generation cycles. Identifying specific data requirements and understanding the importance of the requirement leads to more effective cooperation, and thus an improvement in execution performance.

The interface management process can only be effective if all project participants embrace the concept and incorporate it into their work processes, making it a formal method of project communication that benefits everyone in their efforts to achieve flawless execution.

To learn more about MAC/MEC, see "Flawless project execution" on page 66 of this *ABB Review Special Report*.

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The value of RAM

Reliability, availability and maintainability analyses are set to become standard tools in all industries

Kaizad P. Sunavala

RAM analyses – already well established in safety-critical industries such as aerospace or nuclear power – are entering other industries with high pace. While process industries (eg, petrochemical, power plants, oil and gas, and refineries) deploy phased capital project execution methodology with gated transitions from one phase into the next, RAM modeling studies are gradually becoming a standard requirement for the front-end engineering design (FEED) phase deliverables. Based on international standards for RAM studies (IEEE 497, ISO 14224 and others), ABB's FEED delivery model is providing robust reliability and plant availability models in the design stages to mitigate operational headaches later on.

Historically, the design phase – FEED – of a capital project mainly focused on the engineering and design specifications of the equipment, eg, process capacity, design duty, heat and mechanical stresses. Reliability life-cycle studies were seldom performed. Designing for reliability is increasingly becoming mandatory and the results of reliability, availability and maintainability (RAM) modeling studies are critically evaluated in the "gate transition reviews" by the capital project management team.

There are various industry-accepted reliability tools and methods for a reliability professional to deploy. Each method has its applications and limitations. 1 shows the ABB recommendations for a typical capital project. The ideal time for a RAM study is just after the front-end conceptual design is complete, but prior to commencement of the detailed engineering phase. In the later phases, attempts to address the reliability issues are usually cost prohibitive and unfeasible. In short, RAM studies allow project teams to address the potential reliability design issues, bottlenecks, sparing and redundancy requirements before the detailed engineering and construction phase begins Factbox 1.

RAM studies start by developing a pictorial representation of functional interdependencies of the various assets and failure frameworks (commonly referred to as a reliability block diagram, or RBD). With the probability distribution of all states of these interdependencies, Monte Carlo simulations of the whole system provide the modeler with quantitative system-level reliability and availability estimates. The RAM study provides a statistical foundation for each asset's contributions to the overall system availability and reliability.

ABB Reliability Services offers a complete set of reliability tools and modeling services across the entire capital project management life cycle.

"Criticality analysis" is a ranking and categorization method for prioritizing assets based on consequence and probabilities of failures. The results are used to determine in broad terms the overall maintenance philosophy for the asset, such as run-to-failure, condition monitoring, time-based preventive strategies and continuous monitoring.

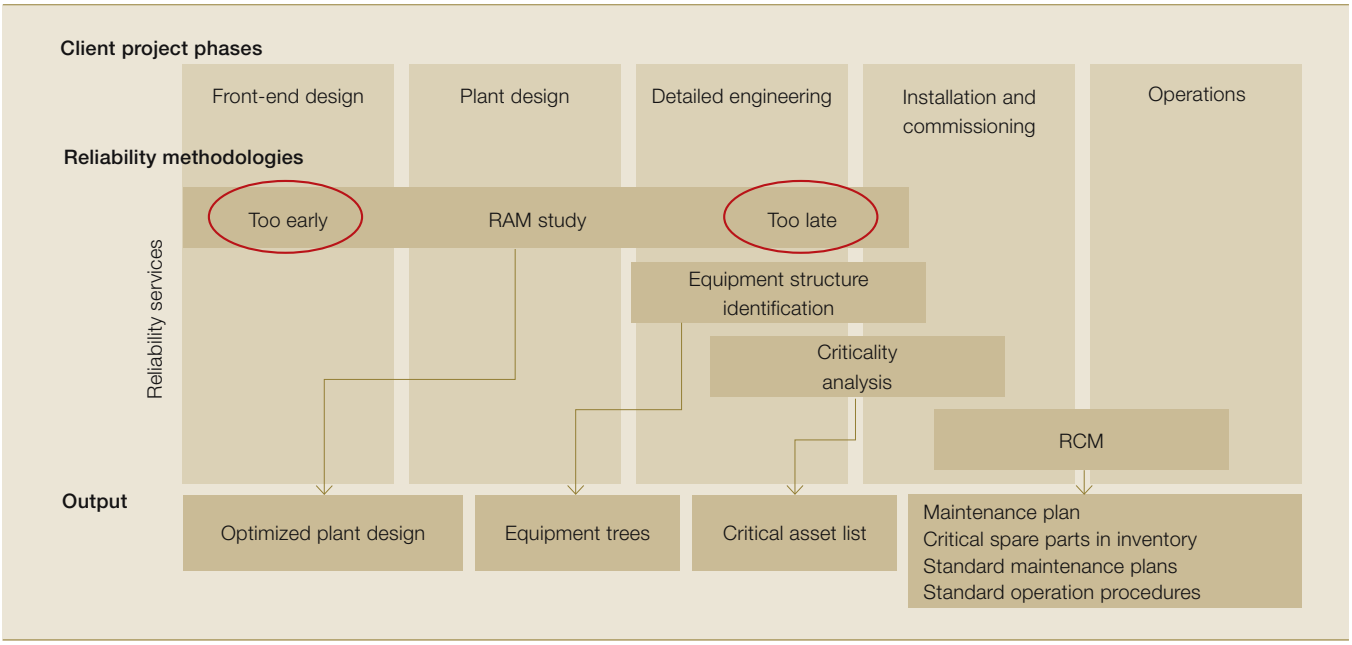
"Equipment trees" refers to the asset hierarchy structure in which all the operating assets are placed in a maintenance management system. The asset hierarchy is a graphical view that shows the relative placement of each asset in the overall system and site based on equipment functions, geography, location and importance. Hierarchical views are very good tools to perform detailed analyses for assets such as costs, reliability and downtime.

Factbox 1 The merit of RAM studies

The steps involved in RAM studies address a number of issues:

- Identifying potential bottlenecks (mechanical and process)
- Estimating the on-stream availability of the unit
- Outlining the planned and unplanned maintenance demands
- Developing optimum shutdown strategies (interval and duration)
- Analyzing the impact of various maintenance staffing loads
- Predicting the impact of equipment redundancy and sparing
- Developing mitigation strategies for expected failure modes
- Performing a preliminary equipment criticality analysis
- Optimizing reliability at the design stages by analysis of a wide range of scenarios

1 Reliability tools for a capital project timeline



Reliability-centered maintenance (RCM) is a structured reliability analysis to identify mitigation for each failure mode, cause and effect. It is typically performed toward the later stages of the capital project timeline to develop the detailed maintenance strategies, spare parts stocking and job plans for preventive and predictive maintenance. Usually, RCM is performed after the RAM, criticality analysis and equipment hierarchy studies are completed.

ABB Reliability Services offers a complete set of reliability tools and modeling services across the entire capital project management life cycle.

Design for reliability

Engineers working on a capital project (ie, an electrical power distribution system or a processing unit) typically develop multiple design scenarios or options that meet the client's operational specifications. Each option or scenario is essentially a cost–reliability trade off. A highly robust and redundant system with standby equipment may be capitally expensive but financially attractive with regard to life-cycle costs, cost of operational downtime, lost profit opportunity, etc.

A RAM simulation study is ideal for analyzing and illustrating the business benefits of each design scenario. 2 shows the typical design-for-reliability tradeoff models for an electrical power distribution system for four loads. In this case study, RAM modeling was performed in accordance with the IEEE 497 specification, using the minimal-cut-set technique to determine the unavailability, number of outages and downtime for each point load.

The capital expenditure (CAPEX) for each of the design options is also determined. This allows the CAPEX project management team to perform a decision analysis based on the cost-versus-reliability tradeoff.

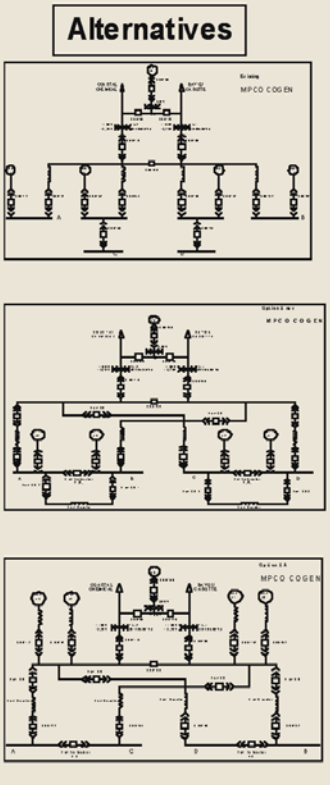
RAM – value drivers

RAM modeling is different from traditional process modeling, simulation modeling, linear program optimization or stochastic modeling. RAM modeling involves analysis of various failure-mode interactions of assets and focuses on identifying operational availability using Monte Carlo simulations. It is highly statistical in nature and requires the analyst to develop distributions for various input parameters. It allows sensitivity modeling – ie, varying the inputs across a range of values that are within the probabilistic range.

Other simulation methods and system process models may contain too many input parameters – failure rates, operational context, restoration times, logistic delays, spare parts availability or stochastic event occurrences – to provide any deterministic results.

RAM processes enable engineers to rank various design options and scenarios; evaluate the impact of future or proposed changes to current operations; allow modeling of spares and maintenance resource constraints; predict system uptime, downtime and slowdowns; and provide a strategic view of the asset's performance over longer time scales.

2 Design-for-reliability study of an electrical distribution system

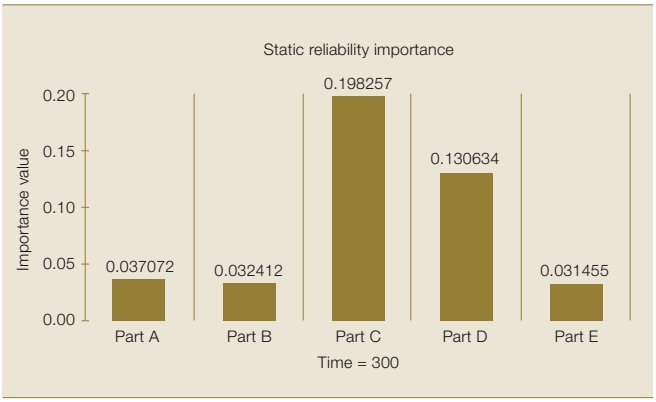


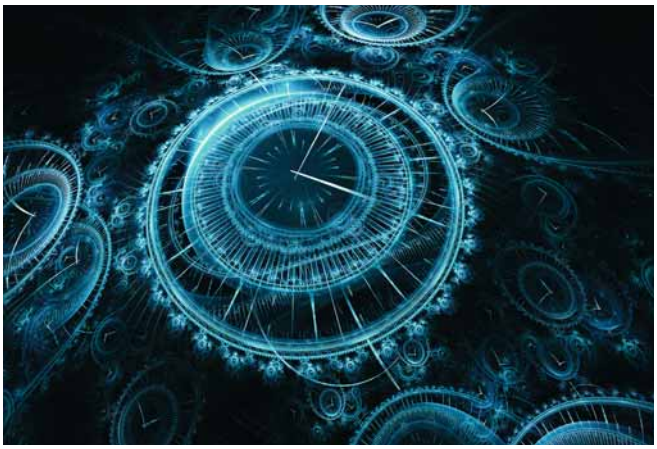
Results

Summary

Name/Location	Average Unavailability	Average Availability	Average Number of Outages 10yr Mission	Outages per Year	Downtime per Year (Hours)	MTBF	
General Upgrade Cost = $ 650,000							
Sub A Load (Set 1)	0.0022622840	0.9977377160	7.8313	0.78313	19.8	466	Days
Sub B Load (Set 2)	0.0026185500	0.9973814500	8.9096	0.89096	22.9	410	Days
Sub C Load (Set 3)	0.0017560470	0.9982439530	6.3041	0.63041	15.4	579	Days
Sub D Load (Set 4)	0.0017599230	0.9982400770	6.3303	0.63303	15.4	577	Days
Option 8			**Project Cost = $ 2,000,000**				
Load (Set 1)	0.0002695524	0.9997304476	0.9183	0.09183	2.4	3975	Days
Load (Set 2)	0.0003160500	0.9996839500	1.0577	0.10577	2.8	3451	Days
Load (Set 3)	0.0001755474	0.9998244526	0.6248	0.06248	1.5	5842	Days
Load (Set 4)	0.0001768230	0.9998231770	0.6175	0.06175	1.5	5911	Days
Option 8A			**Project Cost = $ 2,700,000**				
Load (Set 1)	0.0002192446	0.9997807554	0.7603	0.07603	1.9	4801	Days
Load (Set 2)	0.0002659483	0.9997340517	0.9085	0.09085	2.3	4018	Days
Load (Set3)	0.0001290963	0.9998709037	0.4614	0.04614	1.1	7911	Days
Load (Set 4)	0.0001298799	0.9998701201	0.4676	0.04676	1.1	7806	Days

3 Reliability importance ranking chart for a system of five components





RAM studies can often answer the following questions:

- Which are the potential critical components and process bottlenecks?
- Which equipment has the highest risk of operational failures?
- What is the production and cost impact of adding or removing equipment?
- What are the "What-if" scenarios and their predictions?
- What are the potential single points of failure?
- What is the impact on system reliability and availability of varying duty cycles, service-life limitations, wear-out items, or environments and conditions?

The RAM process

To successfully utilize the RAM model, it is essential that all engineering disciplines have a sense of ownership and that the project team, including the operational and maintenance representatives, is completely engaged in the development of the model. The process outlined below involves a high level of consultancy approach and involves a high level of engagement.

The ABB RAM process involves completion of five basic tasks. The method is very simple, highly repeatable and reproducible. The key feature of this method is the requirement that the developed RAM model is "owned" by all disciplines – eg, process, electrical, mechanical, instrumentation, and project management. The work breakdown structure for each task of the ABB approach is shown in Factbox 2.

A RAM study is often viewed as a comprehensive risk analysis for the capital project that models the operational and reliability risk dimensions. It is a powerful tool for developing Six Sigma strategies, supply chain optimization (process reliability modeling) and world-class pacesetter turnarounds, and an excellent tool for incorporating design-for-reliability concepts in the capital project design.

Quantitative risk understanding

A RAM study is an excellent quantitative tool that provides the project team with numerically ranked indices and importance values for a system of components. 3 shows how the reliability importance of a five-component system has been analyzed for each failure mode. The reliability importance value for each component is a measure of its weight to the overall system's reliability value. In the system shown here, Parts C and D have the highest impact on the overall system's reliability. Hence, the designer may want to ensure that adequate redundancy, sparing and optimization be done on those components with

Factbox 2 ABB's RAM approach

1. Data collection
- Asset registry
- Equipment taxonomy based on structure, failure modes and maintainability
- Historical and estimated failure rates by failure modes
- Estimated restoration and repair times
- Mean logistic delay times (spare parts availability, crewing, resource availability, work planning, etc.)
- Asset-dependency identification (reliability networks) development
- Failure impact on production, throughput, safety, etc.
- Material damage mechanisms and their impact on asset life
- Preliminary preventive maintenance models

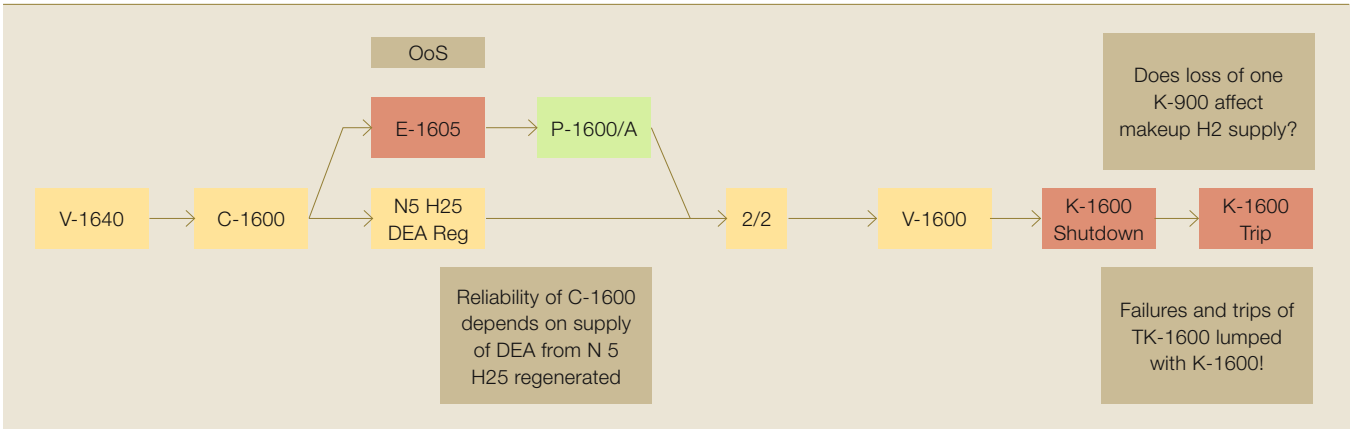
2. Review and block model validation
- Validating the block model with multidisciplinary team
- Identifying sensitivity parameters

3. Modeling and simulation
- Performing simulations with various parameter input
- Developing scenario portfolios
- Identifying P10, P50 and P90 scenarios (probabilistic values of 10%, 50% and 90% likelihoods)

4. Validation and documentation
- Validating the final simulation results
- Documenting various scenarios: assumptions and probabilities

5. Report generation
- Developing time-based charts for reliability (probability of event occurring), availability (predicted uptime and downtime) and maintainability (predicted resource demands)
- Documenting bottlenecks: process, reliability and other events
- Developing impact curves on turnaround schedules
- Quantifying benefits for stocking decisions
- Projecting life-cycle costs
- Projecting maintenance staffing requirements

4a Typical reliability block diagram



the highest reliability importance.

Reliability block model

4a and 4b show a block model and simulation results (respectively) for a small section of a typical refinery unit. The unit has been synthesized into a number of characteristic blocks. RAM analysts use color conventions to depict the significance of each block on the RBD in terms of the block's operational impact, eg, complete shutdown, slowdown, partial shutdown, momentary trip, sustained outage and no impact.

4b Typical simulation results

General	
Mean operational availability (all events)	0.9387
Expected number of failures	23.05
MTTFF (Mean time to first failure)	158.3 days
System uptime / downtime / slowdown	
Uptime	1713 days out of 1825 days
Slowdown	90 days
Shutdown	22 days
System downing / slowdown events	
Shutdown	16.4
Slowdown	17.6

Experienced RAM modelers document the various scenarios and impacts of external factors on each of the blocks and employ various techniques, such as lumped failure blocks, container blocks, mirror blocks, phase diagrams, nodes, event blocks, asset blocks, clustering, shutdown posturing, load shedding, buffering, and resource constraints.

These are just examples of the methods to describe the risks of failures in a system. RAM models involve fairly complex simulations and are increasingly important decision-making tools for capital project execution.

ABB experience

A number of RAM studies carried out with demanding customers revealed several issues that are of critical importance for the success of a risk assessment for failures of complex systems.

A RAM study is not merely an engineering, number-crunching exercise, but a multi-disciplinary engagement activity where the various team members collectively represent the operational risk profiles and events to be modeled. It cannot be developed with a "silo" approach, but requires a high level of collaboration.

A RAM study is an excellent quantitative tool that provides the project team with numerically ranked indices and importance values for a system of components.

RAM analysis is an important FEED-stage gate deliverable in capital projects. The results can be used to make business decisions to select the best-case design scenario, estimate maintenance staffing decisions and properly estimate the long-term system availability and reliability.

RAM analysis is one of several tools and methods available to the reliability analyst. To develop a high reliability system design in the capital project, it should be applied in conjunction with other reliability tools, such as reliability-centered maintenance (RCM), failure mode and effects analysis (FMEA), criticality analysis, asset hierarchies or stress-life estimations.

Finally, to complete a thorough RAM study, it is important to ensure that all data to develop a comprehensive reliability block model are available. All operational modes, maintenance modes and sensitivity parameters must be simulated to provide a complete risk profile for the system. RAM studies for a typical processing unit or electrical- or gas-distribution system last from four to 10 weeks, depending on the level of complexity and assets.

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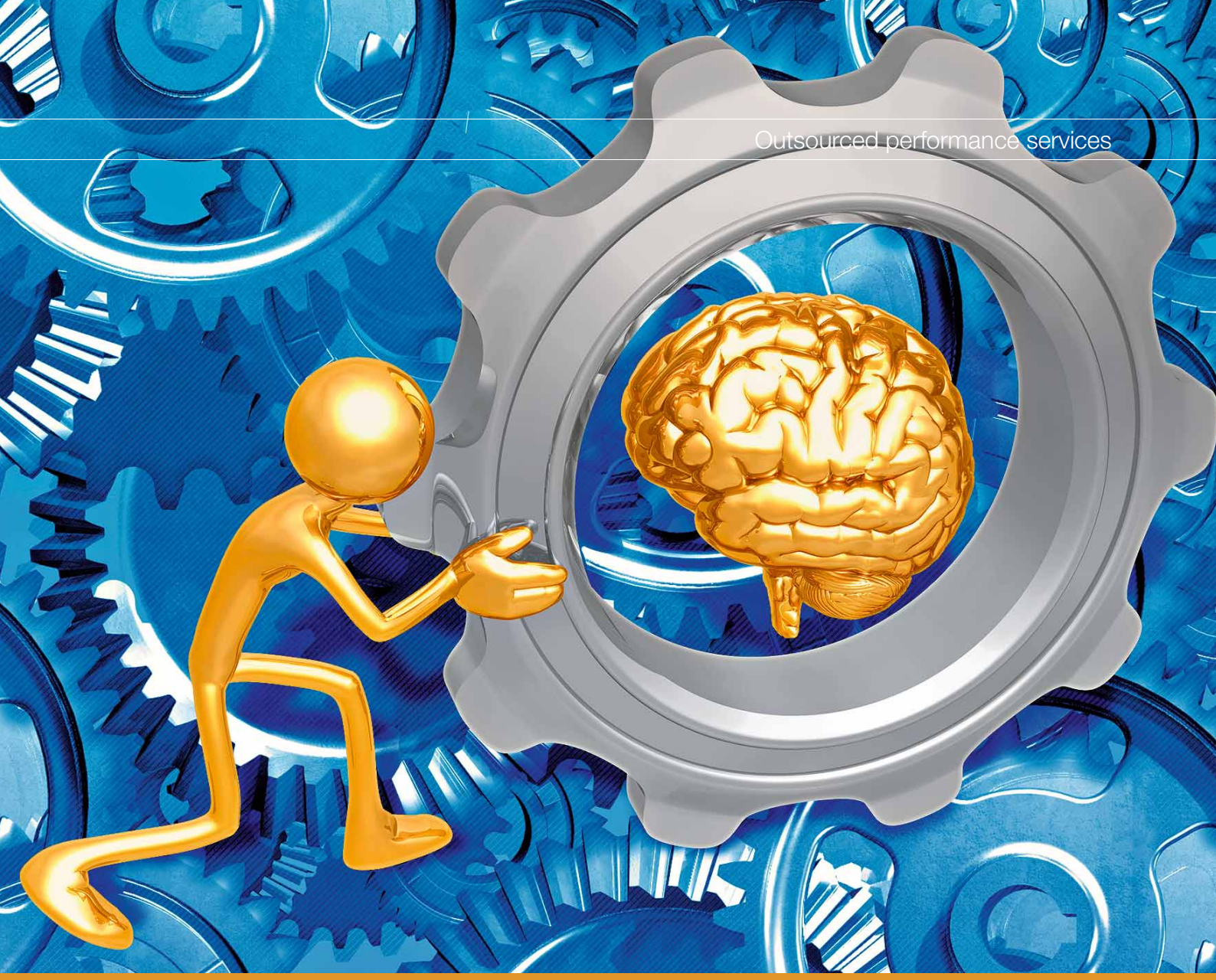


Outsourced maintenance

The ABB Full Service® solution

Johan Desaegher

While most maintenance suppliers are content to confine their maintenance services to delivering acceptable levels of equipment availability, ABB has developed a comprehensive service concept that makes maintenance operations a significant contributor to plant profitability.

Currently in operation at more than 150 sites in a variety of process industries worldwide, ABB Full Service® is a unique partnership agreement in which ABB and the customer jointly define the maintenance targets and share the rewards of success.

Outsourced performance services

Most companies see outsourcing as a way to reduce costs in their non-core activities. Maintenance often falls into this category, especially when it is considered to be no more than a cost center. Once a manufacturer decides to outsource its maintenance function, it can select from basically two types of maintenance suppliers: those who concentrate solely on delivering reduced costs to their customers, and those who take maintenance to the next level. Usually, next level means maintenance that increases the availability of production equipment.

ABB has taken this next level even further with its Full Service offering, where the focus is no longer only on maintenance but also on improving production. It is not just about saving costs but also about contributing to the customer's bottom line. This maintenance outsourcing model is a unique partnership where ABB and the customer jointly create targeted metrics and share risks.

ABB Full Service® is a strategic solution that helps improve the customer's bottom line by driving their plant maintenance function. As such, ABB Full Service® is a maintenance program that turns routine maintenance activities into a profit source by concentrating on five business values 1:

1. Compliance with local and global regulations
2. Efficient use of energy
3. Optimization of production costs
4. Better utilization of resources
5. Effective use of equipment

The maintenance function

In a Full Service agreement, ABB takes over the maintenance function of an industrial plant. The maintenance function encompasses reliability engineering, planning and scheduling, and maintenance execution, which form the heart of the maintenance outsourcing program. By establishing and developing these different maintenance functions, ABB is able to improve the customer's business values.

Reliability engineering defines the preventive maintenance program for equipment and has the ultimate goal of reducing the amount of maintenance required on the site. By setting up the equipment properly, as well as adequately operating and looking after it, ABB can extend the equipment's life cycle. This translates into real savings as it decreases the maintenance budget required – labor is freed up and overall equipment effectiveness is increased due to the less frequent interventions required (planned or unplanned).

In a Full Service agreement, ABB takes over the maintenance function of an industrial plant.

While the initial goal is to manage the current requirements of maintenance, the long-term goal of reliability engineering is to effectively manage the entire life cycle of the equipment. Not only does this involve issues of installation and early operating life, it extends to the equipment's old age and eventual obsolescence.

Planning and scheduling ensures that work orders are executed according to instructions and within the given time interval of the preventive maintenance program. As such, planning and scheduling identifies how, when and by whom a task is to be executed and that it is carried out in coordination with the customer's production planning.

Maintenance execution is not just about performing maintenance tasks but about ensuring that they are done well. This is one of ABB's core competencies. Without skilled workmanship and expertise, maintenance plans will fail to deliver value. Maintenance execution is responsible for a safe and quality workplace based on detailed maintenance instructions and in accordance with the maintenance plan. A library of more than 50 precision maintenance instructions guarantees the level of workmanship at an ABB Full Service® site.

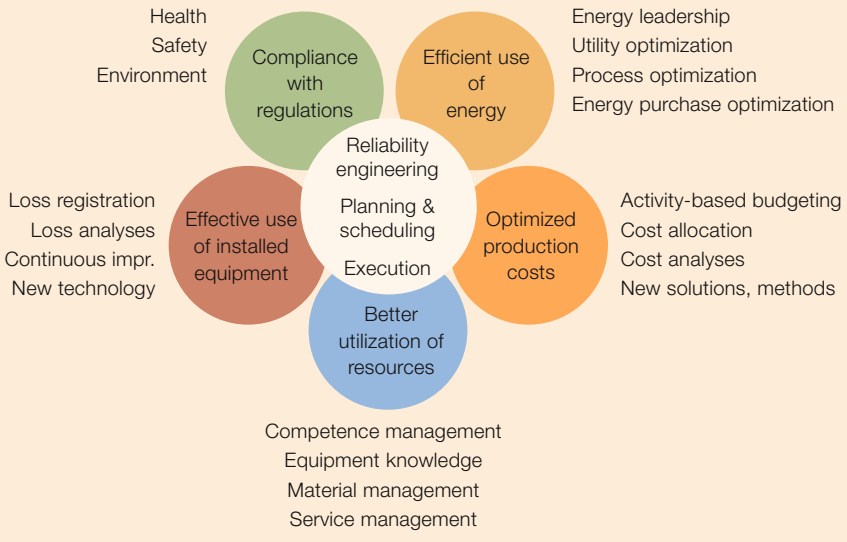
The five business values

By defining and executing the different functions described above, a maintenance organization can help customers proactively drive their business values. The following describe the five business values important to ABB Full Service®.

Compliance with regulations

Health, safety and environmental (HSE) regulations are increasingly important for maintenance. It is the task of maintenance to ensure that the equipment is safe and that it is maintained and operated in a healthy and environmentally friendly way. This ensures compliance with local and global regulations; it also avoids penalties and does not put the customer's operating license at risk.

1 Five business values



The preventive maintenance program includes methods and techniques like hazard and operability (HAZOP) studies, safety instructions, lock-out and tag-out procedures, work permits and risk-based inspection (RBI). Based on ABB's RBI+© program, they form the cornerstone for safe execution of maintenance tasks. ABB requires that OHSA 18001 be implemented at every maintenance site.

Efficient use of energy

Efficient use of energy has a direct impact on a manufacturer's bottom line. ABB experience shows that energy savings of around 3 to 10 percent can be obtained at most process industry sites. For many plants, the energy bill is bigger than the maintenance bill. ABB's energy program focuses on improving, reducing and optimizing energy efficiency for industries and utilities based on four main principles:

- Energy leadership
- Industrial utility optimization
- Process optimization
- Energy purchase optimization

ABB is uniquely positioned to develop and evaluate emerging technologies and apply them as they become commercially viable.

The implementation of ABB's industrial energy efficiency model takes place in three main phases: opportunity scoping, detailed assessment and energy management master plan, and implementation. In the services sector, this kind of model is known as an energy service company (ESCO) or energy performance contracting (EPC). The idea of the entire program is to be self-funding. Savings realized are shared by the service supplier and customer through an agreed improvement program saving model.

Optimization of production costs

Maintenance cost is an element of the total cost of production. This means that an effective and efficient preventive maintenance program can yield higher resource utilization and lower prices for materials and services, and can optimize the plant's manufacturing operations. ABB has developed worldwide standardized workflows to manage the maintenance function as a profit center. Equipped with a customized computerized maintenance management system, where maintenance execution allocates the actual cost of the work orders, the site is capable of analyzing and identifying the major cost contributors. Comparison and exchange of information with other maintenance sites around the world allows the individual site to optimize its maintenance costs. With a professional budgeting tool supported by a financial controller, ABB commits itself to achieving the targets agreed with the customer through risk and reward sharing.

Better utilization of resources

Improved use of resources results in a more effective maintenance organization. Resources in this context refer to skills and competence management, materials or supplies, contractors or services, and asset knowledge.

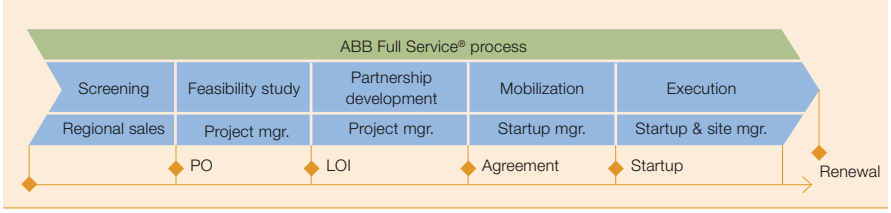
Skills and competence management focuses on the professional development of ABB employees by means of a wide range of global and local training programs that enhance skills at all levels of the maintenance organization.

To manage *materials* or supplies in a cost effective way, ABB has global, regional and local purchasing agreements. The computerized maintenance management system (CMMS) at the maintenance site tracks the inventory and warehouse indicators to optimize the amount of capital tied up in stock and the quantity of materials used.

Contractors on site are also managed via the CMMS. A preferred supplier list is established and regular performance reviews are carried out to improve the quality of delivery.

Asset knowledge is the competence of collecting, managing and using all information about the equipment maintained. Information includes drawings,

2 ABB Full Service® process



Outsourced performance services

electrical diagrams, original equipment manufacturer (OEM) manuals, supplier catalogs, certificates, as well as maintenance history and information on condition monitoring. ABB's Optimize^{IT} Asset Optimizer and an electronic data management system help the sites to manage dynamic and static information more efficiently.

Effective use of equipment

This seeks to increase the overall equipment effectiveness (OEE) of the plant. By increasing the OEE, it is possible to produce more output with the same investment, or the same output with less investment. To start the improvement cycle, ABB installs – in cooperation with the customer – an online monitoring system that captures the actual performance of the equipment. Then the root cause of the various losses is analyzed by reliability engineers and improvement teams. The ultimate goal is to use this technology as a competitive advantage for the customer's plant operations.

The ABB Full Service® process

ABB has created a tried and tested process in which it develops a collaborative agreement together with the customer 2. The process helps identify the customer's needs and ensures that the methods and systems implemented will improve the customer's business values. A core team of ABB and customer resources follows a proven methodology to collect and analyze information in a stage-gate process that balances investments in time and resources against the data needed to make sound business decisions. At the conclusion of each stage, ABB and the customer review progress and reach agreement on how to proceed.

During the initial screening phase, scope and boundaries, desired outcomes, resource requirements, executive sponsorship, and schedules are evaluated and documented to guide the team through the process.

The next step is the feasibility study phase where functional requirements are developed; benchmarking and gap analysis is completed; current and future states of maintenance approaches, equipment condition, people skills, etc. are identified; expected benefits and costs (value proposition) are identified; and a preliminary decision and risk analysis is conducted.

A partnership development phase follows when the maintenance management master plan is developed to set the strategy for maintenance and reliability at the site. Due diligence is performed for finance, human resources (HR), legal affairs, health and safety, and technical issues. Indicators are defined and the mobilization and transition plan is created. At this point, a maintenance alliance agreement is signed to initiate mobilization.

During the mobilization phase, systems and networks are installed, the new maintenance organization is announced, and implementation plans are finalized for HR, facilities, supply management and accounting. A communication plan is developed to facilitate change management and identify issues early in the program.

The maintenance agreement execution phase begins with startup and training, and the introduction of any new processes. The alliance management process governs the relationship, and continuous improvement programs are introduced to improve performance at the site.

Benefits of ABB Full Service®

The performance-based partnership between ABB and the customer is beneficial to both parties and enables them to work together to achieve a common goal. Results of a Full Service agreement are measurable in terms of cost savings, performance improvements, higher quality, and access to world-class maintenance practices 3.

3 The Boliden copper smelter at Harjavalta, Finland, where an ABB Full Service® agreement has achieved substantial improvements in OEE and concentrate feed, as well as significantly reduced base maintenance costs, and has halved the total recordable injury rate

Performance and financial impact

Each agreement is measured against key performance indicators defined in cooperation with the customer. To demonstrate ABB's commitment to the customer's success, ABB Full Service® includes risk and reward sharing that is linked directly to the plant's performance. Performance improvements are achieved through increased plant efficiency, measured in terms of OEE or optimized energy usage.

Reliability improvement and life-cycle extension

By implementing reliability engineering and life-cycle management, the effectiveness of capital expenditure is improved. ABB Full Service® has more than 400 data records of how to maintain generic equipment in the most

optimal way. ABB's track record of more then 150 outsourced maintenance agreements gives customers access to best practices, from maintenance organizations to work-order planning and inventory management.

A risk/reward performance mechanism ensures that continuous improvement opportunities are identified and captured over the life of the agreement.

Enhancement of the supply chain

By determining the ratios of ordering/handling costs versus inventory carrying costs, the optimal classification scheme for replenishment can be determined, taking into account safety stocks. This enables customers to reduce their inventory costs and increase the service level of spare parts in a plant maintenance environment.

Maintenance managed as a business

A detailed feasibility study is carried out and a maintenance management master plan drawn up before signing a Full Service agreement. This provides the customer and ABB with a clear picture of the current state of the assets, and allows costs to be accurately forecasted and managed over a multi-year contract. As production levels increase or decrease, maintenance costs can be scaled accordingly, allowing benefits to be calculated on a per-unit basis and eliminating the need to allocate significant fixed costs over variable production levels.

Creation of a service mindset and culture

The transformation to a service-minded culture is guided by a change-management program that includes HR processes and the orientation and motivation of new and existing employees.

Access to ABB know-how

Reliability technology is a core competence at ABB, and the company is uniquely positioned to develop and evaluate emerging technologies and apply them as they become commercially viable. In addition, ABB's large customer base and early exposure to new technologies allows it to maintain a highly skilled workforce that is able to implement and maintain industry-specific solutions.

ABB Full Service® partnerships

ABB Full Service® partnerships are three- to five-year performance-based agreements, in which ABB works with the customer to continuously maintain and improve equipment performance and reliability for an entire facility. By focusing on reliability and improvement, ABB facilitates better and more intelligent budgeting, workflow planning and resource allocation, and ultimately delivers maintenance activities that contribute to profits.

With a global network of world-class expertise, shared knowledge of best practices and the latest technologies, ABB's Full Service agreements support the efficient introduction and use of new process technology and concepts. A risk/reward performance mechanism ensures that continuous improvement opportunities are identified and captured over the life of the contract to reinforce the strategic intent of the agreement.

For more information on ABB's Full Service offering, see "Contracting good health" on page 84 and "A head start to profitability" on page 88 of this *ABB Review Special Report*.

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Contracting good health

A leading pharmaceutical company has outsourced its maintenance operations at a new production facility in Italy to ABB

Marco Apicella

ABB is one of the world's largest providers of solutions to the life science industries, with a capability and product portfolio that ranges from advanced control, optimization and manufacturing execution systems, to process analytics, packaging line robotics, and plant electrification and automation systems.

A key element of this offering is the ABB Full Service® maintenance contract, more than 150 of which are in operation in a variety of industries worldwide. One of the most recent is a leading international pharmaceutical company, which outsourced its maintenance operations at a new production facility in Italy to ABB.

The company, which is one of the largest pharmaceutical corporations in the world, awarded the contract to ABB in July 2007. The five-year contract covers a variety of maintenance activities, including routine maintenance and calibration, asset monitoring and optimization, and the supply of production resources to assist plant operation personnel. It also includes performance-based bonus payments to ABB for its contribution to the customer's bottom line.

The customer site utilizes a biopharmaceutical batch process to produce an active pharmaceutical ingredient (API). The final product is an antibiotic for infusion into the human bloodstream. The plant employs approximately 20 people in production operations, supported by an additional 12 under the ABB Full Service® maintenance regime Factbox 1.

For batch changeover (a new batch is started every 15 days), extra personnel are subcontracted by ABB to accomplish the additional work required in a regulated and validated environment.

Although ABB was awarded the contract in July 2007, a substantial number of tasks were accomplished beforehand, including 12 months of maintenance engineering studies, the drawing up of a maintenance management master plan, and training of personnel. A detailed analysis of the technical documentation was carried out by ABB experts in Full Service and pharmaceutical processes, and an onsite survey performed with the customer. On the basis of these detailed preparations, ABB proposed a two-phase approach consisting of a design phase and an operative phase.

The partnership between the customer and the ABB site teams shows a high level of mutual trust and respect with clearly defined boundaries of responsibility.

The design phase

The design phase started in June 2006, during which ABB carried out essential maintenance engineering activities in three key areas: maintenance system implementation, maintenance activities management, and continuous improvement Factbox 2.

In addition, ABB manages the subcontractors who perform activities such as coordination and supervision of routine maintenance, metrology calibration, corrective or extraordinary maintenance activities, and spare parts management.

Factbox 1 ABB Full Service®

An ABB Full Service® partnership is a long-term, performance-based agreement in which ABB commits to maintain and improve the customer's production equipment.

In a Full Service agreement, ABB takes over responsibility for the engineering, planning, personnel provision, execution and management of an entire plant's maintenance activities.

Benefits

- Improves plant performance
- Increases the reliability and life cycle of production equipment
- Manages maintenance as a business
- Manages change and creates a service culture
- Gives access to resources and knowledge of ABB's global network
- Simplifies the sourcing of suitably qualified personnel

Customers also benefit from ABB's global expertise, technology and industry best practices from more than 150 ABB Full Service® active partnership agreements around the world.

Site quality operating manual

Based on information gathered during the design phase, ABB prepared a site

quality operating manual that defines the maintenance service quality policies and specifies how organizational and operative procedures are to be verified and implemented.

The document aligns and integrates the quality policies and manuals of the customer and ABB, and defines and indicates how to implement the "nonconformity" procedure.

In addition, the scheduling of quality audits is also addressed with regard to: operative flows, structure, internal personnel, external personnel, analysis of the quality manual, internal methods, and organization.

ABB organization and resources

Three full-time maintenance engineers were present at the site during the design phase. They were managed by an ABB site manager and supported by local ABB technical and financial resources based in Milan. ABB also started to recruit and train the core site maintenance management for the operative phase.

The operative phase

The operative phase began in January 2007 when ABB assumed control of the maintenance activities that had been jointly defined by the customer and ABB during the design phase. These activities were many and varied, and included those involving calibration as well as reactive, preventive and condition-based maintenance.

Also included were the management and maintenance of the computerized maintenance management system (CMMS), as well as management of the site quality operating manual and the performance of activities risk analysis. ABB also assumed responsibility for the spare parts warehouse and spare parts procurement; the implementation of maintenance, quality and safety-improvement projects; the complete PDCA (plan, do, check, act) continuous improvement process for maintenance engineering; the execution of engineering studies looking into operational improvement potential; and, when required, the execution of return on investment (ROI) studies.

ABB then took over the task of updating the existing site key performance indicators (KPIs) and all technical documentation drawn up during the design phase – in particular, the maintenance standard operating procedures (SOPs) and maintenance plans. ABB informed the customer of any changes made in the technical design documentation. Updating and maintaining these documents remains the responsibility of the customer for process validation reasons.

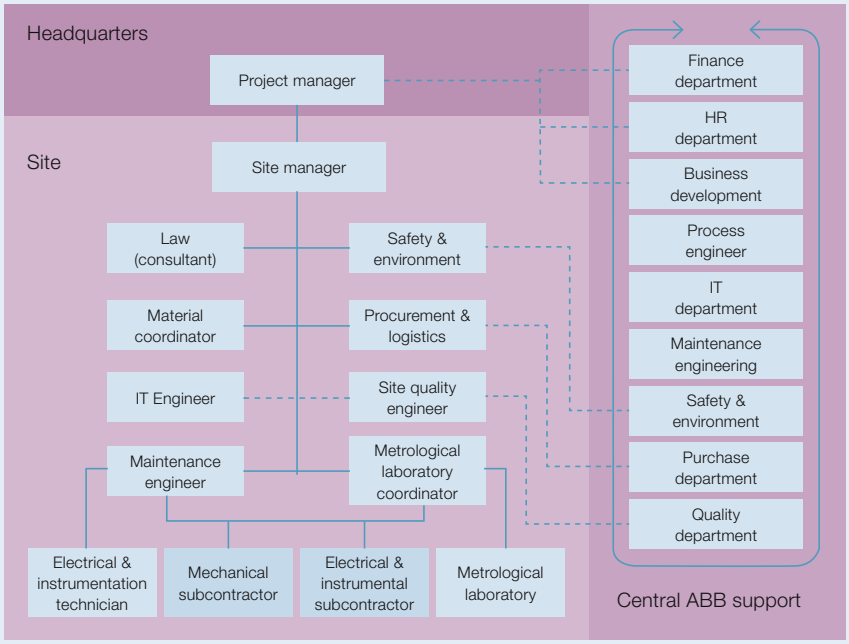
In addition, ABB managed the legal documentation and compliance process regarding health, safety and environmental items such as fire protection and pressure relief audits on plant protection equipment.

Finally, in July 2007, ABB assumed responsibility for the planning, management and execution of all maintenance activities at the customer site under its ABB Full Service® agreement. During the last six months of 2007, the customer and ABB jointly defined the KPIs and related targets that set the baseline and direction for the performance-based partnership, including bonus and penalty clauses, for the coming years.

Good working relationship

The partnership between the customer and the ABB site teams shows a high level of mutual trust and respect with clearly defined boundaries of responsibility. Weekly information meetings

ABB Full Service® site organization for the project



with production, quality and maintenance personnel review disturbances and the previous week's activities, as well as forthcoming activities and improvement opportunities. Monthly reports are generated containing all business-relevant figures, performance indicators and activities.

A well-structured equipment hierarchy record is maintained for the automation scope, maintenance SOPs and maintenance plans, with calibration plans in place for all major equipment to allow management of the assets. The CMMS is owned by the customer and is used to log all equipment-related activities. Work orders can be opened by ABB or the customer but can only be closed by the customer, once all required activities have been confirmed.

ABB's capability in life sciences

ABB's scope of supply capability to the pharmaceutical industry includes the supply of control, optimization and safety solutions; instrumentation, analytics, robotics, and automation; and electrical equipment, from motors and drives to medium-voltage and low-voltage distribution equipment. ABB also provides solutions for process analytical technology (PAT), as well as consulting and validation services.

ABB's service capability extends from ad hoc support to fully outsourced maintenance of the complete production and electrical assets of a plant. This is enhanced by an ABB system that provides integral asset management and a bi-directional interface with CMMS, thereby allowing the automatically generated asset triggers to prompt predictive maintenance as an integrated record within the CMMS to be created. These triggers are highlighted to the operational personnel on the screen displays and can be sent as SMS messages to maintenance personnel when immediate attention is required.

Additionally, the combined system supports asset optimization by the customer or ABB staff, as well as work-order control, full asset audit tracking of process modifications, asset recalibration, and generation of electronic batch records in compliance with 21CFR Part 11. Products and services from ABB also support the total life cycle of automation assets and include the provision of ABB and third-party hardware, as well as integration responsibilities and application software to cGmP (current good manufacturing practice) standards and the recommendations of ICH 8, 9 and 10.

Factbox 2 Maintenance engineering activities

Maintenance system implementation consists of:
- Complete equipment and instrument data inventory
- Detailed analysis of the installed equipment/instrumentation operational and calibration status
- Standard operating procedures (SOP) design
- Detailed maintenance activities design, consisting of 800 preventive maintenance plans and 1,500 metrology calibration plans
- Computerized maintenance management system (CMMS) implementation and startup
- Spare parts supply inventory and warehouse flow design
- Safety and quality procedures design

Maintenance activities management involves:
- Organizational design of maintenance
- CMMS management
- Preventive and extraordinary maintenance operations management
- Reporting

Continuous improvement comprises:
- Ongoing review of the maintenance plan on the basis of root cause analysis (RCA) methodology
- Drafting and discussion of technical conditions for a global service contract

For more information on ABB's Full Service offering, see "Outsourced maintenance" on page 79 and "A head start to profitability" on page 88 of this *ABB Review Special Report*.

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A head start to profitability

Full Service: the successful concept of viable partnership

Ben Venter

In today's increasingly competitive business environment, challenges and risks associated with investing in plant improvements are less tangible than ever. For this reason, companies investing in new plants or upgrading their existing sites are well advised to partner with world-class organizations that have expertise in complementary areas that can help accelerate benefits. With ABB Full Service®, a partnership arrangement that improves plant operations through maintenance excellence, companies can minimize risk and maximize success in their investments.

An excellent example of ABB Full Service® helping a customer accelerate his greenfield startup and achieve sustainable production is Vale Inco Newfoundland and Labrador Ltd. (formerly Voisey's Bay Nickel Company) in Labrador, Canada. With the help of ABB, Vale Inco was able to achieve commercial nickel production significantly ahead of schedule and attain an all-time-high production level.

For many process industry and manufacturing companies, the achievement of a world-class operational status when building new plants or investing in productivity improvements is very difficult. Many organizations simply look to maintain their current profit and revenue levels by cutting costs and outsourcing. Investing in sustainable business improvements seems to be less attractive than focusing on short-term returns.

However, with these companies constantly facing increased customer demands, hypercompetitive market pressures, and higher shareholder expectations, concentrating on short-term improvements may lead to diminishing results. Businesses can win by focusing on their core expertise, such as mining, papermaking, rolling aluminum or tire building, and partnering with companies that better understand other important non-core processes in order to achieve higher results.

ABB Full Service® is a performance-based maintenance partnership that drives operational excellence.

Customer maintenance

The ABB Full Service® reliability management approach is different from traditional maintenance outsourcing because it assumes complete responsibility for maintenance and focuses on improving productivity in a performance-based manner. Traditional maintenance outsourcing drives cost cutting and transfers less important activities to a third party while the plant management continues to manage maintenance itself. The problem with this approach is that after limited financial benefits have quickly been realized there is no room for additional improvement. Suppliers focusing on protecting their thin margins are reluctant to enter a necessary partnership with the company to further improve the customer's processes.

ABB Full Service®, conversely, is a performance-based maintenance partnership that drives operational excellence through sustainable productivity improvement and reliability excellence. With ABB Full Service®, ABB shares risk by contractually committing to key performance indicators (KPIs), such as increased overall equipment effectiveness (OEE) and reduced total maintenance costs, and assuming full responsibility for customer maintenance. One of the greatest advantages of the ABB Full Service® approach is that it enables the customer to focus on what they do best, while ABB concentrates on leveraging maintenance to improve customer profitability.

ABB Full Service® in greenfields

The Full Service approach in a greenfield site includes key additional steps that help accelerate business improvement and minimize risk. The seven distinct phases for implementing an ABB Full Service® agreement in a greenfield are a proven and standardized approach that entails mutual effort from ABB and the customer. At the conclusion of each phase, ABB and the customer discuss goals, accomplishments and next steps:

1. Front-end engineering
2. Detail engineering
3. Equipment selection and procurement
4. Construction
5. Commissioning
6. Startup
7. Operation

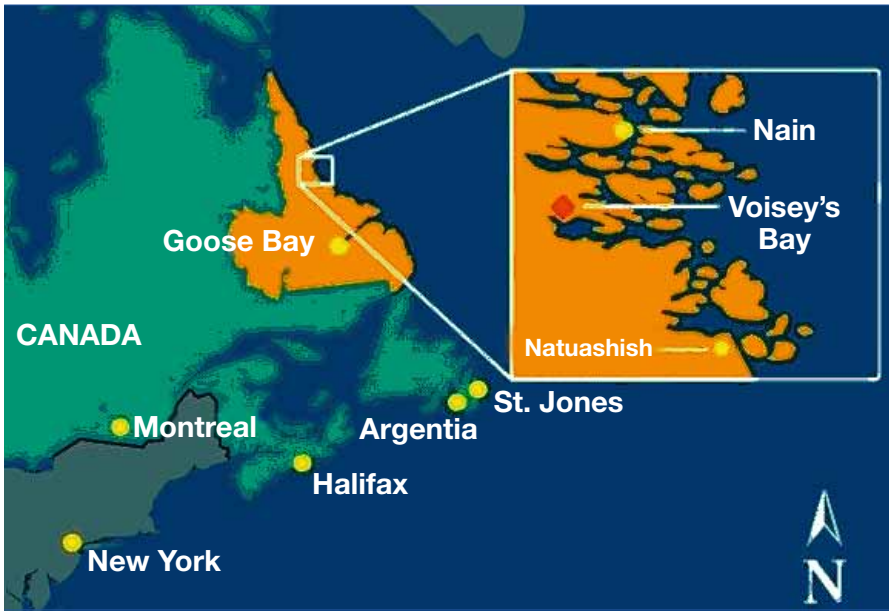
A powerful demonstration of success

Vale Inco, remotely located with little local infrastructure, is a $1 billion greenfield nickel mine and concentrator 1. The mine started operations in 2005 and employs more than 350 people with an expected annual production of approximately 50,000 tons of nickel for a minimum of 14 years.

Startup at Vale Inco involved implementing maintenance programs and plans, including condition-based, time-based and breakdown maintenance.

The entire maintenance function is handled by a partnership between ABB and Iskueteu, a local company that specializes in construction and operations support. ABB began by providing reliability consulting for the equipment selection, construction and maintenance planning phases. Additionally, ABB provided training for commissioning, startup and on-going operations, and through the Iskueteu partnership, is now responsible for maintaining all process equipment, site facilities, the port and the mine. One key challenge was the management's strong desire to "hit the ground

1 Vale Inco in Labrador, Canada

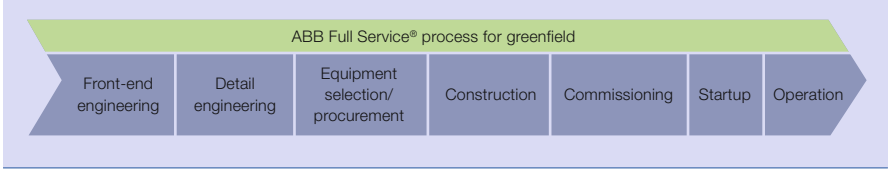


running," achieve very fast plant start-up and accelerate equipment performance.

In the commissioning phase, ABB and Vale Inco worked together to facilitate an efficient start to the next phase by ensuring all pertinent equipment, tools, and procedures were prepared, and key contractors were recruited. This involved creating the Maintenance Management Master Plan, a proven ABB methodology that improves maintenance by instituting best practices, and actively participating in the health, safety, and environmental continuous-improvement discussions.

Another key initiative in the commissioning phase was employee training and competency management. This included refining training materials, conducting equipment-specific training and doing company team-building exercises. In addition, Iskueteu/ABB participated in ABB Full Service® training, which included defining and developing roles and responsibilities, and training on work-order systems, customer relations and the ABB Full Service® agreement. One of the training approaches implemented is ABB's Competency Development Program, where each maintenance employee has a specific personal development program that helps him complete a quality job safely, efficiently and effectively the first time. In Vale Inco, the Competency Development Program methodology identified more than 1,200 specific training programs required for maintenance operations to be successful.

2 ABB Full Service® operational excellence model for Greenfield plants



With ABB Full Service®, Vale Inco achieved 90 percent of rated capacity for the mine concentrator in just three months after startup.

Startup at Vale Inco involved implementing maintenance programs and plans, including condition-based, time-based and breakdown maintenance. During implementation of condition-based maintenance, Iskueteu and ABB introduced new techniques, including ultrasonic testing, and developed an effective inspection strategy for each group of equipment. Furthermore, an Asset Management Program, which included life-cycle costing models and replacement strategies, was developed. Creating an optimal Asset Management Program for a greenfield site was a significant challenge since there was no historical asset and performance data to perform benchmarks and predict asset failures. So, during the startup, ABB and Vale Inco began measuring all performance indicators, including OEE and relevant operating costs, and developed and implemented continuous improvement programs.

In the final ABB Full Service® phase for greenfields, primary maintenance programs were executed, managed, and supervised, and non-routine maintenance activities were performed. Also, KPIs continued to be measured and reported against targets, and root cause analysis procedures were implemented.

Vale Inco's commitment, ABB Full Service® management expertise and the ABB Full Service® methodology 2 produced the fastest ramp-up for any greenfield mine of the customer's consortium. Vale Inco achieved 90 percent of rated capacity for the mine concentrator in just three months after startup. In addition to an accelerated ramp-up, Vale Inco achieved significant performance improvements through incentive-based contracts, and experienced no major disturbance due to heavy investment on employee training. In fact, Vale Inco contributes six percent of all hours paid and worked by employees into retraining hours, and has achieved 1,000 days without lost time due to injury.

Achieving a fast ramp-up coupled with high employee satisfaction drove Vale Inco to realize commercial nickel production significantly ahead of schedule and attain an all-time high production level. Peter C. Jones, president and chief operating officer of Vale Inco, said in 2006, "We achieved commercial production well ahead of our original schedule. Thanks to this excellent ramp-up, we expect to produce some five thousand tons of nickel more than expected." This case clearly demonstrates that the combination of ABB Full Service® and strong customer commitment and focus results in a partnership that delivers exceptional operational and financial achievements.

Sustainable performance

Businesses can win by focusing on their core expertise and collaborating with companies that better understand other important non-core processes. ABB Full Service®, a partnership arrangement that improves plant operations through maintenance excellence, is an outstanding example of how customers can minimize risk and maximize success in their plant reliability investments. By bringing together excellence in reliability management, world-class business processes and innovative execution models, ABB delivers results for its customers.

For more information on ABB's Full Service offering, see "Outsourced maintenance" on page 79 and "Contracting good health" on page 84 of this *ABB Review Special Report*.

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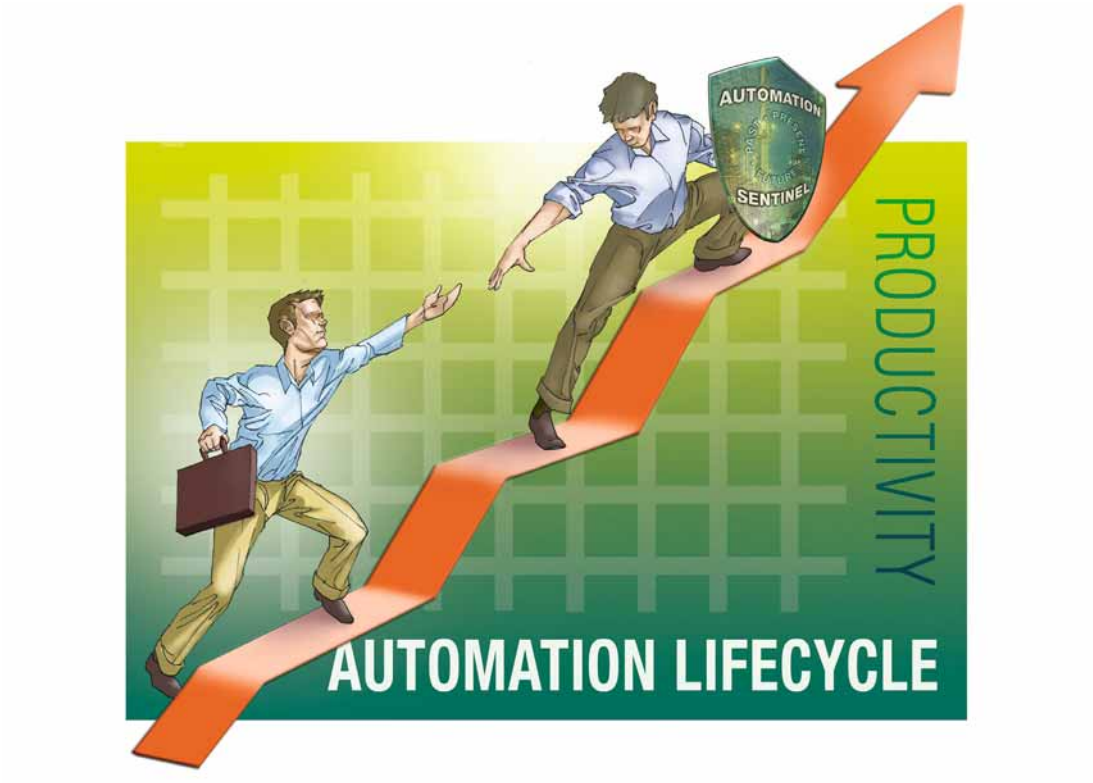

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