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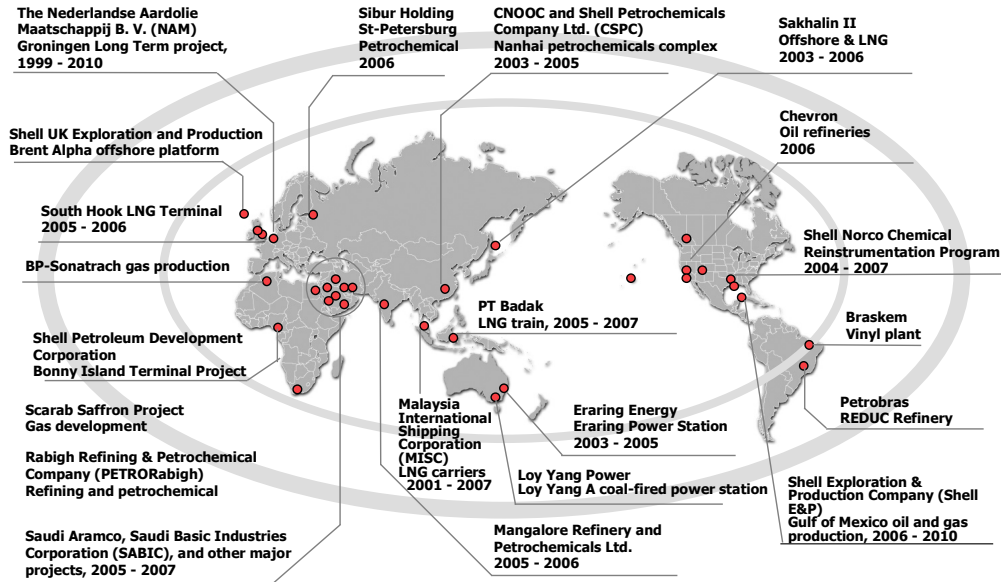
By ARC Advisory Group

FEBRUARY 2008

Yokogawa Matures a Best Practice Culture for Successful Project Execution

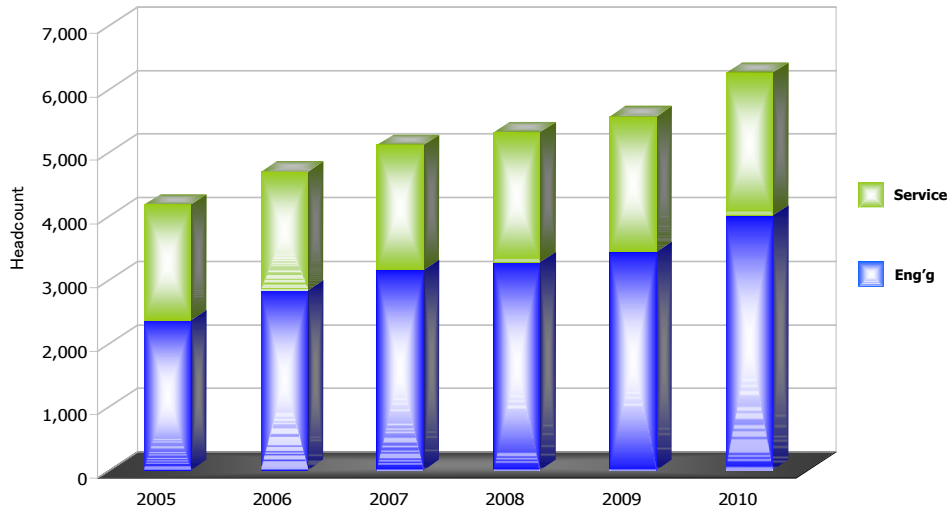
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Yokogawa Crafted its Project Execution Capabilities in Some of the World's Largest and Most Critical Process Installations

**Automation Engineering & Customer Service experts:
4,000 (2005) to 6,000 plus (2010)**



Yokogawa Continues to Build its Project Execution & Engineering Capabilities

Executive Overview

The ability to deliver a full scope of project execution capabilities is becoming more important than ever for automation suppliers that wish to compete on a global scale. Process automation suppliers have always had some degree of project execution capabilities, but only recently have suppliers and end users begun to realize the true economic impact that pre-

Many of the world's leading end users, particularly in the process industries, are applying the MAC concept to all of their capital projects. End users have reported up to a thirty percent savings on projects versus the traditional approach.

cise and comprehensive execution capabilities can have on the success of an automation project and on plant lifecycle costs.

Large grassroots projects and upgrade 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, shrinking capital budgets, and shrinking timetables. Aside from

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), which assumes responsibility over all automation related aspects of a project.

Many of the world's leading end users, particularly in the process industries, are applying the MAC concept to all of their capital projects. End users have reported up to a thirty percent savings on projects versus the traditional approach. Costs are reduced in nearly all areas of the project, from training to commissioning and installation. Automation suppliers need to combine their expertise with industries and application with their ability to execute projects in a consistent manner. This means developing practices and procedures that are standard and can be reused across multiple projects to reduce cost.

Yokogawa is one supplier that has evolved its project execution capabilities to provide a superior value proposition to the end user. The company has done this not only by adding personnel and vertical industry capabilities, but also through implementing the internal work processes that are required to maximize their project execution efficiency.

End User & EPC Requirements Demand Superior Project Execution Capabilities

End users are under more pressure than ever to do more with less. Project execution requirements are more important than ever not only for automation end users but also for engineering and procurement firms (EPCs). The automation market is undergoing a boom cycle that has not been seen in

Both end users and engineering and procurement firms (EPCs) are increasingly looking to automation suppliers to provide them with automation project execution capabilities. There is more to this equation, however, than simply project backlogs.

decades. End users in the chemical, oil and gas, refining, and other industries are pushed to the limit when it comes to executing new projects around the globe. All you need to do is look at the backlog of projects of the major automation suppliers to see that there is enough momentum in automation projects to drive growth for years to come.

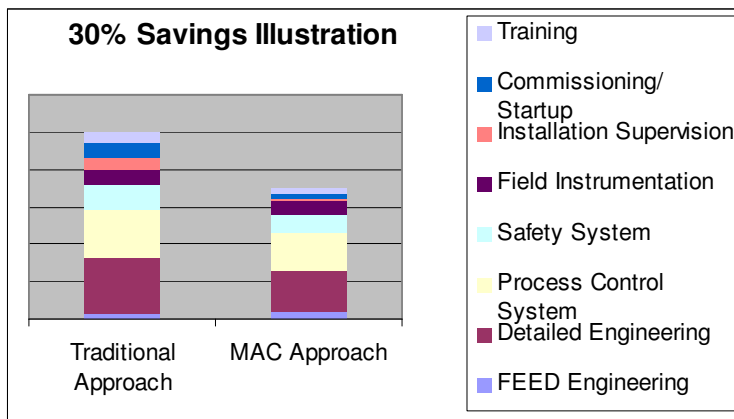
Both end users and EPCs are increasingly looking to automation suppliers to provide them with automation project execution capabilities. There is more to this equation, however, than simply project backlogs. Many factors are contributing to growth in project and engineering services for automation suppliers. As a result, suppliers are beginning to fill the role of a main automation contractor (MAC), overseeing all aspects of automation project and providing a single point of responsibility for an automation project from design to startup.

The ability of the customer to influence project costs diminishes as the project nears its latter phases, but these latter phases are also where the bulk of project costs start to accrue. The ability to have a single point of responsibility in an automation supplier that acts as a primary automation contractor is essential to controlling project costs, especially when it comes to preparing expert proposals that portray a realistic and honest view of project costs so they can be managed effectively. Yokogawa certainly has the expertise to provide this level of project execution. The company has built a global pool of experienced in-house engineers over the years, and Yokogawa is particularly well positioned to handle very large turnkey automation projects.

Instrumentation & Automation Knowledge Base is Consolidating around Suppliers

Over the past several years, the knowledge base of the automation and controls marketplace has greatly increased among automation suppliers. While EPCs still have a good knowledge base for generic automation and controls, the expertise in specific supplier offerings has shifted in favor of the automation suppliers. In the wave of downsizing that occurred in the '80s and '90s, many leading end users in the process industries either eliminated their internal automation and control engineering departments or radically reduced them in size, many by 50 percent or more. With the immanent wave of retiring baby boomer employees, end users are faced with even more of a challenge around executing projects and conducting day-to-day operations. EPCs have undergone a similar transformation, and view automation as less of a core competency than before. Most of the big EPCs used to have large automation and control departments with running versions of all the major suppliers' DCSs and instruments. This is no longer the case.

Both end users and EPCs are faced with the increasingly difficult proposition of finding qualified personnel. This is an issue not only in developed



The MAC Approach Can Result in Project Cost Savings of Up to 30 Percent

regions such as North America and Western Europe. Even in China, despite the large number of engineering graduates turned out every year, there remains a dearth of highly trained and qualified personnel to fill the needs of the process industries.

The automation suppliers have stepped in to fill these requirements. Many of the key personnel with expertise in automation that are retiring from the end user companies are finding new careers as consultants and engineers at supplier companies. Suppliers as a whole have greatly increased their application expertise and project execution capabilities to fill the void left at the end users and EPCs. Yokogawa's project execution services business, for example, has grown well into double-digit rates over the past several years as it meets the increasing project execution needs of its end user and EPC clients.

Shortening Delivery Times & Reducing Time to Startup

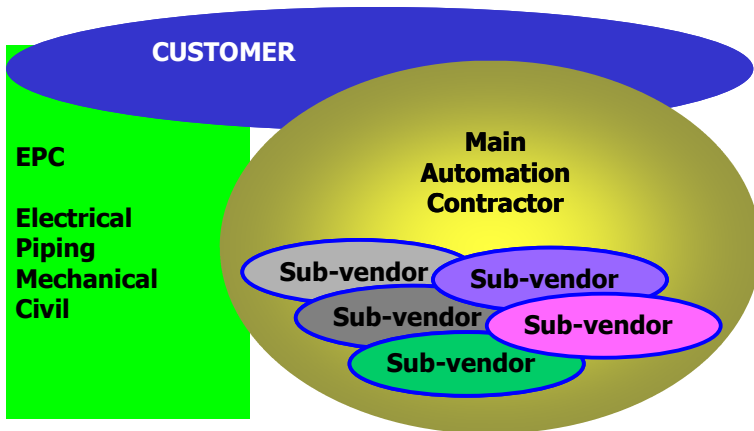
The increasing pressure faced by end users and EPCs also means that projects need to be finished as quickly as possible. Quicker time to startup means quicker time to profitability. In industries such as fine chemicals and life sciences, faster time to startup is a matter of competitive survival. Automation suppliers with the right capabilities can provide a single point of responsibility for project management – coordinating activities among multiple automation suppliers and subcontractors and freeing up the end user and EPC to focus on what they do best.

Reduce Complexity of Vendor Scope & Design changes

End users and EPCs no longer have the time or the resources to deal with many different automation suppliers on a project. We live in an increasingly open world, and any automation project is going to have several different suppliers for key building blocks such as control valves, production management applications, safety systems, and more. Relying on a single automation supplier as a single point of responsibility to coordinate

efforts among multiple suppliers and subcontractors can increase precision, save considerable time and money, and lead to faster startup times.

Using a MAC as a single point of responsibility also results in increased design reliability. One of the key differences between MACs and main instrumentation vendors (MIVs) is the greater level of collaboration and communication with the end user. By acting as a channel between the supplier and system integrator partners on a project and the end user



A MAC Assumes a Single Point of Responsibility for All Automation Related Phases of a Project

and EPC, there is more effective communication, which results in less changes in project design during the lifecycle of the project. This is particularly true when it comes to control system engineering and design, since the MAC is typically the primary automation system supplier and should be able to draw from a significant resource base to perform this task. Early involvement of the MAC in the project means even further reduction in the risk of miscommunication on the project between the suppliers, EPCs, and end users.

Reducing the “Four Cs”: Cost, Commissioning, Customization, & Coordination

There are four key areas where taking the MAC approach provides an economic advantage to the end user. These include reduced coordination effort, commissioning time, and customization, all of which accumulate into reduced installed cost and cost of ownership. As a single source of responsibility, the MAC removes the associated effort and cost of juggling several different suppliers and/or systems integrators from the end user. Single point of ownership for the design effort results in lower engineering costs and helps to eliminate another enormous source of cost: customization. ARC believes that custom integration of disparate applications results in significant added cost where it is required.

With better engineering and a reduced need for custom integration, commissioning and startup are achieved much faster, with a seamless handover from the project phase to operations. The resulting operational strategy of the plant is ultimately driven by the accrued knowledge achieved in design and installation. When a MAC transitions to a collaborative lifecycle partner, it can bring all the knowledge it has captured during the project to bear in supporting the customer, as well as sharing this knowledge with the customer to help them achieve operational excellence (OpX).

MAC Suppliers Can Take Total Instrumentation Database Ownership

When it comes to instrumentation, the creation of a single engineering and design database for all instrumentation-related information is a key element in achieving operational excellence. Of the vast amount of engineering data generated, the portion that contains instrumentation information can provide the most value. Not only is the instrumentation asset information important, but the continued health of these assets is critical to other business process management functionalities as well. MAC suppliers have the ability to take ownership over a total instrumentation database and ensure its consistency. This can be very valuable not only in the design and implementation phase, but also in the operational phase of the plant.

Yokogawa's Guiding Principles & Capabilities for Project Execution

Yokogawa's stated goal is to be the number one supplier of process automation systems and services worldwide by 2010. The company's primary tool for executing this strategy is the VigilantPlant campaign. VigilantPlant is essentially a path toward operational excellence placed in the context of Yokogawa's offerings and capabilities.

VigilantPlant communicates a real value proposition to users in a cohesive way that creates a compelling reason to consider Yokogawa. Yokogawa has given substance to the VigilantPlant campaign by clearly outlining its value proposition, which is based on the three basic principles of Seeing Clearly, Knowing in Advance, and Acting with Agility.

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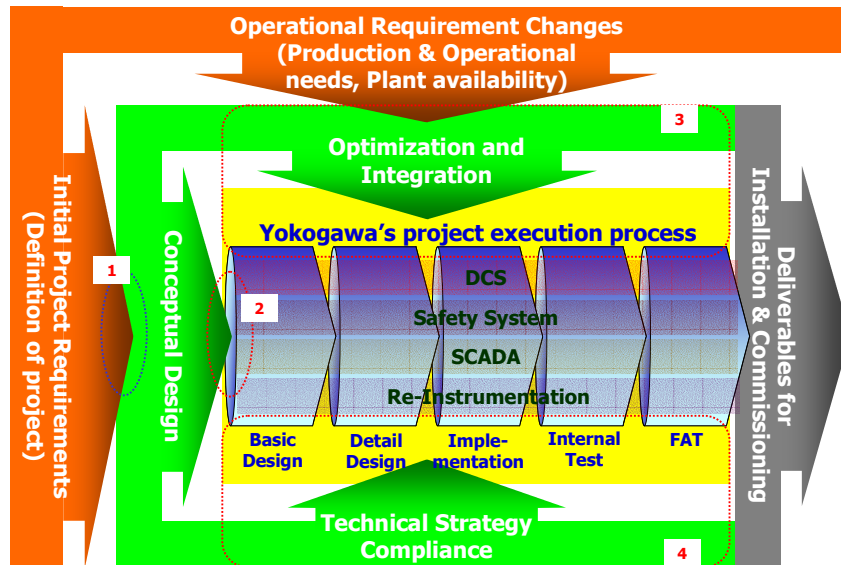
Yokogawa's goals through the project execution aspect of its new VigilantPlant strategy are to accurately and clearly define the scope of work to be accomplished; determine the project schedule through completion; identify areas of potential risk and develop migration plans; develop a detailed execution plan; and provide a project environment that encourages team building. As a Japanese supplier, it has always been necessary for Yokogawa to have full-scale project execution capabilities, which are expected from Japanese end users and EPCs. Yokogawa has greatly expanded their project execution capabilities in its key markets outside of Japan as well.

Yokogawa Continues to Mature in Project Execution & MAC Capabilities

The Yokogawa approach to project execution is designed to meet customer project requirements and operational requirements in a vigilant manner. Four key steps govern the work processes to ensure that the deliverable actually meets the customer requirements based on the latest information available, not only based on the initial project requirements.

The first step revolves around identification and definition of the customer requirements. During the early stages of project definition, Yokogawa staff interact proactively with customers to assess and define both project and

operational requirements. The second step is converting conceptual design to basic design. Overall technical strategy is transferred to key domains in an interactive manner, ensuring the design philosophy is consistently



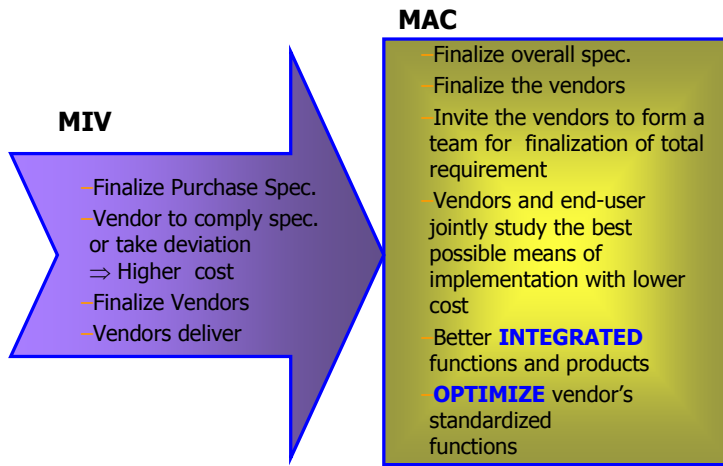
applied across multiple domains involved. The third step is managing operational requirement changes. Identification and definition of customer requirements is a continuing activity during the execution of a project. The Yokogawa project team is equipped with the right tooling and skill-set to manage this continuous stream of requirements during the project, governed by proper change management processes.

The fourth step is technical strategy compliance. During each project phase review, Yokogawa's total lead engineer verifies the validity of technical strategy, ensuring that leading-edge technology is applied while considering various constraints. Technical strategy compliance is verified in light of customer requirements for future expandability and maintainability.

From MIV to MAC: Expanding Capabilities for Better Project Execution

Yokogawa has made a journey from being a main instrument vendor (MIV) to a true MAC, and in ARC's view a definite distinction should be made between the two. What distinguishes a MIV from a MAC? In its early stages, Yokogawa provided engineering and project section support for its own instrumentation and control systems. In these early days, many of the project responsibilities were in the hands of the EPC, such as preparing scope, schedule, specifications that would be adhered to, and good engineering practice for suppliers to follow and adhere to. EPCs also coordinated with the various vendors to ensure projects were completed as specified. As an MIV, Yokogawa accepted more responsibilities that were normally assumed by the EPC, coordinating with various sub vendors to ensure they maintained quality, uniformity, optimal integration of applica-

tions, provided optimal integration, and kept within schedule and budget constraints.



Key Differences between MIV and MAC

lowest cost. As a MAC, Yokogawa also works with the other vendors to provide improved integration and optimization between functions and products. This results in not only smoother project execution, but also a full understanding of the project. A full understanding of the project results in reduction of over-specification and reduces overall system cost.

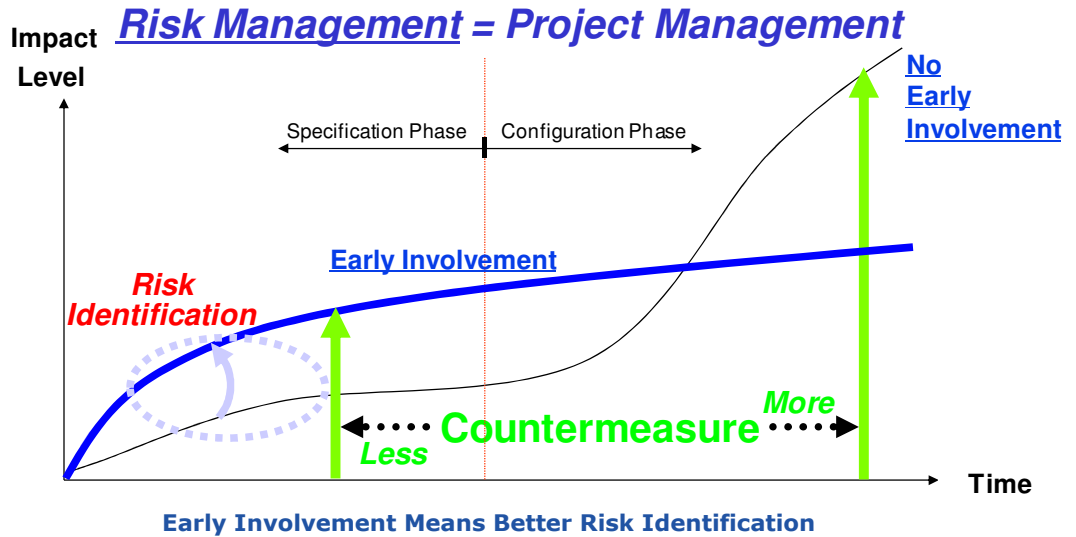
Yokogawa’s evolution from MIV to MAC came when it expanded its capabilities to include involvement in finalizing the overall project specification. The MAC approach is more collaborative in that it involves inviting the other vendors on the project to form a team for finalization of the total project requirements. The MAC facilitates the process of the vendors and end users jointly studying the best possible means of implementation at the

The Benefits of Early Involvement

Early involvement by a MAC can have a big impact on the success of a project. The further on in the phases of project implementation changes occur, the greater the cost to the end user. Early MAC involvement in a project means that fewer changes are made during the execution of the project. The reason for this is a smoother transition in the project between the specification phase and the configuration phase. The project is more accurately specified because Yokogawa acts as both MAC and system supplier.

Front-end engineering and design (FEED) is one example of early involvement where the MAC can have a big impact and add value. The FEED stage is where much of the value is built into the project. Many suppliers view the FEED process, in conjunction with consulting, to be a critical factor in the determination of project success and derived benefits for the customer. Technologies such as fieldbus, dynamic optimization, and real time performance management rely on the success of a good engineering and design effort, as well as a seamless transition from engineering and design to implementation, operations, maintenance, and the rest of the plant life-

cycle. Suppliers can leverage the knowledge gained in their own FEED work with their service capabilities in the rest of the plant lifecycle to create more effective automation strategies.



True MAC Capabilities Provide a Basis for Collaboration

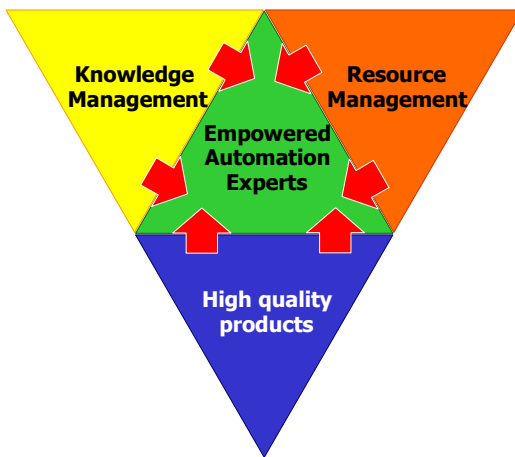
Yokogawa sees the MAC approach as a basis for a collaborative relationship with the end user. In re-instrumentation and migration projects, the basic expectation of the end user is to retain the operating environment as is, which is easily said than done. Yokogawa as a MAC enables such “as is” operating environment by in-depth understanding of customer requirements. Furthermore, Yokogawa as a MAC leverages its system integration expertise to ensure future expandability.

Yokogawa supports customers through training personnel, sharing information with the customer relative to the project, making design improvements during the project, and providing further advice on how to lower total cost of ownership. Yokogawa’s collaborative approach does not end after project startup. After startup, Yokogawa provides both operational and maintenance services, where its knowledge of the project can again come into play to reduce operations and maintenance costs.

Operational Philosophy: People Drive Project Excellence

Yokogawa realized many years ago that they needed a good operational philosophy with which to execute their projects. With the ultimate goal of delivering customer-centric solutions, Yokogawa's operational philosophy is built on three essential elements that empower Yokogawa's automation experts – high quality products, knowledge management, and resource management.

High Quality Products Form the Foundation



High quality products are essential for any supplier that wants to remain viable in the marketplace. Yokogawa understands this and has a strong focus on product quality and reliability. Yokogawa is one of the key automation suppliers in today's marketplace that can offer a high reliability, "bulletproof" system that is highly trusted and has a large installed base in critical process applications in the refining, chemical, oil and gas, and other industries where reliability and availability are crucial.

Knowledge Management Fosters an Environment of Best Practices

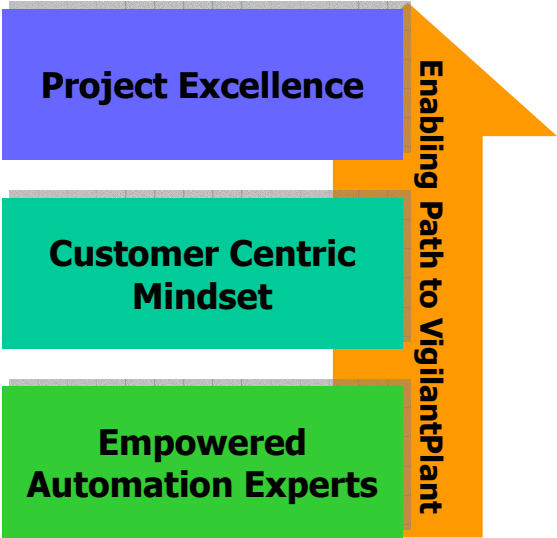
Yokogawa's system for knowledge management was born in June 2003 during one of the company's Global Strategy Workshops organized by the company's regional headquarters operations and Yokogawa corporate headquarters. The managing directors at the regional HQs agreed to form a global knowledge management steering committee (KM@Y) with the global headquarters Vice Presidents. This is significant because it means knowledge management has the full support of senior level management, which is continuously involved in KM@Y core activities. Yokogawa's KM@Y system provides a platform for sharing project execution knowledge and best practices across the global organization. The system makes archives, standards, and lessons learned readily available, all in the context of a standard IT environment and using accepted knowledge management best practices.

Formation of the KM@Y system was necessary to prevent the formation of silos within Yokogawa corporate headquarters in Japan and the company's rapidly growing regional organizations. Because Yokogawa is expanding so rapidly around the world, its regional organizations need to have access to the high level of expertise that exists with the company's corporate expertise in Japan, and vice versa.

Global Resource Management Enables Dynamic Resource Mobilization

Yokogawa's globally expanding execution capabilities also present a challenge in terms of resource management. An increasingly large pool of employees with diverse industry and application experience requires a sophisticated system of resource management in order to deploy the right people to the right projects around the globe, both physically and virtually. This system of dynamic resource mobilization makes it easy to identify the right engineering personnel in the right location and provides an infrastructure for support and training. If Yokogawa had not implemented its practice of dynamic resource mobilization, it may have failed in its past mega-projects.

Empowering Automation Experts to Deliver Customer-Centric Solutions



Empowered Automation Experts are a Key Part of Yokogawa's Strategy

The combination of quality products, a good system for knowledge management and sharing of best practices, and an intelligent approach to resource management empowers Yokogawa's automation experts to execute projects in a diverse range of industries, no matter where they happen to be located. It also fosters a customer-centric mindset that results in an enhanced capability to understand customer requirements and to deliver projects that are on schedule and within budget.

Yokogawa has made significant investments in its human resources network for engineering. The company currently has more than 3,000 engineers in its Industrial Automation business unit, all connected through the global engineering network described here. The company works closely with its human resources organization to continue to bring in new people to

match the growth in its project execution and systems businesses, to identify key skills needed, and to drive information about those people and skills into globally standardized frameworks. Yokogawa’s global consolidation of human resources will track the skills and career plans of all engineers around the world so the unique talents of every engineer are fully developed and engaged in global operations. It will enable international human resources mobilization from different parts of world to form a team and work together.

Standard Execution Framework: Work Breakdown Structure

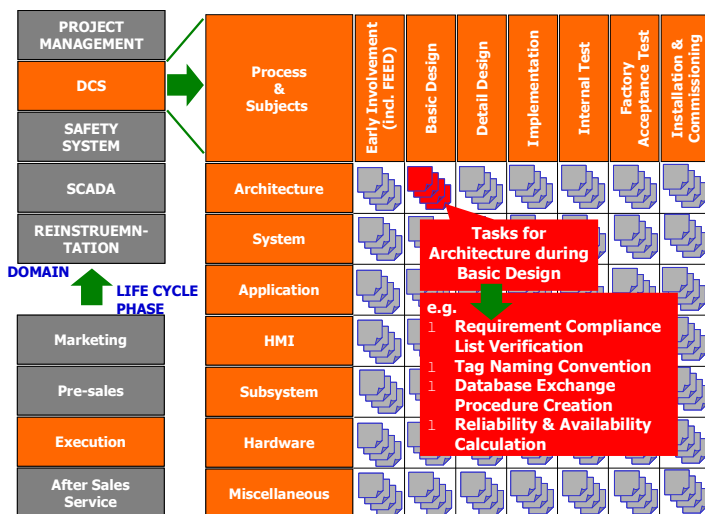
On top of the people-centered operational philosophy, Yokogawa realized that a standard framework was also necessary for effective project management, and it introduced a globally standardized Work Breakdown Structure in 2005 to address this issue.

The Importance of a Standard Work Breakdown Structure: One Yokogawa, One Approach

According to the Project Management Institute (PMI), The Work Breakdown Structure (WBS) “can be compared to a building’s foundation.

Without a good foundation, a building may collapse. Likewise, without a good WBS, project success may be negligible. The WBS defines a project’s work in terms of deliverables and the process phases appropriate to the organization/project. It also is the basis for establishing all steps/tasks, effort, costs and responsibility.”

The Yokogawa Work Breakdown Structure lies at the heart of all planned activities in every stage of the value-chain: from pre-sales to execution and service. The work processes are based on this structure and assure quality in project execution, identify



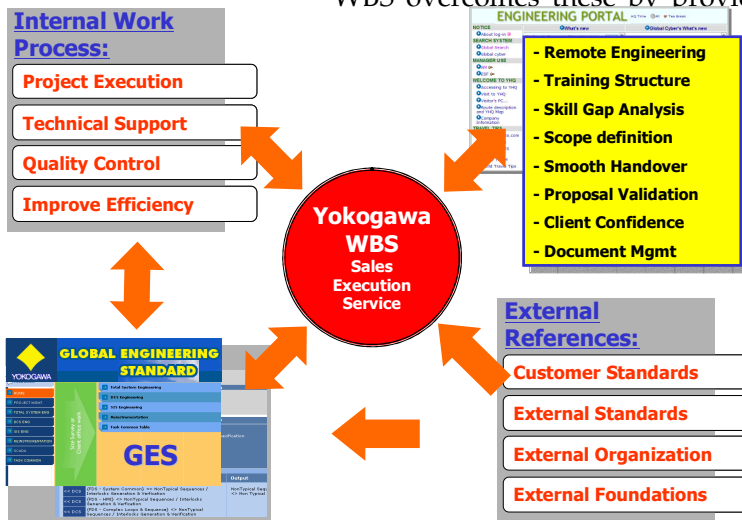
Yokogawa’s Work Breakdown Structure Provides a Standard Execution Framework

which technical support is most effective in each task/phase and hence improve overall efficiency. Through this integration of work-process and a smooth handover from sales to engineering to startup, Yokogawa and its customers can consistently reap benefits in the form of higher predictability in project execution.

Yokogawa's Work Breakdown Structure is more than just a basis for a corporate engineering standard, it is the way in which the company was able to realize a global project organization. The true mega-projects in the process automation industry require resources that are distributed across wide areas, incorporate multiple languages and cross cultural barriers. WBS overcomes these by providing a unified and structured framework and approach to workflow and project implementation.

It also enables Yokogawa to split up the scope of work amongst its internal engineering resources and break down the projects into manageable layers.

The WBS also incorporates the unique requirements of different business domains and disciplines. The work breakdown structure for implementation of a DCS, for example, is different from that of implementing a safety system or a fieldbus project.



Yokogawa's Work Breakdown Structure Provides a Foundation for its Project Execution Capabilities

WBS is now fundamental central hub to improve the central activities, and provides a platform for remote engineering, training structure, and skills gap analysis. For example, skill gap analysis is normally conducted before organizing a project team through verification between skill-inventory of available human resources and project attributes. This verification process refers to WBS to confirm task dependencies and required skill-set in each task.

Common Contents for Execution: Global Engineering Standard

WBS defines the common framework in which sales, execution, and service are provided. Closely related to WBS is the Yokogawa Global Engineering Standard (GES), which is Yokogawa's internal standard for executing projects across geographically distributed resources, bridging the diversity of languages, cultures, and expertise in the Yokogawa organization. GES provides the standard and templates for unification of project implementation, utilizing the company's global engineering network.

GES Portal Provides Standards

GES portal is an intranet to facilitate usage of standards in accordance with Yokogawa's project execution process from early involvement (including FEED) through basic design, detailed design, implementation (including assembly), internal system test & integration test, factory acceptance test, shipment, and installation & commissioning. It provides the most appropriate materials such as templates, tools, reference documents and check-sheets to deliver projects with high quality at the right time.

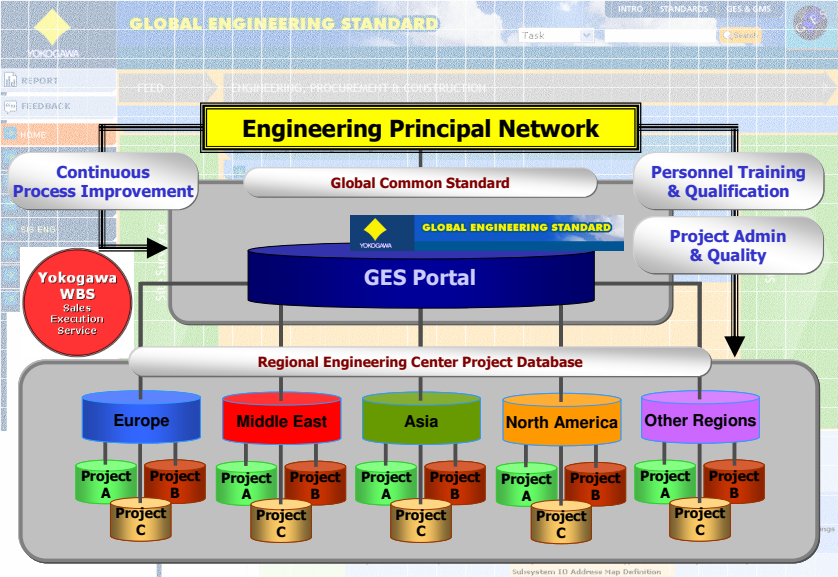
Templates are derived from thousands of project experiences and incorporate lessons learned, helping to avoid creating deliverable from scratch while preventing inconsistency in execution. Tools include Yokogawa's "yGet suite" that covers a wide area of fabrication for DCS and safety systems, expediting working process while ensuring high-quality deliverables. Check-sheets are utilized to verify internal and external deliverables in accordance with the Yokogawa's project execution process, making sure that the quality of deliverables meets customers' requirements.

A Path for Continuous Content Improvement through Engineering Practice

GES is not a closed system. Within GES is an Engineering Principal (EP) Network that assures each region adheres to the rules set out in GES and provides a mechanism for feedback of execution experience and improvements back into GES. Any deviations from GES are reported to regional operations based on local practices or project requirements. EP also provides an environment to perform GES benchmarking and follow-up

meetings to assure action items are closed properly. EP is also the regional focal point to customers' standards and external standard organizations.

EP assures compliance of GES in projects with the objective to increase efficiency and to refine engineering estimates, and it does this in several ways.



The Engineering Principal Network Provides a Basis for Continuous Improvement

EP Network is used to perform project review at least twice: before basic design completion, and during project closeout. It is used to manage IP rights in a project to maximize sharing of project knowledge.

Secondary responsibilities of the EP Network are to perform the actual rollout of the GES to Yokogawa staff, and for training and induction of new staff. EP is the source of information for Yokogawa staff for how to apply and use GES. It also serves as a conduit to the sales, service, and quality operations within

Yokogawa, providing quarterly reporting of KPIs for GES adoption and a monthly summary report of all GES activities to regional engineering managers. EP Network helps the regional domain experts to evaluate potential changes and improvements of GES.

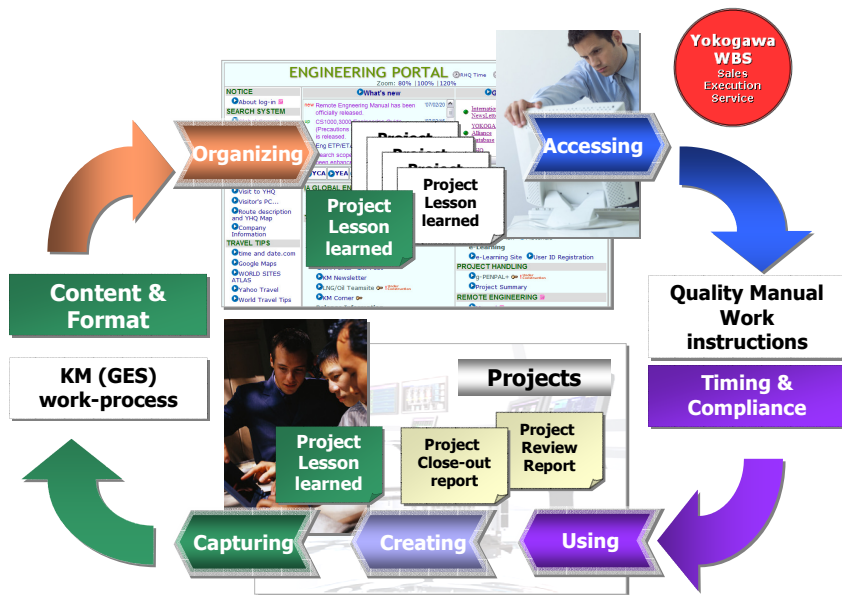
Knowledge Management as a Backbone

Yokogawa's mission in its project execution business is to change its previously quiet image to one of leadership in the worldwide market. This means leveraging its engineering expertise as much as possible. Managing the knowledge of a global engineering organization is no easy task. To do this, it was necessary for Yokogawa to implement an advanced knowledge management (KM) system to capture important lessons learned. With the company's expanding global footprint, this system had to be a single standard system across the entire engineering execution organization so this knowledge can be shared, regardless of location or language, and can be

leveraged with the Work Breakdown Structure and Global Engineering Standard.

Developing skills via training and promoting a culture of collaboration are necessary in order for knowledge and work to be shared and reused. Within Yokogawa, the workflow of sharing information on projects is based on a five-step knowledge lifecycle, from knowledge creation to capture, organiza-

tion, access, and use. Each step requires specific activities, tools, and forms.



Yokogawa Knowledge Management Workflow

In the knowledge creation phase, Yokogawa has standardized on a single method to monitor, support, and innovate the creation process in projects. This can only be applied if line managers and lead engineers are supporting it, and they are properly trained in the methodology. Existing work processes such as project close-out review are in place, and can be expanded with after action reviews (AAR), project reviews, and GES deployment reviews.

While projects are running, an independent party reviews the AARs, project reviews, project related Q&As to/from technical supporting organizations, and other outputs from the project team and extracts lessons learned. The value of these lessons learned is not leveraged if the organization waits until the project close-out to review them. Yokogawa’s KM work processes define the content and format of these lessons learned, and identify when action needs to take place and by whom.

In the organization phase, the content, which is useful for future projects, is stored so that users can find it. The metadata entered in the document properties are defined, keeping in mind that the content may be useful for many types of users, not only project engineers. The context of the content is completed with industry information, customer information, and project information so the user can apply it without risk of applying an unsuitable solution.

When users need to access information, the metadata selected when storing it is the driving factor to assure the right information appears in the search

As the engineering practice network does, the knowledge management system reduces the cost of developing custom solutions, because knowledge can be shared, reused, and continuously improved throughout the company.

result. Yokogawa has implemented advanced IT tools in a way that allows the company to integrate its content, management systems and search tools into a single Enterprise Content Management system, and the company has set up a special IT workgroup to implement and maintain this system. The use of and compliance to the system, is governed by Yokogawa's ISO work instructions to make sure that engineers take advantage of and use the KM system. As the engineering practice network does, the knowledge management system reduces the cost of developing custom solutions, because knowledge can be shared, reused, and continuously improved throughout the company.

Yokogawa Project Execution in Practice: CSPC Nanhai

There are several examples of projects that highlight Yokogawa's capabilities in project execution and as a MAC. One of the best examples of this capability is the CNOOC and Shell Petrochemicals Company Limited (CSPC) Nanhai project in China. CSPC Nanhai is an integrated refining petrochemical complex in Guangdong, China, which is a joint venture between China National Offshore Oil Corporation (CNOOC), Royal Dutch/Shell group, and Guangdong Investment and Development Company. The new integrated petrochemical complex was successfully started up at the end of 2005. As MAC, Yokogawa coordinated operations between six international engineering contractors, Chinese design institutes, and many other subcontractors and served as a single point of responsibility to streamline project management and facilitate deadline requirements.

With only three years from front-end engineering and design (FEED) to completion, the project featured an ambitious schedule that was completed on time. The Nanhai Project is notable for many reasons, and is one of the largest Foundation Fieldbus installations in the world, with a total of 60,000 I/O points, 16,000 Foundation Fieldbus devices, 3 main control rooms, 15 field auxiliary rooms, 200,000 software tags.

One of the primary objectives of the Nanhai project was to use technology that was reliable and proven in the field, but that did not exclude the use of new technologies and ideas where applicable. Aside from making extensive use of fieldbus devices, the project used a significant number of vortex and Coriolis flowmeters, which are still regarded as new technology among many chemical and refining industry end users. Another example of new technologies used includes Yokogawa's DCS Anywhere technology, which was developed at the request of CSPC and allows engineers to access control rooms from any point on the plant network.

According to Yokogawa, DCS Anywhere web portal is the first installation of its kind. Yokogawa developed the technology in cooperation with CSPC.

During the design & engineering stage, CSPC & Yokogawa worked closely to ensure the new system would perform to spec. Design challenges included:

- LAN bandwidth & latency
- Wireless LAN integration
- Web-based application software
- Access control based on user group profiles
- Firewalls & antivirus protection
- High-speed Ethernet routers
- Redundant network
- Optical-fiber networks
- Segregation of IP addresses for each application

Although it has value throughout the plant lifecycle, the technology has proven to be especially useful in the commissioning phase by providing access for plant surveillance and monitoring across different levels of the plant organization, from maintenance engineers to process control technologists, process engineers, and operations managers via desktop PCs over the plant network, or through wireless networks.

According to Head of Instrument Engineering of CSPC, Seah Ooi Kiat, "DCS Anywhere technology was implemented on time and before the commissioning work began. For such complex system design, it is absolutely

necessary for the client and the vendor to cooperate closely, with the team spirit and the mindset to overcome challenges and achieve the final product. Yokogawa has been receptive: they have listened to our requirements and have been willing to make changes whenever we encountered difficulties. They have delivered what we wanted, on schedule and within budget."

Execution of the plant automation project occurred in four phases - Functional Design Specification, Detailed Design Specification (DDS), Staging and Factory Acceptance Testing (FAT), and Installation and Site Acceptance Training (SAT). Functional Design Specification described general project requirements, while DDS described the detailed functionality of each plant. The staging and FAT ensured that all systems were rigorously tested with simulated inputs. Interaction and communication between subsystems was

also extensively tested. Yokogawa dedicated more than 200 staff to the staging and FAT phase, plus another 50 people from CSPC. The Installation and SAT and commissioning phase involved more than 300 people from Yokogawa and CSPC, and the installation contractor.

Note: portions of the CSPC related information is reproduced with permission from: 'All in hand at Nanhai', Process Worldwide 1-Vol. 9, Mar 2006 (page 17-18); 'Monitoring a megaproject', Process Worldwide 3-Vol. 10, Sep 2007 (page 20-21)

Strengths & Challenges Moving Forward

Yokogawa's ambitious goal of becoming the number one supplier of process automation by 2010 requires the development of a global project execution business built around the right people, technologies, and work processes. The company is rapidly accomplishing this through large investments in new engineering centers, deployment of a single standard corporate Work Breakdown Structure, and a Global Engineering Standard. The company has also deployed many internal tools to facilitate knowledge

Yokogawa's transition from a Main Instrument Vendor to a true Main Automation Contractor, however, was not won only on the basis of its internal tools and work processes. Many end user clients believe that Yokogawa brings a high level of integrity and dedication in projects.

management, knowledge sharing, capturing lessons learned, and executing projects smoothly and efficiently. An additional benefit to this is that Yokogawa can take these same knowledge and tools and embed in their own system, application, and product offerings.

Yokogawa's transition from a Main Instrument Vendor to a true Main Automation Contractor, however, was not won only on the basis of its internal tools and work processes. Many end user clients believe that Yokogawa brings a high level of integrity and dedication in projects. Much of this comes from the company's Japanese culture, which is accustomed to providing a high level of service to the customer. Yokogawa's close interaction with clients during projects provides the foresight to determine which solutions best fit the project and customer requirements, and enable Yokogawa to integrate the available services rendered by its various divisions and partners.

To succeed in the project execution business in the long-term, however, Yokogawa needs to continue to compartmentalize services and break them down into manageable chunks. While it is building its engineering exper-

tise rapidly around the world, the company must be careful to manage this growth and ensure that the standard WBS, GES, and Knowledge Management procedures are followed and key information is captured for reuse in the global organization. Yokogawa must also continue to leverage its strength in project execution to drive growth in its lifecycle and operational services business. The company realizes that its obligations to the customer as well as its future opportunities in large part exist after the startup and handover process.

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Acronym Reference: For a complete list of industry acronyms, refer to our web page at www.arcweb.com/C13/IndustryTerms/

API	Application Program Interface	IT	Information Technology
BPM	Business Process Management	KM	Knowledge Management
CAGR	Compound Annual Growth Rate	MAC	Main Automation Contractor
CAS	Collaborative Automation System	MIV	Main Instrument Vendor
CMM	Collaborative Manufacturing Management	OpX	Operational Excellence
CPG	Consumer Packaged Goods	OEE	Operational Equipment Effectiveness
CPM	Collaborative Production Management	OLE	Object Linking & Embedding
CRM	Customer Relationship Management	OPC	OLE for Process Control
DCS	Distributed Control System	PAS	Process Automation System
DOM	Design, Operate, Maintain	PLC	Programmable Logic Controller
EAM	Enterprise Asset Management	PLM	Product Lifecycle Management
EP	Engineering Principal	PMI	Project Management Institute
FAT	Factory Acceptance Testing	ROA	Return on Assets
FEED	Front End Engineering & Design	RPM	Real-time Performance Management
GES	Global Engineering Standard	SAT	Site Acceptance Training and/or Testing
HMI	Human Machine Interface	WBS	Work Breakdown Structure

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