Operational Excellence seems an elusive goal for Oil and Gas operating companies. Growing mounds of data, equipment reliability issues and overwhelmed operations personnel create risks that may prevent equipment from running as designed, ultimately standing in the way of achieving desired production goals. This paper will address reducing the risk to production from downtime caused by complex graphics, overzealous alarming strategies and lack of live data presentation to subject matter experts in the organization. We will address approaches to deploy affordable subject matter oversight through carrying automation concepts to cloud computing. In addition, we will highlight example projects and our experience.

Introduction

When heavy industry firms are viewed on a global basis, world class operations achieve an Overall Equipment Effectiveness (OEE) Score of 91 percent. Historically, the offshore Oil and Gas industry lags this score by ten points or more (Aberdeen Group “Operational Risk Management” October 2011). OEE is the quotient of quality, availability and efficiency scores. Of these, availability seems to impact the Oil and Gas industry score to the greatest extent. Unplanned downtime caused by a myriad of reasons is the primary culprit, but there are ways to help drive effectiveness scores higher in order to achieve operational efficiency objectives.

Pursuit of offshore reserves in the next decade will involve complex extraction methods and extensive use of subsea extraction technologies. Extraction of the next wave of reserves will require complex facilities both on the ocean floor, as well as in the form of more traditional surface production facilities. Facing the growing complexity of production systems, oil and gas operating companies are struggling to successfully operate these complex facilities with a retiring pool of subject matter expertise.

Replacing industry and organizational knowledge is a challenge driving production companies to explore locating subject matter expertise in hubs where resources are leveraged across several assets. The challenge comes about in two areas. First, the production systems – both on the surface and on the sea floor – require complex production systems and subsystems with many components. As a result, the automation systems that operate these facilities are extremely complex, often requiring operators to interface with more than 200,000 tags of data and resulting alarms. Second, placing subject matter experts in regional hubs creates security risks that must be addressed in the design of automation systems. Enabling 24-hour live-data access for remotely located subject matter expertise requires establishing tunnels in internet technology to empower monitoring from remote offices, tablet PCs and mobile devices. A sound security strategy is required as a part of this enablement.
Financial Impact, Where Company CFO’s Believe Operations Should Look for Excellence

In a 2011 report titled “Operations Risk Management,” Nuris Ismael of the Aberdeen Group cites findings from polls of the CFO’s of many industries. According to the study, the top issue facing operators today is the need to maximize return on assets (Figure 1).

![Figure 1 – Pressure on Operators](image)

This report also reveals that CFOs of Oil and Gas enterprises are concerned with reliability of assets and lifecycle costs. Failure of assets was the risk cited as having the greatest potential impact on achieving operational excellence (Figure 2).

![Figure 2 – Risks Having the Biggest Impact](image)

Oil and Gas-focused companies desire higher efficiency. As facilities grow more complex, the pressures to capture return on investments increase and the need to achieve excellence grows. However, operation of production systems continues to create sources of risk by impacting asset reliability and creating production downtime.
Risk of Large Systems for Complex Production Facilities

Over the next decade the production facilities required to extract Oil and Gas reserves offshore will continue to grow in complexity. Complex facilities create risk in a few different ways:

- Operations personnel are not completely equipped to deal with the complexity of automation systems and can become overwhelmed with data.
- Traditional approaches of replicating P&ID documents on computer screens create overwhelming operations methods and overwhelming alarming schemes.
- Risks in the form of automation system response times do not align with possible process subsystem interaction times when undesirable events occur.
- Automation systems must be optimized to consider the interaction of subsystems allowing designed hazardous event barriers to work as planned preventing propagation of unsafe events between subsystems.
- As processing equipment for fluid handling moves to the sea floor in greater frequency, automation processors for the equipment must also move to the sea floor.

Finally, the industry will need to manage these complex facilities with a shrinking pool of subject matter expertise. The risk to operational efficiencies as a result of shared subject matter expertise is driven by the amount of data each facility generates. How are these resources presented with the facts? Can they find the truth fast enough to impact operational efficiency? Tools that enable data presentation via Internet access are beneficial, but, these tools must present data in a usable format that empowers subject matter expertise to quickly identify where they can provide the most impact. Additionally, these tools must utilize methods that meet both capital and operating expense budgets.

Figure 4 demonstrates the view of the Oil Industry versus Best in Class operations (Aberdeen Group “Asset Performance Management Driving Excellence through Reliability Strategies” November 2008). Oil and Gas CFO’s believe their DCS systems drive advanced analytics, but these systems fail when it comes to collaboration. The information presented in the DCS is overwhelming when supplied to people not equipped to deal with it. The result is lower reliability scores, which contribute to an overall reduction in overall equipment effectiveness (OEE) scores. Receiving live data empowers people in facilities engineering to help improve asset reliability.
Empowering Safe and Complete Operations through Applied Automation

The first place to address facility risk – including both operational efficiency and safety – is through applied automation systems. Traditional approaches to control often involve a large data network that runs at whatever speed the system server can handle. In order to create applied automation systems that address the requirements, organizations must consider how the process systems and subsystems interact, they then must determine the response times required to contain catastrophic events or temporarily control hysteresis within the affected system or subsystem. Achieving an automation system that will work as an effective tool to help drive operational efficiency requires consideration of several topics, including:

- Total loop response times to effectively control systems and sub systems
- Graphics strategies specified to create operator interaction in the simplest form
- Comprehensive alarming strategies to present operations personnel only what they need to see and act upon
- Controller sizing and utilization rates to maintain desired loop response (vendors will skimp on processors with undesirable results over the long term if not specified)
- Network design that avoids bottlenecks
- Network design that permits controller interaction irrespective of server speed
- Selection of a technology horizon during the front end engineering and design (FEED) phase that creates a secure environment for operations is critical
- Treatment of subsystems as peers, and avoidance of stacking systems

The design of automation systems during the FEED phase of the project requires careful consideration of how systems interact. Traditional control systems on a given unit are often found loaded to the point that optimal response times within a unit approach 500 ms. These controllers are then connected on a network that, in effect, works at the speed of a server that sits on the network. This response time is typically in the two- to five-second range. Using the water treatment sub process as an example, if the unit takes a temporary surge in water, the other systems need to throttle back relatively quickly. Communicating the challenge across the automation system can take longer than the 200 ms time slot of the water challenge propagating upstream on the vessel. This leads to down time on the vessel because the end-to-end loop response time is hindered by the speed of network, which is controlled by the server.

Two examples help build the case of simplification achieved in design to drive efficiencies on complex offshore production facilities:

About four years ago, Rockwell Automation completed the start-up of a safety system and an energy management system for a complex FPSO off the coast of Nigeria. The systems on the vessel were stacked. The energy management system contained a supervisory distributed control system (DCS), energy management system, switchgear management system and motor control system. Each vendor was provided a two second, end-to-end response time. All vendors’ systems met this response time during factory acceptance testing. However this meant that optimal loop response time from a DCS screen to a motor and back was eight seconds if it all worked correctly. In reality, when the vessel was first brought online, the four-stacked systems delivered response times of up to 25 to 30 seconds.
The start-up personnel spent costly time optimizing network traffic to reduce these times to the six- to eight-second range end to end. However, in the unlikely event of an unsafe condition, those response times might still challenge operating the vessel as designed; meaning propagation barriers might not work as designed.

A subsequent complex offshore platform reveals a different result, also driven by design. Rockwell Automation again provided the safety system, motor control system and power and energy management system. All of these systems were managed by a large, complex DCS. However, extensive use of Ethernet also was designed into the system. The energy management system and the motor control system communicated as peers on an Ethernet network. The safety system featured dedicated inter-processor Ethernet connectivity, and each of these systems leveraged data sharing with the DCS for operational interfacing.

The resulting performance improved dramatically when compared to the previous project. Safety system interaction subsystem to subsystem occurred in less than 50 ms. Interaction between the energy management system and the motor control system also occurred in less than 100 ms, and the end-to-end response time for a DCS operator to operate a pump, and see a result on the screen, was two seconds or less. Why this success? During the design phase, a technology horizon beyond what was available at FEED was selected – the networks were carefully planned to optimize performance and network-data optimization occurred during the project-build phase as opposed to during platform commissioning.

**Reducing Operational Risk through HMI Simplification**

Figure 4 demonstrates a very traditional HMI screen that follows a common school of thought – put as much information on a screen as possible and provide the same view to operations. Each of the devices on the screen had the ability to generate two to four alarms, and could drill down for trend information and other point-display data. A brief view of the screen demonstrates a busy appearance, which can quickly drive operator fatigue. Imagine operating this screen on the night shift and receiving the blame for missing an alarm!
In the previous example, alarm summaries required a separate screen. That screen was often displayed on the wall in the control room and the volume of alarms was overwhelming. Figures 5 and 6 show alternative examples of operator screens. These displays were designed to provide operations personnel information that would help them be successful in their roles. Meanwhile, multi-dimensional graphics, trends, and gauges help quickly demonstrate operational conditions and effectively reduce operator fatigue.

Figure 5 – A Separator Screen with measurement data readily available

Figure 6 – A distillation column displaying critical data readily accessible
Transitioning to Improved Reliability

The steps mentioned above could drive significant improvement in asset reliability. However, without empowering centralized subject matter expertise with live data and giving them the means to collaborate with operations and maintenance personnel in real time, the industry will struggle to meet reliability and efficiency objectives. Senior maintenance and facilities engineering personnel are best positioned to utilize data – condition-based combined with historical – to drive reliability improvement in the asset.

Traditional methods continue to impact downtime. In short, if engineering or maintenance has to build a spreadsheet, hunt down data, manipulate it, and then sort through it to find the truth, the time lost in taking action will lead to increased downtime. Role-based visualization and reporting, paired with the automation of non-productive work, creates an environment that drives collaboration and improves performance.

Today, technology exists to empower workflow automation and collaboration using simple Web tools. Simple browser access allows personnel to collaborate using smart phones, tablet PCs and personal computers. The question is, does an enterprise build the technology within their firewalls or does it take advantage of cloud computing technology to drive collaboration as a paid service?

The answer requires a broader view of data usage and data strategies. To achieve reliability and efficiency targets leveraging available data, Oil and Gas operating companies must develop data strategies that address a number of considerations. Is the data required for collaboration also governed by regulatory or investor expectations? If that is the case, an enterprise should likely consider holding the data within their corporate structure and investing in infrastructure to store and present it. Capital budgets and IT resources can limit the ability to build the systems required to achieve the desired collaboration – challenging the pursuit of reliability and efficiency targets. Purchasing the applications as a cloud-based service can speed up the path to collaboration with a pay-as-you-go model.

The Emergence of Cloud Computing

Cloud computing is rising technology that has quickly appeared on the horizon of CIO's across many industries. Figure 7 from Gartner’s Technology Update of 2011 indicates cloud computing as technology that today is high on the priority of CIO’s but was not on their horizon five years ago.

Figure 7 – Gartner’s Survey of CIO’s on Important Technologies
Figure 8 provides a view of the key components of cloud computing. On the left side of this chart, the classic model of software installed on enterprise-owned infrastructure is demonstrated – infrastructure is owned, operating systems are owned and applications are developed to provide user access and interface to data. With each subsequent column moving left to right, less infrastructure is owned by the enterprise interacting with the data. One example that follows in this paper has been developed using Microsoft’s Azure cloud computing infrastructure.

Cloud technology provides a vehicle to manipulate and manage data. Purchasing software as a service enables an organization to move faster into the realm of operational excellence through better utilization of existing data. Purchasing operations management tools as a service avoids using capital budgets and specifically circumvents issues of funding across assets. Services are paid for as they are used with operating budgets. Utilizing cloud computing to share operating conditional data creates an environment for operational improvement. ‘Private clouds’ leveraging the same technologies can be deployed if an enterprise has considerations that require all of the data to remain within their enterprise (regulatory compliance, investor compliance, etc.)

In developing strategies that utilize data to drive collaboration between disciplines, an enterprise needs to develop a data strategy. Some of the data such as, safety records, testing records and flow records are regulated and as such have mandated storage. Other types of data have investor compliance storage and security requirements. In the case of investor or regulatory data an enterprise still desires collaborative tools but likely needs to hold the data within its company structure. Looking at Figure 8 again, collaborative tools and dashboarding are also available in traditional methods of a capital project, purchased software and application development operating within the enterprise data structures. The next two sections of this paper will address examples of a traditional infrastructure approach and a cloud computing approach used to drive effectiveness in an organization.
Automating Workflow within the Firewall

Cloud technology enables the manipulation of data and automation of non-productive tasks within standard server architectures owned and operated by the enterprise utilizing the data. Hypervisor environments allow multiple applications to run on traditional cluster technology in data centers. Applications exist which permit the aggregation of data from disparate sources with federation then utilized to create role-based visualization and automation of manual tasks (e.g., production allocation, well test verification, regulatory system testing documentation, etc.). Technology helps significantly reduce non-productive operations while presenting the data in a way that drives personnel to focus on areas where they can impact the business to improve efficiencies. Figures 9 and 10 show an example of workflow automation and the resulting dashboard presented to personnel containing role-rich information designed to help improve the effectiveness of the individuals working on the asset.
This is an example of over 65 workflows automated on an FPSO off the coast of Nigeria where the operator claimed significant benefit from implementation of tools to help drive efficiencies. In SPE 127691 the operator claimed 50,000 bbl per day benefit from improved collaboration. In this example, the operating company invested in infrastructure and application packages. All data remains within the company firewall.

Moving Applications to the Cloud

Automation systems can require both significant capital investments to build as well as ongoing operating expenses to maintain the infrastructure. In many cases, collaboration is desired, but securing the investment is difficult due to organizational barriers in funding capital projects across assets or simply because the resources do not exist. Leveraging cloud computing foundations, applications can be built within the cloud infrastructure and provided as a service. Collaborating in this fashion is possible within constraints of operating budgets using a fund-as-built model. In most cases, the cost of the tools required to gain efficiency benefits are significantly lower than the cost of building traditional systems.

M.G. Bryan is a Dallas-based manufacturer of pumping systems used in mud-handling systems and fracturing systems for drilling of non-conventional wells. M.G. Bryan’s customers send trucks into the field where they provide services to oil and gas enterprises developing oil and gas fields in land-based operations. The pumping systems have a high degree of local automation, but pump operations personnel are not equipped to make decisions regarding when to stop pumping and perform maintenance. For example, the trucks require regular maintenance, and some of the filters require replacement as often as every eight hours. Combine the need for regular maintenance with customers looking over the operator’s shoulders, and occasional mistakes are made with valve positioning and/or running the truck until it breaks in an attempt to please an anxious customer. This drives significant maintenance costs, and downtime is a big problem.
M.G. Bryan sought to empower the management of their customers to help ease this problem by raising the supervisory horizon through Web access to critical truck data. They also looked to ease their customers’ supply chain challenges by empowering the purchase of consumables for the systems with the same tool. Utilizing cloud technology, a set of work flow rules were developed as an application in Microsoft’s Azure environment. The Windows Azure environment provides a cloud computing infrastructure hosted in Microsoft’s data centers. It runs Microsoft’s fabric layer and is hosted in a cluster at Microsoft’s datacenters that manages computing and storage resources of the computers. The data center provisions the resources (or a subset of them) to applications running on top of Windows Azure.

The system developed is shown in Figure 11. A cloud gateway was developed that takes data from a programmable logic controller and transfers it to the cloud. As communications in this industry are often unreliable, the gateway was developed with the necessary “handshaking” and “store and forward” features to provide data integrity and accurate data flow to the cloud when communications were available. In this example a private cellular network served as a tunnel used to permit up to 4000 systems to interact with the cloud.

Applications and workflow were then developed to present critical pump information to M.G. Bryan’s customers over their existing technology to interact using simple browser technology. The workflows indicated the location of the truck, maintenance conditions, truck operating conditions and fracturing batch campaign data for the given operation. Figures 12 and 13 are examples of these dashboards provided.
M.G. Bryan’s customers benefited significantly from the solution. In the first 90 days of operation, remote supervision eliminated four unplanned trips to the field and prevented one major breakdown – remote expertise identified a problem and was able to fix it prior to catastrophic failure of the equipment.

Conclusion

Operational Excellence seems an elusive goal for Oil and Gas operating companies. The foundation for achieving these goals begins with properly planning, designing and applying automation systems. Applying the systems in a way that reduces operator fatigue and empowers operators to perform the required tasks is the beginning of the path towards improved reliability of systems. Driving to world-class performance standards requires moving the supervisory horizon and establishing a collaborative environment that allows subject matter experts, maintenance personnel and operations personnel to collaborate utilizing data available from the asset. Cloud computing should be considered as a means of achieving these goals quickly.
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