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A Standard Solution for Upstream Oil and Gas Surveillance

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Abstract

ExxonMobil* is developing and implementing new systems and work processes that will increase the efficiency and effectiveness of well, reservoir, and facilities surveillance across their operated assets worldwide. For opportunities with a significant information technology component, often referred to as "digital oilfield" initiatives, ExxonMobil applies a broadly consistent, systematic approach to the identification of technologies or suites of related technologies which will add quantifiable value given our asset mix and organizational structure. To derive the greatest impact and efficiency, the new technologies are then implemented within established standard computing systems which allow scalable global solutions.

Improved surveillance, whether it applies to well productivity, well integrity, reservoir performance, or surface facilities, has been identified as an area with a significant opportunity for volumes uplift and for improved work efficiency. ExxonMobil is developing a number of new surveillance tools, processes, and systems, some of which will utilize proprietary in-house technology with others developed jointly with vendors. This paper will focus on one such initiative, termed "Production Surveillance and Optimization" (PS&O). The PS&O initiative is a combination of enhanced IT capabilities and ExxonMobil-standard surveillance processes and best practices that will be employed worldwide starting in 2008. Key features of the PS&O tool are that it connects to disparate datastores such as corporate data repositories and data historians, allows automated alerting when production conditions deviate versus expectations, allows automation of follow-up diagnosis and analysis, and provides access to proprietary best practices relevant to the task at hand.

Introduction

Through its financial and operating performance, ExxonMobil has achieved value with its global functional organization. Increased upstream-wide standardization, integration, and automation will drive the next step-change in performance for the subsurface work environment. These capabilities will be applied to the associated work processes, tools and technology, and data and knowledge management practices as assets pass through the discovery, development, and production phases of their lifecycles. This will extend ExxonMobil's ability to realize both economies of scale and fit for purpose (scalable) subsurface solutions. [1]

This paper provides an overview of the EM^{2010} initiative to develop a standard solution for production surveillance and optimization (PS&O) using a systems approach to achieve the EM^{2010} vision. The approach to delivering subsurface work environment improvements is depicted in Figure 1. The lower layers are foundational and must be established before the other layers can be put in place. Business value is delivered through the integration

* Exxon Mobil Corporation has numerous subsidiaries, many with names that include ExxonMobil, Exxon, Esso and Mobil. For convenience and simplicity in this paper, the parent company and its subsidiaries may be referenced separately or collectively as "ExxonMobil." Abbreviated references describing global or regional operational organizations and global or regional business lines are also sometimes used for convenience and simplicity. Nothing in this paper is intended to override the corporate separateness of these separate legal entities. Working relationships discussed in this paper do not necessarily represent a reporting connection, but may reflect a functional guidance, stewardship, or service relationship.

and scalability of these layers and requires more business involvement in design of the higher layers.[1] An explanation of how this is being done in a manner consistent with ExxonMobil's global functional organization philosophy is presented here.

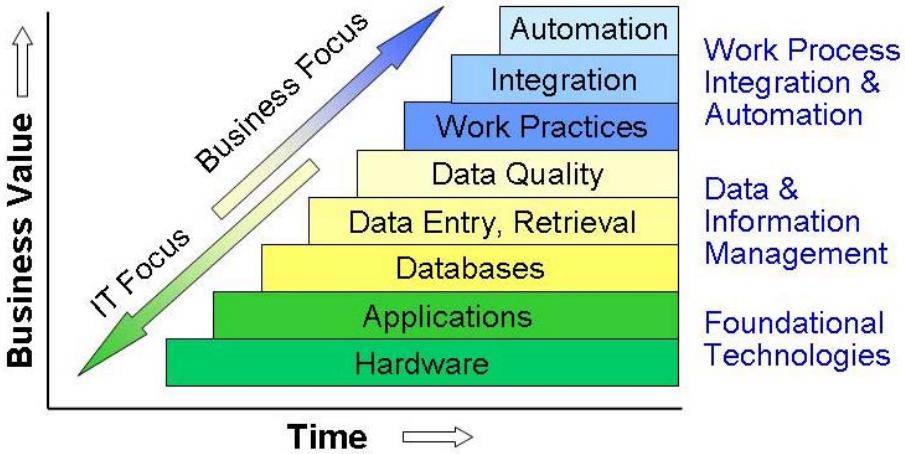

Figure 1: Approach to Applying Digital Technology to Work Process Integration and Automation[2].

Understanding the Problem and Determining the Opportunity

Individual views of how production surveillance and production optimization are defined and how best to address the opportunity vary widely. Additionally, many different production data capture and reporting systems exist for the range of assets typical of a large operating company. The data captured, the frequencies of measurement, and the storage formats vary compounding the difficulty of developing a standard solution. Since "necessity is the mother of invention", engineers or technicians will oftentimes build custom systems with local databases, spreadsheets, macros and other software that works for them but is neither easily supportable nor suitable for broader deployment. The systems may or may not run without their assistance. When these engineers and technicians transfer or retire, their successors may have difficulty running the custom system or enhancing it. In some cases, the new engineers and technicians will build their own custom solution to replace the one in place. While the custom solution has the benefit of providing the expertise of some engineers and technicians for a specific asset, they are typically not sustainable over the long term, nor can the expertise and learnings be shared easily with engineers and technicians assigned to similar assets elsewhere.

When the PS&O effort was initiated, a team was assigned to define the scope, estimate the development effort, and document the benefits. Although a fully integrated solution will ultimately include all components of the producing system (i.e., reservoirs, wells, and surface facilities which include production separation equipment and flowlines), the inital focus of the PS&O initiative is on the fundamentals of surveillance and optimization for a well or group of wells. There are other surface and reservoir-related efforts underway within ExxonMobil pertaining to broader asset management processes.[2] The PS&O team has periodic information exchanges with these teams to ensure alignment and integration where it makes sense.

A case for action was developed to demonstrate the potential value of improving the organization's PS&O capabilities. Figure 2 shows current and future PS&O work processes:

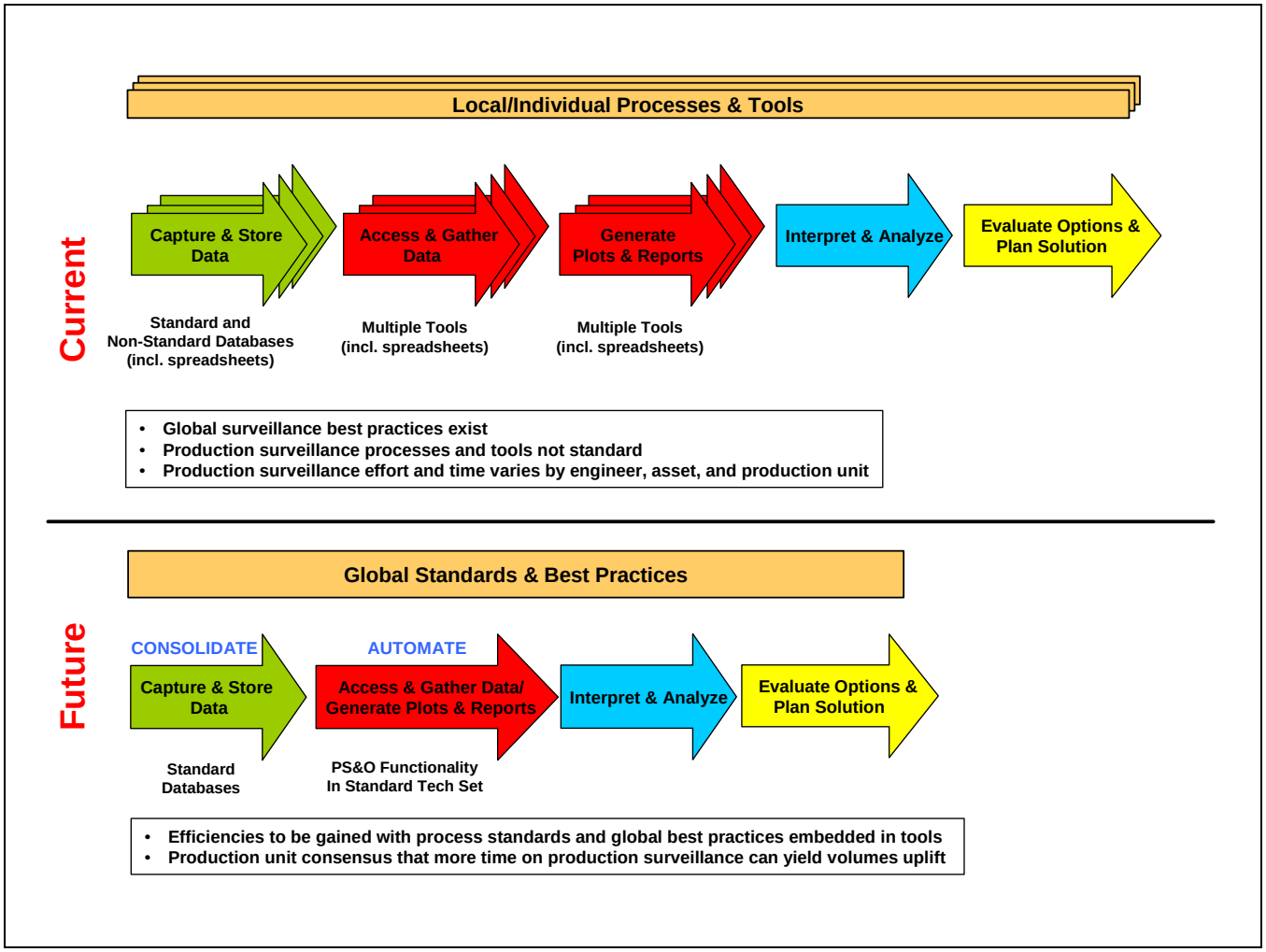

Figure 2: Basic PS&O Process (Current and Future).

The top part of Figure 2 illustrates the current PS&O process at a basic level. Stacked arrows indicate a lack of standardization in that aspect of the process. The stacked horizontal bars showing "local / individual processes and tools" impact several steps more than others in the current PS&O process. In many cases, production data is not captured and stored in the same manner for different producing assets. The data captured, the frequency of measurement, and the format that it is stored in may vary. These data sources may or may not be easily accessible by engineers and technicians depending on various factors (e.g. existence and usability of a user interface to the data source, multiple incompatible formats, engineers and technicians may not have the knowledge and ability to connect to the data source, LAN / WAN and database security restrictions may apply, etc.). Nonetheless, relevant production data must be gathered from all relevant data sources in order to generate the plots and reports required for surveillance. Plots and reports are used for interpretation and analysis of the data. (In the absence of a tool or system which can provide this functionality, spreadsheets often serve as effective solutions to aggregate data and conduct further analysis.) Once production problems have been identified, then remediation options may be evaluated before recommending the solution. Within ExxonMobil, the last two steps are generally covered by a combination of organizational processes already in place and training (classroom and on-the-job) and are not in the initial scope of the PS&O initiative.

The bottom part of Figure 2 shows the future PS&O process. The objective is to establish and deploy global standards for PS&O data, tools and work processes which is an opportunity for efficiency gains within the current PS&O process. The necessary data will be stored in company-standard databases representing a consolidation of several current data stores and a move away from individually-managed data sources such as spreadsheets. When contained in company-standard databases, it is possible to provide standard user interfaces for data presentation (e.g., plots and reports) which can be readily generated for analysis. This will also enable a level of automation for certain aspects of the PS&O process, some which will be implemented with the current PS&O

initiative and some which will be implemented later. Company best practices, presently available as documents, provide the basis for the implementation of standard PS&O work processes built into the system. Text descriptions of and references to company best practices and local applicable PS&O guidance are available within the system in the context that engineers and technicians will do their work. Lastly, the PS&O system functionality will become part of ExxonMobil's standard Technology Set of technical computing applications, or Tech Set, which is managed and supported on a global basis.

Estimating and Validating Business Benefits

To assess the opportunity, the PS&O team conducted interviews with engineers and technicians from each of ExxonMobil's operated production units who were knowledgeable of local production surveillance practices. The results showed some anticipated variation due to the different work processes necessary for different asset types, particularly production well types (naturally flowing, injection, artificially lifted) and reservoir recovery mechanisms (primary, secondary, tertiary). Some assets have actively managed, advanced PS&O systems with some level of automation, whereas others have less sophisticated and less frequently managed systems. In some cases, engineers must respond to organizational priorities such as drilling and workover activity or annual planning activities resulting in less time for production surveillance during these periods of peak activity. Thus the average time spent on PS&O activities reported by the respondents and the potential efficiency improvement determined from the interviews ranged widely for individual assessments. Of particular interest, the survey results indicated that on average 44% of the time is presently spent gathering and accessing data and generating plots and reports. Refer to Figure 3 for more details. The team risked the average efficiency improvement used for the potential PS&O initiative benefit and still had sufficient economic basis to proceed. Note that the efficiency gains are sufficient to justify the PS&O initiative and that it was not necessary to include production volumes or reserves increases (effectiveness gains). This is an example of ExxonMobil's ability to leverage size to realize economies of scale.

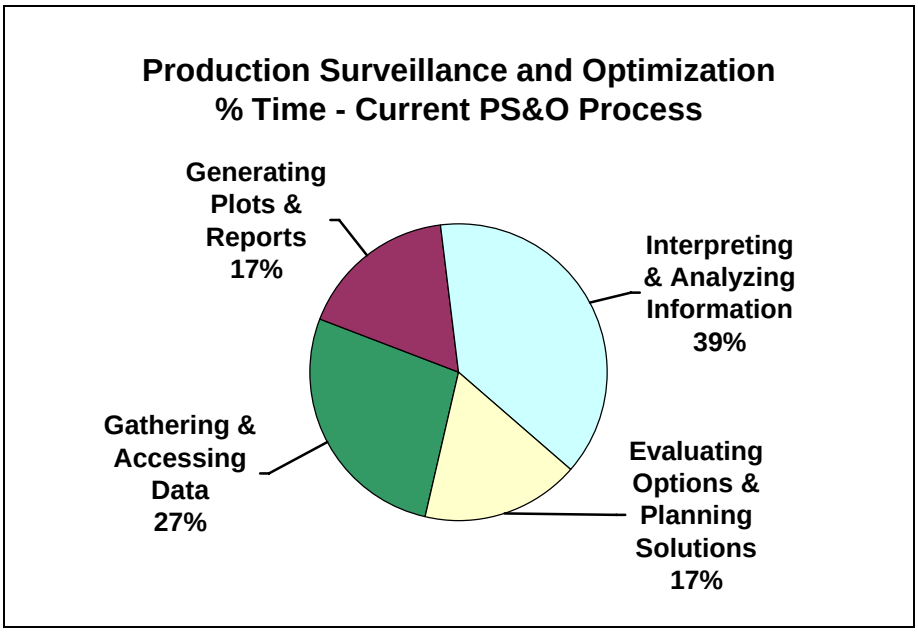

Figure 3: Average Time (%) Spent on Current PS&O Process

Before proceeding further, a pilot project was conducted to validate the estimated efficiency improvements. This was done by first determining a minimum set of requirements for a PS&O system that might be applicable to a fairly broad range of asset types. A PS&O system with limited functionality and access to the necessary data was developed and configured. Subsequently, a fairly broad range of assets was selected for the pilot to reflect the diversity of the original survey samples. Before the pilot commenced, the same survey was given to the pilot participants who had not previously seen the survey nor were familiar with the results. The pilot participants were then trained to use the system and asked to utilize the system as part of their routine surveillance work processes

for a period of time. The PS&O team closely monitored use of the system throughout the duration of the pilot project. Upon completion of the pilot, lessons learned were documented and the pilot participants were given the opportunity to review and change their initial responses. For the most part, the pilot participants agreed with the responses they provided before the pilot started. The average survey results from the pilot participants were confirmed to be similar to the original survey results.

Development of the Standard PS&O Solution

With the benefits estimates from the PS&O survey validated, approval to proceed with the PS&O initiative was granted. Ownership of the initiative was assigned to a functional manager on the business side of the company. Engineers defined the system and data requirements utilizing learnings from the PS&O pilot. The requirements were reviewed by engineers from all production units to ensure they satisfied the needs for their asset types including 1) surveillance and optimization of natural flowing, injection, and artificially lifted wells and 2) monitoring of well integrity tests and chemical treatments. Additionally, standard PS&O processes were developed by engineering advisors. An IT project team was formed within the ExxonMobil Information Technology (EMIT) organization to develop and configure the PS&O system based on the business requirements. Governance of the IT project includes a PS&O Stakeholders Committee with management representation from the business and IT organizations.

The PS&O system functionality is illustrated in Figure 4. The bars are stacked in order of increasing system capability and complexity consistent with the approach used to develop the subsurface work environment presented in Figure 1. Starting at the bottom, connections are made to company-standard databases. The databases which contain the data needed by the PS&O system have been and are being deployed independently. The PS&O application can be connected to each database as it becomes available. Alternatively, it is possible to connect to existing local databases as an interim solution if there is sufficient business value to justify this. Connecting to the necessary databases provides a common interface to deliver PS&O functionality to engineers and technicians. Once this is done, it is possible to build capabilities as needed. Additionally, the data for the PS&O system is now available to other applications in a standard format.

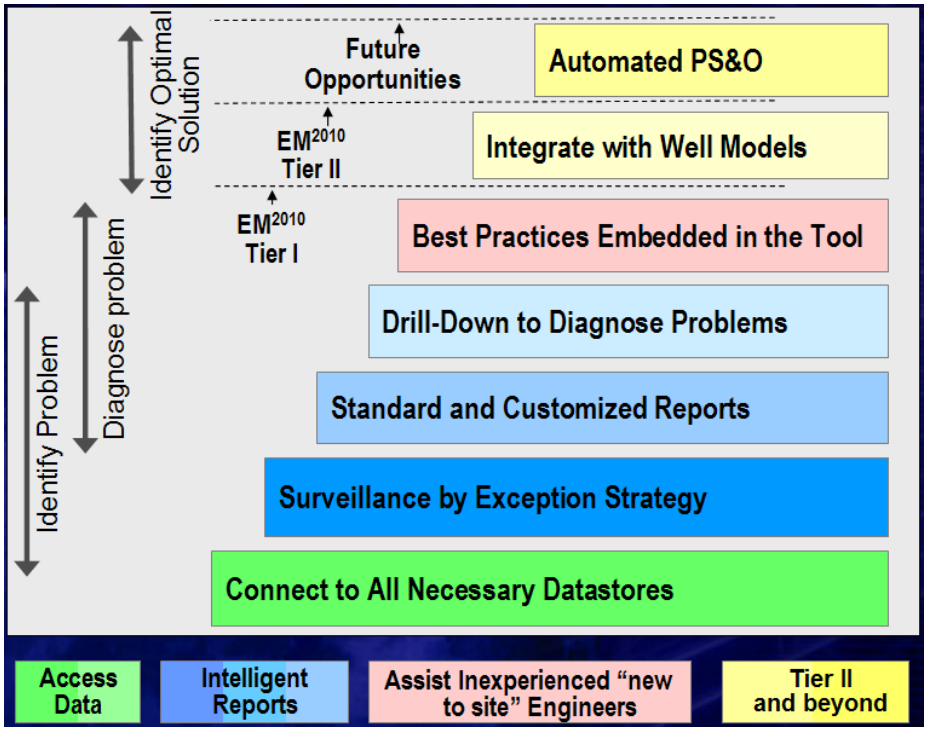

Figure 4: Summary of PS&O System Functionality

After the data is available, the engineering functionality can be developed. The PS&O project team is taking a

tiered approach to developing and deploying functionality. In Tier 1, “surveillance by exception” capabilities are being developed which allow new data entering the system to be checked against criteria previously defined by engineers and technicians working a specific asset or group of assets. The result is a prioritized list of wells which need to be further evaluated. This allows the system to continuously screen wells for problems as new data enters the system and saves the engineers and technicians from having to make the same check periodically for individual wells.

Once the prioritized list of candidate wells is generated, standard reports for various well types are available for analysis. Additional custom reports and charts can be configured and, if necessary, well problems can be further diagnosed by querying the data or utilizing other available tools. To leverage corporate knowledge, company best practices are available within the context of the current work process. Company best practices, presently available in various documents, as well as local applicable PS&O guidance will be available within the tool in the form of text descriptions and standard work processes. This is particularly useful in assisting less experienced engineers and technicians to analyze well problems and develop appropriate solutions.

The PS&O Tier 1 effort will allow data trending and comparison as well as some analytical capabilities. Comparing current performance against previous performance is referred to as “surveillance”. The Tier 2 effort is referred to as the “optimization” phase of PS&O since this will extend system functionality to include well models. In essence, Tier 1 will identify wells performing off trend, and Tier 2 will identify wells not performing optimally based on a well model. Looking further ahead, it will be possible to build on the Tier 1 and Tier 2 capabilities and continue to streamline PS&O work processes through automation. The business will continue to drive future extensions to and improvements of the PS&O system.

A series of pilot projects is being conducted during the development of the PS&O system. Each pilot is focused on the surveillance needs specific to an asset. Additional functionality is delivered with each pilot iteration. This has allowed for business input into the configuration of the system as it is being developed. This iterative development approach has made it possible to validate functionality with engineers and technicians using the system in the production environment and make adjustments before commiting to global deployment. This also helps to create a greater degree of initiative ownership on the part of the business. This high level of business engagement during the development process has been beneficial in improving the final product, but it creates some project management challenges. Specifically, each pilot generates more ideas on how to improve the system which could impact project scope. Scope issues are worked by the PS&O Stakeholders Committee to balance the business value of system changes with project deliverables cost and schedule.

Conclusions

ExxonMobil's global functional organizational structure and its commitment to and discipline in executing global standards provide a unique ability to integrate and leverage subsurface work processes, tools and technology across upstream companies and technical disciplines[1]. The PS&O initiative is leveraging this capability to deliver a standard solution for oil and gas surveillance. Business ownership and guidance is a critical success factor. As the subsurface work environment is more fully integrated, additional organizational capabilities will result.

PS&O work processes vary depending on asset type making it challenging to develop a standard solution. Quantifying the potential benefits is also difficult but necessary to better define the opportunity and gain business ownership and active participation which are essential to success. A broad range of data and system functionality must be available with a certain level of flexibility for engineers and technicians to work effectively. For any given asset type, it is not expected that all functionality and data types within the PS&O system will be used, but essential functionality required for PS&O work processes must be available for each asset type. Otherwise engineers and technicians will continue to build local solutions which are likely to be difficult to support or become obsolete when they transfer or retire. Implementing best practices into the work processes and making them accessible in the tools used by engineers and technicians provide a means to institutionalize the company’s distinguishing capabilities.

An iterative development approach utilizing pilot projects in a production environment allows for continuous input by the business and helps to build ownership of the system before deployment commences. However, project scope must be carefully managed as new ideas and improvement opportunities come to light. A tiered approach to system development allows functionality to be staged in over time under separate projects and provides some flexibility to adjust deliverables within project cost constraints. Proactive project governance involving all key stakeholder representatives provides an effective means to make decisions and resolve issues while balancing

the needs of the functions impacted and helping ensure project success.

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