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Measuring Development and Adoption of New Oilfield Systems Using Technologies With Real-Time Capability

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Abstract

If a brand-new oilfield product or service becomes widely used in less than a decade, that's fast. The fact is that the petroleum industry is one of the most conservative when it comes to adopting new technology. This paper proposes and describes the use of a capability adoption index to benchmark and measure the development and adoption level of oilfield systems with real-time capability.

The capability adoption index is a tool for measuring and managing the advance of real-time technology in the industry. The application tracks incremental change and provides a roadmap for technology development and adoption. There are three main reasons for deploying systems with real-time capability. First is the growing shortage of skilled professionals. Second is the need to operate in harsh or environmentally sensitive regions, where monitoring and controlling operations from a distance can improve safety and limit the environmental footprint. The third driver is that systems that feed back data in real time may increase production by allowing operators to respond quickly to changing conditions in the well.

The 10-level index provides a bigger picture of the maturity of real-time technologies within the global market. The different levels of technology adoption are illustrated both for geographic areas and for different services. The roadmap towards autonomous automation provides more efficiency and profits for the operating company. For service companies, the ability to drill, test, operate, and control wells with real-time capability helps maintain the quality of service delivery. It creates more efficiency for people and systems.

In the industry's journey toward autonomous automation, the significance of the index is a measurement allowing companies to look back at their progress, manage change, and plan the road ahead.

Introduction

In the conservative oil business, it often takes five years or more to adopt new technologies and services. The Capability Adoption Index is a management tool that measures the acceptance level of ten key capabilities that use what the industry loosely calls "real time" technology. Developed for internal use, the global capability adoption index for real-time systems could advance and help speed the deployment of oilfield technology worldwide and would be a valuable tool for our industry.

Here we define real time capability is the adoption of digital technology for the rapid transfer of field data to individuals or control centers, and the ability of humans or control devices to respond with equal speed to the data they receive. The ultimate goal is an autonomously automated system that responds to changing conditions in a timely way.

Drivers and approach for real time capability

There are three main drivers for deploying systems with real time capability. First is the growing shortage of skilled professionals, fueled in part by the coming retirement of a large portion of the industry workforce. Real-time systems give one person or team the ability to increase efficiency. Second, there is a need for real time, remote control technology in harsh or remote environments. And third, real-time systems have the potential to increase production by responding faster to changing conditions in the well.

Although many of the systems for managing oilfield operations in real time are available now, people and processes often lag behind. There are also gaps in the technology itself. Some tools enabled with real time are still being developed, both to meet existing needs and to create new capabilities.

The Capability Adoption Index for established technology illustrates how far along adoption is advanced for a portfolio of products and services enabled with real-time systems. The index also lets managers compare market acceptance of proprietary technology with that of competitors and guides investments to further advance on the capability roadmap.

Application and use of a capability adoption model in the oil industry

A global adoption index for the petroleum industry, based on the proposed capability adoption model, would be a valuable tool[1,2]. Application of the model is proposed for managers and planners with the following responsibilities.

1. **Global disciplines and processes**. Managers with a focus on a specific discipline or process, aiming to improve maturity and efficiency of existing processes in a certain discipline. Examples of processes are well planning and execution, well completion, production optimization, maintenance management etc.
2. **Regional operations.** Those who are responsible for operating an asset, region or area, aiming to improve the maturity across all processes in that region, country, area or continent.
3. **Global company-wide technology and practices portfolios.** Program owners with responsibilities managing the overall portfolio of technology, processes, and services across global operations or executive sponsors of initiatives known as the Digital Oilfield or Next Generation Oilfield.

The three focus areas are presented in Table 1. Geographic regions are presented in the columns, while rows depict specific processes or disciplines. A horizontal section represents a single discipline or process throughout all geographic areas, while a vertical section represents all processes in a single operating area. The entire matrix reflects global and company-wide aspects for the entire portfolio of technologies.

Process / Region	Africa	Asia	Europe	- Netherlands	- Norway	- United Kingdom	North America	South America
Well Planning and Execution								
Well Completion								
Production Optimization								
Maintenance Management								

Table 1 Usage Scenarios

Description of the Capability Adoption Model

The capability adoption model consists of 10-level technologies and practices capability roadmap, a capability adoption index, and a framework to view and manage organizational capabilities.

10-Level Technologies and Practices Capability Roadmap

The 10-level capability roadmap reveals technologies and practices with real time capability as shown in Table 2.

Level #	Capability
10	**Autonomous and automated intervention** Autonomous and optimized control of a defined set of wellsite activities, with system ability for automated intervention.
9	**Model based diagnostics with automated interventions** Automatic diagnostics based on modeled processes and data from the wellsite with automatic intervention based on system recommendations.
8	**Global Collaboration** Global teams working collaboratively with access to expertise within and outside the organization.
7	**Model based diagnostics with manual interventions** Automated diagnostics based on modeled processes and data from the wellsite with intervention suggestions to the extended team.
6	**Remote operation and actuation** Remote operation of a device, tool or system at the wellsite from an offsite location.
5	**Extended team and expertise beyond the wellsite** An offsite organization providing continuous support to wellsite through monitoring, surveillance, and diagnostics activities.
4	**Diagnostics and analysis** Tools and processes to efficiently analyze all available data, diagnose problems, and recommend solutions to the wellsite.
3	**Surveillance with early warning** Automated alerting of unexpected events or detection of deviations from pre-set norms.
2	**Monitoring** Monitoring of data streams aggregated and transmitted from the wellsite, with the ability to communicate with the wellsite.
1	**Data acquisition and transmission from wellsite** Data is acquired at the wellsite and transmitted to an offsite location for remote monitoring.

Table 2 Ten Levels of technologies and practices with real-time capabilities.

Computing the capability adoption index

The capability adoption model is shown graphically in Table 3 for the drilling process.

#	Practices \ Technologies	Today	2010
10	Autonomous and automated intervention		
9	Model based diagnostics with automated intervention		
8	Global collaboration		
7	Model based diagnostics with manual intervention		
6	Remote operation and actuation		
5	Extended team and expertise beyond the well site		
4	Diagnostics and analysis		
3	Surveillance with early warning		
2	Monitoring		
1	Data acquisition and transmisson from wellsite		
		46%	100%

Table 3 Capability Adoption Index

- Orange color indicates technologies and practices that are infrequently or rarely used (<25%). The capability is assigned a score of zero.
- Yellow color indicates more frequent use of technologies and practices with real time capability (25% to 75%). The capability is assigned a score of 1.
- Green shows systematic and wide usage (>75%), a level that can be considered full mature and adopted. The capability is assigned a score of 2.

The Capability Adoption Index is then computed as:

Capability Adoption Index (%) = $\dfrac{\sum_{n=1}^{10} n \times S(n)}{110}$; where $S(n)$ represents the score for level n, and 110 is the max score.

A higher adoption index represents higher levels of efficiency, as reflected by the adoption of more advanced capabilities. The capability adoption index allows managers to benchmark and track progress over time in particular operating areas, in a particular process or across the organization.

Framework to view and manage organizational capabilities

The capability adoption index can now be combined with the process and geographic information to form a company-wide view of the adoption of technologies and practices.

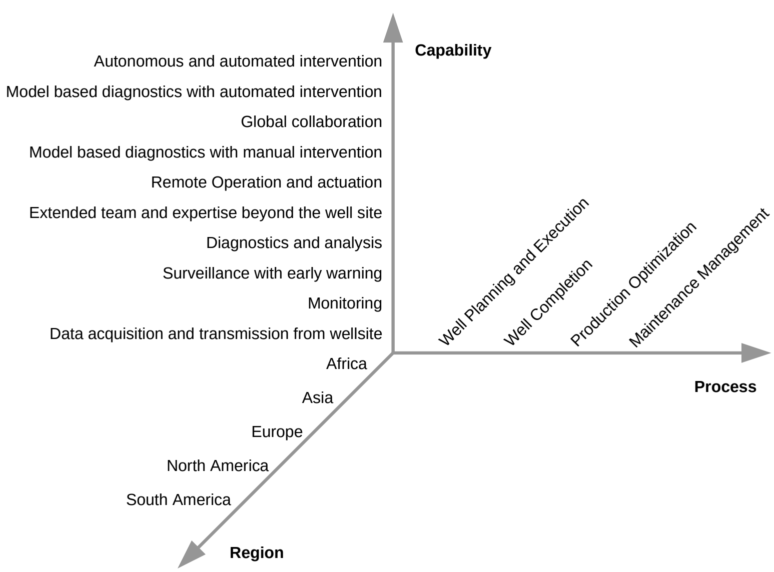

Fig. 1 Capability Adoption Framework

Usage and Examples

The capability adoption model is applied to examples for each of the three different usages scenarios.

Application 1: Global Disciplines and Processes

Well planning and execution process at an operator

Data acquisition and transmission from wellsite (level 1) is the starting point for all levels of real time capability. With increased connectivity delivered by extensive infrastructure, the industry moved towards web-based data delivery systems since the 1990's (level 2) enabling remote monitoring or witnessing. In recent years, web-based data delivery systems aggregate data from various sources into a single data stream. For example, the industry standard Wellsite Information Transfer Standard Mapping Language (WITSML) data standard allows operational data from different companies to be combined and transmitted[4]. Streaming WITSML data into analysis or visualization applications ensure operational trends analysis and continuous updating of the geological context (level 3 and 4). Operation support centers (level 5) are now being widely deployed. Teams of experts located in the operation support centers now view the same data and bring their expertise to most drilling operations. In a few cases, drill bit is now directly steered from an offsite operation support centers (level 6). Many operators are looking into connecting their centers around the world to achieve a global collaborative team supporting their operations 24x7 (level 8).

#	Well Planning and Execution	Today
10	Autonomous and automated intervention	
9	Model based diagnostics with automated intervention	
8	Global collaboration	
7	Model based diagnostics with manual intervention	
6	Remote operation and actuation	
5	Extended team and expertise beyond the well site	
4	Diagnostics and analysis	
3	Surveillance with early warning	
2	Monitoring	
1	Data acquisition and transmisson from wellsite	
		28.2%

Table 4 Global View of a Process

Specific to well placement and directional drilling, more automation is on the way. For example, closed loop modeling of drilling responses, with comparison to the geometric well plan and comparison with the geological model (level 7 and 9) is now possible and is being increasingly utilized. In the near future, discrepancies with the model will be translated into an automated execution (level 10) of a steering command, in cases only to be acknowledged by a person at surface before execution[3].

As a global process owner, the capability adoption model provides a consistent mechanism to compare the state of a disciple or process across all the operating regions of the company. The global view is generated by a roll-up of regional capability assessments conducted by each regional team. Color coding provides quick comparison between the different regional operations. A representative global view for an operator is shown in Fig. 2.

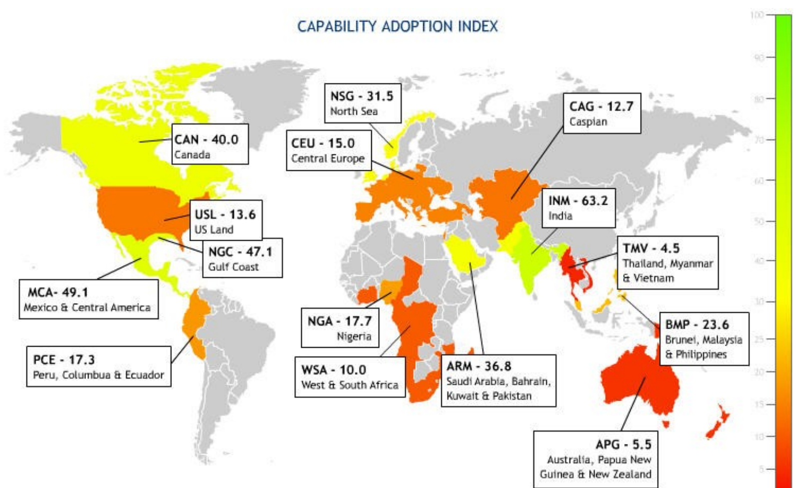

Fig. 2 Geographical view of a Global Process

Application 2: Regional Operations

North Sea operations of an operator

The operating environment of the North Sea is challenging in terms of remote offshore rigs, heightened environmental and safety considerations, and personnel and expertise constraints. Also with increasing cost of rig time and operations, running to optimum efficiency is vitally important.

Integrated Operations has been an area of considerable focus in the operationally challenging region of the Norwegian Continental Shelf (NCS)[5].

#	North Sea Operations	Drill	Compl.	Prod.	Maint.
10	Autonomous and automated intervention				
9	Model based diagnostics with automated intervention				
8	Global collaboration				
7	Model based diagnostics with manual intervention				
6	Remote operation and actuation				
5	Extended team and expertise beyond the well site				
4	Diagnostics and analysis				
3	Surveillance with early warning				
2	Monitoring				
1	Data acquisition and transmisson from wellsite				
		46.4%	21.8%	10.0%	13.6%

Table 5 Regional cross-process view

OLF, the Norwegian Operators Association, has estimated that implementation of integrated operations on the NCS can increase oil recovery by 3-4%; accelerate production by 5-10% and lower operational costs by 20-30%[6]. Petoro (2003) estimated the net present value of IO on the NCS to NOK 150 Billion.

Significant investments related to integrated operations have been made over the past few years, and all the key processes of well planning and execution, well completions, production optimization, and maintenance management have progressed in their real-time capabilities, although to varying degrees. The capability index model can be used to form a North Sea view across all the major processes of operations. An example of such a view is shown is shown in Table 5.

Application 3: Global company-wide technology and practices portfolios

A large service company

From the perspective of a service company, the capability roadmap can help guides investment decisions to drive more efficiency from operations. As illustrated by the model reliable connectivity at sufficient bandwidth is critical for enabling operations with real-time capabilities. Other issues to improve on the infrastructure side are: communication equipment availability, hardware and software configurations, security standards, and connection stability and support.

Our investment in telecommunication equipment can be traced back to the co-development of the VSAT (Very Small Aperture Terminal) technology. Mobile communication units are outfitted on our logging trucks and cabins to ensure real-time data delivery (level 1) and improve service quality[7]. Company-wide satellite dish deployment has more than doubled to 846 units, from 417 just a year and a half ago. About 1/2 of our units are located in North America, and other areas are catching up. At the beginning of 2007, Wireline deployed 298 proprietary satellite dishes and 50 third party units, outfitting 37% of their acquisition units with connectivity. By the end of 2007, more than 300 wireline logging cabins were added to active service, the number of acquisition units with connectivity surpassed 50%. BGAN terminals provide connectivity for additional areas.

Connectivity allows for supporting field engineers from remote operation support centers. These centers further enhance service quality by the monitoring (level 2) and controlling operations remotely by very experienced staff (level 5). Committed to improve service quality and lifestyle for our staff result, we invested in the operations of remote support centers (level 6). Currently, we operate 47 drilling support centers and 16 wireline centers, staffed with hundreds of dedicated and experienced surveillance engineers. With our systematic practice of support centers we attained level 5 in the capability adoption model for well construction.

The experts in remote centers now routinely steer a wellbore (level 6). For example, in northern Mexico, we drilled in excess of 100 wells remotely last year. Table 3 reveals the assessment of our capabilities today, and our ambition for 2010 for well planning and execution exemplifying the use of the capability adoption model.

Conclusions

With the advancement of digital initiatives in our industry, it is important to quantify this advancement. The proposed capability adoption model provides a roadmap to drive higher levels of technology enabled in real time and drive our industry towards operating with more efficiency. The proposed capability adoption index quantifies capabilities across both individual business units and across regional markets. The model helps manage portfolios of technologies throughout business units and operating areas and is valuable in guiding investments to drive more efficiency and create more value creation possibilities.

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Nomenclature

BGAN	Broadband Global Area Network
n	*Level n in the model [1..10]*
NCS	Norwegian Continental Shelf
NOK	Norwegian Krone
S(n)	Score for level n
VSAT	Very Small Aperture Terminal
WITSML	Wellsite Information Transfer Standard Markup Language

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