Reducing the "Data Commute" Heightens E&P Productivity

Michael Brulé, Technomation; Yanni Charalambous, Oxy; Mark L. Crawford, ExxonMobil Global Services Company; and Charles Crawley, Chevron

In information management and decision making, the "data commute" emerges repeatedly as a big problem in achieving more efficient workflows. SPE's Digital Energy Technical Section has conducted several in-depth statistical studies that show an unacceptable amount of time in the E&P workforce lost searching for data, integrating it from multiple sources, and preparing it for analysis in applications (Brulé et al. 2008; Hite et al. 2007; Mochizuki et al. 2006). Once engineering and operational data are in the application package for analysis, any updated or more recent data require a repeat of tedious, barren, and nonproductive processes to prepare and reload the data, a sort of "oilfield entropy" that is a drag on the E&P industry. The time that could have otherwise been spent making operational or project decisions is lost to activity that has nothing to do with engineering and geoscience.

Some industry professionals might be resigned to dealing with data as just part of the workday, but most recognize a fundamental tenet: it is not the data per se, but decisions—based on data-derived information—that drive actions and create *value* **(Fig. 1).** We acknowledge the importance of engineering techniques, operational effectiveness, risk-factor evaluation, and project methodology, but here we separate them to examine and quantify just one assertion: making informed decisions would be quicker if the underlying necessary data are always ready to go. *"If I can make that decision accurately, but a month earlier, and can do this across many projects, many wells, many fields. . . ."* Faster decisions with precision have tremendous value and provide much leverage in an industry already hindered by a shortage of qualified people.

Contexts of Oilfield Integration

Oilfield integration spans all areas of the oil and gas industry, from subsurface to surface to business. International oil companies (IOCs) currently have several oilfield-integration efforts as initiatives. Understanding the *context* of these oilfield integrations is important to understand what the IOCs are trying to accomplish. When we speak of integration, just what are we actually integrating? There exist several contexts of integration that must be recognized and accomplished to realize the vision of the digital oil field:

- **Data integration—**Data accessible to everyone, across disciplines, and consumable in software
- **Workflow and process integration—**Combining and automating work processes for greater efficiency
- **Disciplines integration—**The leverage of experts across disciplines like the geosciences, drilling, production, and reservoir (Mochizuki et al. 2006; Sankaran et al. 2009)
- **Operations monitoring and control integration—**Real-time operations centers, 24×7 ubiquitous monitoring portals (Hudson 2009; Brulé and Hodges 2007)
- **Asset modeling integration—**Also known as integrated asset modeling, "composite" subsurface and surface model-

Mike Brulé *has more than 30 years of experience in offshore and onshore reservoir engineering, production operations, and major projects, including North Sea gas cycling and Gulf of Mexico enhanced oil recovery and deepwater field development with Shell and Kerr-McGee. He founded Technomation, a consultancy that has provided E&P-focused software, real-time business intelligence, and information technology (IT) systems solutions. He earned a PhD in chemical engineering and an MBA from the University of Oklahoma.*

Yanni Charalambous *is an IT director at Occidental Petroleum. He has 21 years of experience in the oil and gas industry, starting his career with Royal Dutch Shell where he worked for 12 years. After a short period at a startup company, he joined Occidental as the manager of E&P systems. He is also currently serving as the chairman of the Oilfield Integration Subcommittee of SPE's Digital Energy Technical Section.*

Mark Crawford *is an IT business architect for ExxonMobil Global Services. He has 23 years of upstream experience with approximately half of that time serving as an operations engineer for Mobil E&P US and half in various central computing support roles for Mobil and ExxonMobil. He is also currently serving as the vice chairman of the Oilfield Integration Subcommittee of the SPE's Digital Energy Technical Section and an active participant in the Energistics PRODML Special Interest Group.*

Charles Crawley *is the upstream account coordinator for Automation with Chevron Energy Technology. He has 35 years of industry experience covering a variety of assignments, both domestic and international, including technology development, major projects, and operations.*

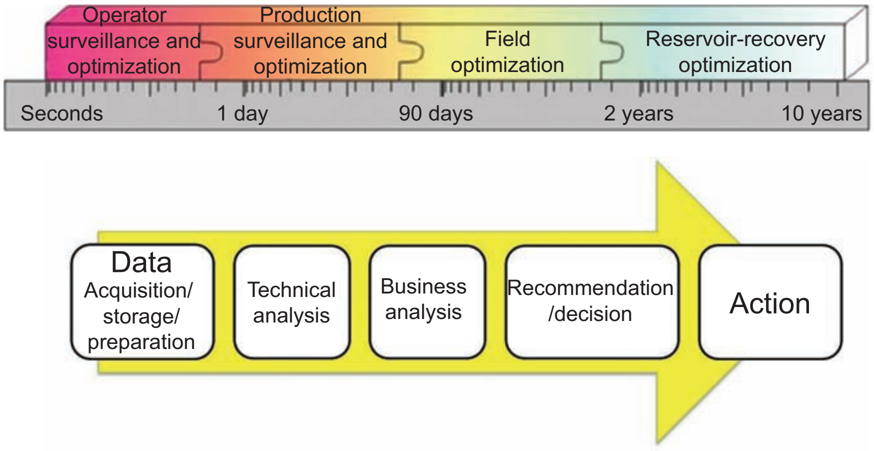

Fig. 1—Time-based operational processes and the data-to-action work cycle.

ing and simulation, and integrating other parts of the value chain

- **Software integration—**Integration of applications and other types of software for interoperability, which includes service-oriented architectures and data exchange based on various XML-based industry standards such as WITSML, PRODML, and PIDX
- **People integration—**Real-time collaboration, 24×7, around the globe

SPE Digital Energy Survey

The SPE Digital Energy survey, involving more than 200 responses representing more than 30 companies, indicated that data stand out as fundamental and foundational to the other integration contexts. The survey revealed that the collection and movement of data from stage to stage in Fig. 1 is difficult from several aspects as shown in **Figs. 2a–c.** More than 83% of those surveyed perceive gaps in oilfield data integration that impede their daily work. Only 14% of the people had more than half of their time available for doing actual analysis.

The survey indicated that 41% were spending 26% or more of their time just identifying the data needed to support their analysis. Another major consumer of the limited human resources was data preparation. Sixty percent of the people had to dedicate more than 26% of their time to prepare the data for consumption by analysis routines. These two combined activities were the largest consumers of human resources, and had no practical value on actual field operations.

In data acquisition, storage, and preparation to analysis, the survey indicated that the greatest problems are in the assembly of data from multiple sources and the subsequent consumption of those data by different software from multiple vendors. Once the analysis is complete and decisions are made, the application files and analytical tools become islands of information that can be remembered or understood only by the people originally involved with the analysis and decisions.

The survey noted other engineers' complaints regarding analysis tools:

- Require that poor-quality data or data with gaps must be fixed before the tool can process it
- Require integration from multiple databases
- Lack flexibility, are format sensitive, and require repackaging data from one application to the next
- Difficult to use, cannot be run in automatic mode, and require scarce specialists
- Cannot integrate data of different time scales
- Cannot easily handle data from some of the more complex wells from unconventional reservoirs

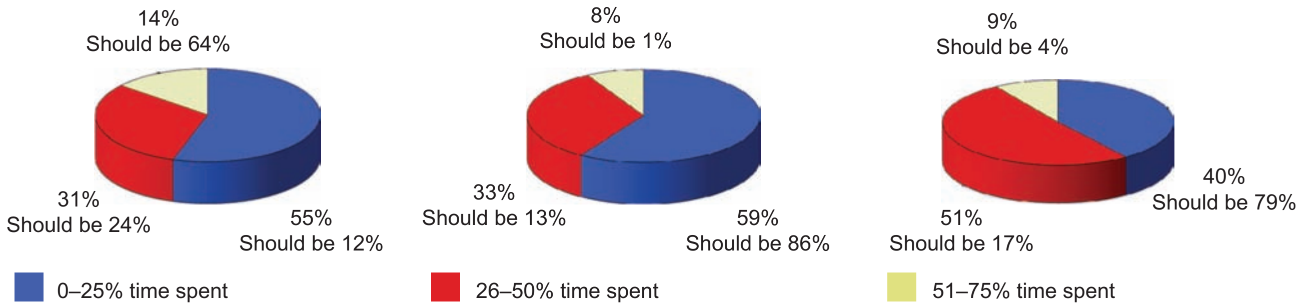

Fig. 2a—Performing analysis: Most SPE survey respondents have less than half their time available for actual engineering.

Fig. 2b—Identifying data: Half the respondents spend more than a quarter of their time just identifying data.

Fig. 2c—Preparing data: Another quarter of respondents' time is lost just to get the data in an analyzable form.

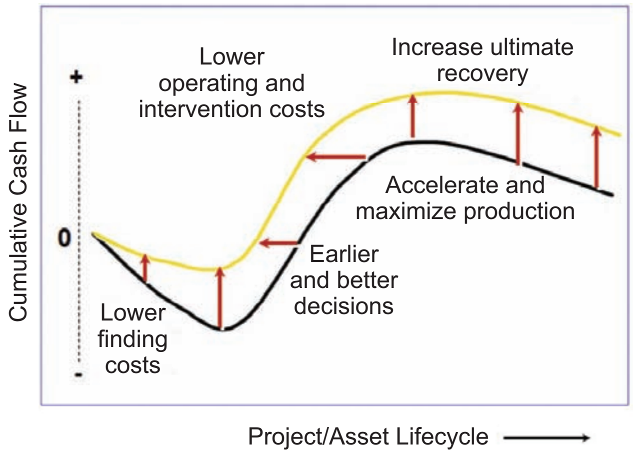

Fig. 3—Removing the entropy associated with the data commute.

The survey further revealed that currently a meager 9% of the operator respondents are able to get data automatically from their real-time systems into their engineering or geoscience analysis routines. The other 91% of operator respondents had to consume more than 50% of their time and human resources to identify, format, and prepare the data for the analysis tools. A staggering 55% of the respondents had less than 25% of their professional time available for analysis, decision, and action. These statistics show that there is a significant potential workforce that is sequestered in the data commute, unavailable for value-adding activities that utilize their engineering and geoscience education and experience.

If a comparative analysis of the data is desired using different tools, formatting and preparation are required to match the limitations and expectations of each tool. We believe this to be a key reason that only 21% of the survey respondents use commercial tool vendors specializing in oil and gas for the majority of their work. The remaining 79% use Microsoft Excel, in a completely nonintegrated, noncollaborative, "micro-silo" fashion. The personal Microsoft Excel spreadsheet is the greatest competitor that any commercial E&P tool faces. In addition, the lack of auditability of Excel "micro-databases" is a growing liability concern among E&P companies.

IOC Directions and Experiences

Separate independent studies by IOCs corroborate the overall finding that "engineers spend half their time unproductively chasing data." One IOC has identified standardization of data and information management practices as a foundation for enterprisewide work-process integration and automation (Crawford et al. 2008). The company is developing a production surveillance and optimization (PS&O) solution, which was justified on its potential to minimize the amount of time required by engineers and technicians to access data and prepare it for analysis. Based on an internal survey of current PS&O processes across all production units around the world, the IOC identified that engineers and technicians spend an average of 44% of their time accessing information and preparing it for analysis.

Early in the process, they identified the data attributes that are required for surveillance of flowing, injection, and artificially lifted wells. They also conducted assessments of each production unit to determine existence and accessibility of the data. Surveillance-by-exception techniques are used to compare newly measured values against historical values using certain criteria. When deviations occur outside of predetermined thresholds, the system alerts engineers and technicians. The automated optimization uses a similar approach, but checks for exceptions in the measured data against performance forecasts based on well models. The IOC will seek future opportunities for more automated surveillance processes. The capabilities of the system are based on integration with various production-data-capture systems, with integration facilitated by mapping the data sources to a standard format.

These detailed and quantitative studies provide the basis for making a reasonable estimate of the time savings that effective integration would provide for performing a study, say for determining if a field would benefit from waterflooding, or when a waterflood program should be initiated for best results. The estimate for the change in time for detecting that a waterflood review is needed is more difficult, but likely results in an even larger benefit. While the time for analysis and decision may be cut to half with effective integration, the time for opportunity identification may easily be cut to a quarter. As value is created from decisions and actions, moving those decisions and actions forward in time creates additional value. *With half the time spent just on the data commute, that is a nominal 2× potential increase in the workforce, with the same people.*

Example Field Scenarios—Waterfloods and Workovers

In these examples, we are separating the effects of decision time from engineering know-how, looking only at the impact of making high-quality decisions faster. We are *not* changing the amount or nature of the engineering and geoscience work. We are not changing the techniques applied across the industry in field surveillance, geoscientific study, and engineering best practices. Most important, we are *not* exercising snap judgment or changing the quality of the decision. We are looking only at the effect of removing the lost, non-value-adding time in getting to the decision, as shown in **Fig. 3.**

Waterflood Case Example: Spraberry Driver Unit, West Texas. The first example uses data from a well-known classic waterflood study to show the benefits of improved data integration and accessibility. The overall strategy and many engineering considerations are covered for this classic waterflood study in an SPE reference publication of waterflood case studies (Elkins 1975). Here we extract a few basic parameters reported during the study, and calculate a *conservative* estimate of the value of reduced time to decision:

- Production after primary recovery: 2,620 BOPD
- Average production during waterflood period: 4,270 BOPD
- Minimum typical waterflood study time: 8 months
- Reduction in study time with data *integrated* and *accessible* (i.e., the reservoir engineer can start the analysis right away without having months of data preparation):

- ◦ "Time to Decision" cut in half to 4 months
- ◦ 4 months ≈200,000 bbl accelerated production
- *Worth USD 2–3 million/month from a simple cash-flow standpoint at recent average oil prices, just for one of many waterflood units for several fields*

We do recognize that economic alternatives should be compared on a net-present-value (NPV) basis, and NPV is affected by other factors such as accounting for royalties, taxes, capital expenses, operating expenses, capital expense and operating expense acceleration, etc. However, the purpose of this simple arithmetic exercise is to clearly highlight the conclusions and resulting principles drawn from the figures used in this article. The burden of the data commute on oilfield workflows, leading to delayed decisions, has significant economic impact on any project in any field. When many fields in a company's portfolio are cumulatively analyzed, the cumulative impact is staggering.

With daily integrated optimization with data constantly fed to models, which corresponds to the last stage of the digital oilfield vision (Unneland and Hauser 2005), the need for a waterflood study will have been realized *earlier* (not counting the time that the study would have taken). A study would have been initiated in, say, 2 years, instead of the traditional 3–5 years. Add at least another 3× plus to NPV. Surface facilities would not have to be overdesigned to catch up on water injection, and safety and compliance issues would be greatly reduced.

Condensate Field Workover Case Example: Offshore Gulf of Mexico. Our workover case example is from a gas-condensate field with condensate production dropping precipitously, well below the production levels originally forecasted (Brulé and Hodges 2007). The example field represents a typical scenario: crestal gas injection is used to maintain pressure and to maximize condensate production from a large reservoir. Average bottomhole pressure is decreasing and natural-gas-liquid yield is declining. Well gas/oil ratios, watercuts, and gas flowrates are escalating much faster than forecasted. The root cause: sands migration is cutting out the chokes in several wells and making the gas rates uncontrollable, causing pressure maintenance failure on the overall reservoir. The asset team is charged with uncovering this problem through near-real-time operations monitoring and business intelligence (BI) performance management, and then communicating and collaborating in real time with its service company to do workovers on the affected wells and solve the problem. This example shows the value of real-time monitoring in role-based, process-aligned "surveillance cockpits," i.e., context-relevant portals with highly intuitive visuals (Brulé and Hodges 2007). This interactive portal has "set points" based on forecasted bounds on certain monitored production parameters. When those bounds are exceeded, then the asset team is automatically notified, a "management-by-exception" approach that lets the asset team find any "needle in a data haystack" problem.

Real-time monitoring and surveillance clearly propels the oil and gas industry in managing its assets. However, what about the situations portending asset nonperformance uncovered by comparing current production with models, i.e., the "optimization" in PS&O? The system is a "moving-window" view that does not incorporate sufficient data for real-time *predictive analytics* (Stone 2007). We are referring to situations in which typical trends will be close to expected and only slightly deviating from the expected long-term trajectory. The deviation from expected performance often has to become quite significant before the issue or need for analysis is identified. While it is easy to find the well that is down or the facilities processing upset through the monitoring and control system, problems that are slowly developing or have always been suboptimal do not stand out as well. Examples include the well that is slipping from expected performance, the facility that is no longer operating at optimum, or the reservoir that is not performing as expected. These "frog-in-boiling-water" examples will likely require some real-time, in-line analysis of information and subsequent *prediction,* through modeling coupled with statistical approaches to identify the problem. Effective integration with the automatic feed of data to analysis models or predictive analytics based on statistics could reduce the time to solve an insidious problem or identify a hidden opportunity (Crawford et al. 2008; Hudson 2009; Brulé and Hodges 2007).

Examples Outside the E&P Industry

Ian Ayres in his book *Super Crunchers,* talks about an important escalating trend in all industries: the rise of decision making with statistical and stochastic approaches on massive amounts of data. In this book and in several other sources, several examples of advanced-maturity companies outside the oil and gas industry are given (Ayres 2007; Kneuer 2008; Yakubowsky 2007). These companies have been successfully practicing operational BI with real-time streaming data. We discuss one well-known marquee company whose business has relevant similarities to PS&O in the oil and gas industry.

Boeing is an example of a company that uses real-time data-sharing and predictive analytics for reliability, maintainability, and testability engineering. This outside-industry analog is applicable to well and surface-facilities equipment reliability and maintenance monitoring, root-cause analysis, and preventative maintenance. In 2002, Boeing rolled out its In-Service Data Program (ISDP), an electronic standard for sharing aircraft information to find and correct aircraft problems (Kneuer 2008; Yakubowsky 2007). Data are continuously monitored from suppliers and airlines, including repairs, flight hours, and landings. The resulting analytics are used to track airplane performance, determine system improvements, and aid in new airplane development.

In analogy to Web-based production-reporting systems in E&P (Brulé, 2008), ISDP includes an analysis and Web-based reporting tool called Airplane Reliability and Maintainability System (ARMS). ARMS provides 24×7 availability for a worldwide audience, including all the major airlines and more than two dozen aircraft-component manufacturers. ISDP/ARMS supports fault reporting, root-cause identification and resolution, schedule reliability monitoring and reporting, airplane statistics reporting, and log book and removal analysis and reporting. In addition, the system provides more accurate data to Boeing's engineering community for faster and better decision making, faster response time, reduction in time for determining and resolving service-related problems, ability to compare repair and removal data to determine which modification has a better payback, and contingency planning for failures that might occur in the future. A further comparison can be made to the adoption of Spec2000 for aerospace data standards, which is ahead of the full adoption of similar E&P standards. The business case for Spec2000 has clearly been established (Yakubowsky 2007), which supports the business case for E&P data standards.

Conclusion

In the highly technical business of E&P, *data* stand out as fundamental and foundational to other E&P contexts of integration (disciplines, process, asset modeling, application, operations centers, and people). Recent detailed surveys by the SPE Digital Energy Technical Section and by several IOCs show beyond anecdote that an unacceptable percentage of an engineer's or geoscientist's time is spent unproductively in the data commute. Improved data integration to reduce the amount of time spent on data overhead in PS&O work processes has the potential to substantively expand workforce capability, even if the number of people in the industry stays the same, simply by increasing their effectiveness and their ability to focus on true engineering and operations matters. Many other opportunities exist, and their contribution to operational excellence, profitability, and safety is enormous. These business improvement opportunities are in addition to those that the industry achieves with its impressive advances in engineering and geoscience modeling and simulation.

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