

Obtaining Value From Oil & Gas Model Based Asset Management

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Abstract

In this paper Aspen Technology will discuss some of the key success factors for a successful implementation of an optimiser, surveillance or planning system to an Oil & Gas Asset. Initially the Asset needs true buy in from members of all the differing disciplines, and a willingness to maintain their parts of the models used. To improve this buy in, the industry is finding that it helps to build the models using the favoured tool sets of the various discipline involved, which will naturally tend to be maintained. The use of standard, but disparate tool sets across engineering, financial and management disciplines requires the ability to integrate and communicate within the desired workflow. Recent advances in software engineering with the use of Microsoft .NET technology are making the dream of engineering modelling software and finance system collaboration a real possibility. The paper will review the requirements of integrated asset modelling systems and review some of the successes and failures of Operating Companies in achieving this dream. Aspen Technology will challenge the industry to help shape the revolution in integrated asset models.

Introduction

Imagine a gas plant that can automatically tune itself to stability. Imagine the same gas plant predicting a problem twelve hours in the future. Imagine a pipeline control system asking the Operations team for a pigging run. Imagine a facility telling the Gas Contracts team that it can't make those nominations. Imagine the facility telling the Business Development team that the proposed tie-back in year three will cause compression problems. Now, finally imagine all these solutions executed from a common suite of software applications, those favoured by each discipline and connected up from a number of remote locations. Imagine a system for today's Oil and Gas company workflows, protecting and enhancing value. The evolution of integrated asset teams has been underway for some years. The quiet revolution of the associated asset applications has just begun. The key question is; can an integrated asset model be formed that utilizes the trusted domain applications of the Oil and Gas company today, and can that model be used by all disciplines in a sustainable, maintainable way with a low total cost of ownership?

Model Based Asset Management

Reservoir, production and facility simulation has developed far in the last thirty years. Oil and gas simulation has become robust, accurate, easy to use and boasts over eight thousand users worldwide, mainly in petroleum, production or facility engineering roles. A number of Oil and Gas companies that hold a modelling culture close to their corporate values have extended the use of simulation into Operations and Business Development disciplines. The Oil and Gas field of today is a complicated system with a high degree of discipline interaction and dynamics that make it impossible for the human mind to control and optimize both technical and business parameters. Typical questions that assets are asking themselves daily are as follows:

- **Are the Oil & Gas assets performing to plan, and how do we know?**
- **Are we choosing the optimal plans for developing the assets over their lifetime?**
- **Are we achieving the targeted Return On Capital Employed (ROCE) for the assets?**
- **Are we meeting all of the ever-growing HSE guidelines?**
- **Can we forecast reliably, allocate with confidence or optimize with knowledge?**
- **Do we drive enough value from the reservoir simulation and engineering model investments?**
- **How effective is the organization at capital avoidance?**
- **Are we drowning in data or are we knee-deep in knowledge?**

The industry can only achieve the answers to these kinds of questions through integrated discipline workflow and the development of model based asset management.

Oil & Gas Industry Background

The Oil & Gas computer sector alone is estimated to spend more than \$2 billion annually on hardware, software and services, a figure that does not take into account networks and communication infrastructure. The Oil & Gas industry is unusual in its high degree of dependence on information technology in order to meet its business goals and with the

enormous quantities of data which it generates and processes. Alongside this problem, the industry is addressing the changes required due to new and evolving working practices that the popularity of inter-disciplinary asset teams has brought about. The oil industry currently spends about 3% of its total revenues on information technology. Despite this level of spend, a number of published surveys show that the industry gets poor value for money. The effect of technology, though, cannot be denied. Figure 1 (in the Appendix) shows a graph from The Norwegian Petroleum Directorate that shows that the recent trend for the Norwegian Continental Shelf is to increase Oil & Gas production without increasing significant total capital expenditure. Much of this capital avoidance is directly attributable to the use of information technology, computer simulation and increasingly intelligent operations technology for enhanced and extended recovery.

There is also a problem in providing IT systems to support evolving working practices. Due to the length of time applications take to develop, there is a lag between a change in working practices and the provision of IT systems to support the practices. For a long time, Oil and Gas companies have been unable to reap the benefit of new technology to cut costs. Bought-in applications, as well as those developed in-house, use disparate data formats, different database systems, a variety of application interfaces and are unable to intercommunicate without the production of expensive, bespoke application interfaces. Suffice to say the E&P industry will strive to spend more money on information technology to achieve capital deferment and support evolving working practices. For this data formats, vendor collaboration and asset wide applications and solutions will be demanded from the vendor and software community. E&P is predicted to increase its overall software spend by roughly \$220mn a year for the next three years. Figure 2 (Appendix) shows ARC's [1] prediction of the growth of simulation software alone in the facilities and downstream process simulation markets. Oil and Gas is expected to grow facility simulation 30% year on year for the next three years as emerging uses for modelling technology is found in the Operations and Business disciplines.

As the Norwegian sector example shows, new and more efficient technology has become the key to growth among Oil and Gas companies and can often explain the lack of growth in their required capital budgets, from the simple equation of software technology costs less than steel. In 2002, oil and gas companies cut capital budgets to focus on improving their balance sheets at time when low prices and high drilling costs did not justify heavy spending. Now, even with Oil and Gas prices high, with an eye to improving return on capital employed, Oil & Gas companies are not spending much more. Capital expenditure levels have not returned to the levels of pre-2000. Information technology is part of the reason that they don't have to. A recent study by Cambridge Energy Research Associates [2] found that so-called digital technologies have the ability to increase world oil reserves by 125 billion barrels in the next five to 10 years; citing that not only do they improve recovery efforts but they also reduce costs.

"Demand will grow by 900,000 barrels-of-oil equivalent a day over the next few years," said CERA President Joseph Stanislaw during a recent conference. "Companies are looking at new ways to restructure themselves. New technology means companies don't need to drill as many wells to find oil."

As an example of this, Canadian super-independent Encana Corp. [3] expects to spend about U.S. \$3.3 billion on capital projects in 2004, around the same levels as in 2002. Better technology has allowed the Alberta-based company to get more from exploration and production activities. What's more, technology is giving the independents better ways to exploit assets cast aside by the majors. With enormous reserve replacement targets, the biggest of the majors have had to move on and search for big-potential oil and gas in areas subject to more geopolitical unrest and risk, such as West Africa. As an example Apache Corporation, which has spent \$1.3 billion to buy North Sea and Gulf of Mexico assets from BP, can use the newest technologies to drill and optimize an existing field and double the rate of recovery, industry experts have commented.

An interesting view of the industry potential comes from Accenture [8] : "data-management software and Internet-based technology has become an integral part of the business for Oil and Gas companies. An Oil and Gas company that fully utilizes second-wave technologies to streamline its back-office and process support technologies could reap a reduction in selling, general and administrative (SG&A) costs in the range of eight to 10 percent. For a typical,

large Oil & Gas firm, SG&A costs represent an estimated 10 percent of the total enterprise costs. Thus, a 10-percent reduction in SG&A outlays would reduce overall corporate spending by 1 percent; a major gain, given that these savings would drop to the bottom line”.

In a CERA study entitled "Global Oil Trends 2003" researchers found that global oil demand in 2002 increased less than 20,000 barrels per day - the weakest growth since 1983. World oil production fell for the first time since 1999. This shows that although overall trends are upwards, and changes are dramatic, in the Oil & Gas business, companies must be structured to respond to dynamic business climates. Overarching the tenuous balance between supply and demand fundamentals in the middle of 2004 are the same geopolitical and military tensions that greeted oil markets early in 2002.

Also of note, estimated world proven oil reserves grew by 181 billion barrels from year-end 2001 by 2003. The growth can be primarily attributed to heavy oil in the Canadian Alberta Oil Sands, amounting to 175 billion barrels, that had gone previously unreported. The Oil Sands themselves will dictate new and improved hardware and software technologies to make extraction a viable opportunity. In addition, though the average price of West Texas Intermediate crude in 2002 posted the narrowest percentage change since 1970, the commodity's price fluctuated wildly from quarter to quarter in 2002. In the first quarter of 2003, crude averaged \$21.54 a barrel but swung to \$28.29 a barrel by the third quarter.

LNG will play a substantially larger supply role in the global energy markets through 2004 and onwards. Demand for natural gas in North America is projected to increase to 33 trillion cubic feet in 2020 from its current level of 22 trillion cubic feet. This is a 50 percent increase. That said, the U.S. consumes a third of the world's natural gas every day but has less than 2 percent of its reserves. So where's the supply to come from? "Our view is that LNG is required," has stated Hal Kvisle, president of TransCanada Pipelines. "The U.S. and Canadian supply basins will be challenged by growth and can't meet demand. The emergence of competitively priced LNG signifies that North America is entering the global gas market." LNG is predicted to supply up to 11 percent of total market demand by 2010. Today, it makes up 0.1 percent of the supply.

A graphic example of the changing Oil & Gas market is that in the US in the next 7 years; in all, natural gas demand is expected to increase by 14 percent by 2010, while U.S. production will be 6 percent lower. Sluggish drilling in North America did pick up in the last two years, but it won't be enough to stem the long-term decline in North American natural gas production. Much more needs to be done to extend and enhance existing facilities and recovery patterns. Much the same is true of North Sea production rates and reserve quantities. This will require that existing terminals need to be expanded and new terminals built, though investors would have to make a significant commitment to providing capital resources. Gas is moving closer to being a global industry. "The geographical dislocation of reserves to market is being partly mitigated by new cost-effective ways of linking stranded fields and customers with significant progress on integrating supply and demand" said Martha Carnes of Oil & Gas Insight.

The Oil & Gas industry will need to demand leaders in the highly technical upstream processes and modelling software, at the heart of the petroleum industry, contribute new and innovative solutions in exploration and production. In reality the cost of finding and producing hydrocarbons has dropped substantially over the past 15 years, but new technology is required to further ensure that this pace is accelerated and that the smaller size of new finds are still economically viable.

The Digital Oil & Gas Field

Oil and Gas producers are looking to integrate global operations and the energy supply chain into a cohesive picture including exploration and production, distribution, marketing and sales, even trading, financial and fiscal & environmental reporting activities. A global enterprise resource planning (ERP) system gives companies the resources they need to better balance supply with demand, reduce inefficiencies and redundancies, and lower the total cost of IT infrastructures. The challenge is to develop overlay solutions with more domain content that can improve the knowledge inside the enterprise systems that producers depend on most for operations, planning, project management, workflow, document management, executive

information and decision support, scheduling, database management, data warehousing, and much more.

The Oil and Gas industry continues to demand the need for increased efficiency coupled with higher oil and gas recovery, improved productivity, and lower cost. The industry must capitalize on the opportunities provided by ever more capable and cost-effective digital technology. An important new result of this convergence has been an emerging vision of the "Digital Oil Field of the Future" or the "i-Field", "e-Field" or "x-Field". Although most Oil and Gas companies have a particular line (or two!) of thinking for the Digital Oil Field most do agree that it is the pursuit of innovative, but practical and cost effective, approaches to improving and potentially transforming reservoir production and management against the background of volatile oil prices, a weakening economy, and the "downsizing" of the E&P workforce.

The Digital Oil Field of the Future (DOFF) will enable next generation reservoir performance. DOFF is envisioned to offer decision makers a comprehensive framework for pragmatic yet forward-thinking, business insight that can be used in strategic and operational planning, to ensure faster, more reliable decisions. DOFF promises optimized asset performance through enhanced data integration and knowledge management, analytical tools, real-time systems, facility monitoring and business monitoring. However, CERA reports that the full potential may be constrained by pressing business, technological, and organizational challenges that, unless overcome, will diminish the DOFF's scope and impact.

CERA also reports that expanding the use of new-generation digital technologies can potentially increase world oil reserves by 125 billion barrels — an amount greater than either Iraq's current reserves or the combined reserves of Latin American countries. The DOFF technology that the industry reports as the next wave of value creation include remote sensing, production visualization, intelligent drilling and completions, facility automation, modelling and data integration. "To achieve this the core will need to be a vastly improved set of tools that will enable Oil and Gas companies to see reserves more clearly, plan optimal drilling and production strategies, and manage operations more efficiently," says William Severns, CERA's research director

Many tools based on these technologies are either already in use in the Oil and Gas industry, or will be commercially available within the next 3 to 5 years. With these capabilities, companies may be able to increase the amount of Oil and Gas recovered from a given field by 2 to 7 percent, reduce lifting costs by 10 to 25 percent and increase production rates by 2 to 4 percent, reported CERA in the industry wide study conducted to investigate the DOFF.

The revolution in digital technologies could well transform the dynamics of world oil and gas supply at a time when the industry faces major choices on investment. Achieving the vision of the DOFF will require more than new technologies alone. It will require the alignment of strategy structure, culture, systems, business processes and, perhaps most important, the behaviours of people. Visionary companies who truly want to capture the "digital value" will need to create a climate for change, and then maintain strong leadership through the change and employ the skills and techniques from leading software and service organizations.

Deploying the Digital Oil Field of the Future

There are three likely scenarios of the deployment of The Digital Oil Field of the Future as seen by CERA:

Scenario 1: Business as Usual - Digital technology, information, data and models is used in an incremental way to reduce costs, increase recovery and improve production, but no fundamental changes are made in business models, competitive strategies or structural relationships.

Scenario 2: Visionary - Those Oil and Gas companies who can best adopt and apply digital technologies, and concepts, will use them to gain significant competitive advantage. This will involve significant investment in software and IT technologies along with culture and management change.

Scenario 3: Vendor Relationship — A new set of large E&P companies, potentially including former state oil companies and national oil companies, use the availability of turnkey solutions to optimize production and leverage into larger industry positions. This will involve the use of third party technology consultants and solution partners in an unprecedented way.

For most Oil & Gas companies an evolution approach that blends all three scenarios may well be the chosen route. In most cases the three level implementation approach, of Figure 3, for the Digital Oil Field of the Future, will match the development of a stepwise architecture within the Oil & Gas company systems. The foundation of the DOFF is engineering simulation, with integrated asset models and portfolio views of the business built on top. At the heart of the digital revolution in the upstream energy industry is a shift from historic, calendar-based, serial processes to real-time, parallel processes for finding, developing and producing oil and gas assets. Real-time data streams, combined with breakthrough software applications and ever-faster computers, are allowing the creation of dynamic, fast-feedback hydrocarbon reservoir, production and facility models. These dynamic models, running in conjunction with remote sensors, intelligent wells and automated production and facility controls, will allow Operators to visualize, like never before, what is happening in the subsurface and surface facilities and accurately predict what needs to happen next to maximize production and efficiently manage field development. For Offshore Operators this technology revolution will lead to the efficient de-manning of offshore systems and the realization of remote offsite monitoring and control, in many cases from field offices, onshore, managing several offshore fields from one control room. This can only be done with advanced asset management technologies, combining a number of traditional discipline roles.

The following is an interesting anonymous industry quote that summarises the current thinking of Oil & Gas modelling: “in the near future, modelling and simulation will represent a new way of doing business. Modelling and simulation is migrating away from the exclusivity of experts to a ubiquitous collaboration tool for non-technologists such as Operations and Managers who make everyday production, operational and business level decisions.”

Digital Oil Field of the Future Technologies

Figure 4 shows the overview technologies and capabilities required of the DOFF.

Visualization, from reservoir through facilities for both daily operations and long term business development will play a large role in the DOFF. Already in the Drilling disciplines the 3D large format rendering of complex data sets enhances the field development planners' ability to optimize well placement and well paths, to identify areas of bypassed oil and to minimize group time-to-depth errors. This kind of visualization is now extending to the daily production operations teams in the form of Operation Centres via portal technologies. The DOFF technologies accelerate the rate of recovery of hydrocarbon and reduces finding, development and lift costs. Figure 5 shows an example of the visualization portal abilities of today's internet based consoles. Technical and business data of the asset are displayed on a polar diagram indicating soft and hard key performance indicators that are in line with required performance and those that need immediate attention. The intention here is that all disciplines are able to view the same high level performance of the asset key performance indicators.

A major area of the DOFF, already widely in place, is that of intelligent drilling and completions. 'real-time' subsurface data acquired during drilling operations is used to maximize reservoir penetration by steering the well path and is also to avoid drilling problems. Down hole sensors (e.g., temperature, pressure, multi-phase flow) and flow control valves installed during the completion stages help to optimize well productivity, enabling operators to identify zones of early water breakthrough and injection inefficiencies, and to control flow in these zones by adjusting choke levels. When applied in conjunction with other technologies, such as remote sensing, the recovery may be boosted by up to 7 percent for the reservoir over field life.

The next big wave of DOFF value will be obtained from enhanced and full field automation. Monitoring and remote control technologies, which are already mature and widely used in

downstream, enable automated data gathering, data reconciliation and gross error detection before passing to surveillance and optimization technologies for maximum performance and automatic alarming. A number of these types of systems have begun to appear in the operating control room of the forward thinking Oil and Gas companies. Some examples are covered in the next section. The extent of the technology deployed, today, covers dynamic facility and pipeline simulation predicting slug flow and hydraulic surge problems some 12 hours before they ever could appear and upset process and transmission specifications. In the main, these technologies will be located in control rooms and will act as early warning systems and ‘the silent operator’ watching closely for, as yet, undetected problems. In the future full, closed loop, advanced process control systems will self-tune production systems so that automatic and predictive operation of the production equipment will yield the elusive 100% uptime record.

Data integration and visualization will continue to be a key area of focus throughout the next few years in digitizing the asset. Many new applications will bring knowledge gleaning ability from the data collected. However the collection and management of the information about the reservoir, down hole conditions, flow line network and facility will need to be aggregated and transported to get the right information to the right person at the right time, producing a data platform for knowledge based decision making.

Oil & Gas model based asset management techniques will begin to play a major role in the DOFF in bringing the predictive power of the production engineering toolset to the real time data platforms discussed previously. Process and production simulation models will move from the domain of the engineering expert to be used by Managers, Operators, Business Development, Contracts and Finance. The analysis and prediction of near real time and future asset performance becomes a reality in the world of model based asset management. For this the complete integrated asset from sand face to transmission systems will be modelled dynamically in real time for both slow rigorous, and fast proxy loop modes.

Production optimization techniques, traditionally used in downstream processing will be deployed in the Oil and Gas business for the offline and online closed loop optimization of gas plants, flow line systems and production facilities. These optimization applications will be deployed on top of the domain accepted production and process simulation applications. A large number of production gas lift applications have shown gains of over 12% in equivalent production from the use of optimization technology with well, network and facility compression and separation simulations.

Production planning techniques, including Linear Planning (LP) and Mixed Integer Non-Linear Planning (MINLP), again traditionally used in downstream processing, will be deployed in the Oil and Gas business alongside traditional MS Excel techniques for a resulting, new generation, model based approach to planning. This innovative approach will allow Gas Dispatch Teams, as an example, or Production Planners to perform fast profit meter, planning analytics for the entire asset.

All of these technologies will be integrated together to form a solution orientated, role based system for the management and development of the oil and gas field.

So what technologies are enabling this fast paced change in the industry?

Production and Facility Simulation Comes of Age

Firstly production and facility simulation has come of age. The ability to predict very complex facility simulations in both steady state and dynamic mode has been achieved by continued integration of thermodynamic methods, hydraulic simulations and unit operations. As an example Figure 6 shows the complete simulation of an MDEA / CO₂ system for a packed column as achieved by new thermodynamic systems built into the process simulation technology [4]. Facility simulation has progressed far such that dynamic start up and shut down simulations have become routine and trusted among the engineering community. Figure 7. shows an actual Wobbe Index trace over the period of a few hours compared with the dynamic simulation run from the initial conditions of the unit; an excellent agreement is obtained with reality and the dynamic simulation. So much so, that one can begin to think of the dynamic simulation as a "Virtual Plant" for operational, advanced process control and business analysis by a number of different departments. A number of Oil & Gas Operations staff have been known to ask "why do we need a model". The cartoon from J Klossner [5] in Figure 8 answers this question perfectly. It was phrased even better by Jim Trainham of Dupont: "If you can't model your process, you don't understand it. If you don't understand it, you can't improve it. And if you can't improve it, you won't be competitive in the 21st century."

Integrated Asset Models Become A Reality

Oil & Gas facilities simulation, control, optimization, operator training, collaborative engineering and planning disciplines, have a rather fragmented application of a number of associated technologies. In partnership with a number of key vendors the Oil & Gas business is seeking the promise of optimized asset performance through enhanced data integration and knowledge management, look forward analytical tools, real-time systems, facility monitoring, business monitoring and portfolio score carding. The first step is the adoption of Integrated Asset Models that use comprehensive existing applications that are integrated together by a common 'glue' layer allowing a full model from reservoir to consumer of even reservoir to reservoir.

New concepts are appearing from the software community in the form of workflow solutions that enable oil and gas assets to be modelled from a suite of selected software adaptors that include facilities, wells and hydraulics network solvers and can bring data from all these disperse and third party tools into one common environment, creating the Integrated Asset Model. One can then apply engineering and business applications to identify asset-wide improvement opportunities. An IT architecture, based on Microsoft.NET is proposed to handle the distributed computing and web services requirements to match the different tools within the Integrated Asset Model, with the required data sources and server nodes to execute the required solutions. CIM-I/O drivers are required to allow the models to map to on-line plant tags from DCS, PLCs and SCADA systems, etc plus SQL driver sets are needed to map Field Data Capture Systems and contract databases. A full suite of optimisation mathematical solvers (LSSQP, MINLP, LP, Neural Networks, etc), proven downstream, are then expected to deliver the advanced production optimization and planning capability to solve complex optimisation problems involving both continuous and discrete planning and forecasting events. The Microsoft .NET technology in the asset model allows published data to be subscribed to by other applications; an example being embedded EXCEL to create views, reports, interfaces, etc.

So What Is The Microsoft.NET Framework?

The Microsoft® .NET Framework [6] is an important new component of the Microsoft Windows® family of operating systems. It is the foundation of the next generation of Windows-based applications that are easier to build, deploy, and integrate with other networked systems. Most consumers will never notice that the .NET Framework is running on their Pocket PC, smart phones, or desktop computer. But they may appreciate the reliability, ease of use, and ability to connect to other systems that the .NET Framework helps bring to computers.

The .NET Framework helps software developers and systems administrators more easily build and maintain systems with improvements toward performance, security, and reliability.

The .NET Framework simplifies Windows software development. It provides developers with a single approach to build both desktop applications—sometimes called smart client applications—and Web-based applications. It also enables developers to use the same tools and skills to develop software for a variety of systems ranging from handheld smart phones to large server installations.

Software built on the .NET Framework can be easier to deploy and maintain than conventional software. Applications can be designed to automatically upgrade themselves to the latest version. The .NET Framework can also minimize conflicts between applications by helping incompatible software components coexist.

The key advantages of the .NET Framework in the facilities area, are that it helps

- IT professionals better integrate existing systems with native support for Web services.
- Assists with the deployment of software to both users and Web servers.
- Facilitates the development of software with improved reliability, scalability, performance, and security.
- Helps developers be more productive by:
 - Making it easier for them to reuse existing code.
 - Enabling them to more easily integrate components written in any of the more than 20 supported programming languages.
 - Helping them more easily build software for a wide range of devices using same skills and tools.

The software vendor community, by developing solutions based on a web-based architecture enabled by .NET, and accepting such standards as WITSML from POSC within a .NET architecture will be able to expand the scope for integrated modeling to significantly improve operations and increase value for oil & gas companies.

Visualizing the Results

Building on the Integrated Asset Model many Oil & Gas companies are looking for a portal environment that will allow multiple asset models to be visualized, compared and analyzed with distributed data sharing and events management, via proven and accepted enterprise platform message bus technologies, such as that available from TIBCO. Key visualization and workflow technologies required include; look forward analytics, production scorecard, workflow management, production reporting, capital planning and scheduling that can be performed on a uniform, company wide, basis and allow for rapid, informed decision making. Figure 9 shows an example of such a visual system as used by ADMA OPCO in Abu Dhabi for planning and scheduling of the Umm Shaif offshore field with flaring and environmental drivers, that uses a number of models underneath, connected to field data [7]. ADMA OPCO have the following requirements of the enterprise planning system:

- Should run a year plan in under 1 hour
- Use best available technology
- Must be robust
- All data input and output via a Graphical User Interface (GUI)
- Low-pressure gas and condensate errors should be less than 5%
- Should have both Steady State and Dynamic capabilities
- Must allow for easy upgrade and inclusion or modification of facilities
- Must run on desktop computer
- Must automatically generate production-planning reports

ADMA OPCO are certainly forward thinkers in the deployment of engineering simulation, asset models and portfolio visualization but this type of technology must be adopted by all Oil & Gas companies as part of the process of extracting incremental value from the next generation DOFF.

The People Factor

The Oil & Gas business for Operators, E&C's and Consultancies has become a fast paced, challenging environment where business and technology thrive together. An oil price moving from \$9 to \$30 per barrel in the space of 12 months provides a climate of change and opportunity. Major recent changes in the Upstream Business include:

Technical	Managerial	Information Technology
Horizontal wells	Asset based management	Real time seismic
Coiled tubing	De-layering	Complex reservoir simulation
Ship based production	De-manning	Network communications
Multiphase flow lines	Alliances	Process data historians
Sub sea enhancement	Parallel engineering	Smart well technology
Coupled simulation models	Integrated teams	Advanced control systems
Deeper, smaller, harder reserves	Mergers	Internet

Major petroleum engineering advances in well & tubing techniques along with ship based production, multi phase flow, integrated production system models and deeper, smaller & more contaminated reservoirs, are at the forefront of the technical revolution. Removal of significant cost layers with mergers and risk sharing through alliances, together with multidiscipline parallel engineering teams have become standard management practice. The information technology revolution means that a manager or engineer want to see real time process information, real time performance and real time profits. All of this is information that can be harnessed in the DOFF approach.

These drivers translate into a key number of DOFF activities that must be built into the Oil and Gas company workflows and performed.

For instance for Facility Engineering these would include:

- Production Facility Controllability
- Production Facility Start-Up
- Production Facility Shut-Down
- Production Facility Flaring Analysis
- Production Facility Flow Assurance

And for Asset Management the DOFF includes strategies for:

- Production Asset Optimization
- Production Asset Planning
- Production Asset Forecasting
- Production Asset Control
- Production Asset Surveillance
- Production Asset Reliability

And for Portfolio Management a DOFF strategy for the following must be developed and deployed:

- Production Portfolio Portal
- Production Portfolio Scorecard
- Production Portfolio Workflow Management
- Production Portfolio Reporting
- Production Portfolio Collaboration
- Production Portfolio Planning
- Production Portfolio Scheduling

The Oil & Gas business, although somewhat behind downstream, has now realized the importance of the DOFF in the asset and portfolio performance space. The requirement is for an integrated asset model that provides the synchronization between the oil and gas reservoir and the process facilities, driving the true value from pore to pump. Allowable production gains upwards of 5% in throughput, associated increases in asset ROCE of 3-5 percentage points and engineering efficiency gains of above 30% have been noted by a number of Operators. But the warning signs are apparent. Many production optimizers commissioned in the past are now switched off and mothballed. Many planning systems are dead. Why? Because the people changed or the facility changed and there was no built in work flow to ensure that the integrated asset models changed with them. It is the author's opinion that role based visualization, at the pinnacle of the DOFF, will ensure that the underlying models and technology are kept up to date through the demand of daily use and the number of users that access the underlying applications. Role based visualization and internet portals may well be the saviour of the Integrated Asset Model and the guardian of it's deployment across multiple disciplines.

The Value of DOFF

In the report CERA detailed the value of the DOFF [2] techniques, from real experiences of the operating community as follows:

Field Type	Base NPV (Billion US\$)	NPV Increase of DOFF Approach (Million US\$)
Greenfield Shallow Gas	1.5	100
Brownfield Shallow Gas	0.803	7
Greenfield Deep Water Oil	3.7	505
Brownfield Deep Water Oil	1.78	190

Conclusion

Oil and Gas production is a complex industry in terms of assets, operations, planning and capital investment decisions. Nothing is ever constant as reserves deplete and new discoveries are brought on stream. Process equipment is continually required to manage changing production profiles that it was not initially designed for. The financial landscape of an oil and gas company is just as complex and uncertain with the ever changing oil and gas prices, and multiple joint partners to communicate with. The concept of the DOFF in oil and gas has strong application in linking the Engineering to Business streams, and maintaining communication and decision support with disparate asset bases and joint partners. The use of many of the techniques highlighted in this paper will ensure the industry can:

- Determine the optimal size and location of compression facilities by analyzing the combined effects of fuel consumption, capital costs, market parameters, and reservoir performance over the life of the field
- Optimize well delivery rates to maintain gas nominations, while minimizing flare rates and power consumption

- Improve product recovery (e.g. Ethane & LPG) and processing contract management
- Forecast and allocate gas production
- Forecast and allocate oil production
- Determine lift-gas allocation rates that will maximize production from all of the wells in the gathering network
- Optimize sub-surface choke settings based on constraints located in the surface facilities
- Provide operational visibility to avoid potential undesirable or hazardous operating conditions (e.g. Slugging)
- Determine uncertainty and manage risk

The DOFF concept does away with existing 'silo-based' decision-making processes and enables the personnel across an Oil and Gas company's value chain to access a common set of data and models to make faster, more profitable decisions. Built on user-based consoles, and a workflow integration platform tailored to meet the unique requirements of Oil & Gas operations, the DOFF provides Oil & Gas companies with a new set of capabilities to achieve operational excellence. The goal is the ability to make informed decisions and profitably execute across Oil and Gas assets, leading to substantial improvements in return on capital employed (ROCE) and operating margins with the reduction of finding, development, lifting and processing costs. The author encourages Oil & gas companies to develop, test and implement a DOFF vision for their own organizations in a step-fashion suited to the cultures and goals of the company. DOFF may prove to be key differentiator for those Oil & Gas companies that prosper in the new digital age.

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http://www.accenture.com/xd/xd.asp?it=enweb&xd=industries%5Cresources%5Cenergy%5Cnews%5Cener_news_global.xml

APPENDIX

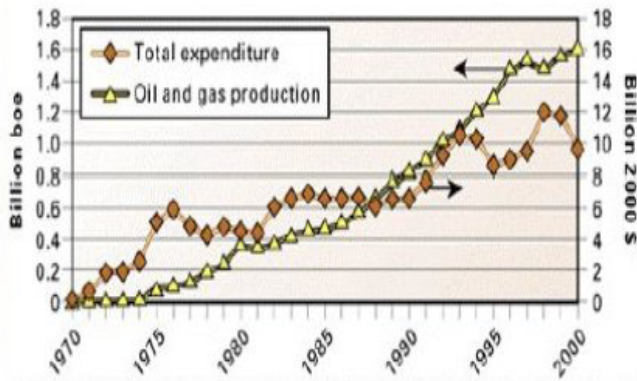


Figure 1. Norwegian Oil & Gas Expenditure. Source: The Norwegian Petroleum Directorate.

Total Shipments of PSO Software and Services (Millions of US Dollars)

CAGR = 8.5% Percent

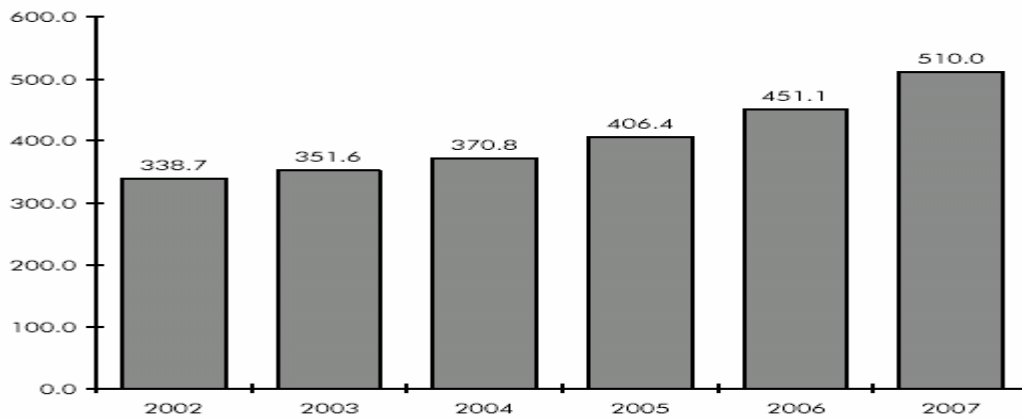


Figure 2. ARC Predicted Process Simulation & Optimization Spend for the Process Industries. The Predicted Growth in Oil & Gas, Alone, is 30% Over the Next Four Years.

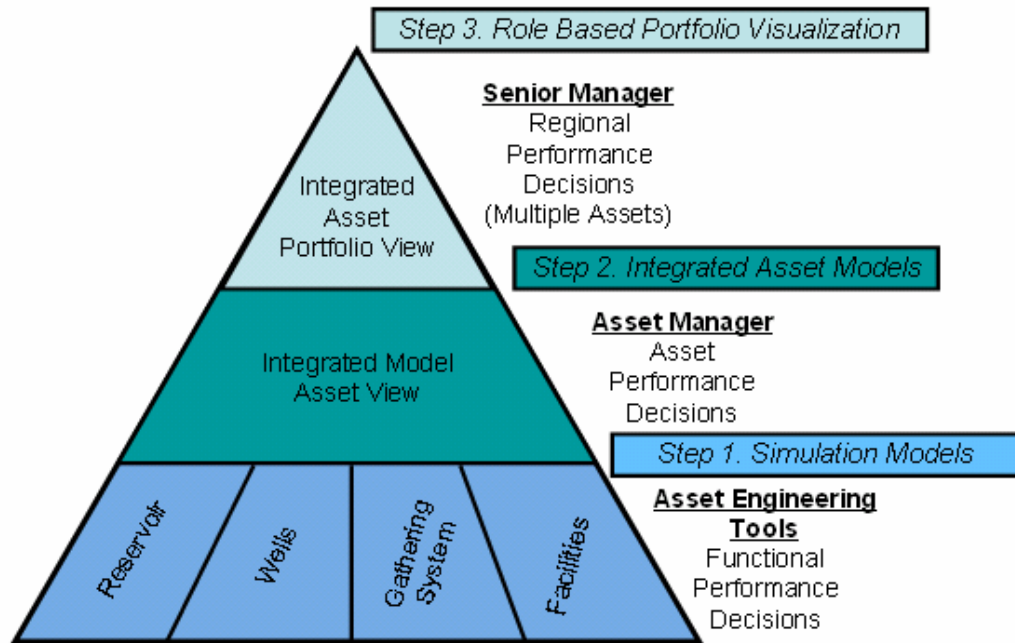


Figure 3. A Three Level Implementation Phase for the Digital Oil Field of the Future. The Foundation is Engineering Simulation, with Integrated Asset Models and Portfolio Views of the Business.

Digital Oil Field - Portal Visualization
Production Scorecard
Portfolio Management System
Oil & Gas Workflow Engines
Contract & Maintenance Scheduling
Allocation & Accounting
Contract Analysis
Economic Analysis
Operator Training
Advanced Process Control
Optimization
Forecasting
Surveillance
Integrated Asset Model
Reservoir, Production & Facility Simulation
Data Visualization
Data Analysis
Data Validation
Data Storage & Field Data Capture
Real Time Data Acquisition

Figure 4. The Technologies and Capabilities Required of the Digital Oil Field of the Future.

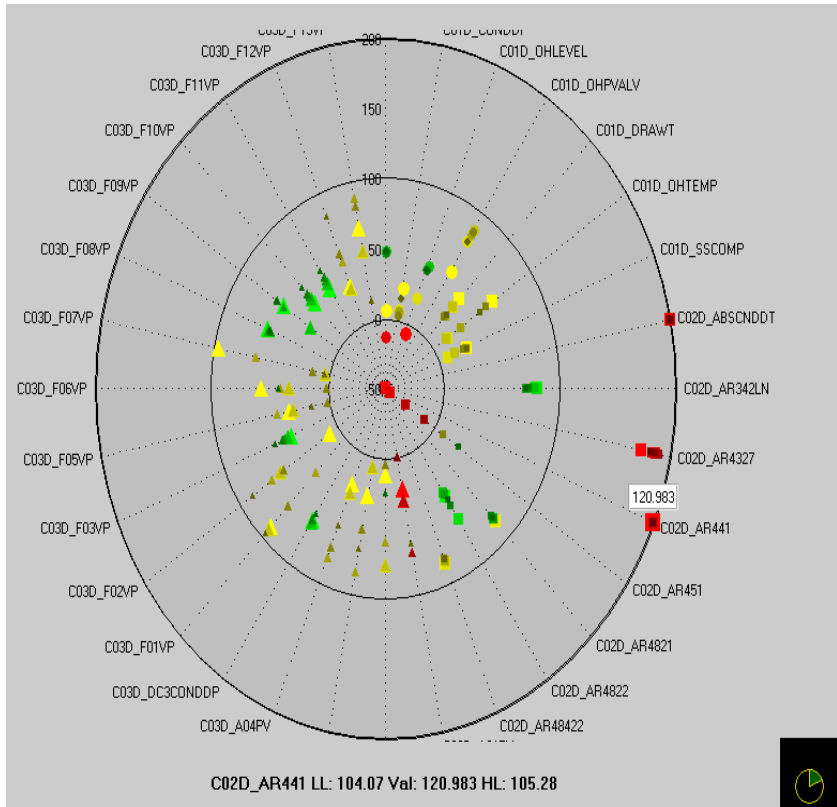


Figure 5. A Operations Control Room Polar Diagram of Asset Technical and Business Parameters for Fast Visualization and Decision Making.

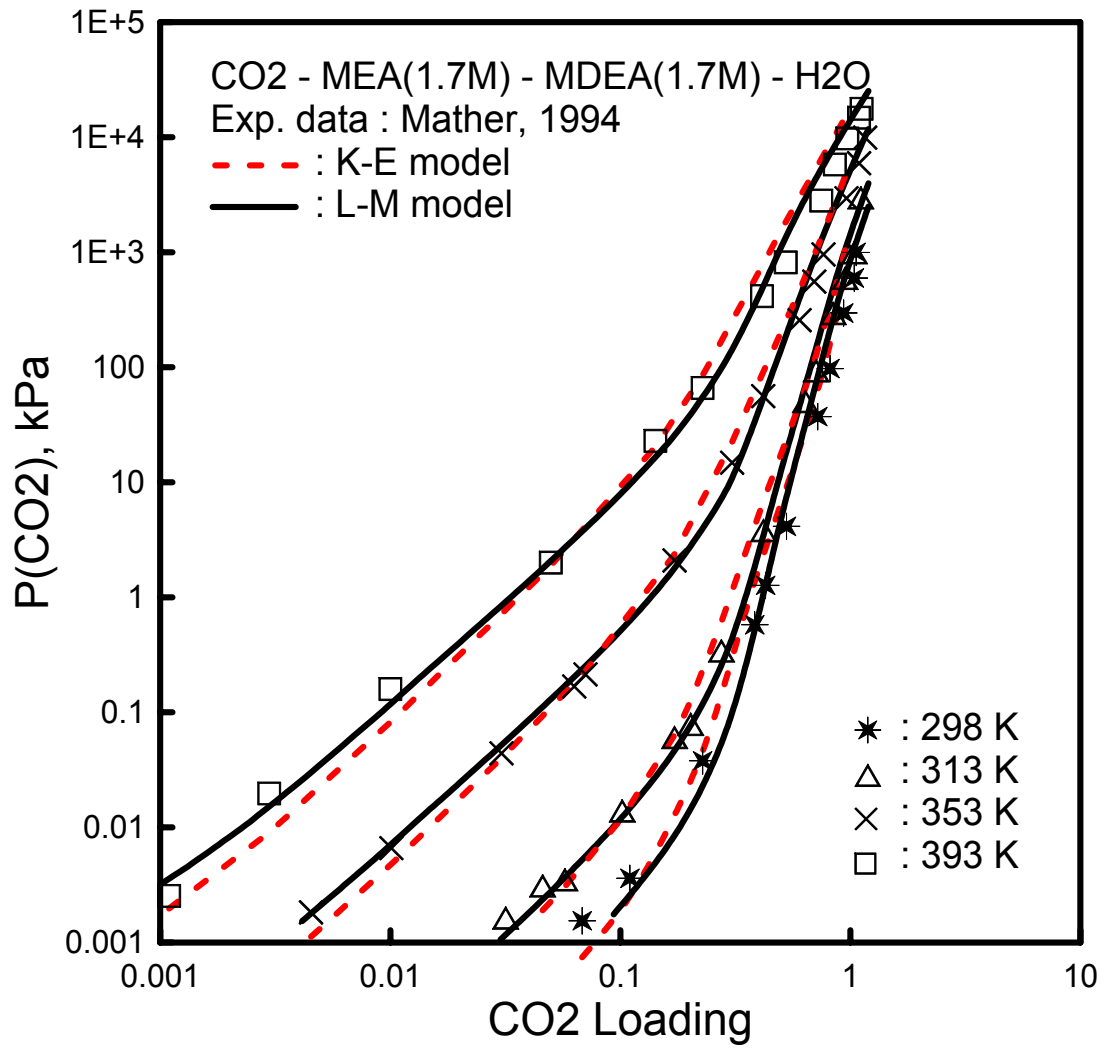


Figure 6. A Rigorous Simulation Method in HYSYS for Gas Sweetening Process using Packed Columns. Jian Chen, Gordon Zhao and Dan Zhang, Schlumberger, AspenWorld2002 Washington, DC, Oct. 27 - Nov. 1, 2002.

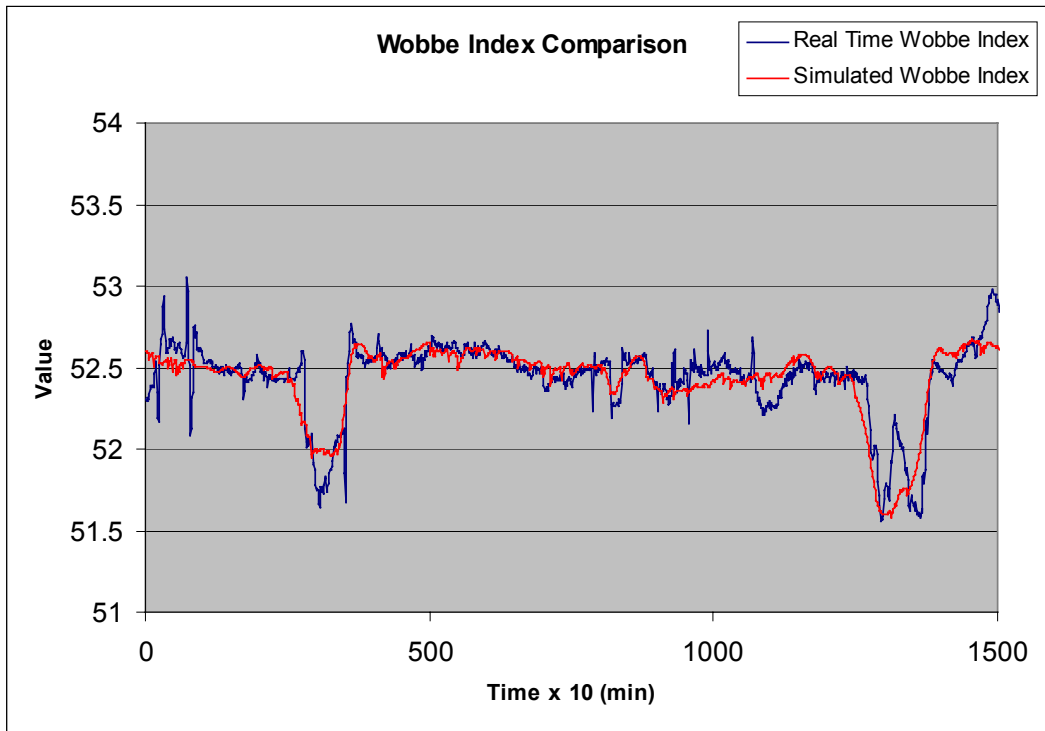


Figure 7. Wobbe Index Comparison of Real Time Measured vs HYSYS Dynamics Simulation Run for Several Hours From Initial starting Point for a North Sea Gas Asset.



Figure 8. Smooth Sailing from www.jklossner.com

