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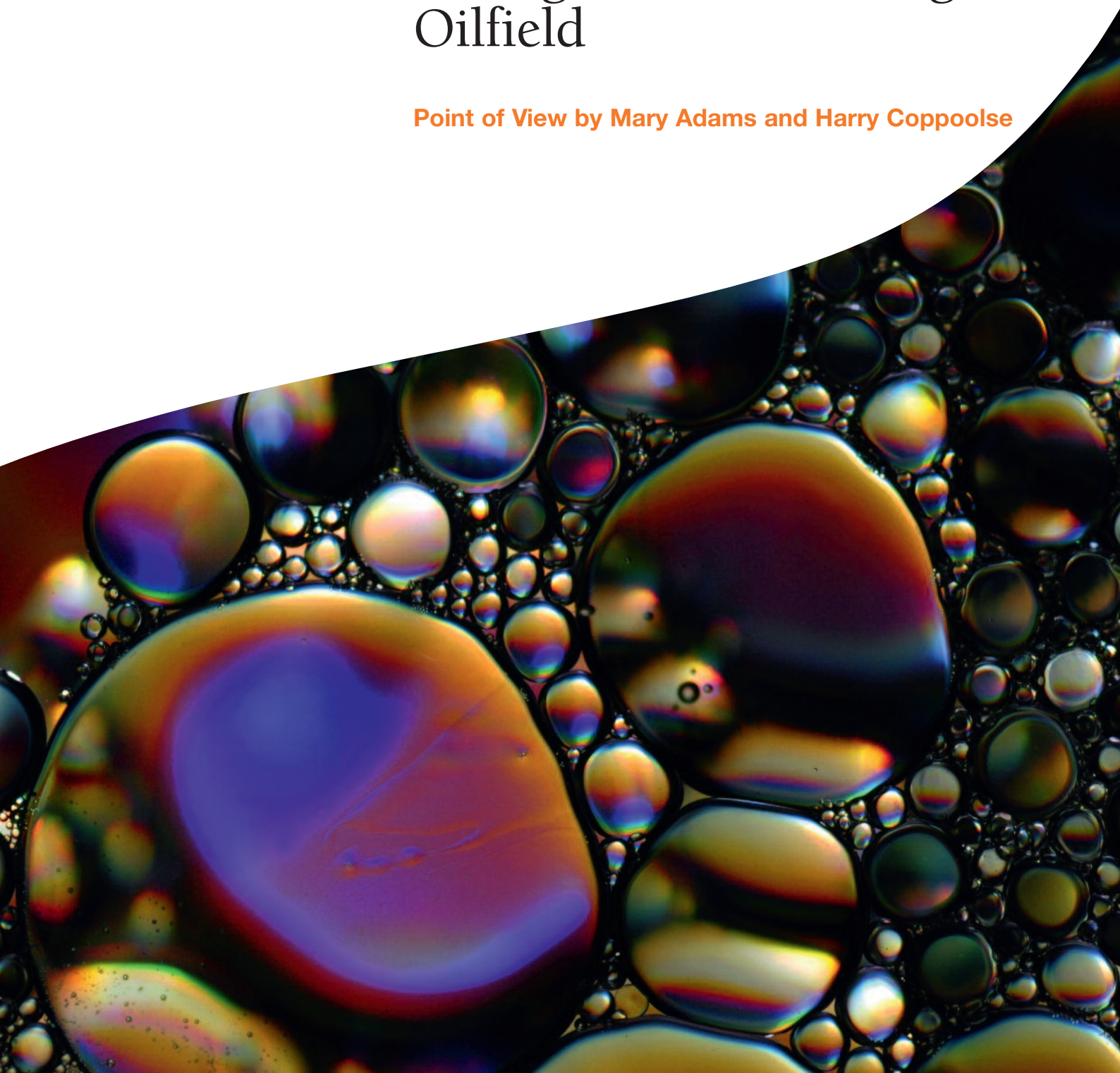
When Data Worlds Collide: E&P Content Management in the Digital Oilfield

Point of View by Mary Adams and Harry Coppoolse



Just as astronomers have discovered new planets, black holes and cosmic events in our celestial universe – the oil and gas industry has discovered the data that forms the center of their universe has expanded, exploded, and parts have even imploded. Data can now be considered content that takes various shapes and forms: paper, electronic, 2D, 3D and 4D models, documents, spreadsheets, web content, messaging, photographs, video, and sound. Statistically, this universe of data is not really helping companies to explore and produce on a new scale that is safer, more efficient and strategic. It is in fact a costly, time-consuming data management nightmare to access, use and trust data. So why is finding a trusted version of data as hazardous as navigating through an asteroid storm?

In today's competitive exploration and production (E&P) atmosphere, the ability to exploit E&P data is key to make informed, actionable decisions that support the vision and business strategy. How a company uses its E&P data can be the difference between average performance and competitive advantage. Good data enables consistent processes; deeper levels of collaboration; faster, better decisions. It is the ability to link strategic portfolio decisions to tactical optimization decisions. More importantly, data is rapidly becoming the pivot point for environmental and safety actions. But just how dependable is the *"data"* cornerstone at most E&P companies?

Many oil and gas companies segregate data management initiatives into data layers or *"worlds"* and fail to see the big picture. E&P data is in sight, but out of governance scope. What is the business impact? Is the industry looking at its data through the wrong end of the telescope?

Different Data Worlds – Inhibitors to Value

Companies tend to segregate their content into different *data worlds* that do not necessarily interact with one another and therefore fail to achieve integrity and maximum business value. Consider the distinctly different users and uses of data across a typical company:

- Enterprise data is owned and maintained by the organization. Applications and systems are version-controlled, consistent, stable and maintained by IT departments. This can include ERP systems pertaining to finance, purchasing and accounting, human resource, email, HSE systems, Intranets and Internets. Typically, this data is owned by departments, project teams or individuals and duplicated multiple times.
- Documents can vary from reports, forecasting spreadsheets, presentations, physical paper, meeting minutes, R&D, to documents associated with major capital projects and engineering. Users comply with company-selected application suites such as Microsoft® Office Suite and Adobe®, although individual and departmental customization is possible through templates, macros, etc.
- Exploration data is geological and geophysical information. This data is the basis for making decisions

about acquisition, evaluation and drilling programs. It can be defined as well information such as headers, positional data, logs, reservoir pressures, well tests, time-depth data, casing, core, stratigraphic, petrophysical and other interpreted data such as reservoir simulation models. Typically, this data is owned by engineering functions, project teams or individuals.

- Production operation data is a continuous stream of measurements from the monitoring of equipment, fluid flows, distributed temperature and parameters at a plant or drilling site. Often there is a direct link into ERP via CMMS[1] systems, to incorporate the flow of data. Real-time drilling includes software to remote monitoring, modeling, and controlling processes to optimize drilling while increasing safety and reducing risk.

Each of these data worlds comes with its own unique management challenges. Each has its own intricate subsystems and plays an important role in an organizational infrastructure. The content each world produces is used for different purposes, in different formats, with different life spans. This creates disconnected information management silos comprised of multiple versions of content dedicated to different organizational groups.

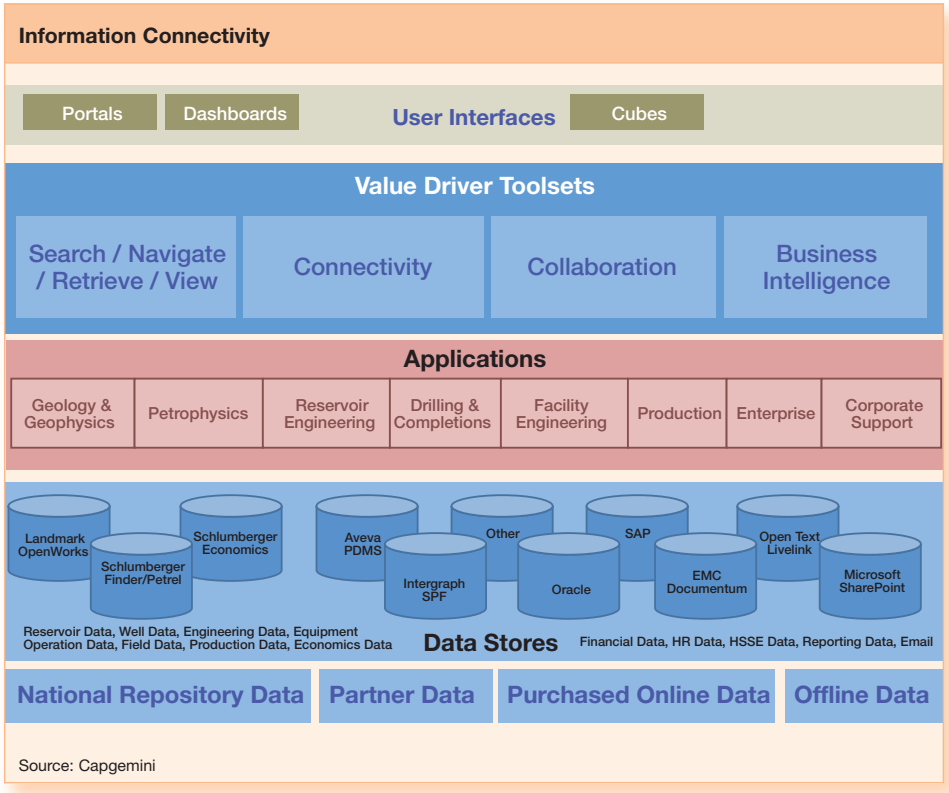
How can a company ensure compliance, integrity and accessibility from one data solar system to another? Continually evolving technology will continually increase the amount of data at every level within a company. If content management processes are not aligned and governed, this data explosion will eventually expose companies to greater risk, higher cost and diminished data integrity. What happens in the digital oilfield when the worlds collide?

Future World – Continuous Data Integrity

Data integrity can enhance the value of E&P data to gain efficiencies, reduce cost and make better decisions. Imagine a new data landscape based on content rather than data silos. Maximum value is derived from information connectivity using integrated tools that stretch across all data worlds.

The figure below shows the concept of the information connectivity landscape, supported by an underlying pillar of data integrity.

The figure shows that the right information can be connected at the right time to the right users via role-based interfaces that are based on relevant information and access control. Value driver toolsets can then help users maximize data mining, manipulation and decision-making.



Source: Capgemini

1 Computerized Maintenance Management System

The drivers can be defined as:

- Accessibility; the ability to perform global view/search/navigate/retrieve functions based on roles. This can provide significant productivity.
- Collaboration; based on teams being able to see the same data and documents in real-time to make better, faster decisions as a collective group –*on surface and subsurface data and co-authored documents*. This collaborative platform can include software, hardware, processes and facilities.
- Connectivity; integrated processes and data sharing between databases and applications, based on business process management.
- Business intelligence tools; these can be applied to rapidly analyze content, collaborate and develop data warehouses when all data is accessible, shared and connected.

Imagine a company that views its data landscape through this new connected landscape. A typical work day might include the following activities:

A team meets to discuss a drilling program. They open a production cube and are able to view the license information, pertinent email communications and information from the legal and finance departments, and trusted versions of well logs and other subsurface data concerning the area.

An engineer sits at a workstation to consider the best way to do a work-over. Using business intelligence tools, the engineer has access to the financial data from the corporate financial system and operational data coming from production monitoring systems.

A petroleum engineer needs to do fracturing optimization. The job is performed efficiently through the ability to search and access data from different databases without the need to open applications, export and load data.

A New Concept of Content Management

Data can now be considered content that takes various shapes and forms. For years, the marketplace has offered many types of innovative electronic document management systems (EDMS). However, there are very few products that include E&P data management, which pushes the three data worlds further apart. But what if the best practices from the EDMS systems could be applied and adapted for E&P content management?

This paper proposes that oil and gas companies should embrace a new concept of global content management to develop a vision and governance structure that can extract the most value from their E&P data for today and into the future.

Data Integrity Factors – Building Value

A critical success factor in the Future World scenarios is the underlying data integrity that enables multi-functional connectivity. Quality management, assurance policies and procedures are crucial, but improved content management can also play a vital role. Four key factors can form the integrity foundation:

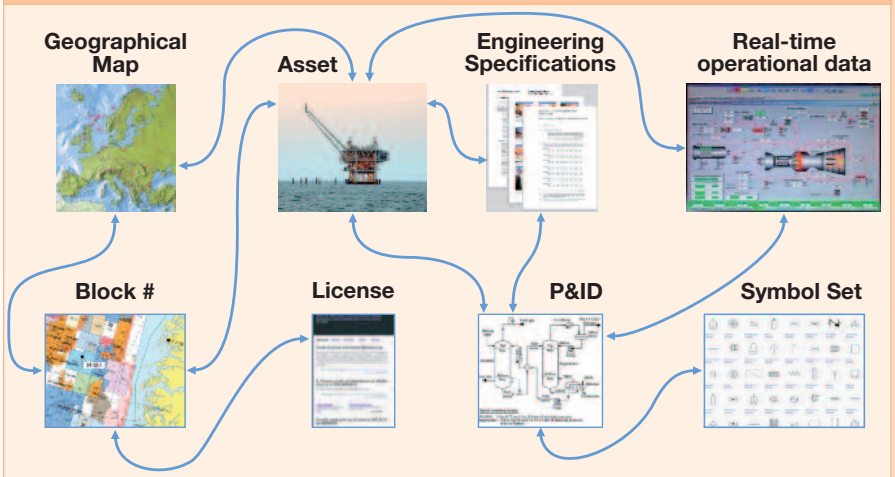
- User Interfaces based on established and integrated roles, business process management and data flows
- Information lifecycle management to maintain quality and integrity
- Records management that includes data capture, storage and retrieval for interpreted data, documents and other relevant information upon which key business decisions are based
- An information governance framework geared towards flexibility between the data worlds that enables growth and balance in both content and technology and assigns clear data ownership, responsibility and accountability. This will form a strong foundation from which consistent data specifications can be built that enable collaboration and integrity control.

User Interface

Interfaces are the primary navigation device for users. Effective user interfaces are based on rethinking and redesigning the way people work, and aligning their roles with key processes to capture and apply high-value business information. Many companies already use portals, dashboards and applications. Probably the least used interface is the data cube. This is a relatively new concept for the oil and gas industry based on multi-dimensional data relationships. Whereas portals create doorways based on user functions; a cube could provide the content based on relationships. Data cubes are popular in Online Analytical Processing (OLAP) because they provide an intuitive way to navigate various levels of summary information in the database.[2] This makes it possible to launch users directly into a view of the data geared specifically around their requirements based on their specific role. The following diagram applies the cube logic to the engineering role.

The following example applies the cube logic. Suppose an Engineer cube was created to enable a user working on a P&ID drawing to jump to a data sheet, dynamically generated forms providing process and engineering data. Business process management can provide a clear understanding of the data required for departmental and individual usage that is aligned to business objectives and workflows. Once that is achieved, the appropriate user interfaces can be designed and processes can be automated.

Engineering cube example



Source: Capgemini

Information Lifecycle Management

For the context of this paper, ILM should include a comprehensive approach to managing the flow of an information system's data and associated metadata[3] from creation and initial storage to the time when it becomes obsolete and is deleted.

The diagram on next page shows the generic lifecycle phases usually applied to documents, but should be applied to all content. Metadata can be included in the classification or indexing phase.

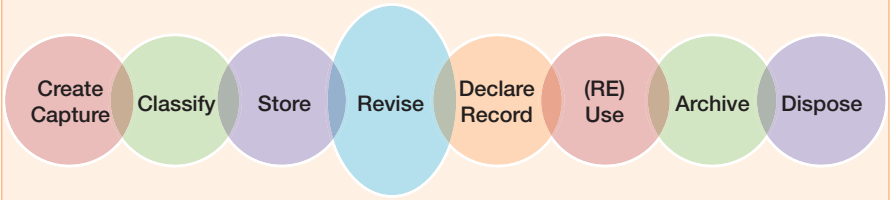
These points should be considered when contemplating ILM across the data worlds:

- The content life span is different in each data world. Operational data, transactional content, business control documents vary in retention from three years to indefinite, depending upon global and country-specific legislation and regulations. Surface data is often asset-related and has a life expectancy between 10-50 years. Subsurface data has an indefinite retention span, since geological data

2 Mumick, I., D. Quass, B. Mumick, Maintenance of Data Cubes and Summary Tables in a Warehouse, In Proc. ACM SIGMOD Conf. on Management of Data, Tuscon, Arizona, 1997, pages 100-111.

3 The common definition for metadata is "data about data." Metadata documents data elements or attributes, (name, size, data type, etc) and information about records or data structures (length, fields, columns, etc) and information about the data (where it is located, how it is associated, ownership, etc.). Metadata also includes descriptive information about the context, quality and condition, or characteristics of the data and keywords.

Information Lifecycle phases



Source: Capgemini

can be of value for decades. If data is deemed long-term, the issue of format and/or application and/or system obsolescence must be considered.

- To enable global collaboration, technical and infrastructure challenges must be considered. For example, does a company have enough network bandwidth for exploration data?
- One of the most important features in ILM is the assignation of ownership, accountability and policy for confidentiality.
- ILM struggles with business continuity and backup/recovery. It needs to support the disposal requirements from records management as well as the e-discovery requirements (in case of litigation or M&A).

Records Management

Records are the data and content that companies need/want to keep and dispose under strict control. A record serves as evidence of an activity or transaction performed by the organization that requires retention for an established period of time.

***Note: The key** difference in records and document management is the act of management: a record never changes (although its properties might).*

Records straddle the different data worlds and can be data, documents, electronic (email[4]) or physical entities. Once role-based interfaces and lifecycle rules are established, a robust records management plan can be made that addresses life span. For example, 5% of documents will be considered records and 80% of subsurface data may be considered as records. Records management is becoming an automated process.

It is important to note that records management is becoming an automated process. This means that procedures can include automated captures based on specific events or triggers in embedded in the process. For example, when a contract is approved, it is automatically declared a record.

Information Governance Framework

Governance must be established in how data is created, manipulated, stored, made available for use, (re-used) and retired. This means company-wide standards, procedures

4 In a recent survey, Osterman Research found that email is now accepted as written confirmation of approvals or orders in 79% of organizations. Since emails have become the electronic substitutes of legal business documentation, the information being passed on through this electronic correspondence constitutes a record and therefore must be treated as such.

and processes that can include a combination of supporting information technologies.

The starting place is not the software marketplace, but developing the strategy and vision through the following steps:

- Vision of the future organization
- Organizational changes and governance structures required
- New business processes and ways of working (collaboration)
- Services or outsourcing required for maximum business process management
- Future architecture; IT infrastructure, applications, tools, etc.
- Policies; information specification, email, retention and disposal, export control, messaging, Intranet publishing (e.g. Wiki), security, etc.
- Business case; to identify and measure the benefits.

Once the strategy is selected, an equilibrium must be established between cost, risk, resources, organizational changes, IM/IT architectures and designs, etc. A content management interwoven into overall data management governance can enable a company to dominate the digital oilfield and create a new company culture of cross-communication and fertilization of business built on a solid foundation of trusted data.

Information Lifecycle phases

Level	Integrity Factors				Value Drivers			
	User Interface	Lifecycle	Records Mgmt	Governance	Access	Collaboration	Connectivity	Business Intelligence
Enterprise	●	◑	◕	●	●	●	●	◕
Document	◕	◑	◑	◑	◔	◑	◔	○
E&P Data	◔	○	○	◔	○	◑	○	○

Enterprise = ERP systems, HSE systems, Intranet
Document = Office suites, email, drawings
E&P Data = Well data, seismic data, simulation models, measurements, etc.
Diagram based on expected usage per level (not user performance). ● = full

Source: Capgemini

Demonstrating Value Based on Integrity

Let's take a closer look at how the maturity level of the integrity factors in each data world impact the value drivers. The figure above was designed to demonstrate that best practices do exist at certain levels within a company that can be adapted and used for E&P content management in the governance model.

Companies seem to forget that colleagues in other departments are also working in different data worlds for a successful business model. Companies can counteract E&P data integrity degradation by considering how the sister data worlds have resolved the issues. In other words, which lessons learned from the enterprise and document worlds can be re-used at the E&P level?

Enterprise World

This data world contains visible, business-critical data that is legislated, regulated, standardized and audited. Vendors serving this world have consolidated into single-source systems such as SAP and Oracle for ERP with customized dashboards and portals. For Intranets and emails, user interfaces are structured portals designed and maintained for the organization as a whole. Software and technology purchases at this level are usually board decisions that include global roll-out blueprints for architecture, infrastructure, process management, formalized IT maintenance support and change management. This corporate ownership ensures consistency, stability and embeds version/migration control. For example, the IT department will provide Intranet upgrades, data archiving and storage services.

Lifecycle is the weakest link, mainly due to overloaded email and Intranet systems, which has a pull-through impact on records management. Most companies have established clear policies, procedures, roles and responsibilities for enterprise content to ensure integrity. The governance at this level prepares the data for the future by enabling migration and storage solutions ready for dynamic re-organization. Enterprise data must be refreshed and updated to continue business transactions with the outside world of suppliers, partners, customers, etc. Lack of efficiency at this level has dire consequences in the ability to conduct business transactions.

The powerful combination of these integrity factors, especially prevalent in the ERP system, drives value across the toolsets. ERP systems use modules that provide interconnectivity and role-based portals to collect, process, and present information. The one version of data is accessible, modules are linked to data stores, collaboration is enabled across departments, inter-company and with third parties.

Business intelligence is becoming an industry standard.

The E&P data world can adapt applicable governance and data management. E&P roles, process and work flows will most likely need to be created based on current company policies.

Some major ERP vendors have already developed modular interconnectivity from key enterprise modules to E&P content. For example, Oracle[5] brings oil companies an integrated view of operations, using a data management and business intelligence solution for the exploration and production business. SAP for Oil & Gas[6] is a set of solutions that supports fundamental business requirements while providing end-to-end solutions that cover upstream, midstream, downstream, and marketing processes from wellhead to retail outlet.

Document World

Many of the applications running in the document world share infrastructure, IT maintenance and compliance with the enterprise world. This provides stability in the applications but not the content. Most companies use a combination of standalone automated software systems and methods to address issues for document, record, and content management. This resolves issues such as version control, confidentiality, compliance and accessibility of various types of structured and unstructured electronic information to improve search capacities.

Most companies have some form of electronic document management; but often each system is implemented differently with a general lack of overall information governance. What we find is that the majority of document world residents do not use EDMS to manage their documentation. Integrity starts to slip in lifecycle, records management and governance via data overload and duplication. This is reflected in the value drivers through reduced accessibility and lack of information connectivity as documents become buried or orphaned in team rooms or network and private drives. At this level, Business Intelligence tools are extremely limited.

Collaboration shines brightest in this data world. Forrester Research[7] published a study showing 65% of companies surveyed planned to invest in software to enable collaborative teamwork. Collaboration was defined as document repository, team workspace, basic library services, and ad-hoc workflows. For document world residents, the structure is present, but the problems with integrity and cultural changes (my data – your data – our data) still represent challenges in implementation. The document world suffers from duplication of documents and email and ownership/accountability is unclear. The lessons of the document world are based on structured lifecycle phases that automated software can provide, collaboration software and methodology, and associated cultural changes.

5 Oracle Corporation website

6 SAP website

7 © 2008 Forrester Research, Inc. All rights reserved. Enterprise And SMB Software Survey, North America And Europe, Q32007. The purpose of this study was to analyze adoption trends in Software technology for companies in North America (US and Canada) and Europe (UK, France, and Germany). Forrester surveyed 1,017 Software IT decision-makers at North American and European Enterprise companies. In terms of geography, 701 are from North American companies and 316 are from European companies. Out of all respondents, 82% are considered an "Executive." All respondents were screened for significant involvement in IT decision-making, as well as IT purchasing processes and authorization.

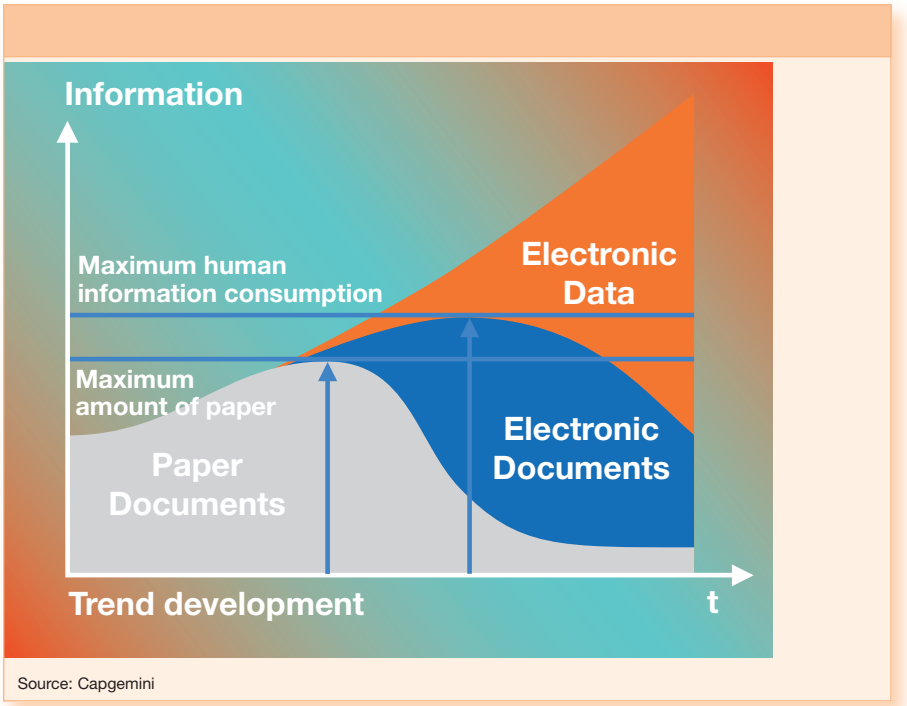
E&P Data World

E&P data is vastly different from Enterprise and Document data, which negatively impacts the ability to leverage the integrity factors to achieve quality assurance and trust that drive value. The E&P data world is divided into functions that make it a complicated technical ecosystem with specialized technology needs.

The integrity factors that most companies are starting to address include user interfaces to create functional portals, data governance *lite* based on IT rules and engineering data warehouses. Since most of these initiatives are immature, they currently have little effect on increasing overall data integrity.

It is the unique nature of the data itself that provides the biggest challenges to data integrity. Unlike the other data worlds, E&P data can be created in-house or purchased from external sources such as national data repositories or vendors[8] or acquired from other oil companies. As digital oilfield technology moves towards real-time data frontiers it creates a proliferation of digital data. Today, approximately 75% of new data arrives in a digital format ... but what to do with *over a century's worth* of tons of drawings and maps and petabytes of information already locked away in private offices, data warehouses and hard drives?

The global trend is towards digital documentation and integrated suites of processes that can draw specific data from a variety of application and database sources. If we apply this trend to the oil and gas industry, the E&P data world immediately wobbles off course at both ends of the spectrum. A significant amount of subsurface content is still physical. Many companies have scanning projects underway to convert paper to electronic format. This can be a time-consuming and costly chore.



Source: Capgemini

Electronic conversion is a necessary step, but it only represents a shift in data format. Most geoscientists continue to rely on drawings and documents because they don't trust digital data. This move from document-centric to data-centric thinking can be easily confused with good data management, i.e. all the data is digital, therefore it is correct.

Another important aspect of good subsurface data management is having consistent and reliable metadata. Metadata is important to distinguish the quality and utility of data sets. Lack of metadata management means that more time must be spent in checking the quality of data. Based on the longevity of content, the rising volume of data in its different formats, and the super user data caches, lifecycle management is a difficult task.

No lifecycle management translates into poor records management. For many companies, Microsoft® PowerPoint has become the de facto records manager – documenting data snapshots frozen in time, not the data

8 Digital Earth[10] is building the first online directory where oil & gas professionals can search for energy information, suppliers, and people around the world. Digital Earth is going through public sources of oil and gas information and indexing documents according to oil and gas terminology. (well numbers, geographic locations, types of drilling, etc.) Product launch is proposed in 2009. Some companies are already involved as well as national data repositories.

itself. No clearly documented audit trail of the decision-making elements on interpreted data results in a loss of both user efficiency and data value through re-interpretations and reiterations. For explorationists, the integrity of historical data is key in making good business decisions. Missing or incomplete data used to develop a well planning program can cost up to $23 million for a dry hole or drilling outside a concessionary boundary.

This overall lack of data integrity dramatically influences the E&P data world's ability to leverage the value drivers. On average, geoscientists spend approximately 30% of their time searching for data. Petroleum engineers may spend up to 70% of their time opening software applications to find data.[9] By removing the need for individual searches to find reliable data, a company can expect approximately 15% increase in productivity.

Collaboration has become the oil and gas industry buzzword for the virtual workplace. The E&P data world has heavily invested in building facilities with hardware, software and cameras to connect onshore to offshore personnel and control rooms with field personnel. The biggest limiting factor is that true collaboration can only happen if you have your own house in order. So on top of the document data world's collaboration problems, significant problems exist with the sharing of real-time E&P data because most E&P data world residents do not trust their own company data. However, the industry is rapidly maturing in this area and the use of functional collaboration for upfront planning of wells using advanced visualization tools can increase the pace of real-time well delivery and planning scenarios.

Can You Change the World?
How dependable is the *"data"* cornerstone at most E&P companies? We have shown that each data world is profoundly different, but they all work together to create the bottom line. The current model of isolated content management at the Enterprise level will not increase competitive advantage in the marketplace.

Plotting a course of continuous data integrity for the E&P business platform is a daunting task. If your company has already started a data management project, there are best practices to be shared between data worlds that will boost the integrity maturity levels in E&P. It means engineering a vision with a comprehensive strategy and that includes all data worlds' users and IT. It means refocusing your telescope from a single data world to the entire universe of data that forms a company's most valuable asset: content.

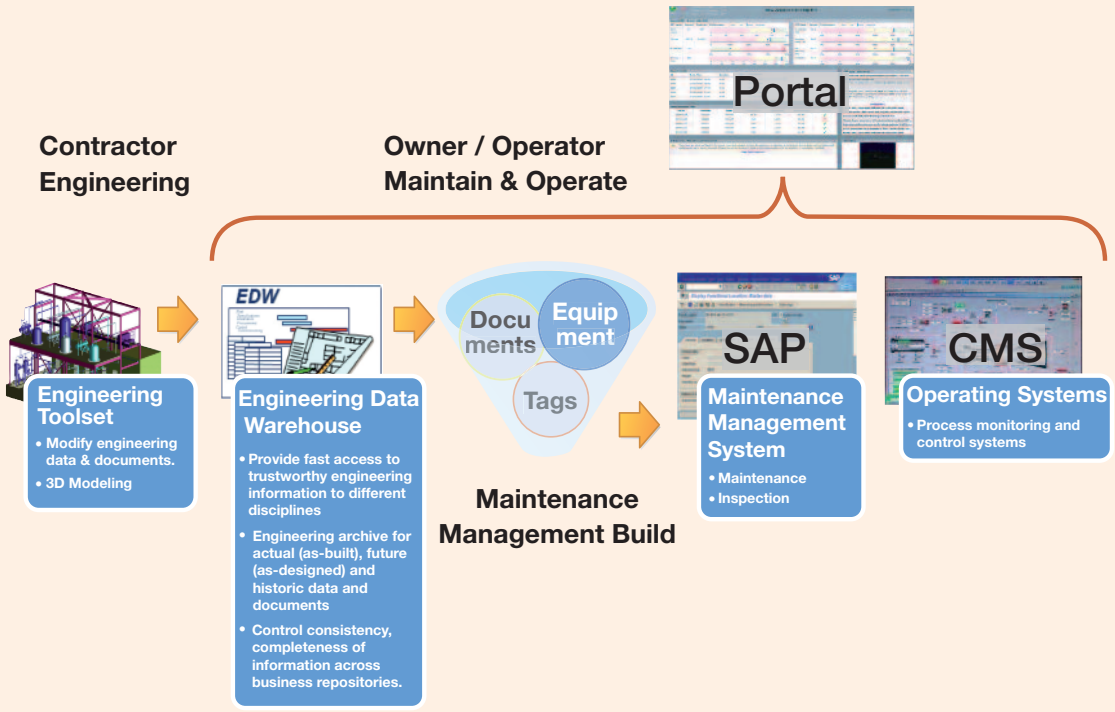
Can you change the world? Can you afford not to? Charles Darwin noted, *"It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change."*

Some companies are already changing their worlds by creating engineering data warehouses (EDWs). An EDW can provide critical data validation and integration capabilities for asset creation, maintenance and operations related work processes to provide operational staff with immediate access to accurate information about the plant. This concept is shown in the following diagram.

Note that the system is designed to validate and consolidate information handed over from contractors, which can then be integrated with applications and ERP maintenance systems.

9 Landmark – Orchestrating Production, Digital Energy Journal – January 2008

EDW Concept



Source: Capgemini

Top 10 Integrity Tips

Content management may seem insurmountable – but the payoff comes in sensible project chunks that increase integrity and move closer towards information connectivity. Here are 10 tips to consider to start constructing an information governance framework:

1. Adapt Enterprise world governance policies and practices to the E&P world.
2. Adapt IT group best practices to the E&P world (data storage, application version control, etc.).
3. Perform role-based analysis to understand business management processes and data flow across the data worlds.
4. Recognize which content should be linked to enable information connectivity across all data worlds.
5. Assign data ownership to specify who within an organization is responsible for various aspects of the data, including accuracy, accessibility, consistency, completeness and updating frequency.
6. Develop a master metadata management framework to standardize metadata as a corporate reference set.
7. Once the master metadata reference set is defined, then the subordinate document management software can use it as a key building block for collaboration, document creation and records management.
8. Develop an E&P records management program that includes data capture, storage and retrieval for interpreted data, documents and other relevant information upon which key business decisions are based.
9. Clean house – enforce the disposal of content that is ready to be retired.
10. Launch change management to start changing the user culture to embrace a new connected data landscape…after all, they are the ones that will need to trust the content to squeeze out the value.

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