

Plant Information Management in the Statoil Åsgard Offshore Project

A Case Study

Process, Power & Marine, a division of Intergraph



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1. Introduction

Statoil and Intergraph have established a close e-Engineering business partnership. e-Engineering addresses access, management and administration of technical plant information in all main work processes in development projects, and on into operations. This partnership formed a joint integrated e-Engineering team to drive the successful development and implementation of a web enabled, standards based Plant Information Management (PIM) data warehouse to hold all technical as built data, originally for the Åsgard Offshore Project. This data warehouse is based on Intergraph's SmartPlant Foundation (formerly Notia) solution, which comprises a managed repository for plant information and an extensive portfolio of e-Engineering and Technical Information Management (TIM) applications for creation, browsing and maintenance of plant information. Successful e-Business also relies on this managed and controlled plant information.

Following Åsgard's successes, lessons learned are being incorporated into corporate "best practice" for all future developments. New projects, Kristin and Snøhvit, are both deploying PIM as their complete, consistent and integrated "plant information asset" store. Both the Norsok standards organisation and the Åsgard project experience highlights e-Engineering's huge potential for cost reduction of more than 30% in future development projects. Major benefits in the current investment made in a PIM data warehouse have already been experienced during the Åsgard B project phase. This has been achieved by the implementation of e-Engineering applications and the associated improved business processes. The objective to gain an investment payback in 2 years has been exceeded. These achievements represent a world-class, quantum leap in plant information management. They have been accomplished by the merging of Statoil's oil and gas engineering domain expertise with Intergraph's engineering focus and software delivery capability. The building of close relations with the main contractor, Kværner Oil & Gas, has also been central to enable the introduction of new applications and improved work processes during the project.

Further major benefits from the PIM data warehouse lie during the 30 year Åsgard plant operation and maintenance phase. Statoil are now actively proving information management benefits can be achieved during the operational phases.

2. Statoil and the Åsgard Oil and Gas Field Development

Statoil is the state-owned Oil and Gas Company in Norway. It has 17,000 employees, annual revenues of US\$14 billion, and operations in 23 countries. It operates more than 20 on/offshore installations in the North Sea.

Åsgard ranks as the largest subsea development in the world. The Oil & Gas Journal described it as the most daring and complex subsea project ever launched. The Åsgard development, located 200 km off the coast of mid-Norway, is one of the largest and most complex offshore oil/gas developments on the Norwegian continental shelf. A total of NOK 33 billion (US \$4.4 billion) is being invested in production facilities, wells and sub sea installations.

The Åsgard development consists of :

- Åsgard A, an oil production ship that came on stream in mid-1999
- Åsgard B, the world's largest floating gas platform which began operations in October 2000 designed to produce 12 billion cubic metres of gas per year, much of which will be piped direct to continental Europe
- Åsgard C the storage vessel for condensate from Åsgard B
- Sixteen sub-sea templates

3. Statoil's Objectives for the PIM Data Warehouse

The equipment and materials required to build huge and complex offshore facilities such as Åsgard come from many suppliers and contractors around the world. Thousands of people from many organizations and disciplines participate. A successful project depends to a large degree on the effective accumulation, communication and management of plant information. Eighty percent of this is technical plant information. Equipment suppliers and contractors create most of the information early in project development. As the field owner-operator, Statoil's task is to capture all the as-built plant information in a form suitable for re-use during plant commissioning, operations and maintenance. This information also comprises an invaluable intellectual resource for future developments in Statoil. Relevant business drivers for Statoil are:

- Shorten the time to first oil and gas production
- Introduce improved, integrated work processes across the value chain by implementing e-Engineering applications via a common web portal on the corporate Intranet and the Internet.
- Increase the operating efficiency of the plant
- Maintain operating licences, safe operation and Health and Safety Executive (HSE) compliance
- Shorten plant shutdowns for planned maintenance; reduce unplanned shutdowns, maintenance overruns and repair costs
- Reduce the spare equipment inventory
- Reduce plant information hand-over costs from contractors and suppliers; receive consistent as-built plant information in good time for commissioning and operations
- Assure data longevity and re-use of information over the whole plant life cycle.
- Integrate technical plant information with other business systems to provide common e-Business solutions.

To further these business aims, Statoil decided it needed a single integrated solution for sharing and exchanging all plant information.

4. Phased PIM Implementation Strategy

During 1996, Statoil mounted a study of the business benefits that a standards based PIM data warehouse would deliver. The investment appeared attractive. Indeed, the company expected its investment to payback in less than 2 years.

The Statoil PIM project started in January 1997. As the design of the Åsgard A ship was already too far advanced, Statoil's first target was the Åsgard B gas platform. The initial emphasis was to be on equipment information. Given the incomplete status of the available standards at this time and technological challenges related to delivering a satisfactory implementation the decision to implement the Åsgard PIM data warehouse was a bold and visionary step made by Odd Mosbergvik the Åsgard Director. It resulted in the first operational data warehouse based on the POSC/Caesar (ISO 15926) standard product data model.

The PIM data warehouse project was initiated with the mandate to gain concrete business benefits in Åsgard from implementing a data warehouse based on an industry standard product model. Bjørn Henrik Magnus was appointed PIM project manager. The solutions developed were to provide the basis for the next generation of plant information management systems for Åsgard operations, and replace the existing portfolio of plant information systems in Statoil.

During early 1997 Statoil collaborated with Norsk Hydro and Saga Petroleum in the VÅV Joint Industry Take-up Project. The objective was to acquire suitable software for the POSC/Caesar based data warehouse. The take-up project on behalf of these three oil companies contracted Intergraph to develop and supply its SmartPlant Foundation software for this purpose. Intergraph successfully delivered SmartPlant Foundation on target and within a fixed price by the contract date in August 1997. At this stage SmartPlant Foundation comprised a POSC/Caesar compliant repository without working applications.

4.1 End User Applications

The next stage was to load data and develop applications. An integrated team of Statoil and Intergraph personnel was established to design and deliver end-user applications. The following major milestones were achieved in this phase extending from Q4 1997 to Q1 1999:

- PIM in procurement, including administration of standard (catalogue) equipment data sheets and documentation
- PIM structure manager and tag manager
- PIM with 2D Browser and 3D web interface
- PIM document administration, including document index and electronic archive
- PIM Change Management

This phase was very successful. The applications were well received by the Åsgard B project and proved that stable, high-performance, intuitive, web-based applications could be delivered on top of a POSC/Caesar data warehouse via the corporate Intranet and the Internet.

4.2 Commercial-off-the-Shelf Software Approach

The enormous potential value of the PIM data warehouse was already becoming clear by mid-1999. However, the initial applications were specific to Statoil and more were needed. As Statoil wanted the software to be commercialised, it gave Intergraph ownership of the bespoke applications developed to date, and a US \$2m software and services contract in July 1999 to continue SmartPlant Foundation development and to work in partnership with Statoil to develop commercial-off-the-shelf (COTS) software modules. As well as the enhancement and productisation of existing Statoil-specific modules, Intergraph has created additional PIM / SmartPlant Foundation modules. These include:

- An enhanced web interface (including use of XML) to provide extensive data creation and manipulation facilities
- Engineering numbering, including syntax control
- A module for Instrument Loops (field instrumentation, fire & gas and telecom)
- A module for managing Electrical Distribution Networks
- Bi-directional integration with SAP R/3 and Statoil's in-house Piping Inspection System
- Document Management

Important technical features of this productisation phase are the migration of the PIM data model to an industry standard. Intergraph has developed a generic data model, following the principles of ISO15926. This environment will simplify the work of application developers as it provides an interface to applications at a higher abstraction level, shielding them from the current complexity of the underlying POSC/Caesar product model.

5. Åsgard Achievements at the Millennium Start

Bjørn Henrik Magnus, Statoil PIM Advisor said, "Our original objective was to implement an Åsgard PIM data warehouse based on an industry standard product model for as-built plant information for Åsgard B, concentrating on equipment data. We have managed to do much more than that, and have so far expanded the PIM functionality more than three times, with the same budget. The objective to gain an investment payback in 2 years has been exceeded. PIM has become our integrated solution for ALL plant information and will replace our existing portfolio of systems for maintaining plant information."

The PIM project major benefits areas have so far been:

- PIM in procurement administration, focused on standard equipment information
- PIM in engineering change management
- PIM in plant commissioning

The work has proved the solution based on POSC/Caesar is effective for taking on and maintaining the huge volume of as-built plant information that characterise offshore developments. The partnering of Statoil, with its plant and business expertise and Intergraph, with its engineering focus, software development and services teams is delivering a focused practical solution and real benefits. PIM has all plant information and documentation for Åsgard B validated and loaded, and also included all plant information for the other Åsgard field installations. During the project phases, the PIM solution was regarded as being "mission critical" to the Åsgard development with over 500 users, 40-60 normally working concurrently. In Åsgard development PIM included:

- 3500 changes (DCN's/DCR's)
- 120,000 tags
- 305 manufacturers, 3000 models/types
- 60,000 documents/drawings etc.

Statoil experienced a full scale PIM implementation on Åsgard. The response times from PIM were very fast, for example, a complete equipment data sheet can be created on the fly in less than one second. PIM users during the project phases were mainly discipline engineers working for the main contractor, Kvaerner Oil & Gas, at two sites in Norway, other EPC contractor personnel throughout Europe and Statoil's own engineers preparing for operations start-up. Usage also included equipment suppliers. Statoil expects the number of users to escalate to over 3000 users in the corporate rollout phase.

6. The Industry Standards-based Data Management Core

The data management core of Statoil's PIM data warehouse is SmartPlant Foundation Intergraph's Data Warehouse Solution. This adopts a standard format for data representation to facilitate exchanging and sharing information among applications. SmartPlant Foundation is based on the POSC/Caesar (P/C) product model, adopting the principles of EPISTLE Core Model as an implementation of the ISO 15926 P/C standard for plant information. It embodies the neutrality, openness and longevity inherent in STEP-based technologies and is a mechanism capable of describing plant data that is independent of any particular authoring/ creation system.

The P/C model holds data in a highly normalized form as numerous data objects. These are linked by a multitude of relationships. It is the extensible P/C Reference Data Library (RDL) that gives meaning to the generic model and ensures it can be used for practical application in the oil & gas industry. With the data that describes all the materials, equipment and activities associated with Åsgard B, PIM became a data warehouse and single source of information usable throughout the plant life cycle by all authorized participants. In SmartPlant Foundation, the data model has been de-normalized to some extent to provide good system response within the technology available today.

Statoil found that loading plant data via STEP Part 21 files was inefficient. This problem was cured with Intergraph's help by developing a new data loading and exports module. With this Statoil cut the time for a typical loading operation from more than a week to one hour.

Data consistency and rule checking is essential. PIM has a separate QC module implemented externally as a staged data store, where information is assembled and subjected to quality checking. The checks are performed on a denormalized relational table structure before data is "exploded" into the P/C structure for PIM.

The PIM concept includes some Intergraph applications that today are not based on the SmartPlant Foundation core data warehouse eg. INtools the Instrumentation and Loop System. They are however integrated into SmartPlant Foundation, ensuring that the data is synchronised between SmartPlant Foundation and the applications. Intergraph's development programme includes the migration of many of these applications to the SmartPlant Foundation data model.

7. e-Engineering Applications

A key element of the SmartPlant Foundation data warehouse is the separation of plant information from the applications that browse or create/modify this data in the data warehouse. Use of the P/C ISO 15926 standard information makes this a practical proposition for information longevity through the long life of a plant. Statoil and Intergraph are jointly developing these COTS applications via an integrated team where Statoil has a leading role in specifying COTS application functionality.

The Statoil-Intergraph development plan is the blueprint for Intergraph's continuing strategy for partnering with customers to develop practical solutions that deliver real benefits for the Process Industries.

7.1 PIM Web Interface

PIM user applications implemented for Statoil are characterised by a consistent, intuitive web-based Graphical User Interface (GUI). A prime requirement for PIM applications has been the provision of a web-GUI. Developments such as Åsgard include contractors and suppliers around the world and the availability of a common PIM Web-Portal accessible via the corporate intranet, extranets and the Internet was established as an early prerequisite for PIM applications. Exploitation of the Internet and a common web-portal to plant information is the only viable prospect of introducing truly integrated work processes across the value-chain on a global scale in projects of the complexity of Åsgard. The web-paradigm offers users a familiar interface and has reduced training and support costs for PIM. This is especially important in locations where limited local support is available. Statoil warn that a good Web interface is not easy to achieve and there were difficult firewall and security issues to face.

Where non-SmartPlant Foundation modules are being implemented as part of the overall PIM data warehouse information will be available for browsing in the SmartPlant Foundation web-browser that will provide a common web-portal for all plant life-cycle information. As an interim measure for non-SmartPlant Foundation modules Microsoft® Windows®-based GUIs will be used to maintain data. Many of the non-SmartPlant Foundation based modules will be gradually migrated over to the SmartPlant Foundation core as a phased development programme and, in parallel, the web GUI will also be introduced for maintaining data in these modules.

7.2 PIM Procurement Management, Including Standard Equipment Information

Traditionally, the management of information and documentation for manufacturers' standard equipment (equipment that can be ordered from a manufacturer's catalogue, e.g. instruments, lighting fittings, junction boxes, cables, electric motors, etc.) within the process industry has been poor.

Repeated submissions by suppliers result in re-entered datasheets, multiple copies of the same data, duplication of suppliers, non-standardisation of equipment variants and fragmentation of information. This wastes time and money throughout the value chain. For the plant owner it results in inconsistencies, errors, and an undesirably large inventory of equipment spares. Supplier user

manuals received by operations are traditionally voluminous, of poor quality and impossible to maintain effectively.

Statoil's initial business objective for PIM was to concentrate on equipment data to cure these problems. The Standard Equipment application was rolled out in early 1998. Statoil arranged for a third party company, Tektonisk, to prepare data sheet information and to get it approved by equipment suppliers before loading into PIM. Framework agreements with suppliers are being modified to make suppliers directly responsible for maintaining the information in PIM via the Internet.

SmartPlant Foundation has now become the common central repository for all standard equipment data and was their PIM "quick win".

Bjørn Henrik Magnus said, "Suppliers now send their information to Statoil only once and it will be held once only. The volume of final documentation required in user manuals for plant operations has typically been reduced by more than 80% by stripping out standard equipment data and documentation and it is bringing large benefits to Procurement. This module will promote variant reductions, reduce equipment prices and at the same time will benefit the external contractors and equipment package suppliers by saving time in acquiring information and documentation from manufacturers."

Data sheets, which can be formatted to Industry or ISO specifications, provide users with a 'virtual document' or a window onto the data contained in SmartPlant Foundation ensuring the most up to date information is utilized. This module is being configured to handle custom equipment in addition to standard equipment.

7.3 PIM Structure Manager & Tag and Asset Manager

The plant breakdown structure is core to functionality and includes:

- Drill-down navigation to tags and design documentation through the geographical breakdown of the plant by plant area and through the process system breakdown of the plant
- Presentation of tag index and process/mechanical data sheet information, lubrication and certification data.
- Drill-down tag hierarchies
- Link from tagged locations to installed equipment (assets) and standard equipment models and variants
- Link of tags, assets, areas, systems etc. to relevant documentation

By use of the POSC/Caesar effectivity date the plant configuration at any past date may be viewed – useful for safety analyses, insurance claims etc.

7.4 PIM Document Management

SmartPlant Foundation is essentially a data-centric solution. In principle, when designers, constructors, plant operators or maintenance engineers need documents, these are generated "on-the-fly" as tabular or graphical reports by applications that draw relevant data from the data warehouse. However, the nature of the business today is that many conventional electronic documents are created during development projects and need to be maintained during operations. In PIM, SmartPlant Foundation has its own Document Management module.

Directa provides document security and access, revision control, check-in/out facilities, document transmittal functionality and facilities for users to subscribe to and be alerted to document updates through e-mail. The PIM integration solution allows the meta-data regarding documents to be held in SmartPlant Foundation, as well as the information regarding the structuring of complex documents such as supplier user manuals.

7.5 PIM Change Management

The management of changes to plant configuration is essential to both effective working and the technical integrity of a facility and its related plant information. Effective change management is important through all phases of a facility's life cycle, but is most acute during the project development phase where thousands of changes need to be administered, hundreds of which may be "live" at any one time. On the importance of change management Bjorn Henrik Magnus commented: "During detail plant design, 50% of the engineering work performed is the result of changes and this rises to 100% after the Approved for Construction milestone during the "Follow-on" engineering phase. Over 4000 changes have been registered for the Åsgard B project. Traditional, paper driven or simple electronic archive systems do not allow users to get a satisfactory overview of changes and their status and what "is in the pipeline", neither do they allow adequate traceability over what changes have affected plant items."

Managing changes is always costly and time-consuming due to the complex interrelationships that exist between the affected plant items, the data and documents, and the work disciplines and companies. A further complexity is the "ripple" effect that one change has on others. The PIM Change Manager tracks the details and status of each change, highlights plant items subject to ongoing change, provides an overview of all changes affecting a plant item and manages the workflow for all changes and mark-ups. PIM Change Manager offers the benefits of an improved overview of changes and their status, simplified handling of changes, improved planning of change implementation, reduced costs and improved traceability of changes.

Bjørn Henrik Magnus said, " It previously cost Statoil between US\$500 - 1,000 to revise a single drawing with Change Manager the company has reduced this cost to 10% (US\$50-100). It improves the change impact planning and change implementation, with consequent lower costs. The big advantage is that it provides management with an improved overview of changes and their status. The savings in this area alone would justify the system expenditure for PIM."

7.6 PIM 2D Graphical Interface and 3D Interface

PFDs and P&IDs are the key documents for every process plant. Normally these are 2D schematics with a multitude of implied references to other data and documents, and to the plant configuration. In the PIM solution, these have become "intelligent" documents, providing valuable interfaces to the plant data warehouse. The solution implemented was initially focused at integrating P&ID drawings with the data warehouse, but it is generic and capable of supporting any drawing type. It therefore allows the intelligent integration of any 2D drawing with PIM, irrespective of which of the project's CAD tools were used to create it.

Engineers browse a schematic on their screen, point to any item or tag, and all the underlying data and menu options become available. The hyperlinks are generated automatically by software that scans the basic 2D schematic. This recognizes tag numbers and document numbers, which become the links to the data within PIM. If a drawing is changed, it is automatically re-scanned to update all the links.

The 3D interface is similar. It provides the links between items in the 3D plant model, created in Intergraph's PDS or other CAD system, and the underlying PIM data. A third party product has been implemented that has the benefit of providing streaming of 3D models over Intranets/Internet. This means a single copy of the visualization model can be held in the data warehouse that can be made available globally across the project. Models are viewed in a web browser frame and clicking on an object sends a query to PIM to retrieve data and menu options. Similarly, for tags located in the data warehouse the 3D model can be retrieved in the browser.

This solution offers the benefit of interoperability, handling all 3D model types encountered in Statoil: including Intergraph's PDS Design Review format and other third party CAD products. It allows all models, irrespective of their origin, to be viewed in a common browser integrated with the data held in the data warehouse.

This interface is particularly useful for planning changes, examining access to plant items, and for planning inspection and maintenance work. Traditionally it has been impractical for most plant owners to use a 3D-plant model, but this 3D Interface removes all obstacles.

7.7 PIM Integration With SAP and Statoil's Piping Inspection System

While the PIM SmartPlant Foundation-based data warehouse handles all technical information for the plant configuration, Statoil has adopted SAP to manage the financial and resource information for maintenance and materials management. These two critical information sources need to be linked, and Statoil and Intergraph therefore jointly developed interfaces allowing transfer of technical information from PIM to SAP while also accommodating navigation from SAP directly into PIM. In the longer term, Statoil will be looking to extend these features to a bi-directional interface, giving PIM users direct access to SAP data, and vice versa. A SAP user who needs direct access to technical information for tags or equipment identified in the SAP material master will be able to start PIM from SAP and retrieve data for the plant item. An engineer using PIM could get details of the repairs and maintenance programme held in SAP for a tag or equipment serial number. Similarly, an engineer can find details of equipment identified in PIM but which is currently in the repair shop or stockyard rather than in the tagged location. A PIM user may also

coordinate the closeout of a work order for repairs or changes that requires the update of the technical information. An interface is also being implemented to Statoil's propriety Piping Inspection System.

7.8 PIM Instrument Loop Administration

Loop configuration includes control instrumentation, fire & gas and telecom physical topology but excludes control system logic. The scope of this module extends from the physical field instrument and associated cables, termination data (junction boxes, cross-wiring cabinets, etc.) to the I/O card and channel/ports into the control system.

This module is both comprehensive and very complex with over 10,000 loop drawings for Åsgard B alone. The accuracy of data and reliability of data presentation in this module is of utmost importance as errors can give rise to highly costly uncontrolled plant shutdowns. Major savings will be realized by the elimination of costly instrument loop drawings and producing parametrically generated loop reports "on demand".

This module will be based on integrating Intergraph's INtools product with SmartPlant Foundation. This means that loop topology data will initially be held external to SmartPlant Foundation though data and graphical loop reports will be available via the SmartPlant Foundation web-browser.

7.9 PIM Electrical Distribution Network Administration

This module includes the detailed topology of the facility electrical distribution network allowing navigation from the main generators via switch gear and distribution boards and junction boxes down to the ultimate power consumers such as motors, heaters, instruments, etc. Functionality will initially cover tracing of the electrical distribution up and down the network but will be extended to include additional functionality such as:

- Ignition source analysis and isolation studies
- Location of available capacity for the installation of new consumers

This module is based on the integration of SmartPlant Foundation with Intergraph's SmartPlant Electrical product.

7.10 PIM Quality Control

A separate Quality Control module has been implemented externally to the PIM Data warehouse as a staged data store where information is assembled and subject to quality control before loading into the PIM data warehouse. This is an existing application that has been developed over several years and has been adopted as a front-end to the data warehouse in Statoil. The structure is based on a denormalised relational table structure that is simpler to run QC checks on before data is "exploded" into the POSC/Caesar structure.

QC checks performed are extensive and include:

- Syntax control (tags, document numbers, etc.) and valid codes (areas, systems, document types, etc.)
- Referential integrity, for example are the to/from tags in the cable index valid, document references to tags that are valid, etc.
- Degree of completion - identify apparently missing data.
- Integrity between indexes, P&ID's and 3D models, e.g. is the line list consistent with the P&ID and isometric data in the 3D model.
- Engineering technical logic checks, e.g. are max. operating pressures quoted in data sheet information below max. design pressures, loops are electrically complete, electrical network topology complete, etc.

Quality is therefore verified before import to the PIM/DWH. Reports from QC were made available to contractors via the PIM/DWH to enable them to rectify errors and omissions before resubmission.

7.11 PIM System Administrator Tools

These are not an end-user application, but a system administrator's toolbox for configuring SmartPlant Foundation for a customer implementation. Though very powerful, this module uses a "drag and drop" type environment and requires no IT programming capability by the user. The module is used to define:

- Plant items (Business Objects) to be handled in SmartPlant Foundation including their relationships to each other and behaviour (methods)
- Menus, toolbars and look-up tables
- User dialogues
- User groups and users

A separate module is available to define the syntax rules for naming any plant item defined in SmartPlant Foundation eg. tag numbers, document numbers etc. The module is highly flexible to generically handle any customer engineering numbering system and includes facilities for generating blocks of plant items.

8. Summary of the Åsgard Project Vision and Benefits

PIM data warehouse is providing the channel for the seamless hand-over of as-built plant data from the project. Normally this is an operation that can take a year and cost up to US\$10m. With PIM the data is properly validated in the staged data store before import from contractors and suppliers. Quality problems are identified early in the project and fixed when it is easy and relatively inexpensive to do so. Information is retained as structured data, which automatically becomes available for plant commissioning, and from the first day of operations and maintenance. Where PIM applications are used for data maintenance then data is validated as it is created.

Statoil has already noted that easy access to all relevant information helps to empower offshore workers and is reducing its large on-shore resources too. There is potential for cutting a huge number of plant drawings and other documents, which typically duplicate much of the plant information and make it difficult to control.

The benefits from PIM are many, varied and large: Statoil summarizes the potential savings as:

- Reduce plant-commissioning work by 10-20%
- Reduce OPEX by 10-20%
- If PIM could be employed from the start of a new plant, potential to save up to 30-40% of the total development cost. The potential savings in a project like Åsgard would be between US\$1.3 -1.7 billion.
- Reduce 10-20% of plant operating costs
- Reduce the volume and cost of equipment documentation for operations by 80%
- Reduce the cost of drawing revision from US\$500-1000 per drawing to US\$50-100 with change management
- Reduce requirement for data handover – historically could take up to a year and US\$10M to quality check and load missing data for a single platform

The requirement, however, is for a data-centric approach where most documents are replaced by reports from current data generated on-demand. It also needs an effective data warehouse, and a range of practical e-Engineering applications. Intergraph's commitment to extend its Engineering Framework core represented by SmartPlant Foundation to cover all PIM modules and provide a common web-portal for the maintenance of this data are important milestones for the future.

The challenge now lies in integrating Statoil's e-engineering solutions with the drive in Statoil to attack costs through implementing improved business processes across the value chain via totally integrated B2B e-business solutions including both Engineering Process Re-engineering and e-commerce components.

Jay Stinson, Intergraph Process, Power & Offshore Division's Vice President of Global Solutions said, "Intergraph and Statoil, through Åsgard, have developed a close working partnership that will now drive forward the development of SmartPlant Foundation to provide the ideal solution for the Statoil installations. This reinforces our strategy to work closely with clients to ensure our solutions meet their business requirements."

Odd Mosbergvik, Åsgard director agrees. "The close collaboration between Statoil and Intergraph has been paramount to our success. The synergy we have managed to achieve through our partnership has given us the confidence to proceed to meet the challenges ahead in reaching the goal of fully integrating work-processes across the value chain by introducing e-Engineering."

9. The Role of Plant Information Management in Åsgard Operations

Information turned over from the engineering, procurement and construction (EPC) project must be properly maintained once production begins. If not, many of the benefits of compiling the plant information asset are lost as unreliability and information erosion seep in. Statoil believes the plant information asset's value is equal to that of the physical plant.

The PIM data warehouse, which held all technical "as-built" data for the Åsgard project, is now used by plant personnel to access and maintain the "as-operating" plant information. Early 2002, data from the Åsgard A oil production ship's legacy systems was transferred to and now is wholly maintained in PIM.

PIM also provides technical information to other operational systems, such as SAP's maintenance management. On a practical basis, the intuitive Web user interface is far easier for offshore personnel, who operate shift rotations of two weeks on and three weeks off, to learn and remember.

Statoil expects numerous business benefits, including:

- Lower training costs due to the intuitive Web user interface
- Lower system maintenance costs compared to in-house legacy systems
- Greater flexibility in introducing new requirements
- Improved change management functionality, reducing the bureaucracy of the change management process
- Improved procurement of standard equipment replacements from better records of equipment installed on the platform

10. Leveraging Åsgard's 'Lessons Learned' into Corporate Best Practices

Statoil has incorporated lessons from the Åsgard experience into a corporate "best practice" using PIM for all new field developments. The following proven benefits, in particular, have prompted this requirement:

- Improved standard equipment information management
- Reduces documentation from equipment package suppliers by more than 50 percent
- Reduces the bureaucracy by eliminating multiple copies of documentation from suppliers
- Improves data consistency by cross-referencing functional locations (tags) to the standard equipment
- Facilitates the identification and reduction of preferred equipment variants
- Provides a single, consistent source of standard equipment information for operations and maintenance
- Improved engineering change management
- Reduces the paper-intensive bureaucracy associated with changes
- Improves management reporting of change proposal and implementation
- Provides an overview of all ongoing and proposed changes
- Identifies bottlenecks in the change implementation process
- Traces all changes that have affected the plant or parts of the plant
- Improves access to all document mark-ups and follows up on their implementation
- Improved information access and quality
- Improves information exchange and sharing via a Web-enabled repository
- Eliminates lengthy, costly and poor quality handover of lifecycle information

11. New Goals for New Projects

As Statoil moves forward with two more large projects – Kristin (a US\$1.88 billion offshore development expected to begin production in 2005) and Snøhvit (a US\$5.1 billion liquefied natural gas development expected to begin production in 2006) – the company is seeking even more benefits from PIM.

To ensure that PIM will always reflect up-to-the minute engineering information, Statoil is implementing automated daily data transfers from the contractor's engineering tools to PIM. This will be shared with all parties involved in the projects.

Additionally, collaborative e-engineering with package suppliers is a major initiative for the Kristin project using PIM via the Web as a common e-engineering vehicle. The timely acquisition and review of information provided by package suppliers is always a major challenge on large development projects. Delays give rise to costly bottlenecks.

Kristin suppliers are being provided with an offline data-gathering tool that is preloaded with the engineering design basis data for their scope of work. Suppliers will communicate directly with PIM via the Web to allocate new tags and to download documents and tag index/structured datasheets to PIM. Package engineers then will review the downloaded information and documentation, and the comments and mark-ups will be available for supplier download.

Statoil envisions that this approach to handling package information will offer major benefits:

- Eliminate the time-consuming transfer of hard copy data and documentation between the contractors and package suppliers
- Reduce the review cycle time for submitted data and documentation
- Eliminate all hard copy submissions of final engineering dossiers as suppliers electronically compile their documents with the PIM gathering tool
- Significantly reduce both the main contractor and the package equipment supplier costs to manage lifecycle information and completely eliminate all final handover costs of lifecycle information
- Improve the quality of lifecycle information from the package supplier since the PIM gathering tool includes quality safeguards that must be met before the data can be uploaded to PIM for review

With Åsgard, the success story focused on the quality and speed of information handover to operations. Using PIM, Åsgard handover was the best ever achieved by Statoil. These additional measures will help Statoil achieve its objective for Kristin – to eliminate handover costs completely while maintaining the quality of information.

Looking to the future, by continuing to apply technology and lessons learned from development and operations, Statoil believes there is still much to be gained in cost reductions and efficiency gains both in operations and future projects. Closer collaboration among contractors, suppliers and owners – together with increased integration of engineering tools and an ongoing adoption of standards – will all play their part.

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