Business Challenge

Drilling and production environments are clearly growing more complex: ultra-deep wells, complicated offsets, extended horizontal well paths and smaller reservoir targets are becoming the norm. In this environment, prolonged well planning cycles, design miscalculations or the wrong drilling decisions can cost millions of dollars – jeopardizing the project’s profitability.

Engineers are challenged daily to efficiently make critical engineering decisions in the face of more complex designs, significantly more data than ever before, and often with a shortfall in experience or training. To help engineers meet these challenges, they require an integrated, multi-user drilling and production engineering environment to facilitate streamlined workflow practices, sound engineering and rapid decision-making. This environment should provide a suite of industry-leading applications for well design and analysis, drilling and completions, and a common database for rapid access to information and safe data storage.

Overview

Integration platform for drilling, well services, production and economics data

The Engineer’s Data Model™ (EDM™) database provides the foundation for Landmark’s next generation of drilling, well planning and operations reporting systems. It provides a single platform for detailed operations and engineering workflows from prototype to plan and actual phases of drilling or servicing a well.

Based on Energistics, PPDM, WITSML and other Open Systems standards, EDM offers the well-engineering professional the broadest range of well data in one database. It is part of a comprehensive data management suite that includes:

- PetroBank® Master Data Store™ – for storing raw or bulk petrotechnical data; especially adept at accommodating large volumes of seismic data
- OpenWorks® – in-depth project data for geoscience applications
- Corporate Data Store™ – for storing final results or “gold” data that conform to corporate standards and processes and that can “seed” new projects

These solutions, functioning together, round out the information life cycle needs of the upstream Exploration and Production (E&P) community.

Knowledge modules and well path data sourced from EDM as shown in AssetView™.

Halliburton
Benefits

Improved Productivity and Profitability

The EDM platform enables engineers to realize valuable productivity gains during the well-planning process through efficient and naturally integrated workflows. EDM technology provides a single data entry point for common information across drilling applications, thereby allowing engineers to move from application to application during their workflow and to access the same data set. Updates to EDM data are also synchronized across drilling applications using Simultaneous Activity Monitors (SAMs).

EDM software also provides the foundation for making both real-time and report-time engineering decisions. A current operation can be analyzed easily on the basis of the latest operational parameters from the daily operations report or real-time WITSML data feeds from actual down-hole conditions. These capabilities enable drillers and engineers to make better ongoing operational decisions and corrections while the well is being drilled. The result can be reduced NPT, minimized drilling time and resources required, improved well performance and improved profitability.

Reduce Cycle Time

Realize substantial productivity gains from reduced cycle times through shared data sets and efficient workflows. Reduce cycle times by accumulating the engineering team's well planning, operations and production information in a single EDM project. Holistic information means that each member of the engineering team has the tools he or she requires to make better, faster and more informed decisions for their part of the process. Overall, this results in increased collective productivity.

Users can easily plan a Well Trajectory, select Casing setting depths and prepare detailed Casing Designs all in one fully integrated engineering environment. StressCheck™ software interface shown above.
**Preserves Data Integrity**  
Ensuring that all members of an asset team are engaged in utilizing the same copy of a data set is critical to minimizing uncertainty and risk. Having multiple copies of project data can introduce confusion as to which copy is the most current, which copy team members should be saving their analyses to, and which copy should be used for further analysis. Having a project database that allows users to create a single copy of working data sets that update dynamically across different applications ensures that engineers are always working with the most accurate, trusted and up-to-date data. Automatic updating helps ensure data integrity by eliminating manual intervention by users and administrators. It also facilitates common well-engineering processes and standards across the company, and can reduce well data management costs.

**Easy Organization of Data**  
An intuitive industry-centric data hierarchy allows easy organization of data in the common Well Explorer system. Data levels include: Company, Project, Site, Well, Wellbore, Design and Case. Additional levels focused on Well Operations include: Completion, Event, Report and Rig.

**Support Knowledge Management Best Practices**  
Based on any operator’s well design methodology, you are able to use and analyze all data captured for offset well analysis, technical limit analysis planning and lessons-learned forums.

**Drilling and Completions Comprehensive Product Offering**  
EDM software is one solution in a portfolio of multiple solutions targeted at the drilling community. Landmark offers applications to address each sequence of the workflow from simple to complex well design and operations, including:

- Well Planning
- Survey Sharing
- Drillstring Analysis
- Casing Run Analysis

Specific products that address each aspect of well design and operation include:

- The WELLPLAN™ engineering suite:
  - Torque/Drag
  - Hydraulics
  - WellControl
  - OptiCem
- Stuck Pipe
- BHA/Drillhead
- Critical Speed Analysis
- Swab/Surge
- Notebook
- COMPASS™ – Survey data management, directional well planning, anti-collision analysis
- CasingSeat™ – Casing scheme generation, shoe-setting depth analysis
- StressCheck™ – Detailed casing design
- OpenWells® – Well operations reporting and data analysis
- Data Analyzer™ – ad-hoc data querying and analysis
- PROFILE™ – Wellbore schematics and reports
- iWellFile™ –Intranet drilling and well services reporting
- 3D Drill View KM™ – Integrated engineering and geoscience visualization

**Application Integration**  
While Landmark offers a portfolio of applications that address each aspect of the engineer’s workflow, we realize that not all of our customers have purely Landmark solutions. Many of our customers have proprietary applications servicing very specific business needs or have other vendors’ solutions from mergers and acquisitions, etc. These applications may play a critical role in your engineers’ current workflows; therefore, in keeping with Landmark’s philosophy of openness, we offer an EDM Software Development Kit (SDK) to other vendors and customers in order to build the best-of-breed workflows that you require. This ensures that you can preserve your current investments while leveraging the broad range of engineering data that EDM software provides. It also ensures that you can integrate any future applications as the needs of your business grow or evolve.

**EDM AutoSync Utility**  
The EDM AutoSync utility provides “Global Data Aggregation” functionality used in a globally dispersed environment. The software enables globally distributed EDM databases to automatically post changes made to a central EDM repository or EDM data warehouse. Connections to multiple regional instances of EDM AutoSync software are easily configured, including settings to control the frequency of data transfer events into the corporate instance as often as once every ten seconds.
Common data and data exposed through OpenWells and COMPASS™ software is synchronized. Whether the data is imported, sent from a rig, or changed manually by an office engineer, changes are automatically pushed to the corporate datastore. The EDM AutoSync utility follows the same logical model inherent to EDT applications for managing updates.

**Common Security Model**

EDM software provides a common menu structure and options, along with single-user login to enforce a common security model and ease the security burden on administrators. EDM’s database security can enforce user access to data, while applications’ security enables the administrator to control which actions are available to different users and groups. These two security systems ensure that your engineers always have the right access to the right data.

**File Attachment Support**

EDM software supports the attachment of electronic documents to data in the Well Explorer system; these can include spreadsheets and even picture files. By allowing engineers to have immediate access to attachments that may contain key well-related data, they can improve their productivity and cycle times. They won’t be limited by lack of information in their ability to make key drilling or operational decisions.

**Unit Management System**

A common unit system provided by EDM stores numeric data to a consistent data set. Each user has access to standard or custom display units sets to enter and view data in their preferred units. However, the easy-to-use Convert Units feature enables them to quickly enter values in another unit without having to change display unit sets. This saves engineers both time and headaches so they can spend their time analyzing data rather than manipulating or converting it into a format that can be more easily analyzed.

### Requirements: Hardware / Software / Operating System

**Engineer’s Data Model™ R5000.0.0**

<table>
<thead>
<tr>
<th>Hardware</th>
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<tbody>
<tr>
<td>Minimum server requirements include:</td>
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<tr>
<td>2 GHz processor, 2 GB RAM, and 4 GB disk space.</td>
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<table>
<thead>
<tr>
<th>Operating System(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Clients or Standalone System:</td>
</tr>
<tr>
<td>Microsoft Windows® XP Professional, SP2</td>
</tr>
<tr>
<td>Server:</td>
</tr>
<tr>
<td>Microsoft Windows 2003® Server, SP2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Software</th>
</tr>
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<tbody>
<tr>
<td>Supports standalone/small network databases through network implementations utilizing Oracle® Enterprise 10g®, Microsoft SQL® Server 2005 and SQL Server™ Express 2005.</td>
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</table>

<table>
<thead>
<tr>
<th>Other</th>
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<tbody>
<tr>
<td>A number of third-party applications must be installed prior to installing EDM software (please consult the release notes for a comprehensive list of requirements). Major third-party applications are:</td>
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<tr>
<td>Microsoft Data Access Components 2.8</td>
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<tr>
<td>Crystal Reports 11.5</td>
</tr>
<tr>
<td>Microsoft .NET Framework 2.0</td>
</tr>
<tr>
<td>Microsoft Visual J#.NET Redistribution Package 2.0</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Related Products</th>
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</thead>
<tbody>
<tr>
<td>ARIES™ software</td>
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<tr>
<td>CasingSeat™ software</td>
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<tr>
<td>COMPASS™ software</td>
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<tr>
<td>Data Analyzer™ software</td>
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<tr>
<td>DEX™ software</td>
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<tr>
<td>DrillModel™ software</td>
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<tr>
<td>DSS™ software</td>
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<tr>
<td>iWellFile™ software</td>
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<tr>
<td>OpenWells® software</td>
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<tr>
<td>OpenWorks® software</td>
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<tr>
<td>PROFILE™ software</td>
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<tr>
<td>StressCheck™ software</td>
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<tr>
<td>WELLCAT™ software</td>
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<tr>
<td>WELLPLN™ software</td>
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</tbody>
</table>
Accurate positioning of the wellbore in the target zone is a critical element to maximizing recovery in any well that is drilled. With the rise in the number of complex wells that involve multi-laterals, severe deviations and long horizontals, this becomes even more important. More horizontal wells are being drilled faster, closer together, with thin target zones, and in previously developed fields. To respond, engineers must drill quickly while avoiding geologic hazards and well collisions to steer the bit to the profitable pay zone.

COMPASS™ software is the industry’s premiere application for directional well path planning, survey data management, plotting and anti-collision analysis. This software, designed for both oil companies and drilling contractors, can improve safety, efficiency and cost effectiveness of directional well programs. It features multiple 2D and 3D planning methods, torque and drag analysis, cost and re-entry optimization, plotting, survey data analysis and driller’s target generation.

COMPASS software is deployed on the Engineer’s Data Model™ (EDM™) database ensuring data consistency and reduced planning cycle times in a shared data and workflow environment. Automatic updates and notifications ensure that asset team members are aware when changes occur and that engineering results are updated in real time.

COMPASS software is an integral component of collaborative well planning in multidisciplinary asset team environments. Integration with OpenWorks® geosciences database ensures that geoscientists and engineers recognize trajectory changes made by the other discipline so each member of the team can immediately provide the feedback required to achieve both engineering and subsurface objectives.

**KEY FEATURES**
- Accurately positions the wellbore in the target zone to maximize reservoir contact
- Through anti-collision analysis and warnings helps avoid costly incidents
- Comprehensive survey data management, data integrity tools, and auditing capabilities

**BENEFITS**

**Accurate and cost-effective well plans**
COMPASS software quickly optimizes simple or complex trajectories based on cost, torque and drag, or anti-collision and can recommend the most appropriate well to sidetrack when carrying out infill drilling. No matter which operating challenge you face from deepwater to unconventional, COMPASS software enables users to accurately position the wellbore to optimize reservoir recovery.

**Avoid costly collision incidents**
Drilling in mature fields or in unconventional shale opportunities requires close monitoring so as not to collide with existing wellbores. To always keep you aware, anti-collision scans can be run interactively with planning, surveying or projecting ahead, while warnings can be configured to alert users when well paths converge at specified minimum criteria.
Reduced well-planning cycle time
Data level integration with the Engineer’s Data Model database and cross domain workflow integration with OpenWorks projects improves planning cycle times and improves operational performance.

FEATURES
Comprehensive well path planning
An interactive editing worksheet allows the user to build the well trajectory in sections. At each stage of well planning, the well path graphics dynamically update as changes are made. The user can revisit, insert, delete or change variables for any section of a plan and the entire plan will be recomputed. Automated slot optimization is available for assigning or re-assigning plans to available slots to improve anti-collision results.
Survey data management
Data can be entered in a spreadsheet, imported using industry standard formats or automatically populated in real time using OpenWire® software. Surveys can be spliced together to form a definitive best path. Incoming survey data can be analyzed for quality via several methods. Survey data is also shared with OpenWells® software, eliminating duplicate entry. Users can project ahead from any point in a survey and determine the optimum path to get back on plan or to hit a target.

Anti-collision analysis
COMPASS software provides spider, ladder (including equivalent magnetic distance), 3D proximity and traveling cylinder plots as well as numerous hard-copy reports. Anti-collision scans can be run interactively with planning, surveying or projecting ahead while recording new survey stations. Warnings can be configured to alert the user when well paths converge per company-specified minimum criteria.

Multiple depth referencing support
Flexible depth reference support allows sidetracks to be drilled using rigs with elevations different from that of the parent bore. An active viewing toolbar allows for quick swapping of depth referencing.

ISCWSA survey tool modeling
Supports the latest Industry Steering Committee on Wellbore Survey Accuracy (ISCWSA) gyro and Measurement While Drilling (MWD) models and uses the ISCWSA survey tool error model where users can configure error terms and weighting functions.

POSC model conformance
Data model conforms to the Petrotechnical Open Software Corp. model for well, wellpath, and directional surveys. Wells may have multiple sidetracks or laterals.

Industry Standard Geomagnetic models (BGGM and NOOA) support
If a company is subscribed to any of these services, the COMPASS software allows the calculation of geomagnetic declination for survey azimuthal correction using these models.

Real-time support
A look-ahead plan can be enabled for use with real-time data feeds. This plan is automatically computed based on the latest survey data. It combines the current survey data, a projection back to the plan and the current plan to total depth (TD). This functionality used in conjunction with WELLPLAN™ enables the user to ascertain the impact of the current actual trajectory with respect to operations when the well is drilled to TD. The look ahead plan is, at any given time, the most accurate representation of the wellbore to TD.

Integration with EDM™ database applications
COMPASS software includes shared data navigation with other EDM database applications using the Well Explorer. It supports EDM database architectures for Reference Datum Levels, Simultaneous Activity Monitor, security, unit management, data migration, electronic document attachment, catalog editor, XML import and export, and field and office data transfer.

OpenWorks database integration
The software communicates directly with OpenWorks geoscience database. Plans, targets, surveys, casings and formation tops can be moved between drilling and geology with a button click or set automatically. Additionally, COMPASS software can transfer information directly to DecisionSpace® Well Planning suite via an automated transfer.

Directional difficulty Index
Tortuosity and Directional Difficulty Index (DDI) information is provided for plans and surveys. The DDI is a measure of the difficulty of drilling the directional profile based on the paper IADC/SPE 59196.

Well path optimizer
The software integrates torque and drag cost and anti-collision analysis into the planning module to determine the best combination of trajectory design parameters. Designs can be optimized for time and cost, torque and drag or anti-collision. The optimizer recognizes designs that are not viable due to mechanical or operational limits and recommends potential sidetrack candidates, saving days of trial and error analysis.

Site/Platform placement optimization tool
Given a group of targets, the COMPASS software determines the best location of pads or platforms to drill in the shortest distance possible.

Wall plot composer
Comprehensive drafting package designed to produce quality presentation graphs for small- or large-format plotters.
System and Software

SOFTWARE REQUIREMENTS
Engineer’s Data Model (EDM)
Microsoft Database Engine (MSDE)

OPERATING SYSTEMS
Microsoft® Windows® 7 Enterprise
64-bit with SP1
Microsoft Windows Vista Enterprise
64-bit with SP2
Windows 2008 Server SP2, 64-bit
Citrix XenApp 6.0
Oracle 11.2.0.2
Oracle 10.2.0.4
SQL Server 2008 R2 SP1

Numerous graphs, text boxes and bitmaps can be incorporated into one plot. Graph options give complete control over scaling, additions, labels, fonts and shading. Use designed layout to create templates for future plots for the chosen paper size.

Sliding sheet and SAG corrections
The software can perform 3D survey corrections based on directional drilling sliding sheet information and/or SAG corrections based on WELLPLAN Torque and Drag string position calculations using the stiff string model, BHA information, mud weight and other relevant parameters.

Complex data transfer and DB synchronization capabilities
Compass allows data transfer between different data repositories allowing easy conflict resolution when there are data differences. This is extremely useful when moving data from the rig to the office and vice versa.

Precise wellbore positioning is essential to optimize reservoir contact and avoid hazards and well collisions to maximize drilling effectiveness.

Landmark Services offers solutions to help you deliver on your business strategies. Contact your Landmark Software & Services sales representative or send an inquiry to LandmarkServices@Halliburton.com.
CasingSeat™ Software

OVERVIEW
CasingSeat™ software is a graphics-based tool for accurately determining casing setting depth and viable casing and wellbore schemes. Using CasingSeat software in the early phases of the casing-design process can lead to significant savings on the cost of tubulars.

The software features inventory-based management of permissible-hole and casing-size combinations and provides layer- and lithology-based characterizations of subsurface boundary conditions and operating constraints, including those associated with wellbore stability, minimum overbalance, and differential sticking. CasingSeat software provides bottom-up and top-down solution methods, based on minimum setting-depth requirements and maximum permissible drill-ahead depths, respectively, for identifying and ranking casing schemes.

CasingSeat software is deployed on the Engineer’s Data Model™ (EDM™) software platform, which contains a fully integrated suite of well-engineering and data analysis solutions. This enables data to be entered just once and then used throughout the system to promote best practices and an environment for managing and accessing operational knowledge and lessons learned.

BENEFITS

Powerful EDM platform integration
CasingSeat software integrates seamlessly with the drilling and completions applications in Landmark’s EDM suite. This integration reduces data-entry time, errors, and training. CasingSeat software shares common data navigation, enabling final designs to be easily used in subsequent analyses by other Landmark applications, such as COMPASS™, StressCheck™, WELLCAT™, Well Cost, or WELLPLAN™ software systems.

Increase productivity and efficiency
All permissible casing scheme solutions are presented to the user for evaluation and selection. The selected casing scheme can be used as input for further study in the well construction workflow, eliminating redundant data entry, saving time, and helping the operator make better decisions.

Solutions ranked for cost savings
Potential casing schemes are ranked bottoms-up and tops-down, based on the relative cost of total hole-volume drilled and estimated casing weight. Engineers can use the relative rankings to select a cost-effective design.
CasingSeat’s user-friendly split-screen views aid analysis.

FEATURES

Design to specifications
CasingSeat software supplies inventory-based management of permissible-hole and casing-size combinations, which are selected using an intuitive graphical interface.

Instant designs
An instant design can be created based on the data input and standard defaults to provide immediate feedback on potential design schemes.

Process archiving
A report of all input parameters and calculations is generated to document the process.

Graphical views
The software provides a variety of graphical views, including pore pressure and fracture gradient profiles, lower- and upper-bound limits imposed by boundary conditions and operating constraints, interval mud-weight indicators, and calculated shoe locations for all casing strings.
Powerful usability features
CasingSeat software features American Petroleum Institute, International System, and custom unit systems, along with a comprehensive online help system. Standard or user-configured report formats are available, along with user-defined preconfigured display tabs. The workspace layout functionality in the design session includes the default system preferred layout or one configured by the user. On-screen results are in user-configurable multi-pane spreadsheets and plot formats.

Solution modes for user evaluation and selection
The software generates solution modes for variations of upper and lower pore pressure and fracture gradient margins, as well as depth shifting of formation layers. All casing scheme solutions are presented for user evaluation and selection.

Pre-configured designs
A template feature enables preconfigured CasingSeat designs to reflect both company design standards and available inventories.

User-friendly data entry
Data is input via spreadsheet format with support for cut/copy/paste and drag/drop operations.
Easily transfer or export data

Links to DEX™ software, Landmark’s data exchange software, to enable easy transfer of relevant data to other DEX-compliant applications.

System and Software

SOFTWARE REQUIREMENTS

- Engineers Data Model (EDM)
- Oracle® ODBC Driver

OPERATING SYSTEMS

- Microsoft® Windows® 7 Enterprise 64-bit with SP1
- Microsoft Windows Vista Enterprise 64-bit with SP2
- Windows 2008 Server 64-bit R2 with SP1
- Citrix XenApp 6.0
- Oracle 11.2.0.2
- Oracle 10.2.0.4
- SQL Server 2008 R2 SP1

Graphical interface for casing and hole-size inventory selection.

Casing, liner, and tubing strings are a significant cost and safety component of the well design. Engineers must strike a balance and create a tubular design that will maintain well integrity, but not over design and drive up costs.

Landmark offers solutions to help you deliver on your business strategies. For questions or to contact your Landmark representative, visit us at landmarksoftware.com.

Sales of Halliburton products and services will be in accord solely with the terms and conditions contained in the contract between Halliburton and the customer that is applicable to the sale. H010678 © 2014 Halliburton. All Rights Reserved.
Casing, liner, and tubing strings are a significant cost and safety component in all well construction operations. Operators need to be able to determine safe designs that are also cost-effective. StressCheck™ casing-design software takes the trial and error out of designing casing, liner, and tubing strings, and helps minimize the cost of well tubulars.

This comprehensive solution automatically generates the lowest-cost casing design based on user-defined loads. Using interactive graphics-based tools, StressCheck software enables quick, systematic, and accurate evaluation of casing wear limits, minimum-cost design solutions, comprehensive tri-axial design, and working-stress design for burst, collapse, and axial installation and service-life loads. With StressCheck software tools, it’s easy to complete designs using the minimum-cost design algorithm or the “click-and-drag” design element.

StressCheck software is integrated the Engineer’s Data Model™ (EDM™) software, which supports integrated operations reporting, drilling, and completions engineering, and well-planning workflows.

**Benefits**

**Higher Productivity and Efficiency**
Integration with the EDM software platform helps reduce data-entry time, errors, and training. Information is entered once and then available to other applications in Landmark’s drilling portfolio. For example, StressCheck has bi-directional integration with WELLCAT™ software and shares fluid densities, cementing and landing data, applicable design parameters, and unidirectional limited integration of burst, collapse, and axial loads, single packer and pipe data, and connections.

StressCheck™ software provides a graphical design limits plot and safety factors for each string.
Low-cost Design
StressCheck software helps lower the cost of casing and tubing design. It automatically determines the lowest cost casing design, based on either standard or user-defined inventories, specific cost, user-defined constraints on valid API and tri-axial design domains, and minimum length of casing and tubing sections. Graphics-based workflows streamline the casing, liner, and tubing string design processes, helping to minimize the cost of well tubulars.

Fast, Accurate Solutions
Determines fast and accurate load, stress, and buckling solutions for vertical and directional wells.

FEATURES

Powerful EDM Platform Integration
Built on Landmark’s EDM platform, enabling integrated workflows and features and providing common data navigation with other EDM applications.

Graphical Designs
Graphical design tools streamline workflows for casing, liner, and tubing strings design.

Automated Load Generation
Running installation and service loads with automated generation of standard or user-defined load cases for drilling and production.

Compression Ratings and Design Factors
Determine connection axial compression rating and design factors, and pipe body axial compression design factors separate from the axial tension ratings and design factors. Results provide views to distinguish between axial tension and compression safety factors for both connection and pipe body.

Connection Test Data Performance
Import or enter connection test-data performance (load and pressure pairs) into a predefined format for two different connection types. The tri-axial stress of the user-defined connection can then be displayed on the design limit plot. This new technology was the result of ISO (International Standards Organization) 13679 recommended practice for testing purposes involving casing and tubing connections.
**Enhanced Schematics**
Enhanced PROFILE™ software like schematics with tool tips for easy viewing.

**Spreadsheet and Graphical Data Views**
Provides spreadsheet data entry, with support for cut/copy/paste and drag/drop operations. StressCheck software provides a template feature for pre-configuring designs that reflect company design standards and available inventories, as well as user and system workspace-preferred layout functionality selection while in design session. It allows graphical views for well configuration, directional profile, formation pressure, fracture gradient profiles and load, internal pressure, external pressure, differential pressure, axial load, and temperature profiles for each load case. It uses graphic and tabular views to display wellbore and load data.

**Convenient Results Configurations**
Provides a design summary of minimum burst, collapse, axial, and tri-axial safety factors for each string, per load and the full tubular program. Standard or user-configured report formats are available, along with user-defined preconfigured display tabs. On-screen results are in user-configurable, multi-pane spreadsheet and plot formats.

**Easy Data Transfer**
Features the American Petroleum Institute, International System, and custom unit systems, along with a comprehensive online Help system. Includes a link to Landmark’s DEX™ data exchange software, permitting easy transfer of relevant data between other DEX-compliant applications. Designs can be exported as *.sck flat files.

**ADVANCED FEATURES**
- Ability to highlight and freeze graph lines to run sensitivity analyses.
- Drag-and-drop casing strings with all the loads and relevant data from one design to another.
- Tab-configuration locking so that multiple pane views can be fixed.
- Gas-over-mud ratio, productive formation pressure to surface internal pressure profile (ratio of well control gas to drilling mud) added to standard list of industry-accepted load cases. Interpolated internal pressure profile of Maximum Anticipated Surface Pressure (MASP) or Maximum Anticipated Wellhead Pressure (MAWP) to fracture pressure at shoe.
- Simple to complex external load profiles, with options for good/poor cement, permeable zones, mud deterioration, annular mud drop, and annular gas migration.
- Pore pressure in open-hole cemented interval.
- Shoe/mud gradients with pore pressure, combines mud-weight pressure column, pressure discontinuity of equivalent mud-weight pore-pressure gradient at prior shoe, and pore pressure in open-hole across uncemented and cemented intervals.
- Default temperature profiles for evaluation of thermally induced loads that arise from drilling, production, and injection load cases; option for user-defined initial condition, and either undisturbed or user-defined service-load temperatures.
- Collapse loads due to salt encroachment.
- Well Containment Screening Tool (WCST) BSEE collapse load.
- Multiple load pressure test; internal pressure test profile share across casing—liner configuration.
System and Software

Software Requirements

- Engineers Data Model (EDM)
- Oracle® ODBC Driver

Supported Operating Systems

- Microsoft® Windows® 7 Enterprise 64-bit with SP1
- Microsoft Windows Vista Enterprise 64-bit with SP2
- Windows 2008 Server 64-bit R2 with SP1
- Citrix XenApp 6.0
- Oracle 11.2.0.2
- Oracle 10.2.0.4
- SQL Server 2008 R2 SP1

- Support casing liner overlapped pressure profile in pressure test load scenarios.
- Both string and load case-specific design factor specification, with independent design factors for pipe body and connection.
- Burst, collapse, axial, and tri-axial safety factors for each load case; burst and axial safety factors based on the lesser of pipe body or connection ratings.
- Load-line generation design based on aggregate of load cases for each load category (burst, collapse, and axial).
- Drag-and-drop selection of casing and tubing sections within interactive graphical design plot.
- User-specified schedule for temperature-dependent yield deration.
- Comprehensive API well-tubulars catalog with provision for user-specified additions.
- Standard API connections and default proprietary connections catalogs with provision for user-specified proprietary connections.
- Single-point converter dialog to show conversion between TVD and MD and vice versa.
- Equivalent von Mises plot view to characterize the exact 2-D plot for the current von Mises criteria.
- WallPlot composer for a single-view montage of the entire design.
- APD (Application for a Permit to Drill) reports, including gas/oil gradient, MASP and MAWP based fraction of gas and mud column definition and frac at shoe or bottomhole pressure calculation methods.
- Send to excel input and output data.

Drag-and-drop selection of casing sections within interactive graphical design plots.

Landmark offers solutions to help you deliver on your business strategies. For questions or to contact your Landmark representative, visit us at landmarksoftware.com.
WELLPLAN™ Software

Your comprehensive suite of engineering tools for well planning
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WELLPLAN™ Suite Well Operations Software

Landmark's WELLPLAN™ Suite is a comprehensive set of integrated well engineering analysis software.

WELLPLAN, a component of Landmark's Engineer's Desktop™, gives drilling and completions engineers a comprehensive set of engineering tools for analysis, well planning, modeling, and well operations optimization. Technology offered in the WELLPLAN Suite functions as an integrated system and includes built-in links to Landmark's well data management software.

The WELLPLAN Suite is deployed on Landmark's Engineer's Data Model™ (EDM), the platform for a fully integrated suite of well engineering and data analysis products. EDM provides one-time data entry, a system to promote best practices, and an environment for managing and accessing operational knowledge and lessons learned.

Benefits

**Powerful engineering environment**
WELLPLAN software's complete suite of seamlessly integrated modules addresses data collection, analysis, well planning, and modeling, creating a powerful workstation for the engineer.

**Optimized workflows**
"Plug and play" compatibility across the WELLPLAN Suite and with other EDM applications enables comprehensive engineering workflows from a single application. The result is an optimized engineering environment and enhanced efficiency.

**Rapid engineering studies via OpenWells data access**
Integration with Landmark's OpenWells rig site data collection and reporting system enables engineers to directly create a WELLPLAN case, automatically populate the case with pertinent field and rig data, then use that information to rapidly undertake engineering studies.

**Increased productivity and efficiency**
Uses sophisticated tools to improve well designs, prevent stuck pipe and BHA failures, reduce drilling problems, and drill the right wells at reduced cost and time with increased safety.

Features

**Integration with other EDM applications**
Provides common data navigation with other EDM applications using the Well Explorer. EDM enables sharing of directional profiles with wells created in COMPASS™. In addition, casing strings created in the StressCheck™ casing design application can be analyzed using WELLPLAN.

**Standalone or multi-user environment**
Operates in a standalone or in a fully concurrent multi-user network environment with powerful user
management and data locking features. Built to scale from a single user application to a corporate engineering system.

**Create Case from OpenWells**
Quickly populate a WELLPLAN case with operational data entered into OpenWells. Enables a quick analysis of daily operations by eliminating the time required to gather this information. All pertinent data is at your fingertips.

**Wallplot Composer**
Create large scale engineering plots using the Wallplot Composer. Predefined templates for every module are available for immediate use right out of the box. Templates can be customized or new templates can be created. Every plot and data box for all modules are available for inclusion in a wallplot. Detailed BHA and hole section schematics are also available for inclusion in wallplots.

**Reporting**
New reporting engine, based on Crystal Reports, generates colorful, professional, reports. The reports can now be saved in various formats such as Excel, Word, PDF, XML, RTF and RPT. In addition, reports can be e-mailed directly from the report viewer in any of the above formats using your e-mail client.

**Enhanced graphics**
Colorful, detailed BHA and hole schematic diagrams are now available with numerous viewing options. These include, deviated/non-deviated and to scale/not to scale. Custom labeling and viewing options are also available. Animation plots have also been updated with high definition graphics. Visual, drag and drop BHA creation is also available. Users can quickly generate detailed BHA schematics without entering data into the spreadsheet. Schematics can be exported to the clipboard for use in other applications.

**Additional utility features**
A Data Dictionary feature has been added to allow users to customize tool tips and labels for data entry fields. A Unit Converter is provided to allow the user to enter data in any unit of choice, regardless of the current unit system being used. The MD/TVD utility allows for quick MD or TVD interpolation for data entry.

**Enhanced library**
The user can save BHA assemblies and fluids to a library. These items are then available for use in any WELLPLAN™ case. This eliminates the need to re-enter complex BHA’s. In addition, the library can be exported to and imported from another EDM database. These libraries are shared with OPENWELLS. BHA’s entered in the daily operations report can be stored in the library.

**Workspaces**
System, Module, and User Defined workspaces are now stored in the database so they are readily available to all users.

**Catalogs**
Catalogs (API RP 7G Tables) speed data entry. Catalogs have been added for mud pumps, bits, casing shoes, port-collars, diverter subs, hole openers and underreamers. User defined catalogs can be exported and imported for use in other EDM databases.

**Spreadsheet functionality**
Enhanced copy/paste functionality for spreadsheet data input.

**Usability features**
Enhanced copy/paste functionality for spreadsheet data input.
- Extensive online help
- Consistent “look and feel” across all WELLPLAN modules
- Comprehensive error checking
• Data is entered into WELLPLAN only once with complete data integration between modules
• Extensive data export /import facilities
• Flexible user-defined units system

WELLPLAN modules
The following modules provide detailed, compatible well planning tools for an optimized engineering workflow:
• Torque/Drag Analysis: provides detailed analysis of the torque and drag forces affecting the drillstring, casing or liner
• Hydraulics: provides comprehensive pressure drop calculations, bit hydraulics, and hole cleaning analysis
• BHA Drillahead: models drilling performance of steerable and rotary drilling assemblies
• Critical Speed Analysis: models BHA behavior and identifies critical rotary speeds and high stress concentration in the drill string
• Cementing-OptiCem: provides tools to design and simulate cementing operations
• Well Control: kick tolerance analysis along with complete modeling of pressure effects observed in the wellbore during kill operations (generates kill sheets)
• Surge: transient analysis for swab, surge and reciprocation operations to avoid well control problems and formation damage. Critical for close tolerance operations and where pore pressure /fracture gradient windows are small.
• StuckPipe: calculates stuck point, back-off force and jar setting and tripping forces
WELLPLAN™ Torque and Drag Analysis Software

Plan and analyze drilling and casing running operations and assess the impact of predicted loads related to torque and drag.

To ensure successful drilling operations, especially in today’s complex wells, it’s crucial to have adequate knowledge of the anticipated loads for drilling and casing operations. Landmark’s WELLPLAN™ Torque and Drag Analysis program provides this critical information.

WELLPLAN™ Torque and Drag Analysis software allows users to identify potential problems during planning and supplies standoff devices, casing flotation optimization and other tools to investigate design modifications for improvement.

In addition, engineers can determine if the selected rig has adequate mechanical specifications to handle well design requirements. The application allows users to stream real-time actual load information into WELLPLAN™, analyze planned versus actual loads, and simulate the effects of different mud types or lubricants.

WELLPLAN Torque and Drag Analysis software is deployed on Landmark’s Engineer’s Data Model™ (EDM), the platform for a fully integrated suite of well engineering and data analysis applications. EDM provides one-time data entry, a system to promote best practices, and an environment for managing and accessing operational knowledge and lessons learned.

Benefits

Effective torque and drag analysis
Performing powerful torque and drag analyses during the design and operations phase of a well requires minimal effort and produces excellent benefits.

Quicker decision-making
Engineers can easily study the effects of different operational parameters along with string and wellbore configurations to determine the best solution for a given design objective. Integration with COMPASS™ on EDM™ technology enables users to make better decisions, faster.

Versatility
This versatile application enables users to meet all well design requirements of downhole tool companies, services companies, and operators.
Features

Drag Sensitivity Plot
A new Drag Sensitivity Plot has been added for quick analysis of actual load data or to assess risk across a range of friction factors for cased and open hole.

Real time data analysis
Actual Load Data, surface loads and torque can be loaded real time from a WITSML provider. This information can be compared to plan data to quickly determine downhole related problems.

Documented reliability
Field-test cases have documented the reliability of the tool, which calculates coefficient of friction and variable coefficients of friction along the Wellbore.

Comparative design analysis
The engineer can easily study the effects of different string and wellbore configurations to determine the best solution to meet design objectives. The COMPASS program can be used to design several acceptable well paths to reach the specified targets, and with the powerful integration afforded by EDM the user can quickly analyze the impact of each.

Industry standard and Landmark enhanced algorithms
Computes hook-load and rotary torque for rig and drill string design, and determines critical buckling forces using Lubinski and Paslay-Bogy equations.

Tri-axial analysis
Axial forces, neutral point, and torque along the drill string can be calculated, and the tool predicts contact forces along the string in a 3D wellbore. Computes equivalent Von Mises Stress and compares it to yield stress (API RP7G).

Five operation modes
Five operational modes are accommodated: rotary drilling, drilling with a motor, tripping in, tripping out, and rotating off bottom. Drag charts covering these modes are compiled.

Multiple applications
Can be used for casing and liner analysis and to determine rotary torque, measured weight, pick-up and slack-off, string windup (with and without bit torque), and stretch for all points along string for the five operational modes.

Applicable to coil tubing operations
Using Top-Down Analysis to analyze coiled tubing operations. In this mode the known injector forces at the surface can be specified. A tension or compressive injector force at the surface can be specified. The calculation starts from top and calculates forces acting on the tubing downhole.

Casing Flotation Optimization
Automatically determines the optimum length of air column to minimize drag forces allowing casing/liner to be run to TD. Alternatively, given a fixed air column length, the maximum depth the casing/liner can be run will be computed.
WELLPLAN™ Hydraulics Software

Landmark’s WELLPLAN™ Hydraulics software delivers all of the analysis tools engineers need to study and design well hydraulics.

WELLPLAN Hydraulics software enables accurate circulation system analysis. The application can be used to study ECDs with regards to pore pressure and fracture pressure problems, to select jet sizes for optimum ROP over a given depth range, and to select flowrates to optimize hole cleaning.

WELLPLAN Hydraulics software performs pressure-loss analysis for all parts of the circulating system, including pressure losses through pipe and annular sections, pressure losses in rig surface equipment including coiled tubing units, and pressure drop across the bit.

WELLPLAN Hydraulics software is deployed on Landmark’s Engineer’s Data Model™ (EDM), the platform for a fully integrated suite of well engineering and data analysis products. EDM software provides one-time data entry, a system to promote best practices, and an environment for managing and accessing operational knowledge and lessons learned.

Benefits

Efficient analysis of complex design
Appropriate analysis tools enable engineers to efficiently study and design hydraulics for a variety of wells, including cases too complex for hand-calculation methods.

Features

Real Time mode
Offers a new Real Time mode for capturing and analyzing real time data. A new operational plot has been added to display real time hydraulics data such as ECDs, standpipe pressure and circulation rates from a WITSML™ provider. This actual data can be compared to predicted values to fine tune hydraulics modeling.

Complete pressure analysis
Accounts for motor and MWD pressure losses, and calculates pressure losses across tool joints. Annulus pressures or ECDs are reported at user-specified depths, and bit jet optimization can be used to achieve maximum hydraulic horsepower, maximum impact force, or maximum nozzle velocity. Includes temperature effects on the drilling fluid with the resultant changes in pressure drop.

Mud type evaluation
Analyzes the entire rig circulation system, utilizing such rheological models as Power Law, Bingham Plastic and Herschel-Bulkey. These analysis functions allow rapid evaluation of mud types.

Annular velocity analysis
Compares the critical velocity to the annular velocity across each annulus section, showing which flow regime is exhibited for different flowrates. Models the effects of split flows when underreamers and hole openers are included in the string.

Hole cleaning mode
Provides a hole cleaning mode to show users how cutting bed height will build up versus hole angle and rate of penetration. Scenarios can be run to show which flowrate/ROP combinations will result in poor hole cleaning. This model has been used and validated on world-record long reach wells.
**Swab and surge analysis**
Conducts swab and surge analysis, calculating pressures and ECDs for a range of tripping speeds. Calculates the tripping schedule for a specified trip margin. Addresses both open- and closed-end pipe, and models circulation while tripping. Comprehensive reports are provided for all hydraulics analysis.

**Extensive graphics capabilities**
Provides extensive graphics capabilities, including plots of pressure losses, annular velocities, hydraulic power, bit impact force, and nozzle velocity as a function of flowrate. Utilities are included for lag time and mud weight-up calculations.
WELLPLAN™ WellControl Software

Landmark’s WELLPLAN™ WellControl software models well kick scenarios and provides critical information engineers need at the rig site.

Using two constant bottom-hole pressure methods (Driller’s and Wait & Weight), the application calculates the pressures observed when a kick is taken and the resulting influx is circulated out of the wellbore.

WellControl software quickly performs the complex calculations required for optimum pumping schedules and accurate decisions.

WellControl tools also assist in casing design and in planning for contingencies during the well design phase. Integration with Landmark’s WELLPLAN Suite and links to the OpenWells™ daily operations reporting systems provide timely solutions to drilling problems.

WELLPLAN WellControl is deployed on Landmark’s Engineer’s Data Model™ (EDM), the platform for a fully integrated suite of well engineering and data analysis products. EDM provides one-time data entry, a system to promote best practices, and an environment for managing and accessing operational knowledge and lessons learned.

Benefits

Timely information
Provides timely information critical to safe and successful well kill operations. Quickly performs complex calculations necessary for optimum scheduling and sound decisions.

Improved decision-making
Enables users to run kick scenarios before drilling and analyze the effects of crew reaction times and rig equipment accuracy on maximum kick volume. Models worst-case scenarios, leading to better understanding and sound decision-making.

Features

Complete simulation
Provides animation to step through a kick scenario and see wellbore pressures as the well is killed.

Enhanced plots
Offers equivalent mud weight (EMW) viewing in plots and displays maximum allowable kick volume below kick tolerance plot.

Mud pump integration with OpenWells™
Transfers mud pump information into WELLPLAN, including slow pump rate data, when creating a case from OpenWells. Mud pump efficiency is also incorporated.

Plan and implement well kill operations
Provides information critical to the well kill operation, as it quickly predicts maximum pressures during kill operations, and provides kick support via pumping and pressure schedules.

- Predicts drill pipe and casing pressure schedules using Driller’s Method and
- Wait & Weight (Engineer’s Method)
- Supplies complete pressure and pumping schedules, calculates top of influx, influx volume, height of influx, and more
- Provides geothermal and circulating temperature models
• Computes influx density and weighting material required, and calculates expected influx volume from user-defined reservoir model
• Includes effect of annular pressure drop
• Provides actual kick support: Kill Sheet and Standpipe Kill Graph
• Kick tolerance, safe drilling depth, and allowable kick volume can be factored into casing design; includes the modeling of oil and salt water influx
• Extensive graphics at user-defined points of interest

Supports complex cases
Easily handles complex cases including:
• Deviated wells, land rigs, offshore platforms/jack-ups (surface BOPs), and semi-submersibles (subsea BOPs)
• Scenarios such as Kick While Drilling, Swab Kick, and Kick at Pumps Down, with a variety of influx fluids including gas, seawater, or oil.
WELLPLAN™ Surge Software

Models downhole pressure surges caused by pipe movement

WELLPLAN™ Surge software gives engineers the tools they need to plan wells and optimize fluid densities to avoid well control problems and formation damage. The Surge application offers complete transient modeling of downhole pressure surges caused by pipe movement during drilling and cementing operations. This program is an integral part of well planning and operations requiring control of surge/swab pressures to avoid well problems.

WELLPLAN Surge software is deployed on Landmark’s Engineer’s Data Model™ (EDM), the platform for a fully integrated suite of well engineering and data analysis products. EDM provides one-time data entry and an environment for managing, accessing and promoting operational knowledge and lessons learned. For more information on the WELLPLAN Surge application, see SPE 67717 Field Validation of Transient Swab/Surge Response with PWD Data.

Benefits

Lower drilling costs
Provides planning tools to help engineers better understand the influence of pipe movement. The result is optimized well designs and drilling practices that lead to fewer costly well control problems and less formation damage.

Accurate solutions for complex situations
Quickly and accurately calculates swab and surge pressures under complex and varying conditions. Offers quick solutions in situations too complex for hand-calculation methods.

Features

Operations applications
Surge tools, analysis, and reports support drilling operations in a variety of situations.
- Analyzing pressure surges due to pipe movement during drilling and cementing operations
- Optimizing the selection of drilling fluid densities and pipe motions for wells with narrow margins between pore and fracture pressures
- Tripping drill strings into deep high temperature wells
- Running long casing strings with low annular clearance
- Supports both conventional and auto-fill float equipment
- Evaluating pressure surges induced by vessel motions while drilling or running casing on a floating rig

Comprehensive reports and graphics
Provides comprehensive reports for all WELLPLAN Surge analyses. Also provides extensive graphics capabilities, including plots of tripping speed versus time, transient pressures versus time, hookload versus trip time, swab and surge limit plots, annulus return flow rate, and equivalent mud weight.

Variety of robust features
Analyzes the entire rig circulation system using the Casson rheological models with a double slope fit. Work string input allows for drill strings, casings, liners, tubing, and packer assemblies. Both open- and closed-end pipe can be modeled and operations can be optimized for tripping speeds. Catalogs including connection types and dimensions are provided for most tubulars.
Swab/Surge and Reciprocation modes
Uses separate modes for Swab/Surge and Reciprocation analysis. The Swab/Surge mode has been enhanced to handle different pipe speeds for the same moving depth, and to allow for circulating during swab, surge and reciprocation operations. In addition, temperature effects can now be included in the analysis.

Pressure modeling and simulation
Models pressures even in wells with extremely low annular clearances. Also enables simulation of specialized casing or liner running equipment such as Port or Diverter collars.

Supports complex drilling issues
Permits the study of cases too complex for hand-calculation methods. Complicated issues include:

- Temperature and pressure effects on the compressibility and viscosity of water- and oil-based muds
- Pipe movement while circulating, displacing and pumping slurries, taking into account the axial elasticity of the moving string
- Variable tripping speeds, formation and fluid properties by depth
- Multiple operations can be simulated, accounting for pipe velocity and the distance of the pipe from the bottom of the hole
- Accounts for inertial effects, can handle multiple wellbore fluids, and models the circulating system elasticity including formation and cement elasticity
WELLPLAN™ Cementing-OptiCem Cementing Software

Improve the likelihood of a successful cement job with Landmark’s WELLPLAN™ Cementing-OptiCem Cementing Software.

This application delivers the technology to design and simulate the optimum cement job, regardless of wellbore complexity or type of program. Jointly developed with Halliburton using its cementing technology, the Cementing-OptiCem program allows users to identify potential difficulties and tune the cementing design before the pumping begins. This increases the likelihood of a successful operation.

WELLPLAN Cementing-OptiCem technology is deployed on Landmark’s Engineer’s Data Model™ (EDM), the platform for a fully integrated suite of well engineering and data analysis products. EDM provides one-time data entry, a system to promote best practices, and an environment for managing and accessing operational knowledge and lessons learned.

Benefits

Save time and money
By identifying potential difficulties and tune the cementing design before the pumping begins, using Cementing-OptiCem tools increases the likelihood of a successful, cost-effective operation.

Optimizes safety
Ensure well integrity and maintain well control by adjusting pump rates to keep fluids below fracturing pressures and above reservoir pressures.

Features

Predict circulating pressures
Predicts circulating pressures at any time during the job, even during “freefall” when the well is on vacuum, and surface pressures indication is zero. Monitor pressures at any and every depth throughout the entire job.

Calculate centralizer placement
Calculates centralizer placement using any combination of holes, pipe sizes, and centralizers of one or more types. Given desired standoff, the program calculates centralizer placement; given stabilizer placement, the program calculates the resulting standoff.

Realistic hole descriptions
Gives realistic hole descriptions by importing caliper log information. View the effects of hole enlargement/collapse on the planned operation.

More accurate friction calculations
Calculates eccentric pressures and eccentricity profiles to provide more accurate friction calculations, top of cement calculations, and centralizer placement.

Foam cement job design
Enables foam cement job design and review. Benefits of the foam cement design can be evaluated, including strength to density ratio, reduced hydrostatic, displacement properties, elasticity, compressibility, etc.
Future planning
Evaluate, troubleshoot, and plan future jobs by comparing the pre-job simulation to actual job results.

Strong analysis tools
Combines multiple cementing functions to dramatically decrease data entry time and increase the accuracy and quality of the job. New graphic displays provide visual insight into what is happening at each moment of the simulation.

Slide bars
Use slide bars to analyze information such as ECD, flow rates, pressure density, viscosity, and foam quality change at any point in the wellbore or any time during the job.

Valuable and versatile functionality
- Integrated wellbore simulation program for most types of cementing
- Integrated and flexible units of measurement throughout
- Dynamic modeling with minimum data entry
- Centralizer design flexibility including any type of centralizer in any combination; any pipe size; any hole size
- Complete flexibility in fluid section:
  - Automatic entry of fluid characteristics drawn from an extensive laboratory derived rheology database
  - Choice of fluid placement based on volume, top of fluid, length, number of sacks, etc.
  - Viscosity profiles based on temperature for more accurate simulation
  - Allows importation of caliper logs for more accurate calculations
- Wellbore temperature profile, simple or complex
- Integrated gas-flow potential calculations to help prevent gas channeling while cement sets
- Equivalent Circulating Density and Pump Rate plots for two zones of interest (fracture and reservoir)
- Includes automatic rate redesign function for maximum displacement efficiencies
- Wellhead pressure graphs that include the effects of "surface equipment" and so relate directly to pump pressure
- Dynamic Fluid Position graphic that replays the simulation by time and depth
- Calculates gas concentrations for foam cementing
- Freefall Calculations table shows predicted surface and bottom-hole pressures
- OTC file transfer capabilities share data between Halliburton OptiCem and WELLPLAN Cementing-OptiCem

Plot features
The following plotting features assist in cementing analysis:
- Max ECD and Min Hydrostatic versus Depth
- Eccentricity Profile
- Final Hydrostatic Profile
- Hydrostatic Curves on the ECD plot
- 3D ECD:Time:Depth
WELLPLAN™ BHA DrillAhead® BHA Design Software

Provides accurate BHA design and selection in complex drilling scenarios.

The first of two software components uses nonlinear 3-D finite element analysis (FEA) technology to solve the structural problem of a confined BHA. The second part of the program uses a combination of analytical methods and rules to determine the drilling tendencies of the assembly.

WELLPLAN BHA DrillAhead software is a component of the Engineer's Desktop™ software suite of technologies which enables integrated operations reporting, drilling and completions engineering and well-planning workflows. The Engineer's Desktop suite is integrated on the Engineer's Data Model™ software platform.

Benefits

Lower Costs
Using the BHA design software ensures the correct assembly the first time and can prevent unnecessary trips and costly motor runs. Operating parameters can be adjusted to enhance BHA performance, allowing tools to stay on-bottom longer.

Proven Accuracy
Accuracy has been verified in numerous field cases, allowing users to accurately and conclusively determine BHA behavior before running the assembly in the hole.

Features

Complex analysis
Analyzes contact forces and displaced shape on the directional BHA while predicting its build, drop and walk rates. Also computes string deflection from wellbore centerline.

3-D Modeling
Models multiple bit types and geological formation data. The 3-D program identifies rotary friction effects.

Flexible Investigations
Study previous directional failures, observe contact forces on sensitive tools or study effects of collar size, stabilizer placement, stabilizer wear, hole enlargement and operating parameters.

Transient Effects
Displays transient effects when a new assembly is run in the wellbore.

Determine BHA Stabilization
Locates contact points and helps determine proper BHA stabilization. Stabilizers are modeled as finite length and not as a point.

BHA Modeling
Models BHAs with multiple bends whether from bent subs, bent housings or double-bend tools currently on the market.

Tool Orientation
Determines the correct tool orientation, selects the proper bent sub, determines bit side loading due to bends, and distinguishes between steady state and transient behavior.
**New Interface**
Provides a new, improved interactive interface with “slide bar” which allows instant analysis of results over a wide range of values.

**Plotting Capabilities**
Displays predicted plots for inclination, dogleg severity, build rate, turn rate and azimuth change for drillahead prediction.
**WELLPLAN™ Critical Speed Analysis Drill String Analysis Software**

Landmark’s WELLPLAN™ Critical Speed Analysis drill string analysis software, predicts and characterizes drill string vibrations that lead to costly string failures.

If you use this industry-proven software just once to prevent a costly failure, CSA technology will pay for itself.

The program is based on a Finite Element Analysis (FEA) model of the drill string and uses Forced Frequency Response (FFR) to determine dynamic behavior. Using CSA tools to analyze failures in the string, adjust drill string design, or evaluate operating conditions allows you to study how different downhole tools affect the drill string prior to tripping in. Whether you use CSA technology during planning or when analyzing a problem after it occurs, the application helps you avoid expensive downhole failures.

WELLPLAN™ Critical Speed Analysis software is deployed on Landmark’s Engineer’s Data Model™ (EDM™ application), the platform for a fully integrated suite of well engineering and data analysis products. The EDM application provides one-time data entry, a system to promote best practices, and an environment for managing and accessing operational knowledge and lessons learned.

**Benefits**

**Lower costs**
Avoids costly failures due to drill string vibration, and pays for itself in just one application.

**Graphical analysis for improved decisions**
Users can view stress components for any rotary speed or position along the BHA. 3D plots make a wealth of information available to improve decision-making.

**Complete drill string analysis**
Analyzes the drill string from bit to kelly for rotary and steerable BHAs. The analysis identifies critical rotary speeds that accelerate pipe fatigue and can lead to drill string failure.

**Accurate modeling**
Models and identifies critical rotary speeds and high stress concentrations in the drill string.

**Features**

**Complete drill string analysis**
Analyzes the drill string from bit to kelly for rotary and steerable BHAs. The analysis identifies critical rotary speeds that accelerate pipe fatigue which can lead to drill string failure.

- Plots relative stress along the string for critical speeds and provides detailed stress output.
- Damping due to the drilling fluid is accounted for and structural damping is modeled.
- CSA analyzes bending, axial, and torsional vibration modes. Analysis is three-dimensional.
• Both complex drill string and multiple drill string excitations can be handled.
• Allows easy adjustment of drill string design or operating conditions such as weight on bit, hole size, friction factors and torque at bit.

**Accurate modeling**
Field proven technology that models and identifies critical rotary speeds and high stress concentrations in the drill string.
WELLPLAN™ StuckPipe Software

When stuck pipe causes drilling problems, you need Landmark’s WELLPLAN™ StuckPipe software.

If the string becomes stuck, you can quickly complete the necessary analyses by accessing the drill string, survey, and other related data from operation reporting systems such as Landmark’s OpenWells™ software. Using the same drill string model as our WELLPLAN Torque/Drag Analysis program, the StuckPipe application accurately accounts for friction and other wellbore effects.

WELLPLAN StuckPipe software is now deployed on Landmark’s Engineer’s Data Model™ (EDM), the platform for a fully integrated suite of well engineering and data analysis products. EDM provides one-time data entry, a system to promote best practices, and an environment for managing and accessing operational knowledge and lessons learned.

Benefits

Quick analysis
Conducts fast and accurate failure analysis and calculates back-off force, force delivered to stuck points, and forces required to set and fire jars.

Improved operations
Accurately locates stuck point and provides information to help free the string.

Effective decisions
Performs jar measured weight analysis to calculate conditions prior to jarring. These calculations allow users to make more effective operational decisions.

Features

Integration with other EDM applications
Provides common data navigation with other WELLPLAN and EDM applications using the Well Explorer. EDM enables sharing of directional profiles with wells created in COMPASS™, Landmark’s industry leading directional planning application.

Standalone or multi-user environment
Operates in a standalone or in a fully concurrent multi-user network environment with powerful user management and data locking features. Built to scale from a single user application to a corporate engineering system.

Stuck point location and failure table
Accurately locates stuck point and quickly produces a failure table for a range of hookloads and torque, which can be applied to attempt to free the string.

Yield load analysis
Performs yield load analysis to calculate the initial status at surface and stuck point, and the minimum over-pull or slack-off-to-load stuck point.

Back-off force analysis
Performs back-off force analysis to calculate conditions prior to back-off, initial surface action for back-off setup, and final surface action for back-off.
Safe over-pull
Determines safe over-pull which can be applied to attempt to free the string, and uses a 3D friction model, unlike stretch charts.
System Requirements

The 5000.1.5 update release supports the platform roll that was done for the 5000.1.3 release. Supported platforms and databases are listed below.

Supported Platforms and Databases for 5000.1.5

• Windows XP SP3, 32-bit
• Windows Vista SP1, 32-bit
• Windows Vista SP1, 64-bit
• Windows 2003 Server SP2, 32-bit
• Windows 2008 Server SP1, 64-bit
• Citrix Presentation Server 4.5
• Citrix XenApp 5.0
• Oracle 10.2.0.4 Server, 64-bit
• Oracle 10.2.0.4 Client, 32-bit (64-bit Client not supported)
• SQL Server 2008, 64-bit
• SQL Server Express 2005, SP3, 32-bit

Desktop and Laptop basic Hardware Requirements

Recommended for Windows Vista 64-Bit Platform

• Windows® Vista Enterprise, SP1, 64-Bit
• 2 GHz processor
• 2 GB RAM or greater
• SVGA Color Monitor
• 106-key Windows ready integrated keyboard
• MS-compatible mouse or pointing device
• TCP/IP based network connection 100 Mbps, or
• FLEXid dongle (bitlock), FLEXnet Publisher version 11.4 (for licensing)
• 3 GB or better disk space
• CD-ROM drive (not required if installing from a network location)
• For Standalone systems, should have parallel port or USB port if dongle/bitlock license used

For more detail on recommended hardware, please contact your local Landmark representative.
OVERVIEW

WELLCAT™ software provides precise solutions for both wellbore analysis and integrated casing and tubing design. It calculates accurate downhole temperature and pressure profiles, which can be used for pipe-body movement and casing and tubing load analysis. WELLCAT software is an essential tool for companies operating in high-pressure, high-temperature (HP/HT) deepwater or heavy-oil drilling and production environments.

Five modules are integrated into a common environment to provide more accurate and reliable solutions to complex design problems. Thermal effects are modeled for drilling and production operations. A comprehensive analysis of loads and stresses on casing and tubing is provided, including service-life analysis. Detailed analysis of the entire casing system is provided to understand the effects of annular pressure buildup and the interaction in the casing and tubing systems within a well. Loads and their resulting wellhead movement are evaluated to determine the integrity of the well tubulars.

WELLCAT™ software is a comprehensive and modular suite of applications that work together to address a wide variety of casing and tubing challenges. It is integrated with the Engineer’s Data Model™ (EDM™) software, which supports integrated operations reporting, drilling, and completions engineering, and well-planning workflows.

Display of an inner string cementing operation with well schematic and temperature results, which are compared against a normal cementing job.
**Benefits**

**Comprehensive solutions**
WELLCAT software provides powerful casing and tubing analysis for simple to complex well configurations, including tension leg platforms, in a single application.

**Understanding of wellhead movement**
Determines and redistributes loads in the casing system for critical well design.

**Reduces casing and tubing costs**
Efficient and accurate designs based on user-defined load conditions can help lower casing and tubing costs.

**Helps design safely**
WELLCAT software helps engineers design safer, higher-quality designs for complex HP/HT wells. Understanding thermal expansion of annular fluids can help engineers design casing that can manage thermally induced wellhead movement, eliminate buckling, and reduce casing collapse of inner strings or casing bursts of outer strings during production operations.

**Features**

**Drilling Design**
The Drill Design module simulates flow and heat transfer during drilling operations, providing full transient analysis. The software offers linked analyses with the Casing Design module.

The Drill Design module is useful for:
- Cementing operations temperature modeling, including complex cement job schedule, spot cement plug in cased and open-hole, and inner string cementing.
- HP/HT hydraulics
- Downhole tool temperatures
- Subsea wellhead and BOP temperatures
- Hydrate inhibition program schedule
- Casing service loads during drilling
- Undisturbed temperature profile from log and drilling data
- Multi-string initial and final conditions, annular pressure buildup, and WHM (wellhead movement) load history

**Casing Design**
The Casing Design module analyzes casing loads, design integrity, and buckling behavior under complex mechanical, fluid pressure, and thermal-loading conditions with standard and automatic load-case generation. Analyses may be performed in conjunction with the Drill Design and Production Design modules (including tubingless configurations).

The Casing Design module is useful for:
- Comprehensive casing design and analysis
- Installation and service loads
- Multi-string load transfer (initial conditions)
- Buckling stability and post-buckling analysis with and without centralizers.
- Support new collapse load, issued by Bureau of Safety and Environmental Enforcement (BSEE), Well Containment Screening Tool (WCST).

**Production Design**
The Production Design module simulates fluid and heat transfer during completion, production, stimulation, testing, and well-servicing operations. The software allows transient and steady-state analysis for single-phase and multiphase flow in addition to providing initial conditions linkage with thermal results from the Drill Design module. It also offers linked analyses with the Tube Design and Casing Design modules.
The module includes VLE (vapor-liquid equilibrium) phase diagrams with definition of temperature- and pressure-critical points.

The Production Design module is useful for:
- Analysis of temperatures and pressures for flowing and shut-in well streams
- Analysis of temperatures and pressures during forward and reverse circulation
- Gas-lift operations
- Tubingless well discharge thermal flow scenario modeling
- Multi-string final conditions annular pressure buildup and WHM load history
- Thermo-setting resin and gel treatments
- Insulation requirements and permafrost thaw assessment
- Fracture and acid-stimulation jobs
- Modeling steam injection (saturated or superheated)
- Modeling a diversity of fluid-type inventory including:
  - Standard (water/oil-based) and compositional muds
  - Standard (black oil), VLE and file-defined hydrocarbons properties linked to third party fluid characterization tool
  - Brines, polymers, and foams
  - General and synthetic muds (PVT fluid definition)
  - Cement slurries
- Mechanistic models for improved pressure-drop calculations:
  - Zhang model (deviated wells, upward/downward flow)
  - Kaya model (deviated wells)
  - Ansari model (near-vertical wells less than 15 degrees)

Tube Design
The Tube Design module analyzes tubing loads and movements, buckling behavior, and design integrity under complex mechanical, fluid-pressure, and thermal-loading conditions with standard and automatic load-case generation. Offers linked analyses with the Production Design module.

The Tube Design module is useful for:
- Comprehensive tubing design and analysis
- Installation and service loads
- Mechanically, hydrostatically, and hydraulically setting mechanisms
- Packer setting sequence
- Tubing movement
- Tubing-to-packer and packer-to-casing forces
- Multiple string and multiple packer completions
- CRA (Corrosion and Erosion Resistant Alloy) tubulars with yield anisotropy
- Displays the ISO ellipse along with a user-defined connection performance curve (ISO 13679) and ISO service load safety factors
- Packer operating envelope load check
- Packer and expansion joint schematics make it easy to visually review and check forces associated with different packers and expansion joints
Multi-string Design

The Multi-string Design module predicts pressure and volume changes due to annular pressure buildup (APB) when the well system heats up as a result of drilling or production operations or the injection of hot fluids into the well.

The Multi-string Design module determines the movement that occurs to the wellhead during the life of the well. Movement is calculated due to strings being run and cemented, static loads being added or removed from the well (nipple-up BOP, hang-off drillstring during a drive-off situation), and pressure or thermally induced loads applied to each individual string in the well. Analyses are linked to Drill Design, Production Design, Tube Design, and Casing Design modules.

The Multi-string Design module is useful for:

• Trapped annuli in subsea operations for determination of tubular burst and collapse loads due to APB. Evaluate APB mitigation option by applying nitrogen and other noble gases and U-Tube effects.

• Structural integrity of uncemented (unsupported) conductor/structural casing in platform operations due to wellhead movement and load redistribution.

• Wellhead movement analysis also includes; Point of Fixity, Lock-Ring Rating, Wellhead Load Compensator, Lift-Off Analysis, and Progressive Failure Analysis features.

• Combined modeling of tubingless well discharge flow trapped annuli and wellhead movement of uncemented production casing scenarios.

• Comprehensive well-soil interaction modeling for multi-stringwell-stress analysis. This model predicts wellhead movement and determines the integrity of the foundation.

VIT modeling is integrated with multiple WELLCAT software capabilities, including temperature and flow simulation, stress, and Multi-string Analysis.
Deepwater license
The additional deep water license capabilities include temperature flow modeling using VIT (vacuum-insulated tubing) thermal flow and tubing analysis of production operations with Electrical Submersible Pump (ESP); Rupture Disk, Syntactic Foam trap annular pressure mitigation techniques, and wellhead-movement progressive-failure analysis.

VIT modeling
The VIT enhancements add critical technology to the WELLCAT modules aimed specifically at solving VIT applications for deepwater and heavy-oil design problems. The heavy-oil capabilities are designed for high-temperature steam-injection scenarios.

The VIT option is used to model thermal flow and stress analysis of vacuum-insulated tubing within the WELLCAT application. VIT is used to mitigate the risks of APB, cold startups, and heavy-oil production when using the latest VIT systems.

Annular pressure buildup
In deep water, high temperature and high annular pressure can cause casing strings to burst or collapse. Operators use VIT to mitigate these risks. VIT temperature-flow modeling using the deepwater license feature in combination with the WELLCAT Multi-string Design module helps model these possible scenarios.

Cold startups
In some subsea completions, a cold startup (initial flow) can be hampered or made impossible because of temperature losses and hydrating near the seabed mudline. VIT minimizes this problem by maintaining wellbore temperatures to prevent hydrate formation. The modeling of these temperature and pressure conditions for VIT can now be analyzed using the deepwater license feature.

Heavy-oil production
In heavy-oil production scenarios, VIT helps maintain lower viscosity levels in steam flooding, “huff and puff,” and steam-assisted gravity drainage (SAGD) projects, reducing the need for artificial lift techniques and increasing total ultimate recovery (reservoir draw down).

Using the deepwater license feature in combination with the WELLCAT steam-injection modeling license feature, it is possible to model temperature and pressure for vacuum-insulated tubing in heavy-oil production scenarios.

Electrical Submersible Pump (ESP)
Extreme to ultra-deep HPHT reservoirs present the challenges of having low natural flow ability; the use of sub-udline system such as (ESP) would help to increase production rates and increase well recovery. WELLCAT software includes production thermal flow simulation and tubing analysis of production operations with ESP.
**Rupture disk**
Among the current trap annular pressure mitigation techniques to prevent annular pressure build up, engineered rupture disk are designed to vent annular pressure in excess to protect outer or inner strings. WELLCAT multi-string module allows users to specify the location of rupture disk in the well mechanical configuration, verify survival initial conditions and solve annuli pressure and volume change due to disk failure.

**Syntactic foam**
WELLCAT multi-string module supports trap annular pressure analysis including the presence of syntactic foam. This trap annular pressure mitigation technique is designed to crush at a specified pressure and temperature creating additional volume for fluid expansion.

**Wellhead-movement progressive-failure analysis**
Wellhead-movement progressive-failure analysis enables a user to obtain axial loads and contact forces of the entire system once the hanger rating is exceeded. The WELLCAT software will distribute the loads through the system once the hanger ratings are exceeded, and only stop reporting once the rating equals the loading condition.

The VIT and Progressive-Failure Analysis features are licensed separately to be used in conjunction with the Production Design, Tube Design, and Multi-string Design modules.

**Steam license**
The WellCAT Steam-modeling option is used to model multiple steam circulation-injection scenarios in single tube circulation, including circulation and reverse circulation, injection through tubing, injection down the tubing annulus, and simultaneous injection through both tubing and annulus.

Dual-tube completion modules:
- Tube-to-tube
- Tube-to-annulus steam circulations
- Reverse circulation
- Dual-steam injection
- Dual-steam production
- Dual-oil production with coiled tubing
- Dual long-string injection / short-string production

The modeling handles super-heated steam or saturated steam with a given quality. The technology uses the rigorous PVT model for steam and water developed by the National Institute of Standards and Technology (NIST).

Transient or steady-state calculations output steam quality versus depth, and fluid temperature and pressure versus depth analysis. In addition, the calculations output steam quality versus time at a specified depth to help determine the steam breakthrough at the perforations.

Temperatures calculated for the wellbore or wellbore components can be used within WELLCAT for stress analysis, annular pressure buildup analysis, and wellhead-movement calculations.
Detailed results presentation
Presentation of calculation results on-screen allows user-configurable, multi-pane spreadsheet and plot formats with user-defined and preconfigured display tabs. Presentation of print results is in both standard and user-configurable formats. Template features for setting standard default configurations are included.

Multiple unit systems
English, metric, and custom unit systems are provided along with a comprehensive online help system.

Easily transfer or export data
Links to DEX™ software, Landmark’s data exchange software, permits easy transfer of relevant data to other DEX-compliant applications. Also, send data from any WELLCAT spreadsheet to Microsoft® EXCEL (input and output results). Import pore-pressure or fracture-gradient data from an ASCII file or EXCEL spreadsheet.

WELLCAT Packaging
- Tubulars Drilling Package—Includes WELLCAT Drill Design and Casing Design modules
- Tubulars Production Package—Includes WELLCAT Tube Design and Production Design modules
- Steam Package—Includes WELLCAT Steam features. These technologies are licensed to be used in conjunction with the Casing Design, Production Design, Tube Design, and Multi-string Design modules
- Deepwater Package—Includes WELLCAT ViT, Electrical Submersible Pump (ESP), annular fluid expansion mitigation techniques rupture disk, syntactic foam, and Wellhead-Movement Progressive-Failure Analysis features. These technologies are licensed for use in conjunction with the Drill Design, Casing Design, Production Design, Tube Design, and Multi-string Design modules.
Precise modeling of fluid flow and heat transfer during drilling and completions and the buildup of trapped annular pressure is essential in the proper design of well tubulars or catastrophic consequences can occur. This is particularly serious in complex high pressure/high temperature (HP/HT) conditions.

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OVERVIEW
Hundreds of activities are performed at a given rig site on any given day and staying on top of everything is critical to safe, productive, and cost effective operations. To manage this complexity requires accurate recording, reporting, and analysis of rig operations across all the variety of ongoing activities. Each team member has different responsibilities that must be supported with the overarching objective to collect and report up-to-date information in a timely fashion and in a manner that is not intrusive to their day-to-day operations.

Supervisors need to easily record and report activities on a single well or across an entire field, while managers require timely and accurate reports to act appropriately. Analysts need to be able to easily access and analyze this information to drive performance and operational improvement, and engineers require it to be readily available for their well engineering and planning projects. All must collaborate together to drive well operations at peak safety and efficiency.

The OpenWells® operations reporting system offers a comprehensive solution to track, report, and analyze rig operations from site sourcing through to abandonment. It provides simple, visual solutions to speed up data entry and leverages the industry standard Engineer’s Data Model™ (EDM™) to store, manage, and share data with Landmark’s leading suite of integrated engineering applications. It provides each member of the team tailored methods to collect and report their data into a comprehensive, collaborative environment for operators to effectively manage well operations of all kinds.

BENEFITS
Streamline activity and morning reporting
OpenWells software utilizes a unique data entry canvas with an intuitive, visual interface that uses interactive illustrations of typical rigs, equipment, and operations to guide users to record or view their information. This simplifies data entry and reduces training requirements, so supervisors can begin using the system quickly.

Reports and entry forms are designed in WYSIWYG (What You See Is What You Get) format to replicate a company’s specific report look and feel. This enables operators to incorporate their custom report design and users know exactly how their data will be shown and disseminated to management.

Improve drilling operations
OpenWells software has several analysis capabilities to help analysts and managers uncover drilling performance improvements. The NPT (Non-Productive Time) analysis module is a comprehensive tool to discover root causes of NPT and uncover hidden losses that can be difficult to find and attribute.
Perform technical limit analysis by looking at offset wells by hole section to identify best practices and lessons learned to incorporate into ensuing wells. OpenWells software enables tracking of all equipment failure details, the cause and types of equipment failure, and failure costs. A Lessons Learned feature allows engineers to provide observations and insights to a particular report that can be searched against and used in similar future situations.

Use the Data Analyzer capability to execute comprehensive data queries to dig into the data to discover relationships, compare and contrast designs, and benchmark operations to provide more context in drilling operations.

**Advance collaboration and decision making**

OpenWells software utilizes the EDM unified data model that is shared across Landmark’s suite of engineering applications like WELLCAT, COMPASS, StressCheck, CasingSeat, WELLPLAN, and DecisionSpace Well Engineering. Operations and engineering information is entered just once and then automatically available across the suite to pre-populate calculations and reports for faster and more accurate analyses. This enables teams to collaborate more effectively.

Use the optional iWellFile™ web dashboard and historical well report viewer to securely share access to up-to-date ongoing and historical well information, output reports, down hole schematic diagrams and analytical results. This is an easy way to share information with team members, management, or partners and help facilitate morning meetings with a dispersed group.
FEATURES

Interactive, visual activity reporting

Using point and click interactive rig site schematics provide engineers with a familiar visual reference to create and edit their activities, such as cementing, logging, and rig equipment, using either a land rig, jack-up, semisubmersible, or drill-ship visual canvass. This takes the complexity out of how to enter information and speeds up training of new users.

Daily operations data entry forms can be designed to look like familiar company reports and to match company reporting workflow standards. This What You See Is What You Get (WYSIWYG) visual data entry allows engineers to use the same report format and look to enter data that then it is distributed to management. This helps simplify data entry and provides an immediate preview of the actual report.

OpenWells software supports support all common reporting aspects of drilling, completion, well servicing, well intervention, construction and reclamation, through plugging and abandonment for onshore, offshore, conventional and unconventional plays. The suite of reports includes more than thirty types of activity reports.

Integrated PROFILE wellbore schematics

PROFILE wellbore schematic software is integrated into the OpenWells software package and provides engineers the ability to create accurate, high quality wellbore equipment and planned completions diagrams as well as view historical equipment and configurations in existing wellbores. Detailed wellbore schematics are incorporated into all OpenWells data entry forms so engineers or rig supervisors can view the current schematic or drill string as they complete the report.

Familiar rig images take the complexity out of data entry and speeds up training of new users.
PROFILE software provides downhole and surface equipment configuration, high resolution equipment symbol visualization, and accurate rendering of downhole equipment and operations. Comprehensive hardcopy wall plots can be created and engineers can build their own wall-plot formats and equipment symbols. At any point in well construction, the software enables engineers to compare planned and actual well construction diagrams so the engineer has an accurate, visual view of operations.

**Engineer’s Data Model (EDM)**

The Engineer’s Data Model software, the industry standard for managing well engineering and operations data, is included in the OpenWells software package. The enterprise grade relational database supports common architectures for reference datum levels, security, unit management, data migration, document attachments, library, output reporting, catalog editor, XML import/export, and AutoSync data transfer.

The EDM AutoSync utility provides tools for automatic synchronization between multiple regional databases located around the world in a common corporate data store. For
example, as daily reports are received from the rigs, or the drilling engineer updates a directional plan from a regional office, the EDM AutoSync utility quietly monitors for new or changed data, then updates the corporate data store with new information.

**Today’s wells**
This feature allows a drilling engineer to quickly review the status of all active wells. Well status, cost information, and details such as depth versus days graphs may be viewed without navigating through the Well Explorer Tree.

**Data entry/output forms editor**
OpenWells provides fully customizable data entry forms through the OpenWells software form customizer tool. Using drag and drop functionality, users configure data entry forms that best suit the operations reporting requirements for engineering teams. These forms can be printed giving the user a true WYSIWYG experience.

**Knowledge management**
The software enables the capture of lessons learned, equipment failure and nonproductive time information. It provides an “at-hand” data capture tool for field personnel to document learning gained during well operations. By leveraging operations experience and learning, engineers can reduce costs and improve future well designs and well construction operations.

**Library support**
Enables users to export and import data from operational area libraries in the EDM database around drill strings, cementing, stimulations, etc. This library feature supports quick moving operations that are “cookie cutter” and significantly increase operations the speed of data entry.
Configure printed reports using Microsoft Word
Simplify report maintenance and reduce support costs by using the familiar Microsoft Word to create, edit and print reports. This can also simplify the regulatory reporting process as users can generate editable regulatory reports in Microsoft Word, allowing analysts to then directly enter information that is not contained in EDM. In the 5000.1.12 release the OpenWells software includes one pre-configured MS Word report, the Texas-W2 Completions report, as an example.

Directional drilling reporting
OpenWells enables users to enter directional drilling-specific, bottom hole assembly (BHA) operations parameters for drilling or sliding mode in the “BHA Operations” tab of the Daily Operations report. This operations reporting system is tightly integrated with COMPASS wellpath planning software.

Spreadsheet Import
The software allows electronic import for all spreadsheets. This enables users to populate a spreadsheet by importing data from external sources, from a file or through the Microsoft Windows clipboard.

Application Security
The application provides create, delete, view, edit and print access to be configured to virtually any information in the system. User accounts can be set up for service company employees, granting secure view, and edit access to the data entry screens relevant to their services.

Data Validation
The Rule Book Editor and Data Validator enable customers to define rule books to ensure data consistency and data quality and to enforce business rules to support operations’ reporting requirements. Administrators can configure when validation is performed. Batch validation is supported to enable multiple reports to be validated in one pass.

Data Analyzer data query and analysis software
Data Analyzer software is included in the OpenWells software package. Data Analyzer software enables simple to complex ad-hoc well-operations data querying and analysis for the entire EDM database. Queries are constructed using an intuitive selection tree where data fields are displayed with familiar user defined. Queries and templates are stored in the EDM database, so that they may be shared among all engineers to promote consistent analysis and query re-use. Engineers can create queries to select information created in engineering applications, such as CasingSeat, COMPASS, PROFILE, StressCheck and WELLPLAN software, or through information captured during well operations using OpenWells software. This functionality supports rapid access to data, enabling engineers to compare and contrast any type of information, benchmark operations, and extract information required for corporate or regulatory reporting.
**Import Activity from the Pason Electronic Tour Sheet**
Supervisors can save time and eliminate duplicate entry by importing operations activity from a Pason Electronic Tour Sheet. Selecting the “Import” button on the time summary data entry form provides the option to import a Pason Tour Sheet. After selecting the Electronic Tour Sheet, supervisors are presented with a preview of the available operations and can select which of those activities to import.

**OpenWells module for Rushmore Reviews DPR, SPR and CPR workbooks**
Analysts tasked with preparing workbooks for the Rushmore Drilling Performance Reviews (DPR), Shale (SPR), and Completions (CPR) submission can now use the OpenWells Performance Reviews module to automatically generate workbooks. Using this module automates export of up to 95% of the DPR workbook, over 50 percent of the SPR workbook and approximately 10 percent of the CPR workbook.
“Hundreds of activities are performed at a given rig site on any given day and staying on top of everything is critical to safe, productive, and cost effective operations. Managing this complexity requires accurate recording, reporting, and analysis with a solution that does not impede the pace of operations.”

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Drilling resources, both capital and human, are scarce and it is important to make the best use of what an organization has at its disposal. Underestimating project costs will cause budget shortfalls, often resulting in delays or incremental requests for expenditures. Cost overestimation is just as bad because the money allocated could have been spent on other projects. It is important to get the estimates as close to reality as possible the first time. Well Cost software, designed specifically for drilling and completions, provides powerful tools to produce accurate project estimates quickly and easily.

Accurate cost estimates are critical for both low-level budgeting and scoping, and for the more detailed Authorization for Expenditure (AFE). Well Cost software generates a comprehensive cost estimate using either deterministic or probabilistic methods, whether users have detailed historical knowledge of their drilling programs or a simple high-level list of tasks and costs.

Well Cost software is built on the Engineer’s Data Model™ (EDM™) platform and integrated with Landmark’s well-design and planning tools, enabling engineers to access historical data and streamline cost estimation and reporting workflows. Reports and plots are automatically generated, making it easy to analyze the results and present findings to key stakeholders.

**BENEFITS**

*The Right Tool for the Job*

Well Cost software was designed by drillers for well construction projects with specific capabilities that generic spreadsheets cannot match. Instead of a single number, the...
the software factors in estimate uncertainty, and generates a range of expected times and costs (P10, P50, and P90). Typically, spreadsheet solutions oversimplify the estimation of risk by collecting the list of tasks, the associated cost estimates, and a contingency factor by which all items are multiplied to account for the unknown.

**Consistent Practice for Budgeting and AFE**

When users have different projects and engineers using different techniques and assumptions to budget their projects, it is difficult to compile, compare, and analyze results across the organization. Well Cost software provides a systematic, consistent methodology and tool that organizations can standardize on saving time, improving team collaboration, and simplifying training.

**More Accurate Estimates**

The best estimates rely on knowledge of how projects have performed in the past. Well Cost software has access to all the historical well data available in the EDM database, making it easy to base new estimates on the performance of previous projects. Integration with Landmark’s drilling applications enables engineering data entered in applications like StressCheck™, CasingSeat™, and WELLCAT™ to be immediately available for use in the costing analysis.

**FEATURES**

**Probabilistic Time and Cost Estimation**

Well Cost software includes a Monte Carlo-based simulation tool that gathers input on the activities, costs, and uncertainties associated with the candidate wells and predicts the AFE cost and drilling time. Well data can be modeled from available historical data, and the analysis can factor in unplanned events such as non-productive time (NPT).

![Estimates over time and depth](image-url)
**Estimate Multiple Well Campaigns**

In addition to producing estimates for single wells, Well Cost software allows users to estimate multiple wells together as a campaign. The resulting single estimate can take into account expected cost efficiencies that result in wells constructed later in the campaign costing less than those constructed earlier.

**Compare Plan versus Actual**

As the project progresses, it can be helpful to understand how the actual cost and time data compare to the estimate. Well Cost software can interface with operational reporting systems to retrieve this actual data and plot it against the estimate. The AFE can then be re-generated for the remaining phases and activities, allowing users to understand the time and cost required to complete the project. After completing the project, the actual data can be used to find the p-value at which the project was executed allowing users to make more accurate estimates in the future.

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**Customizable**

Each estimate requires the use of event, phase, activity, and cost codes that are likely unique to a company. Well Cost software comes with a predefined list of codes which can easily be tailored to match those in a company’s financial accounting system.

**Time-Saving Templates**

Most companies have a set approach to drilling, so there is no need to begin with a blank activity list when starting a new estimate. Well Cost software can be used to define a drilling program once and then save it as a template. Such templates can then be used in the future to expedite the costing process, as the engineer only has to modify the data to fit the requirements of the new well.
System and Software

SOFTWARE REQUIREMENTS
Engineer’s Data Model™ (EDM™) software
Microsoft Database Engine (MSDE)

OPERATING SYSTEMS
Microsoft® Windows® 7 SP1, 64-bit
Windows Server 2008 R2 SP1, 64-bit
Windows Vista 64-bit
Oracle® 11.2.0.2 and 11.2.0.3
Oracle 10.2.0.4
SQL Server 2008 R2 SP1
SQL Server Express 2005 SP3

Automatic Plots and Reports
Well Cost software produces a set of plots and reports as part of the simulation, automatically giving users the tools needed to analyze the output. Plots include a variety of X-Y charts, bar charts, and histograms. The reports are available in standard formats (PDF, XML, XLS), and can be saved, printed, or emailed directly from the application.

Estimation Wizard
An estimation wizard guides users through the workflow, making it easy to understand the process of creating the estimate. Familiar editors and simple input forms are used to collect data, reducing the time required to be productive and streamlining training for new users.

Integrated with Landmark Drilling Applications
Once the estimate is complete, Well Cost software can publish cost and activity information to the EDM database for the OpenWells® Cost Estimate and AFE report, as well as the OpenWells Well Planning report. The software also uses the same framework elements (Well Explorer, Associated Data Viewer, Reference Datum, and the Wallplot) as the other Landmark drilling applications for consistent navigation and ease of use.

Drilling resources are scarce, and it is important to allocate capital appropriately to your opportunities to maximize return on investment.

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OVERVIEW

Designing complex well string operations requires rigorous analysis to define the key aspects of each pipe-related operation in the wellbore. Determining which rig or equipment to use, the proper string components, and the appropriate fluid properties and parameters to drill safely and efficiently are just a few of the challenges the drilling engineer must address. To navigate these challenges, users require software solutions that can manage this complexity and bring to bear a wealth of scientific capabilities while at the same time being simple and intuitive to use.

DecisionSpace® Well Engineering software is the latest evolution in more than 20 years of innovations in well-construction information solutions. Building upon the industry-leading WELLPLAN™ suite, DecisionSpace Well Engineering software extends and simplifies the science through dramatic advancements in ease-of-use and data visualization. Integrated together with Engineer’s Desktop™ and Engineer’s Data Model™ (EDM™) applications, it provides the most complete and unparalleled well-engineering software tool kit in the industry.

BENEFITS

Configure the right tools for any job
Select the optimum rig and equipment, string components, and fluids to drill any type of well (onshore, offshore, deep water, high-pressure/high-temperature, 3D directional profiles, horizontal, and extended reach). Model pipe strings to define optimum windows of operation during the design and execution phases of your well. Anticipate risks and know how to drill faster without compromising the safety of the operation.
Dramatically simple to use
For both the novice and expert user alike, the completely redesigned user interface provides a simple approach to input data and powerful graphical visualization capabilities to interpret it better and faster. Output driving input methodology identifies the required data and provides hyperlinks to the appropriate input panel. The user simply clicks on the hyperlinks and inputs the required data and the application does the rest. The interactive wellbore schematic provides visual feedback throughout. By simplifying this process, users can conduct faster and more accurate analysis that helps make better decisions. The dramatically enhanced usability typically requires minimal training for existing WELLPLAN software users to master, while new users can be brought up to speed quickly.

Well engineering integration
All the results and analysis performed in the DecisionSpace Well Engineering interface are stored in the EDM database, the most widely used database for drilling and completions applications in the world. This data is available across the Landmark suite of drilling applications for other specific drilling, casing, or costing analysis. The applications can operate in a standalone or multi-user environment enabling you to scale from a single user to a corporate-wide system.

FEATURES

Torque and Drag analysis
Plan and analyze drilling, casing, and completion running operations, and assess the impact of predicted loads related to torque and drag. The main calculations are tension, torque, side force, fatigue, and tri-axial stress. A top-down analysis mode allows users to know accurate forces acting along the string all the way down to the bottom of the well based on surface parameters. It also accounts for the effect of hydraulic parameters like fluid properties, flow rate, diverse fluid columns, and pressures. Temperature effect on the string is also considered for the pipe stretch calculations. Riser-less and Inner-string configurations are also modeled as well as the effect of stand-off devices like centralizers and friction reduction devices.

Model any type of directional well profile and pipe strings including stand-off devices and multiple fluid columns.
Hydraulic analysis
This module can be used to model pressure losses across the circulating system of the rig and the well pipe string, estimate the equivalent circulating density (ECD) across the annular space, and analyze formation cuttings transport and its effect on pressure and ECD calculations. Temperature effect is also considered using four different rheological models, fluid compressibility, Fann® Viscometer readings at different temperature points, critical fluid velocity, and bit-nozzle size calculations for optimized rate of penetration.

It considers string eccentricity effect, pipe roughness, returns to sea floor for dual-gradient operations and backpressure for underbalanced operations.

Underbalanced Hydraulics Analysis
With the increased use of Underbalanced Drilling (UBD) and Managed Pressure Drilling (MPD) to improve circulation, ROP, and reduce formation damage and stuck pipe events it becomes critical to properly model multi-phase fluid flow to optimize liquid pump and gas injection rates and control bottom hole and surface pressures.

Using industry well known engineering calculations, this module provides a set of comprehensive analytical tools to determine the feasibility and optimal parameters for operations where more than one fluid is mixed including the injection of gases, and/or continuous formation influx to effectively control the pressures of the entire system. It takes in consideration the effect of wellbore geometries and deviation, string components dimensions, temperature effects, fluid properties and formation cutting transportation. With this module operators can quickly determine pressure, ECD, velocity and cutting transport ratio profiles and other relevant hydraulic calculations for multi-phase fluid circulation operations.

Gas injection rate, flow rate, and bottom hole pressure represented in the shaded operational window is automatically generated.
**Transient Swab and Surge Analysis**

When drilling wells with narrow mud weight windows, high pressure, high temperature scenarios or low clearance in the annular space, it is critical to control the speed and other movement parameters of the string within the wellbore to avoid induced formation kicks or formation damage due to excessive swab or surge pressures.

DecisionSpace Well Engineering now offers the capability to calculate transient pressures within the wellbore caused by pipe movement during tripping and cementing operations.

Highlights:

- Optimized tripping speed schedule
- Detailed pressure transient response at any wellbore depth and at any string depth
- The model considers temperature and pressure effects on the compressibility and viscosity of water- and oil-based muds
- Pipe movement while circulating, displacing and pumping slurries, taking into account the axial elasticity of the moving string as well as the formation and previous casing and cement ones
- Work string input allows for drill strings, casings, liners, tubing, coiled tubing and packer assemblies
- Supports both conventional and auto-fill float equipment

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*Pressure Transient versus time while reciprocating the pipe on bottom.*
**Well Control**

This application’s Well Control module offers the most intuitive workflow in the industry to determine kick tolerance of an operator’s well designs and kill sheet calculations, offering a large set of modeling capabilities and variable effects such as temperature, complex wellbore and string geometries, to reduce the uncertainty when planning a well and/or performing a well control operation.

Highlights:

- Extremely intuitive user interface with high standards on result visualization expediting the usage learning curve and interpretation of results
- Kick class determination and kick tolerance calculations
- Revised kill sheet application based on latest standard IADC forms
- Three types of influx (gas, oil and water)
- Safe drilling depth, maximum allowable kick volume, wellbore kick circulation animation with synchronized pressure profiles, pit volume gain, formation breakdown gradient charts

![New kick circulation animation and kill sheet based on the latest IADC standard form.](image)

**Casing Centralization Placement**

Proper casing centralization placement is a key factor in completing an optimal and safe cementing job. With this module, users can calculate centralizer placement for any combination of hole size, pipe size, and centralizer and determine the optimal spacing between centralizers to achieve a desired casing stand-off, including the effect of torque and drag forces and survey tortuosity. The simple visual interface provides a fast and effective method to input the appropriate data and then visualize the results in an easy to understand way making it easy to compare different alternatives to optimize placement along the casing string.
**Sensitivity analysis**

DecisionSpace Well Engineering software provides a powerful method of performing generalized sensitivity analysis. Instead of performing manual iterations or running several analyses one at a time, users can define a range of values for the numeric variables wanted and perform the analysis simultaneously. Detailed graphical representations enable a quick review of the different alternatives.
System and Software

**Output driving inputs**

Input only the data needed for the specific calculations that will be run. DecisionSpace Well Engineering software provides clear step-by-step guidance to the user on what data is required and leads them through the input panels in just a few clicks. Dynamic navigation and notifications highlight what is needed and how to enter it on the fly, enabling users to know what needs to be done next. Outputs are only calculated when all the right data is input. This enables engineers to use the system faster and easier while supporting more accurate results.

**Interactive wellbore representations**

Results are displayed graphically as part of interactive wellbore representations making interpretation of the results easier to visualize and understand.

**Free upgrade for WELLPLAN users**

Existing WELLPLAN customers that are current in their maintenance and support can license DecisionSpace Well Engineering for no additional license costs. Plus, they have the freedom to run or operate either or both applications at the same time with the same license, using the same data and even on the same computer.

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**SOFTWARE REQUIREMENTS**

- **EDT 5000.1.10.0 or higher must be installed**
- **.NET framework v4.0 (downloaded and installed with DS Well Engineering installer)**

**SUPPORTED OPERATING SYSTEMS**

- **Microsoft® Windows® 7 SP1, 64-bit**
- **Citrix XenApp 6.0 and 6.5**
- **Windows Server 2008**
“We perform Swab and Surge Transient Pressure Analysis using this software for deepwater wells, reducing tripping operation times by 30% on average.”

DRILLING ENGINEERING CONSULTANT FOR A MAJOR INTERNATIONAL COMPANY

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