

# Proven Solutions



**DIRECTORY**

## LANDMARK PROVEN SOLUTIONS

**INTEGRATED SOLUTIONS & INNOVATIVE TECHNOLOGIES**

*Enabling You to Achieve New Levels of Productivity & Adaptability*



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*Almost 20 years ago, Landmark Graphics first established a new standard in the industry when it helped launch an era of computer-aided exploration that focused on 3D seismic interpretation. Since then, Landmark has continued to lead the industry through the development of new innovative technologies and integrated solutions that enable customers to achieve greater levels of productivity and efficiency.*

*In the 1990s, Landmark products and solutions expanded to include the widest breadth of integrated exploration, drilling and production solutions across the oil field life cycle. Landmark software, information management technology, computing infrastructure and professional services enables petroleum companies to find, produce and manage oil and gas reserves more effectively than at anytime in the past.*

*To achieve the higher levels of productivity required in today's competitive marketplace, Landmark offers a breakthrough in upstream oil and gas that focuses on technical-to-business (T2B™) process integration. T2B goes far beyond basic data integration to help you achieve higher returns through process integration, delivering an integrated risk-based asset evaluation and enterprise portfolio management technology.*

*A new online service and support area called MyLandmark<sup>SM</sup> delivers additional customer value. Because MyLandmark is customer-driven, it dramatically enhances the way you interact with Landmark by delivering real-time information and knowledge resources based on your perspective, needs and self-generated profile.*

*"Landmark will continue to focus on leading the industry in creativity and innovation, thus providing direction in the rapidly changing world of business and technology," said John Gibson, Landmark's president and CEO.*

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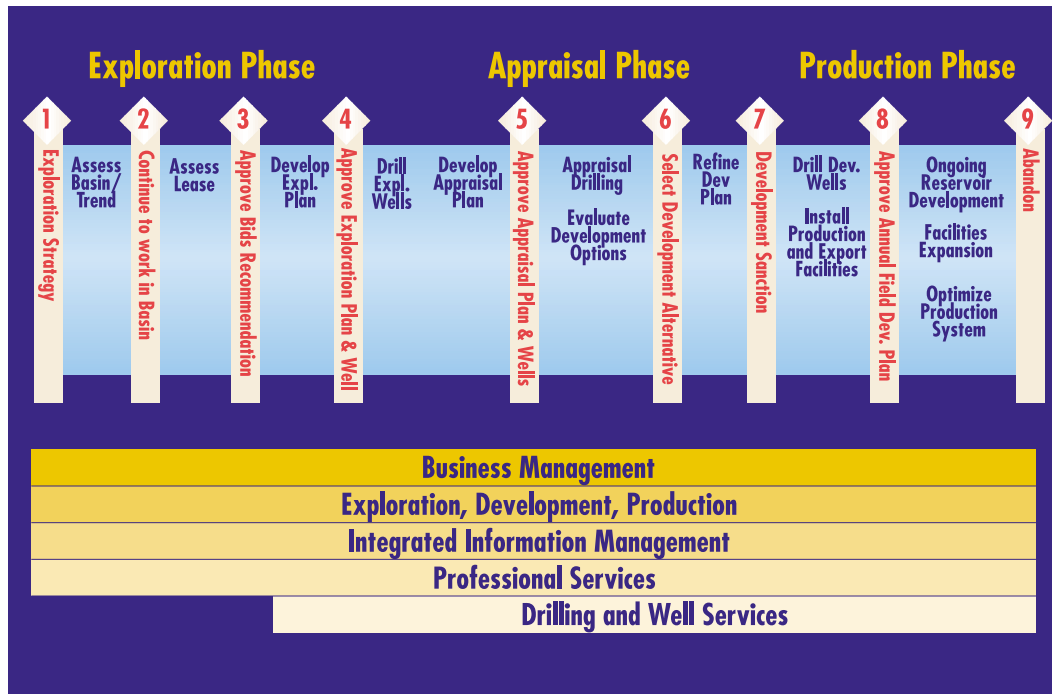
# TABLE OF CONTENTS

<b>E&amp;P Decision-Making Environment</b>	<b>2</b>	DIMS	15
<b>Technical-to-Business Integration</b>	<b>3</b>	Drillability Suite Manager	16
<b>Information Technology Solutions</b>	<b>4</b>	DrillModel	16
Decisionarium	4	iDims	16
<b>Business Management Solutions</b>	<b>5</b>	PROFILE	16
TERAS	5	RESolution 3D	16
ARIES/RMS	5	StressCheck	17
<b>Information Management Solutions</b>	<b>6-7</b>	Wellbore Planner	17
OpenWorks	6	WELLCAT	17
OpenWorks Development Kit	6	WELLPLAN	18
OpenExplorer	7	<b>Production Management Solutions</b>	<b>20-23</b>
OpenJournal	7	Production2000	20
<b>Exploration and Development Solutions</b>	<b>8-13</b>	DESKTOP- VIP	20
Interpret2000	8	Parallel-VIP	21
DepthTeam	9	PetroWorks	21
EarthCube	10	Stratamodel	21
OpenVision	11	Z-MAP Plus	22
PostStack	11	DSS	22
PostStack ESP	11	TOW/cs	23
PAL	11	ARIES/RMS	23
ProMAX	12	<b>GeoGraphix Solutions</b>	<b>24-25</b>
RAVE	12	Landmark/GeoGraphix Scalable Solution	24
SeisWorks	12	Discovery	24
StratWorks	13	GES	24
SynTool	13	PRIZM	25
ZAP!	13	SeisVision	25
<b>Drilling and Well Services Solutions</b>	<b>14-19</b>	SeisXchange	25
Drilling2000	14	WellXchange	25
CasingSeat	15	<b>Professional Services</b>	<b>26-27</b>
COMPASS	15	Product Training	26
Data Analyzer	15	Product Support	26
		Onsite Consulting	26
		Project Consulting	27
		I <sup>2</sup> Consulting	27



# E & P DECISION-MAKING ENVIRONMENT

Landmark Graphics worked extensively with E&P customers from around the world to develop a better understanding of the life cycle of a hydrocarbon field. This graphic portrays a high-level view of the three primary activity “phases” and nine critical “decision nodes” that occur in most hydrocarbon life cycles. Landmark is delivering the industry’s only comprehensive set of solutions, for true Technical-to-Business (T2B) integration, across the entire hydrocarbon life cycle.



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## TECHNICAL-TO-BUSINESS INTEGRATION

To date, the industry has focused on integrating E&P tasks and disciplines to streamline the technical process of finding, exploiting and managing hydrocarbon reservoirs. The next great productivity breakthrough in upstream oil and gas will be technical-to-business process integration, which Landmark calls “T2B.”

Few energy companies address technical and business analysis holistically, incorporating risk and uncertainty at every link in the E&P value chain. Acquisition and analysis of technical data continue to drive business decisions. A more holistic approach reverses the process. Capital can be allocated only when it is clear how additional technical information will impact the corporate bottom line. The oil industry needs T2B integration to improve shareholder return on investment and reduce costs.

At Landmark, our core competency is our ability to develop and implement software that constructs rigorous, holistic models of the subsurface that enable our customers to evaluate business choices in the relative safety of a virtual world, before committing to non-reversible and expensive actions in the real world. “Rigorous” indicates that we recognize all inputs have some degree of uncertainty, and “holistic” indicates that inputs come from a variety of technical and business processes.

Today we can declare with confidence that we’ve made progress towards building an integrated decision system for E&P companies so they can develop their own inventory of opportunities from which they can create their futures. More progress will be delivered since the Landmark synchronous releases going forward are aimed at enhancing the quality and utility of decision-making by introducing functional domain improvements, more data, workflow and process integration, and better resource allocation tools.



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# INFORMATION TECHNOLOGY SOLUTIONS

## **Decisionarium** (immersive environment for collaborative decision-making)

The Decisionarium™ Program is designed to leverage decision-making expertise and knowledge in a shared data management and visualization environment. For the first time, an asset team can take advantage of the latest in technological advances for working together to make much more accurate and rapid decisions. Teams tackling such diverse problems as platform placement, well engineering and prospect evaluation have achieved better answers in less time by working in a collaborative, immersive visual environment. More than just an intriguing concept, this solution has proven to have significant bottom line impact, in terms of increased production, reduced time to first oil and significant savings in drilling costs.

While not the sole focus of collaborative work processes, underlying visualization and virtual reality technologies are a key enabler. Within this broad range of technology, it is important not to lose sight of core business needs. The whole focus is on changing behavior so that multidisciplinary teams can work together in new ways to get better answers and improve business performance. Landmark's Decisionarium program will allow your company to sift through all of the available technology and quickly design a collaborative, three-dimensional solution that best fits your specific business needs.

In addition to helping you create your own collaborative environment, Landmark also has two lab facilities, located in Houston and Aberdeen, for lease in one, three, 10 and 20-day increments. These environments can accommodate up to 20 team members using immersive technologies to most effectively enable collaboration. The labs are configured with Landmark's integrated applications and data management software as well as virtual reality hardware and devices to meet the specific requirements of each asset team. To ensure maximum effectiveness, a Landmark collaboration expert is available to facilitate sessions.

By providing an environment in which cross-functional teams of specialists can work together, visualization and virtual-reality technology provides the first step toward a new leap in productivity. Data and visual integration, combined with new immersive environments, has created dramatic new possibilities comparable in significance to the introduction of 3D seismic technology in the 1980s. Throughout the next decade immersive, collaborative environments will have as much impact on team productivity as the interactive workstation has had on individual productivity over the past decade.



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# BUSINESS MANAGEMENT SOLUTIONS

## **TERAS** (risk-based asset evaluation and enterprise portfolio management)

TERAS™ is an integrated capital allocation system designed to capture and exploit information generated by multidisciplinary project teams. The TERAS program combines powerful economic evaluation and analysis with portfolio modeling and optimization.

Advanced economic modeling techniques allow the user to better identify and evaluate the inherent uncertainties that control oil and gas accumulation, production and development parameters, commodity prices and other economic factors that impact project profitability. These capabilities improve the capital allocation process and, consequently, increase shareholder value.

Engineering, economic, fiscal and geoscience data provided by the respective domain specialists are modeled in the evaluation and analysis module. This collaborative ability highlights the interdependencies and economic impact of each team's data. Once the analysis of individual projects is complete, they are rolled up on a business or corporate basis. The portfolio module then optimizes the portfolio of projects to meet a variety of corporate strategies, goals and constraints. This process clarifies the risk and return issues, which enables management to make better and faster decisions.

Integration with ARIES™ allows TERAS users to develop a dynamic portfolio management system that can account for real-time changes affecting both mature producing assets and higher risk prospects. TERAS exhibits its true power as a dynamic capital allocation tool to modify investment strategy as new opportunities arise, prices change, additional geotechnical and economic information become available, or as fiscal constraints change.

## **ARIES** (economics and reserve management)

ARIES is Landmark's integrated solution that allows you to organize, manage and evaluate your critical economic and production data – so that you get the most return from your assets, both today and tomorrow. Whether you are forecasting future production using decline-curve analysis, or evaluating the economics of a property for acquisition or divestiture, ARIES enables you to plan with confidence. ARIES/RMS™ adds a specialized system to ARIES to calculate, book, reconcile, track and report petroleum reserves values. It provides a standardized process to give the user increased control and accuracy, and there are built-in government and corporate reports to save time and effort. With RMS you can realize the benefits of integrated workflows, information sharing and concurrent analysis, atop most standard databases. For customers using the OpenWorks™ data management system, even more integration is provided between technical, economics and business analyses in the Production2000 release.



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# INFORMATION MANAGEMENT SOLUTIONS

## **OpenWorks** (data management for integrated asset teams)

OpenWorks is the most widely used E&P integration platform and project data management system in the oil and gas industry. Based on POSC, PPDM and other open systems standards, OpenWorks offers the E&P professional the broadest range of oil field data in one database. As the foundation of Landmark's integrated application suite, OpenWorks is designed to meet the needs of an entire asset team, ranging from the exploration geophysicist with limited access to well data, to production geologists and drilling engineers working with the full extent of all geological assets in a field.

OpenWorks offers not only a common data model to integrate pertinent data from various disciplines, but a common communication method between applications and a range of project and data management utilities, all of which facilitate increased data integrity for the asset team.

## **OpenWorks Development Kit** (integration for external applications into OpenWorks)

The OpenWorks Development Kit is offered externally to commercial vendors, as well as in-house oil and gas company development groups, to enable software developers to connect non-Landmark databases and applications directly into the integrated OpenWorks project data environment alongside Landmark applications. The functionality offered through the development kit is the same as used by the internal Landmark application developers. By using Landmark's development tools, third-party applications can access the same copy of data as Landmark applications and can register to receive and send data using Pointing Dispatcher™ – the Landmark communication protocol. Integration via the development kit not only increases data integrity within an interpretation environment, but ultimately ensures choice and flexibility with a Landmark solution.

The development kit is offered free of charge and all external developers are supported through Landmark's OpenWorks Developer Network (ODN) program, a web-based service located at [www.lgc.com](http://www.lgc.com).





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**OpenExplorer** (regional or enterprise data management system)

OpenExplorer™ is Landmark's advanced data management system designed for today's rapidly expanding E&P data environment. OpenExplorer is a scalable solution for a wide range of needs providing corporate, regional, or asset level data management capabilities. The OpenExplorer data architecture is fully integrated with OpenWorks, Landmark's industry-leading project management system, enabling users to simultaneously and seamlessly manage and integrate multiple asset team projects. With OpenExplorer, data flows quickly and easily from field capture through master data stores to working projects, with knowledge capture to rapidly collect and preserve results. OpenExplorer provides support for today's explosion in data volumes, enabling large-scale database construction, as well as virtual database connectivity, allowing multiple working projects and data stores to function as a single data management system.

OpenExplorer features a fully-integrated GIS, graphical and text-based data viewers, ad-hoc query and report tools, a knowledge capture and reference system, and a full suite of data administration tools. The OpenExplorer data model covers a broad range of data types including well information, well logs, seismic data, field and lease information, drilling and production data, and more, all integrated into a unified data management system.

**OpenJournal** (workflow and project documentation tool)

OpenJournal™ provides interactive project and workflow documentation and knowledge transfer capabilities. A linked hierarchical workflow-oriented user interface and file structure makes this application well suited for providing complex workflow documentation for the E&P industry. OpenJournal provides a vehicle to deliver templates for documenting projects such as workflows, reports, notebooks, and presentations for common tasks. OpenJournal allows users to document crucial decision-making steps with tools such as screen capture, image annotation, text input, and links to web sites, files, programs, e-mail, and other projects. OpenJournal publishes its projects in HTML that can be viewed and navigated using any web browser.



# EXPLORATION AND DEVELOPMENT SOLUTIONS

## **Interpret2000: A New Dimension in Space and Time**

The Landmark Interpret2000 (I2000) release features brand new technology and unprecedented flexibility allowing every geoscientist to work in the most optimized manner. In other words, I2000 will allow for the best answer in the shortest amount of time, tailored to your specific business needs.

Prior to this release, and for good reason, there have been numerous references to the new seismic formats. It is important however to note that Interpret2000 is much more than just seismic data format changes. You will find numerous time-saving productivity enhancements in all of the applications in this release. You will also benefit from the added ability to visualize your data and pick well targets, both in your own teams and with partners. Enhancements to OpenVision™ now permit remote collaboration allowing teams in different offices to share in the interpretation and planning phases of their work without the added expense of time and travel.

**More about productivity.** The vision of I2000 is to improve ease-of-use and streamline the interpreters' workflow. A simple example of this is the change in the button bindings for horizon and fault interpretation. Now the mouse clicks have been streamlined and one customer estimates that this simple change will save them a full month during the interpretation process! In addition, there are new features such as:

- New automated tools to shorten the interpretation time. A geoscientist can now automatically assign faults, saving hours of work per project.
- Minimized number of menu selections and easier list searches
- Better graphics and visual capabilities in StratWorks™

Interpret2000 also improves productivity by streamlining and increasing cross-application workflows. One example is the ability to quickly generate velocity models and facilitate rapid iteration between time and depth. Another example uses the new waveform classification, PAL™, RAVE™ and lithologies calculated with either StratWorks or PetroWorks™. With this information, the geoscientist can understand depositional systems much more rapidly and with more confidence.

**Seismic Data Formats.** When Landmark was formed in the mid-80's, our technology allowed for tremendous productivity increases on the part of interpreting geoscientists. We enabled them to interpret 2D and 3D seismic on a workstation, but without all the additional hassles that accompany the old paper process. Still, they were basically working the same way, interpreting line-by-line, first in-line followed by cross-line. Even today, for customers using SeisWorks™ that process hasn't changed much. With the Interpret2000 new data format options, you finally get to



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interpret through volumes. You can easily and rapidly slice and dice a seismic volume any way you choose. These new, optional data formats with greater dynamic range, provide the ability to brick and/or compress your data in order to optimize your interpretation workflow. Today this greatly impacts our SeisWorks customer base, but think of it as a stepping stone for moving to true volume interpretation using EarthCube™ in the future.

If you decide to use the compressed data formats, you benefit from a dynamically applied algorithm that can compress volumes down to much smaller sizes with little loss of fidelity. While this creates the potential for saving precious disk space, it is more likely that you will use that additional space to create more volumes and more types of volumes. This increased variety of volumes will allow you to look at the different attributes of seismic data to better understand the prospect or reservoir in order to make better decisions.

There are many customers who, for various reasons, may not want to convert their seismic data to the new formats. That's not a problem. In fact, the current .3dv format is the most optimized of the data formats for interpreting in a single direction. The technology underlying the new data formats provides the flexibility to choose the format you want to use. For instance, if an interpreter using SeisWorks prefers a more traditional line-by-line approach, then the .3dv format is most likely the way to go. If the geoscientist is required to continuously use a variety of arbitrarily oriented directions for interpreting, then the bricked or compressed formats are more likely the preferred formats to use.

That's a new dimension of technology with *productivity* and *flexibility* in mind.

### **DepthTeam** (depth conversion and depth imaging workflows)

DepthTeam™ provides a toolkit for velocity modeling, model refinement and validation, depth conversion and depth imaging. The DepthTeam interpretive workflows are designed to match the technical solution with the geologic problem. The solution is also scalable to balance time constraints, available resources, changing business situations and tolerance for risk. Implemented within Landmark's integrated exploration environment, DepthTeam workflows lead to reduced cycle times, more accurate solutions, greater confidence in interpretations and better business decisions.

### **DepthTeam Express** (workflows for interpreters in simple geology)

DepthTeam Express™ is a velocity modeling and depth conversion solution created specifically for interpreters. Integration with OpenWorks, SeisWorks, ProMAX™ and the other DepthTeam offerings



## EXPLORATION AND DEVELOPMENT SOLUTIONS (CONTINUED)

creates a workflow environment where all available well or interpreted data is easily accessible. By integrating and calibrating different data types such as seismic velocities, TD tables, horizons and well picks into the velocity model, depth conversions of seismic, faults and horizons will now tie your wells in depth. This reduces uncertainty and allows you to make better business decisions.

### **DepthTeam Interpreter** (workflows for simple geology)

DepthTeam Interpreter™ provides a toolkit for building velocity models, validating the models and converting seismic data or interpreted horizons to depth. Integration with OpenWorks and SeisWorks creates a workflow environment where all available well or interpreted data is easily accessible. Validation techniques and 3D visualization give increased confidence in the accuracy of your depth solution.

### **DepthTeam Explorer** (workflows for moderate velocity complexity)

DepthTeam Explorer™ provides for rigorous interval velocity analysis, model building, model validation and depth conversion. Workflow options include geostatistical risk assessment and depthfold illumination for survey design and depth image validation. Integration with OpenWorks, SeisWorks and ProMAX makes velocity/depth modeling an integral part of your interpretation workflow.

### **DepthTeam Extreme** (workflows for extreme velocity complexity)

DepthTeam Extreme™ provides comprehensive migration velocity analysis, 3D modeling and 3D prestack depth migration workflows for very complex geologic/velocity situations. A component of ProMAX 3D™, DepthTeam Extreme is tightly integrated with SeisWorks to create an interpretive processing environment, where multidisciplinary teams use their collective expertise to solve complex imaging problems.

### **EarthCube** (high-performance volume interpretation)

EarthCube provides a completely integrated, three-dimensional, real-time seismic interpretation system. The analysis and visualization environment forms the basis for a new direction in seismic interpretation. Key features that allow you to manipulate your data include opacity display using volume rendering, zooming and rotation, chair displays and animation planes. Using the unique EarthCube seismic slice plane animation, you create arbitrary seismic slice planes in any orientation – vertical, horizontal, arbitrary or at oblique angles – then drive the slice planes throughout the seismic volume for interpretation. In addition, EarthCube provides a full suite of interpretation tools including autotracking, fault and horizon picking, and voxel tracking. EarthCube allows you to clearly see subtle data changes and identify hidden relationships, and its flexibility allows you to tailor your interpretation to meet your needs, increasing your productivity and accuracy.



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### **OpenVision** (advanced 3D visual integration)

OpenVision is the industry's only integrated geoscience and engineering data visualization tool that displays the widest range of data from multiple data sources in a single 3D scene. With OpenVision, multidisciplinary information from various geoscience applications can be accessed, displayed and analyzed together in a single, shared visual environment. OpenVision gives every member of your asset team access to true cross-application data, and establishes a new workflow standard for the industry.

### **PostStack** (poststack processing)

Built on proven and reliable algorithms from ProMAX, the industry's leading seismic processing software, PostStack™ offers easily accessible poststack processing functions and gives you unmatched control over your seismic data. With PostStack, you can now optimize your data to show particular features of interest and to create multiple interpretation scenarios. PostStack features several quick and easy scenarios for conditioning your data without reformatting or copying. You design the poststack processing function interactively, and apply it to fit your needs. Tight integration with SeisWorks eliminates the need for data manipulation, providing more time for analysis.

### **PostStack ESP** (event similarity prediction)

PostStack ESP™ is an interpretation tool that highlights discontinuities in seismic data caused by faulting or stratigraphic variations. This information is critical to a multidisciplinary asset team working to extract accurate information about the subsurface in the reservoir description and production phases. PostStack ESP operates on the seismic data itself, yielding a high resolution and impartial image of these features, free from interpretive biases. The resulting images not only facilitate the interpretation process, they also insure a more accurate and reliable interpretation at every stage of a project. PostStack ESP increases the value of 3D seismic data by extracting information to support reservoir description, wellbore planning and project risk management.

### **PAL** (seismic attribute extraction)

PAL (poststack attribute library) enables you to enhance your understanding of the reservoir by directly accessing SeisWorks data for attribute extraction. PAL computes statistical and complex attributes interactively and outputs these as horizons, which can be accessed by numerous applications throughout the interpretation process. For example, PAL attributes can be displayed in SeisWorks or OpenVision, or evaluated in RAVE. PAL provides more than 50 possible attributes, making attribute extraction and interpretation an integral part of your daily workflow.



## EXPLORATION AND DEVELOPMENT SOLUTIONS (CONTINUED)

### **ProMAX** (2D/3D seismic processing)

ProMAX for 2D and 3D seismic data processing is a complete system that features state-of-the-art processing technology built around an intuitive, easy-to-use graphical user interface. The system includes many interactive visualization and analysis tools. These tools give you powerful geo-physical analysis and quality control capabilities allowing you to quickly make and implement processing decisions. ProMAX offers features enabling efficient, high-volume processing of large 3D data sets. These features include support for parallel processing, data management and project management, as well as support for robotic data storage devices. There are several ProMAX modules available providing additional functionality.

*ProMAX MVA™* provides a suite of interactive analysis and modeling tools for constructing and validating interval velocity models for depth imaging. ProMAX MVA is based on the concept that prestack depth migration of common offset sections, which use the correct velocity field, will produce images that are structurally identical.

*ProMAX 3DPSDM™* resolves structural positioning and imaging of seismic events in complex geologic situations where conventional time/domain processing fails. ProMAX 3DPSDM provides a scalable, target-oriented approach which allows you to conduct practical 3D prestack depth migration in a common SMP workstation environment.

*ProMAX VSP™* is used to process zero offset, offset and reverse VSP geometries. ProMAX VSP contains a suite of tools that target the generation of conventional VSP products such as the corridor stack, VSP-CDP transform and VSP migration. ProMAX VSP also includes a cross-well tomography package, which handles well-to-well and surface-to-well geometries.

### **RAVE** (attribute analysis)

RAVE is a multidisciplinary reservoir characterization tool that enables geoscientists and engineers to automatically find, visualize and study relationships among various seismic and reservoir attributes in familiar map and cross-section views. RAVE highlights the subtle reservoir information hidden in seismic and production data, revealing opportunities that often went undiscovered before RAVE made this type of analysis possible. Relationships identified in RAVE are then communicated to SeisWorks and EarthCube to determine if they have hydrocarbon significance.

### **SeisWorks** (seismic interpretation and analysis)

SeisWorks is the industry's technology leader for 3D seismic interpretation and analysis. Because it supports seismic interpretation in either time or depth, SeisWorks makes depth interpretation a



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convenient reality. SeisWorks includes full multi-survey merge capabilities allowing you to easily combine 2D with 3D projects, and to merge multiple 3D projects without data reformatting or reloading. The seismic balance functions allow you to correct for differences in amplitude, phase and frequency across multiple surveys and within 2D projects. Faults can be interpreted and edited on vertical seismic sections and time slices. SeisWorks faults are stored in the OpenWorks database, so information from interpreters working on a single project or multiple projects is quickly updated and instantly accessible.

### **StratWorks** (2D geologic interpretation and well log correlation)

StratWorks is designed for geoscientists and engineers who need to efficiently generate and evaluate prospects, characterize reservoirs and support business decisions. StratWorks augments the traditional processes of geologic interpretation with technologically up-to-date features. Built upon the OpenWorks project data management system, StratWorks allows asset teams to rapidly correlate well logs, build cross-sections, tie depth to seismic-time through close integration with SeisWorks, create maps in an integrated environment, and gives the petrophysicist a quick analysis tool for defining lateral producing interval relationships. This integrated functionality helps your multidisciplinary asset team's transition from paper-based projects to a more efficient and accessible toolkit, which reduces costly error, increases productivity, and makes it easier to generate prospects and manage reservoirs.

### **SynTool** (synthetic seismograms generation)

SynTool™ is an essential, integrated interpretation tool that allows you to accurately tie well correlations, formation tops and lithologies with seismic data. SynTool provides the features you need to create accurate synthetic seismograms, and its detailed log editing and processing capabilities help you correct log recording and hole problems. Special thickness and zone editors allow prediction of changes in structure and reservoir properties away from the well. Using SynTool, seismic wavelets can be calculated, displayed and used to derive synthetics.

### **ZAP!** (3D automatic horizon tracking)

ZAP!™ improves your productivity by automating the tedious process of picking and editing seismic horizons within a 3D volume. Using ZAP!, you can create highly accurate interpretations in a fraction of the time – even in areas of complex geology or low data quality. ZAP!'s unique features include statistical analysis to help you set parameters in problem data areas and surgically precise map-based editing capabilities that remove data busts before retracking. ZAP! also allows autotracking within triangulated, fault-bounded blocks, so you can manage structurally complex areas.



# DRILLING AND WELL SERVICES

## **Drilling2000: Managing the Drilling Desktop**

Landmark's Drilling2000 offering is one of the most complete well planning and operations solutions provided in the industry. From prospect evaluation through detailed planning, operations monitoring and ultimately post-well analysis, all elements of the drilling process are covered.

Landmark has integrated the best-of-breed technical offerings supporting well planning and execution into a suite of applications that supports complex workflows. Drilling engineers can now make use of earth model information during both the planning process and operations. The technical well designs themselves can be planned more quickly and effectively using this comprehensive suite of engineering technology. Robust analytical tools allow the analysis of operations data to determine lessons learned as a regular part of the drilling process.

Drilling2000 incorporates Landmark's widely-used set of drilling applications, including DIMS™, StressCheck™, COMPASS™ and a host of others. New technology, such as the real-time operations application RESolution 3D™ and web-enabled data access via iDims™, is featured as well.

The following workflows are easier to work through, and less time consuming, by taking advantage of the integration features in Drilling2000.

### *Integrated Well Planning Workflow – Prospect to Proposal*

Asset teams are often called upon to develop proposals in a minimum amount of time using hard to access data. Using Landmark technology and processes, explorationists and drilling engineers can work together far more efficiently to achieve this. In this workflow, earth model data from the prospect is integrated with engineering tools to generate an accurate path plan, casing design (shoe setting depths) and cost estimate in a drastically shortened cycle time.

### *Integrated Well Planning Workflow – Proposal to Program*

Once a well has been approved, a detailed drilling program must be developed. Considerations such as torque/drag, fluid behavior, temperature effects and BHA performance constraints, among others, should be accounted for during the design process. Landmark technology is used to optimize the drilling plan for performance, while estimating costs and determining risk assessment.

### *Real-time Decision-Making – Improving the Drilling Process*

Once drilling operations begin, it is imperative that information flows as quickly as possible into an environment where decisions can be made. RESolution 3D, technology jointly developed by Landmark, Sperry-Sun and Halliburton, is used to migrate real time MWD, LWD and PWD data into the Landmark OpenWorks database for operations decision support.





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### *More Efficient Operations through Post-Well Analysis*

Data gathered during the drilling process can be of great value when planning the next well. The use of offset well analysis tools produces likely cost and performance characteristics of a new well. Potential trouble areas are highlighted, vendor performance reviewed and process improvement possibilities identified.

#### **CasingSeat** (casing shoe depth selection application)

CasingSeat™ is an accurate and easy-to-use tool to determine casing setting depth and viable casing and wellbore schemes. It provides rigorous shoe selection calculation routines to optimize shoe locations, based on pore pressure and fracture gradients and user-defined design constraints. It features inventory-based management of permissible hole and casing size combinations. The tool provides layer- and lithology-based characterization of subsurface boundary conditions and operating constraints, including those associated with wellbore stability, minimum overbalance and differential sticking.

#### **COMPASS** (directional path planning application)

COMPASS is the leading directional path planning tool for operators, as well as directional drilling contractors, improving the safety, efficiency and cost effectiveness of directional path planning. COMPASS allows well position calculations based on survey values, 2D and 3D path planning, plus anti-collision scanning using a variety of algorithms. Complex trajectory design, torque/drag effects, and platform placement optimization are also supported.

#### **Data Analyzer** (data analysis tool)

Data Analyzer provides an easy-to-use, powerful tool for DIMS users that assists them in gaining maximum value from their data. Ad-hoc queries can be generated with the user selecting from the same user-defined labels and data input structure that they are familiar with. A graphics wizard allows easy generation of pie, line or bar charts. Direct export to Microsoft® Excel or other spreadsheet applications is offered with the click of a button. In addition, DIMS system security and unit handling is fully supported.

#### **DIMS** (drilling data collection and analysis system)

DIMS is a fully integrated and comprehensive operations database, communications, and engineering information data management system for drilling and well services. DIMS is the most widely-used drilling and well services morning reporting system in the industry. As a complete wellsite-based operations reporting and database system, it can be easily configured to adapt to essentially any field operating environment to facilitate operations reporting and query needs. Data Analyzer is also included with DIMS.



## DRILLING AND WELL SERVICES (CONTINUED)

### **Drillability Suite Manager** (project and data flow organizer)

The Drillability Suite™ Manager is a powerful project organization tool that automates data movement between Landmark drilling applications and OpenWorks, using Landmark's Data Exchange (DEX™) technology. Drillability Suite Manager allows an engineer to synchronize project data across applications and platforms, while grouping data into easy-to-follow project folders.

### **DrillModel** (well costing application)

DrillModel™ is a costing tool for preparation of AFE's and budget costs, which can model every step of the drilling operations to determine the effect of changes in well design on the well cost in a consistent and reliable manner. In addition, it can be used to assess the cost impact of down time, technology changes, and drilling one extended reach well versus multiple vertical wells.

### **iDims** (web-based reporting system)

iDims provides drilling and well services morning reports, summary reports and virtually all other information contained in the DIMS database. By combining DIMS data access security with your corporate Intranet firewall to control site access, iDims provides managed access to current electronic well data. Users have the ability to select individual wells, events, report types and dates, and view the list of reports as needed.

### **PROFILE** (wellbore schematic and data viewer)

PROFILE™ retrieves data from the DIMS database in a format defined by the user. PROFILE allows you to configure templates defining what data is required, and its presentation format. These templates contain wellbore schematics, tables, summaries and directional plots. Once a template has been set up, it can be saved and re-used on any well in the DIMS database.

### **RESolution** 3D (real-time data visualization)

RESolution 3D, a service developed jointly by Landmark Graphics and Sperry-Sun, allows real-time updating of earth models in a 3D visualization environment. Real-time data (MWD, LWD, PWD) from Sperry's INSITE™ data gathering system is fed into OpenWorks NT, Landmark's project database, for use on the rig or in the office. On the rig or in the drilling engineer's office, real-time data can be visualized in a Windows NT® environment, along with the interpreted earth model. This information can ultimately be fed into engineering applications such as COMPASS. Simultaneously, the data can be sent to the office where the asset team can use all of the seismic interpretation and log analysis technology to rework the earth model as necessary.



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### **StressCheck** (casing design application)

StressCheck is the leading casing and liner design tool, providing triaxial design and analysis capabilities. Burst, collapse and axial force load cases are supported. Given a defined set of parameters engineers can check the characteristics of a user-defined casing string, or optimize the casing design for minimum cost.

### **Wellbore Planner** (directional path planning in the earth model)

Wellbore Planner™ allows you to visualize and optimize potential drilling targets and plan wells interactively within EarthCube, Stratamodel™, SeisWorks and OpenVision. Platform locations can also be optimized. Through its integration with COMPASS, Wellbore Planner can also interact with a wide range of drilling applications and enable interdisciplinary teams to improve productivity, bringing geoscientists and drilling engineers together in a way that takes advantage of all their resources.

### **WELLCAT** (advanced drilling and production simulation application)

WELLCAT™ is an integrated, modular suite of applications used by drilling and completion engineers to thermally simulate subsurface environments.

The WELLCAT *Drill* module provides transient thermal and fluid flow analysis for drilling operations. Simulations include cementing temperatures, downhole tool temperatures, circulating mud temperatures and other applications.

The WELLCAT *Prod* module allows for thermal simulation of production operations. These include fluid circulation, liquid and gas injection, fluid production, shut-in, reactive gel treatment, cement squeeze, spotting cement plugs and gas-lift operations.

The WELLCAT *Casing* module analyzes casing loads, design integrity and buckling behavior under complex mechanical, fluid pressure and thermal loading conditions. Installation and service loads can be defined by standard load cases, or linked to analyses performed with the *Drill* and *Prod* modules.

The WELLCAT *Tube* module analyzes tubing loads and movements, buckling behavior and design integrity, under complex mechanical, fluid pressure and thermal loading conditions. Installation and service loads can be defined by standard load cases, or linked to analyses performed with the *Prod* module.



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## DRILLING AND WELL SERVICES (CONTINUED)

The WELLCAT *MultiString* module analyzes the casing and tubing configuration in a system approach. Thermal simulations from *Drill and Prod*, together with loading conditions from *Casing and Tube*, are used to determine annular fluid expansion (AFE) pressures that exist within all trapped annuli, as well as movement of the wellhead as each string is subjected to changing loads (thermal, pressure and applied loads).

### **WELLPLAN** (wellbore construction design tools)

WELLPLAN™ is an integrated, modular suite of applications used by drilling engineers to develop optimal well designs.

The WELLPLAN *Torque and Drag* module provides a detailed analysis of the torque and drag forces affecting a drill string during various modes of operations (drilling ahead, tripping in, tripping out, etc.) Drill string design can be optimized to minimize torque/drag forces and reduce the likelihood of stuck pipe and drill string failure.

The WELLPLAN *Stuck Pipe* module carries out drill string failure analysis, calculates force delivered to stuck points, forces required to set and fire jars, as well as back-off force calculations.

The WELLPLAN *Hydraulics* module allows the drilling engineer to design the optimum bit and drilling fluid combination for maximum performance. Three rheological models are supported, including Herschel-Buckley. *Hydraulics* provides a complete analysis of the circulation system, selects the best jet sizes for optimum ROP, and allows study of ECD's with regard to pore pressure and fracture problems. Surge/swab analysis can also be undertaken, as well as hole cleaning.

The WELLPLAN *Bottom Hole Assembly* module models drilling performance of rotary steerable directional BHA's utilizing finite element analysis technology. Drilling tendencies of the assembly can be predicted and bent sub assemblies are also supported.

The WELLPLAN *Critical Speed Analysis* module models BHA behavior and identifies critical rotary speeds and high stress concentration in the drill string. These are identified by utilizing finite element analysis (FEA) and forced frequency response (FFR) techniques.

The WELLPLAN *Cementing* module OptiCem™ uses the latest in Halliburton cementing technology to model the range of fluids pumped during a cementing operation, including spacers, preflush and slurries. It helps the engineer prepare for various effects that may be observed during these operations, such as U-tubing, differential pressures, etc. It also allows the engineer to check



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that the maximum circulating pressures do not exceed the formation breakdown pressure in the open-hole section. Other features include stabilizer placement and foam cementing technology calculations.

The WELLPLAN *WellControl* module models fluid response when a kick is circulated out of the wellbore. The application can be used in casing design to ensure the casing string can withstand the maximum expected influx, and during operations to assist with well kill procedures. Both Wait and Weight and Driller's Method are supported.

The WELLPLAN *Surge* module is a highly sophisticated program that provides an engineer with all of the necessary tools to optimize tripping speeds and fluid densities to avoid well control problems and formation damage during tripping and cementing operations. *Surge* can be used for well planning where surge pressures need to be controlled, or it can be used to diagnose well problems that may be related to pressure surges.



# PRODUCTION MANAGEMENT SOLUTIONS

## **Production2000: Optimization Through Integration**

Landmark's Production2000 release provides a desktop environment that enables production optimization through integration for petroleum, reservoir, drilling, production and economics engineers. This synchronous release provides a first major step in improving critical workflows to optimize production and forecast production performance, while driving better, faster decision-making, increasing returns on expenditures.

Across the E&P business, Landmark's customers strive for greater efficiency in their work processes and these efficiencies have been realized by the integration of G&G processes. However, the petroleum engineering segment associated with drilling and production has yet to realize these efficiencies, and are therefore still faced with a vast array of applications with no commonality. This has created a cost of ownership issue for many companies.

Production2000 provides a desktop environment for data integration and a decision support platform for use by petroleum, reservoir, drilling, production and economics engineers. At the same time, it addresses and helps solve the cost of ownership issue. Production2000 also presents a solution, including an integration path from engineering to G&G, by integrating the PC product data management systems with OpenWorks.

Through Production2000, Landmark has addressed the following:

- Single source contracts from one supplier providing products and system integration;
- Lower cost of ownership through a common operating environment supported by a single operating system and database platform, simplified installation, a consistent product licensing scheme, and a unified data management scheme;
- Higher individual productivity through an integrated desktop environment including a comprehensive suite of products that synergistically support critical engineering workflows;
- Faster take-up and reduced cycle time through consistent product interfaces, ease-of-use, common look and feel, high performance and reduced functional overlap.

## **DESKTOP-VIP** (reservoir simulation)

DESKTOP-VIP™ is a proven, full-featured reservoir simulation system that allows you to construct accurate and consistent reservoir models. The sophistication of DESKTOP-VIP allows you to model complex development processes which cannot be modeled using simpler methods. It offers fast performance in large data sets and, when used with Landmark's 3DVIEW™ visualization package, gives you the power to display detailed well and reservoir structure information and visualize your complex reservoirs in full color. DESKTOP-VIP offers a full suite of integrated reservoir



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simulation pre- and post-processing tools and simulation modules including black oil, compositional and thermal simulation.

### **Parallel-VIP** (parallel reservoir simulation)

Parallel-VIP™ is Landmark's parallel computing version of its industry-leading DESKTOP-VIP reservoir simulation system. It delivers a scalable solution for faster, interactive and more accurate simulations of large and small hydrocarbon reservoirs. Parallel-VIP simulates much larger reservoir models or existing models in hours, rather than days or weeks. It works by breaking the simulation model into smaller pieces and distributing them among multiple processors. This technology can also significantly reduce or eliminate the need for upscaling geologic models prior to simulation. Pre- and post-processors have been enhanced to provide support for these large simulation models. Models in excess of a million grid blocks can be run without upscaling through the pre-processor, simulation and post-processor workflow.

### **PetroWorks** (graphical well log interpretation)

PetroWorks is a powerful, integrated, log analysis tool for asset teams conducting graphical well log editing, analysis and interpretation. This multi-well, multi-zone project environment provides fundamental tools for the team geoscientist/reservoir engineer, including crossplotting, log plotting, histograms, log editing, environmental corrections and user programming. For the petrophysicist it provides advanced interpretation modules and sophisticated user-programming capabilities. This easy-to-use product family includes the PetroWorks Pro, PetroWorks Asset and LogEdit™ products, and has especially tight integration with StratWorks and Wellbore Manager™. Comprehensive integration with OpenWorks allows immediate access to results by other Landmark products such as Stratamodel, VIP™ and Z-MAP Plus™, enabling unsurpassed productivity.

### **Stratamodel** (3D stratigraphic geocellular modeling)

Stratamodel helps your asset teams better understand 3D reservoir characteristics, accurately define hidden reserves in a 3D earth model, and identify potential drilling targets. Stratamodel integrates data and knowledge from geology, geophysics, petrophysics and engineering for more effective reservoir management. This application helps you create a comprehensive reservoir model for the evaluation of complex internal reservoir architecture, fluid flow characteristics, volumetrics, well planning and reservoir simulations. With Stratamodel, you can visualize the 3D reservoir model using combinations of cross-sections, stratigraphic slices and cross-sequence connectivity displays. Stratamodel's onscreen digitizing capabilities enable the user to bias the distribution of reservoir data in the inter-well region based on qualitative facies interpretations or quantitative seismic distributions. Using OpenWorks, interpretations from other applications such as SeisWorks, StratWorks, PetroWorks and Z-MAP Plus can be easily integrated into your reservoir interpretation.



## PRODUCTION MANAGEMENT SOLUTIONS (CONTINUED)

*Stratamodel/Badley's* is an add-on module that incorporates fault seal analysis (FSA) technology from Badley Earth Sciences, Ltd. This module extracts relevant structural and lithologic information from Stratamodel and provides output for the delineation of uninterrupted reservoirs and flow simulation.

The *StrataSim*<sup>™</sup> module provides you with the power to more accurately model the reservoir before full physics simulation in Stratamodel. StrataSim has been enhanced further to make use of fault zone thickness and permeability attributes from Badley's Fault Seal Analysis module to investigate effects of fault seals on reservoir flow.

*Reservoir Framework Builder*<sup>™</sup> (RFB) is Landmark's Windows NT application that enables the rapid and easy building of complex faulted framework models for input to Stratamodel. RFB generates the framework grids and scenario file for building Stratamodel geocellular reservoir models.

The *StrataMap*<sup>™</sup> module offers integrated 2D surface modeling used in Stratamodel. Stratamodel functionality has been enhanced to complement functionality available in RFB.

### **Z-MAP Plus** (integrated surface mapping and modeling)

Z-MAP Plus is a surface mapping and modeling component fully integrated with the OpenWorks data management environment. This integration enables creation of more accurate reservoir models by incorporating data and interpretations from seismic, geologic, petrophysical and 3D geocellular models. Unique features provide capabilities for high accuracy and multiple working scenario analyses. Workflow integration with other OpenWorks-compatible products facilitates effective map-based asset team communication. Productivity tools allow rapid generation of geologic models based on simplified application of geologic form and multi-step workflows.

Included in the Z-MAP Plus application is Contouring Assistant<sup>™</sup>. This tool is an intelligent surface modeling and mapping package based on an expert system and ZCL, a powerful batch command language which allows the user to write run streams and macros for repetitive steps.

### **DSS** (production and reservoir surveillance system)

Dynamic Surveillance System<sup>™</sup> (DSS<sup>™</sup>) is designed specifically to help reservoir and production engineers in optimizing existing production or replacing proven reserves. Completion and structural relationships between wells can be identified using the DSS cross-section capabilities to display wellbore, log and zone data. Users can easily search for anomalous reservoir behavior using dynamic bubble, pie contour mapping. Engineers can monitor well performance indicators such as production and injection rates, pressures, artificial lift conditions and mechanical failure trends





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to identify workover and stimulation opportunities. DSS provides direct links to company databases such as Microsoft Access, SQL Server, ORACLE® and Sybase®. In Landmark's Production2000 release, DSS seamlessly connects to the OpenWorks 1998.7 redesigned data model for production, annotation, scenario and workover data.

### **TOW/cs** (The Oilfield Workstation™/client server)

TOW/cs™ is an enterprise-wide production data management system that provides for the collection, storage and analysis of production data. It has the tools you need to maintain critical operational information in an accurate and timely manner. With TOW/cs, you can capture your production and operations data in the field, thereby eliminating those time-consuming tasks of transcription, hand calculations and manual report creation. TOW/cs also determines daily allocated volumes, valuable data that can be used for detailed variance analysis. Once data is collected in the field, it is allocated and electronically transmitted to the office, where it is used for management reporting, production accounting and production engineering.

Maintaining accurate and timely production data plays a vital role in the success of exploration and production companies. Decisions, both economic and engineering, are only made correctly if the decision-maker has an accurate source of information. In addition, state and federal agencies have instituted their own set of cumbersome accounting requirements and stringent reporting regulations. TOW/cs is an integrated suite of applications for field data capture, production management and optimization, production accounting, daily and monthly operations reporting and regulatory reporting. TOW/cs calculates, summarizes, and stores data on a daily basis, allowing you to react to the information while it is still valuable. TOW/cs also stores data on a monthly basis, allowing corporate access to a "live" production history repository so you no longer need to move data around to evaluate reserves and economics. Best of all, everything is in one place.

### **ARIES** (economics and reserve management)

ARIES is Landmark's integrated solution that allows you to organize, manage and evaluate your critical economic and production data – so that you get the most return from your assets, both today and tomorrow. Whether you are forecasting future production using decline-curve analysis, or evaluating the economics of a property for acquisition or divestiture, ARIES enables you to plan with confidence. ARIES/RMS adds a specialized system to ARIES to calculate, book, reconcile, track and report petroleum reserves values. It provides a standardized process to give the user increased control and accuracy, and there are built-in government and corporate reports to save time and effort. With RMS you can realize the benefits of integrated workflows, information sharing and concurrent analysis, atop most standard databases. For customers using the OpenWorks data management system, even more integration is provided between technical, economics and business analyses in the Production2000 release.



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# GEOGRAPHIX SOLUTIONS

## **Landmark and GeoGraphix: A Fit-For-Business Combination**

Over the years, Landmark's suite of integrated applications has grown dramatically. But we observed that our customers' technology needs varied widely, depending on the complexity of their E&P problems, the production potential of their assets, and the computer skills of their users. We realized that no technical solution could fit every company's need – or budget.

That's why, in 1995, we acquired GeoGraphix, the industry's leading developer of integrated G&G software for desktop systems. To address the computing needs and financial constraints of quite different markets, Landmark and GeoGraphix offer two distinct product lines. Primary differentiators are price point and the amount of technology needed to get the job done.

GeoGraphix applications are aimed at solving fundamental technical problems with an emphasis on core functionality, ease-of-use and affordability. Landmark provides a broader spectrum of higher-value applications, which "push the technology envelope" by applying cutting edge science to solve the most daunting reservoir and operational problems.

Today, GeoGraphix and Landmark offer the most diversified – and the most integrated – portfolio of E&P technology in the petroleum industry. With Landmark and GeoGraphix to choose from, you'll be sure to find a fit-for-business solution, no matter what price point, operating system or reservoir problem you have.

### **Discovery** (streamlined interpretation workflows)

With GeoGraphix Discovery™, you can access, manipulate, analyze and interpret geologic, geophysical, petrophysical and production-related reservoir data in a completely streamlined workflow environment – one that allows you to spend more time interpreting the data and less time managing it. Whether you work in asset teams – where collaboration is important – or alone, Discovery provides a complete suite of integrated tools for evaluating and interpreting well, seismic and log data on your Windows NT desktop.

### **GES** (mapping, data management, and analysis)

The GeoGraphix Exploration System™ (GES™) is a powerful relational database management system optimized for handling all forms of E&P data, including well, seismic, production, lease and cartographic data. Integrated with the database are extensive mapping, surface modeling, 3D and final presentation capabilities, uniquely integrated within a single environment.



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**PRIZM** (well log analysis)

Designed to meet the needs of the interpretive geoscientist, PRIZM™ provides an intuitive user interface optimized to quickly and accurately interpret your well log data. Operating in the Windows NT environment, PRIZM is well suited for both the casual user and the experienced petrophysicist.

**SeisVision** (2D/3D seismic interpretation and mapping)

SeisVision™ is the only fully integrated PC-based seismic interpretation system available to the oil and gas industry today. As part of the GeoGraphix Discovery integrated suite of geoscience applications, SeisVision provides the geophysical interpretation tools needed to evaluate 2D or 3D seismic data from onshore or offshore environments, in simple to complex geological regimes. SeisVision's base-level integration of seismic and geologic data gives you the information needed to better understand your prospect.

**SeisXchange** (data transfer tool)

SeisXchange™ is a PC-based integration tool designed to allow SeisVision and SeisWorks users to move seismic and interpretation data easily back and forth between the two systems. SeisXchange is an add-on to SeisVision. Using common Windows® menu items, you may select SeisWorks data by first choosing the UNIX® server on which the SeisWorks project data resides, then select the project and seismic data from a series of pull-down menus. The selected seismic and/or interpretation data is copied and converted to SeisVision's data formats on the SeisVision client.

**WellXchange** (data transfer tool)

WellXchange™ is a PC-based integration tool designed to link the GeoGraphix Exploration System (GES) with the OpenWorks and GXDM data models. Two versions of WellXchange are available: WellXchange and WellXchange OWC. Prior to the R99.2 release WellXchange and WellXchange OWC were a single product and known only as WellXchange. Today, WellXchange provides GES users with the ability to exchange data between the GES system and the GXDM well data model used within the GeoGraphix geological interpretation and mapping system GESXplorer.



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## PROFESSIONAL SERVICES

Landmark's Professional Services mission is to help E&P companies succeed in using Landmark technology solutions to achieve business goals. Landmark technology is the foundation of all our services, and our service professionals are tightly integrated with our product development groups. We can build the right mix of services to meet virtually any E&P business need. Landmark offers a range of services for users, which can start with point product functionality and extend all the way to creating comprehensive programs to meet strategic business requirements.

### **Product Training**

Product training provides comprehensive instruction on the use of Landmark technology. Training is conducted in state-of-the-art centers, with 12 locations around the world, plus two training sites managed by "alliance partners", for easy access. All instructors are certified on the Landmark products and in the courses they teach and have close ties to Landmark's product development team. For many products both introductory and advanced classes are offered. Courses are designed to provide maximum levels of hands-on experience, to answer questions and have fun.

### **Product Support**

Landmark's product support team provides immediate availability to help in using Landmark applications. The team is a global, seven by 24 operation that was the first in the industry to receive certification from ZD Service & Support Consultants, after completing a rigorous audit of their Houston-based support center. Employing a sophisticated, multi-level approach, our support process quickly directs questions to the right source of expertise. This team is tightly integrated to the product development team, both to answer individual questions and to spot patterns in questions from the Landmark user community.

### **Onsite Consulting**

Onsite consulting brings Landmark to your workplace so that your staff achieves greater value every day from your investment in our technology. Onsite consultants are personal coaches, who provide application troubleshooting and workflow mentoring, freeing professionals to work more effectively and efficiently.



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Landmark consultants network globally as a group and with the rest of Landmark, including product development, product support and individual account teams. They are certified in key Landmark products and coached by consulting managers. With this broad base of Landmark support, onsite consultants can take on a variety of roles to help companies meet their business objectives.

### **Project Consulting**

Project consulting solves business problems using Landmark technology. The emphasis is on improving your organization's effectiveness whether in drilling, reservoir optimization, geophysical and geological technologies, or IT. Projects are designed to meet specific objectives, based on either a quick review or an in-depth assessment, depending on your situation. Project consultants are familiar with Landmark's newest technologies and the most advanced levels of integrated workflows, and have direct linkages to product development teams.

### **I<sup>2</sup> Consulting**

The integration of people, process and technology is a complex change process for E&P businesses. Landmark has created a team of experienced management consultants to assist companies in scoping, planning, implementing and managing these changes across their organizations. The I<sup>2</sup> consulting team offers the highest level of integration for your Landmark environment. The team's name comes from Landmark's I<sup>2</sup> pyramid of "informationalization and integration." The I<sup>2</sup> team works with management to understand your business issues and design a program to map strategic business objectives to the technology and processes needed to support those business goals. The issues in an I<sup>2</sup> project often start at the level of, "How can information technology drive down my lifting costs?" Implementation programs from the I<sup>2</sup> team often involve other parts of Landmark's service teams, and the group is broadly networked across the company.









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