The Imperative for Collaborative Well Planning
The Imperative for Collaborative Well Planning

Authors: Dan Colvin, DeWayne Pratt and David Risdal, Landmark Software and Services

Introduction

With increasing pressures to cut costs, plan complex wells more efficiently, and drill more safely, oil and gas companies worldwide are urgently seeking ways to improve collaboration across traditional gaps between the E&P disciplines. One of the most important—and critical—is the chasm between geoscientists and drilling engineers, who usually tackle technical challenges with disparate software tools and platforms. To unlock step changes in performance, operators must employ technological innovations that seamlessly bridge these domains. Indeed, collaborative approaches to well planning are rapidly becoming essential just to play the game. Smart operators are implementing revolutionary new tools in unconventional resource plays, deepwater wells, and other complex drilling situations. Today, Landmark’s DecisionSpace® Well Planning software is the industry’s leading collaborative solution for geoscientists and engineers.

The value of collaborative well planning

A few years ago, an operator developing a shale gas play in Canada began planning ambitious drilling programs involving nearly a dozen rigs and hundreds of stacked, horizontal wellbores (Fig. 1). Using standalone software tools, hardcopy maps, spreadsheets, and manual methods of pad and well placement, one asset team took 180 days to complete just two planning iterations for 10 pads with 80 horizontal wells, targeting three or four zones in each well. Linking geologists’ horizontal tracks in the subsurface with viable pad locations on the surface without running into interference problems proved so daunting, shale teams typically planned one section of a field at a time. This led to inevitable delays, long hours of rework, costly pad extensions, undesirable environmental impact, and potential lost production.

Figure 1. The operator of a shale gas play in Canada used Landmark’s collaborative well planning technology to reduce the multidisciplinary planning cycle by 80%, saving millions.
To improve efficiency without slowing its teams down, the operator turned to DecisionSpace Well Planning software technology to leverage new tools that seamlessly integrate geology with directional drilling (Fig. 2). The first DecisionSpace pilot project planned the same 80 horizontal wellbores in just 15 days—an 83 percent reduction in cycle time. During that period, 30-40 iterations were completed, dramatically improving initial plans. Automated field scenario planning, visualization and optimization tools enabled geoscientists and engineers to plan the entire field up front, jointly review well spacing and pad plans in the context of the 3D earth model, and reach consensus rapidly. A second pilot also reduced the planning cycle by 80 percent, and saved an estimated $4.5 million in the first phase of operations.

The operator’s asset team members identified a number of additional benefits to Landmark’s collaborative well planning solution. Finalizing a viable plan requires less technical labor and fewer iterations with directional drilling contractors. Field scouts spend less time investigating potential surface locations. Optimizing well spacing, azimuths, wellbore lengths, wells per pad, and pads per block reduces total land area and lowers the environmental footprint. Overall, they concluded, DecisionSpace Well Planning software technology can save hundreds of thousands to millions of dollars per project.

After years of incremental advances, collaborative well planning has become a true game-changing technology that serious operators are adopting all across the globe. To understand the full scope and richness of Landmark’s cross-domain workflow solutions, consider the key advancements we have made over the past decade.

The evolution of collaborative well planning
In the old days, geologists and geophysicists (G&G) would give well engineers or drilling contractors a set of target coordinates. Engineers would design an initial well path, and hand it back for G&G to check out in their subsurface models. Often, the original targets required well designs that were not technically or economically viable. Wells that made sense to geologists did not necessarily work for the drillers. Numerous iterations and compromises ensued. For a single complex well with multiple targets, it could take months to finalize a plan that met all the geological and engineering constraints.
Single well planning
The first step toward collaboration between the disciplines took place in the late 90s when Landmark got the idea to give G&G professionals a simple way of visualizing an initial wellbore plan in the earth model—before the hand off to engineering. Originally, the software did this for a single well at a time. Software developers borrowed a few algorithms from our COMPASS™ industry-leading directional drilling software, and offered geoscientists a handful of drilling parameters to play with. Using multiple applications and a shared OpenWorks® database, geoscientists would pick targets directly in our seismic interpretation software. Then the new Wellbore Planner™ software technology would automatically generate an initial well design, and visualize it using a common 3D viewer (Fig. 3). At that point, targets and initial parameters would be entered (sometimes by hand) into our high-end directional drilling applications—which ran on a different operating system—to perform rigorous path planning and engineering analysis. Drilling engineers would perform anti-collision and torque and drag analysis to ensure viability, optimize the wellbore trajectory, and export it back to the G&G environment for review and approval.

One of the first oil companies to adopt this early collaborative approach used it to keep pace with real-time, multi-lateral horizontal drilling operations in heavy oil fields of the Orinoco Belt in Venezuela. With Wellbore Planner, asset teams were able to prepare more than 20 directional plans in a single day, and a single sidetrack in just 1.5 hours—an enormous improvement over previous methods.

As other operators became aware about this revolutionary collaborative approach, Landmark developers began working closely with R&D groups in large oil companies such as Statoil to incorporate new capabilities, and further integrate the disciplines. Our early TracPlanner™ algorithms enabled cross-domain teams to sit down together, access target points directly from the G&G software, specify the surface location and allocate targets to an initial well plan using multiple automated planning methods (Fig. 4). New PrecisionTarget™ algorithms quantified the risks and probabilities of hitting targets as planned, given the geological, geophysical, and mechanical uncertainties. Data sharing and transfers between G&G and engineering applications were streamlined, minimizing human errors and shortening cycle times. Finally, track planning, target generation, and 3D visualization tools were seamlessly integrated in our unified...
DecisionSpace® platform, which was capable of accessing and viewing critical data from both the OpenWorks geoscience database and our Engineer’s Data Model (EDM™), the industry-leading drilling and engineering database.

An international oil company that implemented the new DecisionSpace Well Planning system in several real-time operations centers found that, in some cases, multidiscipline teams could reduce the well planning cycle by a factor of 100. A large operator drilling complicated wells with considerable uncertainties in the North Sea identified three top benefits of this radically new way of working: better well placement due to integration of the disciplines, reduced operational errors while drilling, and increased efficiency—that is, fewer people could do a lot more work.

Multi-well/field development planning

Remember that all of these innovations applied initially to collaborative planning of a single well at a time, however complex it might be. To this day, high-end directional drilling and engineering applications still handle only one well at a time. However, as operators began to see the value of collaboration, they wanted additional tools to optimize large-scale field developments involving many wells, pads and platforms.

To accomplish this, we integrated new AssetPlanner™ software technology into the existing collaborative well planning software. Sophisticated asset and field planning algorithms enabled automated, multi-well target generation, path planning, platform or pad placement, development scenario evaluation and field-level optimization—all within the context of the 3D subsurface and/or reservoir model (Fig. 5). Rather than settling for a few basic well plans, now asset teams could rapidly iterate through numerous, advanced scenarios until they found the optimum solution, while honoring all existing interpretations and infrastructure. They could estimate both time and costs associated with an individual well plan, selected field development scenarios, or an entire project.
One of the world’s largest oil companies field tested our enhanced collaborative asset planning software to evaluate early development alternatives in an offshore environment with a number of seabed and shallow drilling hazards. The goal was to select reservoir targets, identify viable drilling locations, create multiple well paths that met fracture pressure constraints, determine drilling costs based on an existing cost model, and present development concepts to partners as quickly as possible. Utilizing a wide variety of geotechnical data, a multi-domain team set up the model in two days, automatically generated development scenarios that met all their constraints within two hours, quality-controlled the results in another four hours, and presented targets, trajectories, drilling locations, and estimated costs to partners the very same day. As the team’s drilling engineer stated, “We did in one day what could have taken a month of cross-discipline iterations and data transfer.”

Not long after the introduction of Landmark’s collaborative multi-well/asset planning technology offshore, the explosion of shale gas opportunities drove operators to find new ways to unlock their potential through fast-paced, high-volume onshore drilling programs (Fig. 6). An independent operator of an unconventional U.S. play was one of the first to discover the benefits of DecisionSpace Well Planning software.

To effectively produce tight gas sands having limited drainage areas in the Piceance basin of western Colorado, the operator planned to drill hundreds or thousands of wells in some very rugged topography. Pad locations were limited due to terrain, wildlife populations and migration pathways, and other surface restrictions—roads, power lines, lakes, wetlands, towns and buildings. Planning huge numbers of safe, drillable well trajectories proved overwhelming. Long well planning cycles or miscalculations would have been extremely costly. Landmark’s new asset planning technology enabled the company’s geologists and engineers to quickly design and optimize large numbers of sustainable well plans from restricted surface locations. They were able to keep pace with aggressive rig schedules, minimizing cycle times while maximizing reservoir coverage, enhancing production, and reducing capital expenditures.

Since then, operators of unconventional shale plays and complex deepwater drilling programs have been enthusiastically embracing our collaborative well planning solutions—and demanding even more sophisticated capabilities.
Recent developments in DecisionSpace Well Planning Software

While most of the major components of Landmark’s unique cross-domain well planning solution have been in place for several years, the software and workflows continue to undergo significant refinements. Recently, we have incorporated whole new levels of integration, automation and optimization, new targeting capabilities, relief well planning options, and enhanced support for geosteering workflows.

Integration

DecisionSpace Well Planning software technology has long been able to access data from the subsurface model. However, in the past few years, we have seamlessly merged geology, geophysics, earth modeling, well planning, and hydraulic fracture stimulation software into a single E&P workflow environment based on a dynamic, shared framework model. The DecisionSpace 3D workspace is integrated at multiple levels. Not only can asset teams work collectively within a single multi-domain application to interpret G&G data and plan single wells, multi-laterals, or field-scale development scenarios, but they can access world-renowned information management solutions—OpenWorks®, EDM™, and now the Recall™ well log database. Integration with industry standard GIS technology (Fig. 7) enables teams to visualize and incorporate lease maps, topographic maps, cultural and bathymetry data to properly position well sites and pads while avoiding “no-go” zones, surface obstacles, and potential drilling hazards. For rigorous trajectory optimization, anti-collision, torque and drag and other critical analyses, well or field plans can be shared securely and seamlessly with our DecisionSpace Well Engineering high-end, industry standard engineering software.

**Figure 7.** Landmark’s collaborative well planning tools are integrated with industry standard ESRI GIS technology, streamlining the placement of platforms and pads using lease, topographic, culture and bathymetry data.
Automation and optimization
New patented algorithms enable asset teams to optimize field development plans based on user-specified cost parameters, risk and uncertainty, and degree of difficulty. Our advanced automation techniques allow team members to interactively shift a target, pad or platform location, and watch the well plan update in real time. If any user-defined design constraints are exceeded—such as dogleg severity, turn-drop rate or inclination—the trajectory will turn red. Enhanced flexibility enables engineers and geoscientists to rapidly incorporate local refinement into large-scale field plans, instead of forcing all wells to use the same parameters like some of our competitors. Localized optimization is proving especially critical in unconventional plays, for example, allowing teams to tweak the doglegs in a handful of wells or set pad locations only on slopes of less than, say, 10 degrees.

Targeting
By introducing new targeting capabilities we are making collaborative well planning technology even more valuable in tough drilling situations. While team members can still pick reservoir targets manually within the 3D model, the software can automatically generate targets in more ways than ever before. For example, autotargets can be based on favorable reservoir attributes. In complex faulted environments, targets and well trajectories can be automatically placed a specified distance behind an interpreted fault plane and specified distances from one another. For thin beds and horizontal wells in shale or steam-assisted gravity drainage (SAGD) operations, asset teams can define targets as a percentage of thickness using any two interpreted surfaces, including seismic horizons. Enhanced horizontal targeting capabilities designed specifically for unconventional resource plays now include an option to “fan” out the laterals (Fig. 8) to improve reservoir coverage wherever parallel orientations would not align well with lease boundaries. Targets can also be based on modeled field drainage or specific hydraulic fracture areas. In fields with many surface constraints, well planners can actually create sites, targets and horizontal trajectories in a single click.

Relief well planning
U.S. regulations now require operators filing for deepwater permits to submit at least two relief well plans. Similar requirements are likely to be adopted elsewhere in the world. As a result, Landmark has introduced unique new manual and automated relief well planning options into our collaborative well planning technology.
planning software. Obviously, no one can know in advance exactly where a relief well may need to kill an existing wellbore. Historically, some operators had no formal relief well plan, requiring them to scramble in the event of a blowout. Coming up with a viable plan from scratch could take a full day or two, losing precious time and increasing potential health, safety and environmental liabilities. Other operators would generate an excessive number of intercept plans in advance for every casing section down to total depth (TD), requiring overly expensive and unnecessary work up front.

Landmark is the first technology developer in the industry to integrate automated relief well planning tools (Fig. 9), further streamlining this increasingly critical process. Selecting one of three different intercept methods—simple, oriented, or parallel track—and establishing a range of boundary conditions and parameters, now geoscientists and drilling engineers can rapidly create a technically feasible plan, ready to tweak on-the-fly, if it ever becomes necessary. During pilot testing with a major oil company in the Gulf of Mexico, asset teams successfully designed final relief well plans in as little as 30 minutes. As a result, the operator plans to standardize its relief well planning activities on Landmark’s powerful new solution.

**Geosteering workflows**

In addition to well and field planning, our multi-domain collaborative technology also supports geosteering workflows within the DecisionSpace environment. During real-time operations, horizontal well correlation technology enables geoscientists to pinpoint the current stratigraphic position of the bit, while a look-ahead well plan indicates where the wellbore will go if it proceeds along the current trajectory. “Automated workflow re-execution” or dynamic updating ensures that any change made to any interpreted surface in the existing 3D model—say, repicking a top or adding a new data point while geosteering—instantly revises every associated surface, while honoring all the hard data. Thus, each new logging-while-drilling correlation automatically shifts the top and base of the target reservoir accordingly. Targets that are now too high or low can be fine-tuned simply by moving them onscreen. DecisionSpace Well Planning immediately projects an updated look-ahead well path to the optimal target location ahead of the bit (Fig. 10). Alternatively, the team can establish a set distance between the well path and any reference surface, such as the top of the reservoir.
Whenever new data points modify the structural interpretation, our Dynamic Frameworks to Fill® software automatically revises the 3D model, the targets, and the look-ahead well plan to maintain the proper distance—without any manual intervention whatsoever. As such, operators can stay in the sweet spot all the way to total depth.

Innovative cross-discipline workflows
Landmark’s innovative cross-discipline workflows have come a long way from the simple display of a well path in the 3D earth model. Collaborative well planning is now an integral part of the DecisionSpace unified E&P environment. Seamlessly integrated at both the database and application levels, DecisionSpace Well Planning software technology is critical to success in today’s unconventional plays, complex offshore wells, and fast-paced drilling campaigns worldwide. Large and small energy companies are reaping a range of benefits—from dramatically accelerating well planning cycle times, to more efficient teamwork, better well and field development plans, lower costs and environmental impact.

As an early DecisionSpace workflow adopter in the North Sea summarized it: “As a rule of thumb, if increasing efficiency saves hundreds of thousands of dollars, then reducing operational errors could save millions, and getting more production from better well placement may be worth tens of millions.”

References
[1] “Talisman Energy adopts multidiscipline well planning technology, reducing cycle times by up to 80%,” A Landmark Software & Services Case Study (2012).