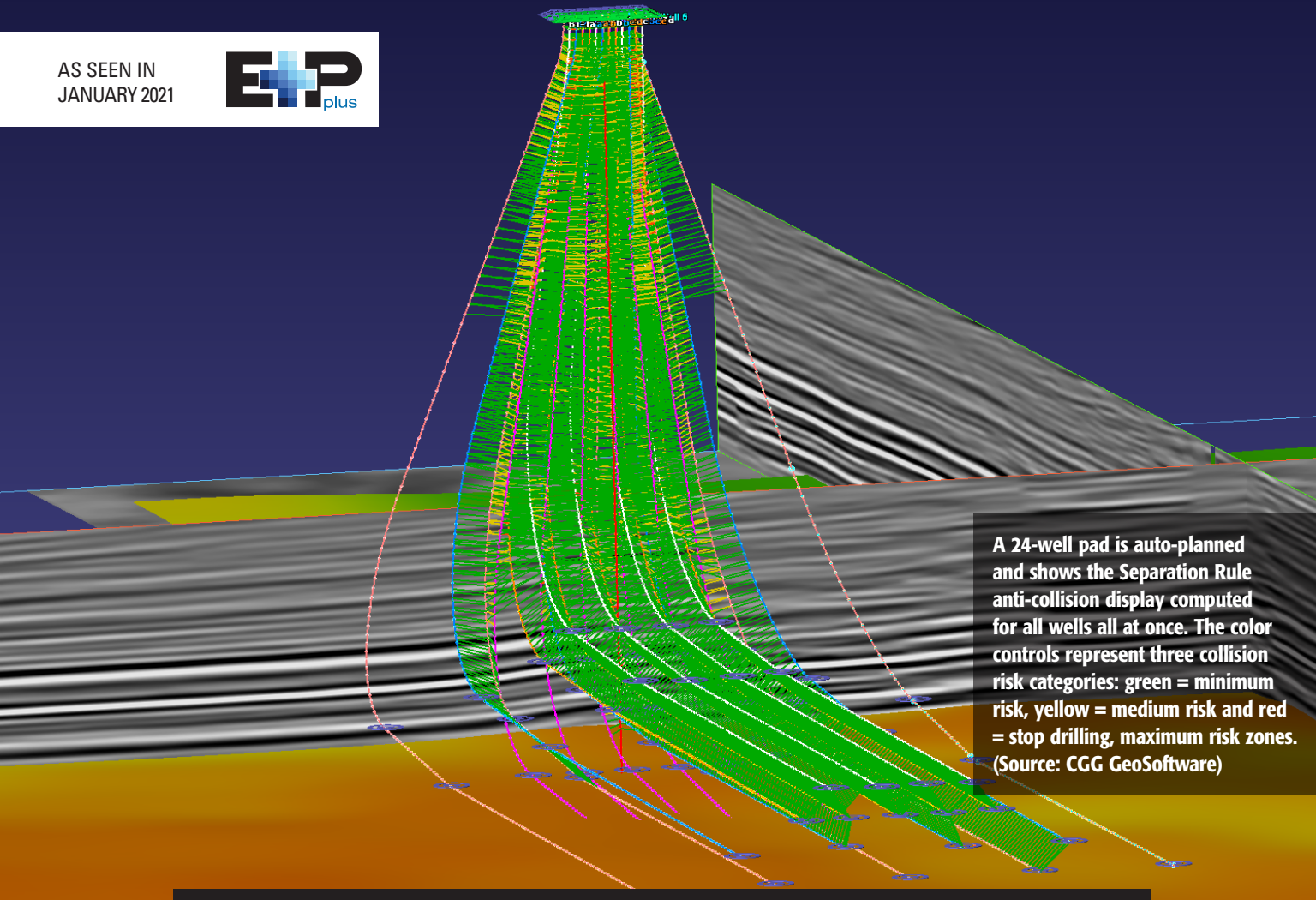


A 24-well pad is auto-planned and shows the Separation Rule anti-collision display computed for all wells all at once. The color controls represent three collision risk categories: green = minimum risk, yellow = medium risk and red = stop drilling, maximum risk zones. (Source: CGG GeoSoftware)

Providing crucial data visibility

New software integrates engineering planning with geoscience data for optimal well path designs.

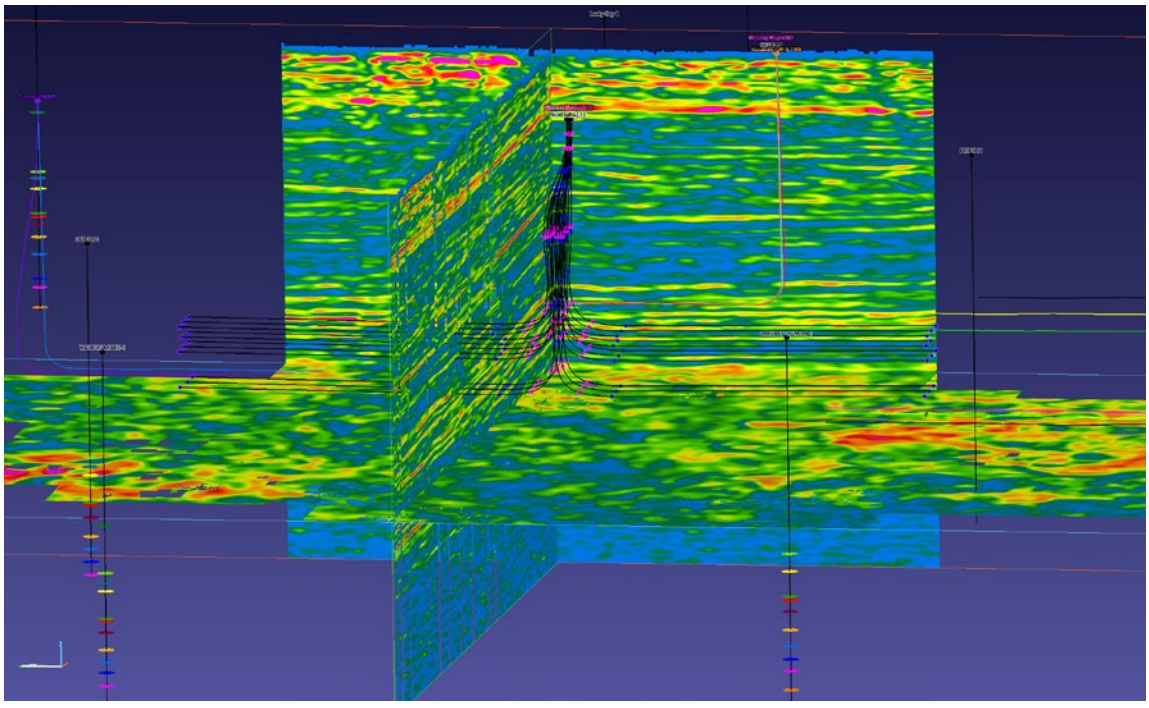
***Joe Dominguez**, CGG GeoSoftware*

Expert knowledge resides in individuals, but data belong to everyone. The petroleum industry is adopting a more integrated team approach to well planning and drilling, with software technology bringing engineering and geoscience closer together for better well trajectory designs. The ability to integrate all available geological and geophysical (G&G) data and related interpretations, and also identify the locations and paths of planned and existing wells, optimizes well planning in unconventional and fractured reservoirs.

A collaborative team of technical experts with access to all relevant data can provide benefits in terms of safety, efficiency and delivery cycle times, and help maximize the project's return on investment. Software advances that support the integration of engineering planning and geoscience data will assist these new collaborative teams to function effectively.

Well path planning technology

Part of the CGG GeoSoftware portfolio, InsightEarth's new interactive 3D



A 24-well pad with automated planned trajectories uses a reservoir characterization volume to plan the landing zones at multiple levels. Automated tools reduce planning cycle time to manage demanding rig schedules. (Source: CGG GeoSoftware)

well path planning solution, WellPath, combines G&G data and interpretation results with engineering planning tools. These tools include well trajectory planning and editing, semi-automated path planning, the latest collision avoidance technology, and reporting and plotting features for company archives. This software environment enables planning and optimization of individual well paths, multi-slot platforms, multi-well pads and development projects. At the same time, it helps minimize wellbore collision risks and maximize potential performance of the overall development plan.

Many current operators use a workflow siloed into various technology domains. Experts within each silo solve specific challenges only within their area of expertise and then pass along their solution to the next team. Integrating these technical experts into collaborative teams in which they can share and access information and discuss corporate data implications will produce the best well plan design. The desired outcome is that the planned trajectory is safe, drillable and traverses the subsurface targets to maximize contact with the reservoir.

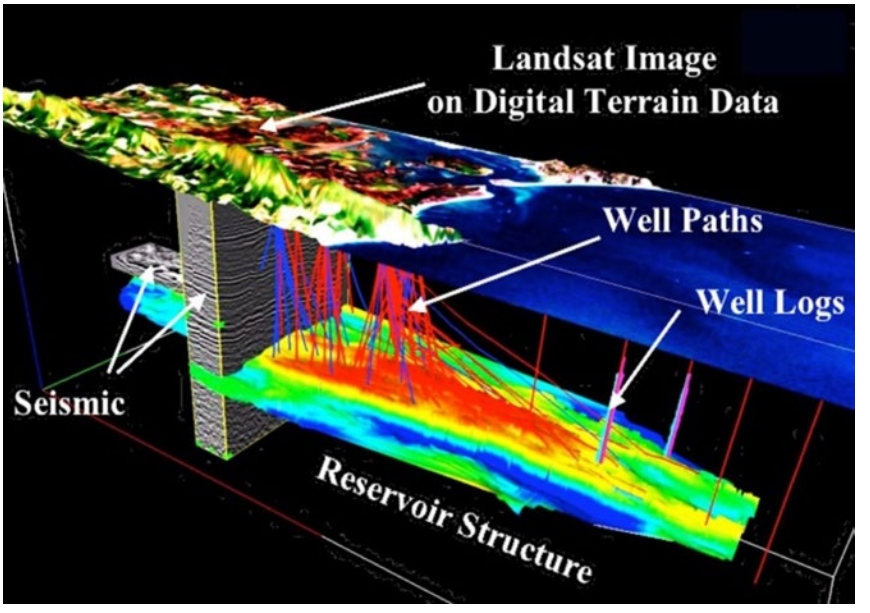
In shale plays, use of reservoir characterization data to change well spacing and alter fracture stimulation stage designs helps mitigate wellbore interference and hits to nearby producing wells. Furthermore, collaboration and access to all salient data enable planners to consistently deliver plans that are drillable. They traverse subsurface targets while managing tortuosity in the plan and thus reduce stuck-pipe zones in the planned trajectory.

The complexity of large multiwell onshore pads and offshore platforms makes it challenging to reserve space for future planned wells. An integrated software environment is conducive to successful drilling efforts that prove up additional reservoir space. Geoscience data, such as reservoir facies and geomechanical property volumes, reveal the subsurface drilling environment's complexity in 3D, including the probable reservoir extents, so drillers can plan for future wells on high-density, multilateral pads and multi-slot offshore platforms.

Interactive directional well path planning that simultaneously adheres to engineering design and geological constraints improves efficiency, optimizes well paths and minimizes wellbore collision risk.

Anti-collision

New software technology improves anti-collision calculation accuracy and implements the latest SPE-recommended Separation Rule for collision avoidance calculations, which is a safety-critical aspect of the integrated platform. Among collision analysis software features is access to graphical representations of positional uncertainty, such as ellipses of uncertainty, a minimum of three anti-collision risk categories, and various plots to analyze



The integration of all geoscience data and well planning tools optimizes well path designs. (Source: CGG GeoSoftware)

collision risks and how this danger may change along the planned trajectory. A 3D display and a ladder plot show the anti-collision calculations graphically as green, yellow and red lines between the reference well and any offset wells, and the separation factor report captures collision risks in numerical detail.

By having the planning and collision avoidance views linked to a 3D viewer with a clear color-coded system to highlight potential collision risks, the team can quickly focus on those safety risk areas and wells. The team and planner can then work to minimize any collision risk in crowded project areas and ensure that the planned well is safe and drillable while still meeting project objectives.

Planning methods

When well paths are modified to resolve collision risks, reservoir facies volumes and interpretation data provide important information that can help planners ensure the planned path stays in the intended reservoir while the plan is being adjusted. Working with geoscience data, it is also possible to represent the reservoir presence uncertainty by setting a target diameter or size. Providing subsurface uncertainty allows flexibility while planners make needed adjustments to a planned well trajectory.

This unified platform offers planners the ability to view and work with volumes of predicted pore pressure and fracture gradient, which helps to delineate no-drill zones and provides valuable information for the casing plan and mud program. When a 3D attribute volume is loaded into a well planning project, inline, cross-line and depth slice views of the volume can be used to place subsurface targets in 3D space. Other surfaces, such as structure maps, fault surfaces and geo-bodies, can be used for setting targets or delineating no-drill zones. This critical information-sharing within an integrated environment enables engineers to plan and adjust well paths to intersect reservoir subsurface targets while adhering to engineering design and safety constraints.

Automated planning methods allow collaborative teams to consider possible design changes to achieve greater cost savings without sacrificing reservoir or safety objectives. Engineers can quickly create a well path plan using at least one surface location and one or more targets. Once targets are connected to a chosen surface location, section curve types are automatically selected to build a well path. Well planners may find it useful to evaluate multiple surface locations and target combinations to determine which trajectory best satisfies the planned path objectives.

When target information and slot locations are available for multiple wells on a pad or platform, integrated software can save well planners considerable time. Rather than building each individual well path one at a time, the automated planner feature will create the well paths for a large number of wells all at once. Editing and adjusting the plans generally takes much less time than building them one at a time. Automation tools such as quick-planning all wells all at once for an entire large pad or platform yields efficiencies and reduced cycle time.

Conclusion

Well planning and drilling, under the best of circumstances, are technically demanding disciplines. Engineers need the best available tools that provide crucial visibility to all data. New technology brings together all the well planning tools with available geoscience data in an easy-to-use and highly effective software that enables useful reporting for quick decisions. Shorter planning cycle time helps planners and drillers meet demanding rig schedules.

A collaborative team of experts, supported with the latest software technology and access to all available engineering and geoscience data, can simultaneously work toward safety and efficiency in the well planning process. This integrated team workflow will reduce cycle time, produce the best trajectory designs, and drive the project to minimize costs and maximize the return on investments. +