Performance goals, communication aid well plan

PLANNING HAS ALWAYS been critical to a successful drilling operation. As well paths become more complex and cost pressures increase, well planning and operational support become ever more important.

A session at the 2001 SPE/IADC Drilling Conference explores new planning and support tools and details experience. The session is to be chaired by **T Marszalek**, **Schlumberger Oilfield Services** and **D Heenan**, **Tesco Drilling Technology**.

NEW SIMULATOR

In the mid 1990s, four major oil companies formed a consortium to work on opportunities to advance upstream technology to mutual advantage.

One opportunity that was identified was to develop a drilling simulator which would support an integrated and automated approach to well planning.

The project began in 1998 with a feasibility study and entered a second phase in 1999 with the development of a working prototype of the simulator.

SPE/IADC paper 67816, "Meeting Future Drilling Planning and Decision Support Requirements: A New Drilling Simulator," describes the outcome of this work.

The paper was prepared for the Conference by **I D R Bradford**, **Schlumberger Cambridge Research**; **J Booth**, **ExxonMobil Upstream Technical Computing**; **J M Cook**, Schlumberger Cambridge Research; **J D Dowell**, **Texaco**; **G Ritchie**, **Schlumberger GeoQuest**; and **I Tuddenham**, Schlumberger Cambridge Research.

The new drilling simulator models the drilling process from well planning through real time optimization to post-well analysis. The new framework combines previously stand-alone aspects of drilling planning and decision support, enables rapid scenario planning and generation of a technically sound and cost effective drilling program.

Specifically, according to the authors, the simulator:

- Automates well planning with a user-friendly interface;
- Allows updating of the plan with data acquired during drilling;
- Uses data taken from a 3D shared earth model;
- Runs quickly on a high-end PC;
- Incorporates aspects of a recently developed real time wellbore stability process;
- Incorporates a rate of penetration prediction and optimization module, developed independently as part of the simulator.

The simulator extensively uses 3D visualization and carries out the complex calculations required for well planning with minimal user intervention.

The user selects and displays an earth model containing geological and other data for the formations to be drilled, a trajectory and a set of drill strings. The simulator can then calculate a default well plan that is translated into a time/depth curve and an approximate cost for the well.

Users can change the default plan at any stage according to preferences or to suit local operational conditions.

The entire process takes about two minutes for a 5,000-m well, according to the authors. This allows for the examination of many different approaches without data reentry.

During drilling, new data are acquired which may conflict with the planning data. The simulator allows easy updating of the data underlying the well plan and rapid revision of the well plan to ensure the well is drilled in the most cost effective way. The user can display views of the predicted state of the well and of the real time data corresponding to the actual state of the well so he can easily spot and correct conflicts.

NEW APPROACH CUTS COSTS

The Ketch field is a carboniferous gas field located in block 44/28 in the Southern North Sea. The reservoir section consists of unstable fluvial sand bodies inter-bedded with shales and coals.

The reservoir is overlain by a thick Zechstein evaporate and carbonate sequence. This presents drilling challenges due to significant well control problems ranging from kicks of brines, methane and H_2S to total losses.

In SPE/IADC paper 67817, "Delivering Exceptional Performance in Ketch Field," **J Kohnert**, **Shell UK Exploration and Production**, details how a new approach saved significant time and money on the project.

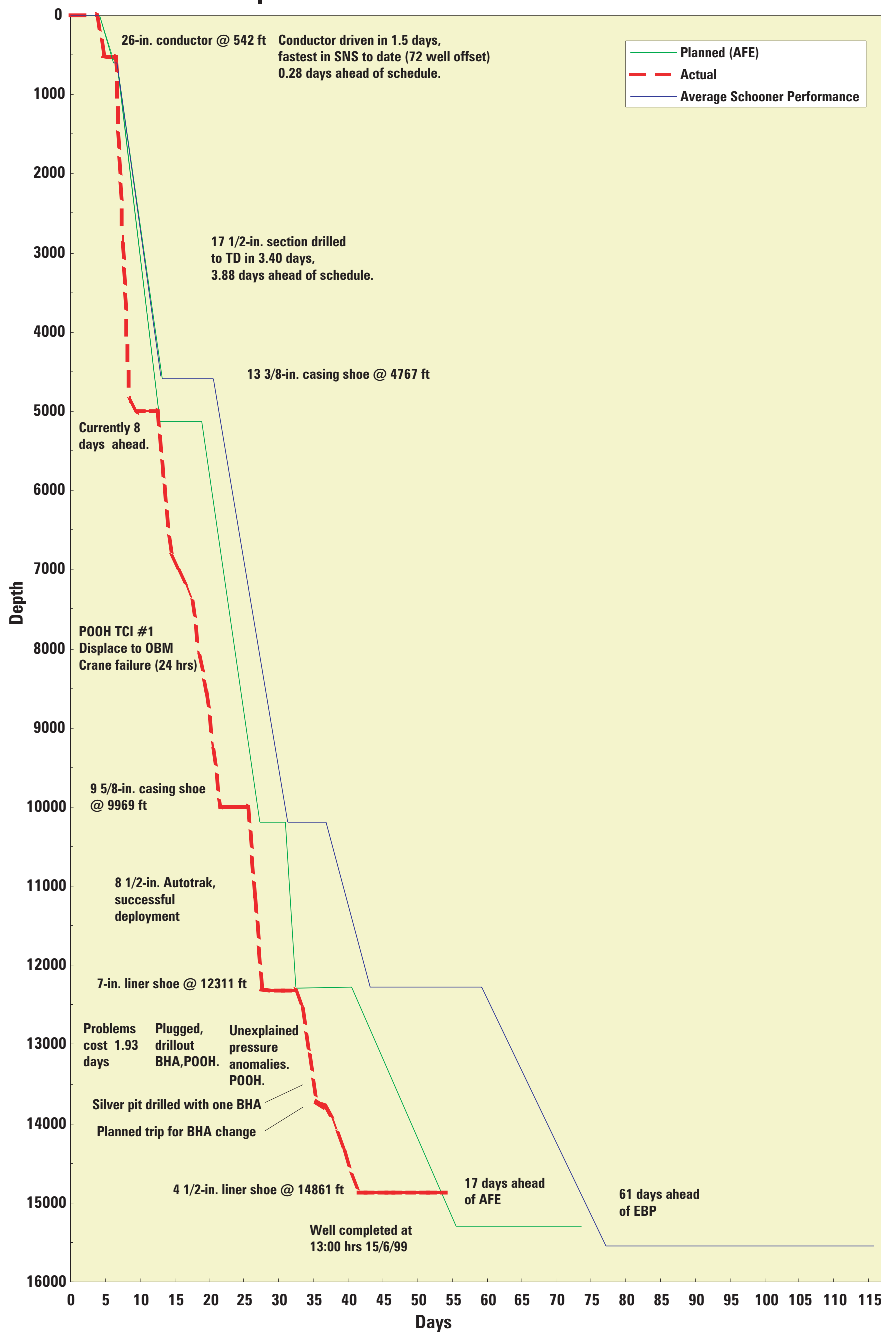
The Ketch project involved four wells drilled by Shell in the northern North Sea from the jackup rig Maersk Enhancer.

The Ketch project required four wells, jackup drilled from a normally unmanned installation. Total budget based on historical, normalized cost data, was 445 days and £48.4 million.

To drill the wells efficiently, the well design and execution were conducted in a manner consistent with Shell's Deliver the Limit philosophy. Delivering the Limit has three main components:

- Calculating and identifying the Technical Limit Time for each well phase to establish the Theoretical Maximum Performance for the team;
- Education of all team members to focus on and challenge all well delivery targets;

KA01 technical limit performance curve



• Execution monitoring and evolution of improvements including new technology to close the gap between current reality and the Technical Limit.

Two-day team building courses were attended by all team members to break down perceived barriers and encourage challenge. An enabling tool used by the team was Performance Improvement Plans (PIPs). The PIP system enabled all team members, from management to roustabouts, to propose ideas to improve operational efficiency. A small reward was paid for all adopted PIPS.

In the execution phase of the project, all non-value-adding operations were eliminated. The remaining operational steps were fully scrutinized and optimized. A drill crew incentive scheme was introduced to reward well budget beating performance.

This new way of working delivered all four Ketch wells with resultant savings of 176 days and £14.2 million against project budget.

HOLE QUALITY

It is often thought that low hole tortuosity is desirable because it means low torque; high tortuosity is therefore undesirable.

In SPE/IADC paper 67818, “Tortuosity Versus Micro-Tortuosity—Why Little Things Mean a Lot,” the authors analyze this belief and offer support for their conclusions.

Authors of this paper, prepared for the Conference, are **T M Gaynor**, **D C-K Chen** and **D Stuart**, **Sperry-Sun Drilling Services**.

The authors note that several types of drilling tools are promoted primarily as a means of achieving reduced hole tortuosity as measured by survey data, with a view to reducing torque and drag.

Obvious examples are adjustable gauge stabilizers and adjustable gauge motors, and more recently, closed loop rotary steerable systems. In parallel, it is commonly suggested that bent-housing steerable motors increase tortuosity as measured by survey data by mixing high dogleg sliding footage and low dogleg rotating footage.

In brief, low tortuosity equals low torque equals “good;” high tortuosity equals high torque equals “bad.”

Recent evidence suggests that any torque and drag benefits derived from reducing tortuosity as measured by survey data (macro-tortuosity) are likely to be swamped by the torque and drag generated by poor wellbore quality (micro-tortuosity).

In the last two years, according to the authors, over 100 wellbore sections have been drilled using long gauge bits primarily in pursuit of drilling improvements broadly encompassed by the term “hole quality.” Most of these bits have been run on steerable motors; some, on rotary steerable systems.

Modeling, measuring, and comparing torque and drag values for sections drilled with long gauge bits and with short gauge bits immediately showed two things.

First, there is no dramatic difference between the values for steerable motors versus rotary steerables when both use similar bits. Second, there is a noticeable difference between torque and drag values for long gauge bit runs versus short gauge bit runs regardless of the method used to drive them.

There is also a corresponding improvement in activities that might be expected to benefit from improved hole quality—reduced micro-tortuosity—such as hole cleaning, logging operations, resultant log quality, casing runs, and cementing operations.

Quantifying these differences by "back-calculating" the friction factors commonly used in torque and drag models shows a general trend. The friction factors that give accurate results for long gauge bits are much lower than the values necessary for obtaining accurate results when using short gauge bits.

Coupled with the observable field results, this suggests that attention to hole quality is likely to have a far greater effect on well design limits, particularly in extended reach drilling, than will minute attention to matching directional survey results to the ideal well proposal.

TECHNICAL LIMIT

The Technical Limit is a current in-vogue process by which the time taken to drill wells, and hence the cost, is believed to be minimized.

In SPE/IADC paper 67819, "The Technical Limit—Illusion and Reality," prepared for the conference by **E W Marshall**, **Equinox Project Management Ltd**, however, the author states that this is only a partial solution. By emphasizing this to the exclusion of everything else, well costs are not being optimized and may even be increased.

The construction of a well depends on a foundation of seven "pillars" only one of which, the well design, is impacted by the technical limit.

The other six—logistics, procurement, tendering and contracting, finance and administration, quality management and verification and HSE—are outside the technical limit process.

In this paper, the authors show that it is the effective preparation of this foundation that adds the greatest value to the well construction process, not the application of the technical limit. Moreover, well costs are made up of three compoents: time-dependent costs, time-independent costs and fixed costs.

By definition, concentrating on the technical limit to push the time/depth curve to the left can only have an impact on the time-dependent costs. It has no impact on the fixed costs and only minimal impact on the time-independent costs.

Given that on many wells, time dependent costs can be less than 50% of the total costs, at least 50% of the well cost is not affected by this process.

Only by addressing the fundamentals of how we design, plan and execute well construction as a project can we hope to really impact well costs and well value, according to the authors.

The authors accept the reality of the technical limit as a partial solution to optimizing well costs. But they also demonstrate the illusion that this is the entire solution.

BIG BORE WELLS

Big bore wells ($9^5/_8$-in. production tubing or greater) were spudded in Quarter 3, 2000 on the Woodside North Rankin A gas/condensate production platform located some 135 km from the Northwestern coast of Australia. These wells were drilled into the Perseus reservoir.

In SPE/IADC paper 67820, "Planning and Execution of Big Bore Wells Off-

Modern drilling rig was used to drill big bore wells for Woodside Energy off Australia.

shore NW Australia," the planning process and the drilling operation are described by authors **S P Dolan**, **G J Williams** and **R J Crabtree**, **Woodside Energy**.

Larger tubing was used as production from the highly permeable reservoirs is tubing-constrained with conventionally sized tubulars ($7^5/_8$ in.).

Woodside has been planning big bore wells since 1997 with varying levels of intensity through the front end engineering phase of the project management process.

KNOWLEDGE MANAGEMENT

In SPE/IADC paper 67821, "Managing Drilling Knowledge for Improved Efficiency and Reduced Operational Risk," authors **S Bargach**, **C A Martin** and **R G Smith**, **Schlumberger**, describe an approach to knowledge management for drilling services.

In this dynamic and demanding environment, it is imperative that a drilling services organization improve its knowledge management—the ability to capture, share, and apply worldwide expertise—to consistently supply the best drilling solutions and practices.

When Schlumberger started a knowledge management pilot project in early 1999, the initial focus was to build a Knowledge Hub—a web portal for drilling personnel.

Key sections are devoted to best practices and lessons learned. Practices are submitted by field engineers, validated by experts, captured in the knowledge base and pushed to field crews for use worldwide.

Today the ability to use in one part of the world what we have discovered in another is made possible by information technology tools and techniques.