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INCREASING WELL DELIVERY EFFICIENCY

Through Enhanced Scheduling

actenum

CONTENTS

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01: EXECUTIVE SUMMARY

*"**Well delivery scheduling**" is the process of scheduling the resources and activities related to delivering producing wells to an organization. It includes not only drilling, but also permitting, pad and facility construction, frac/completion, and POL activities.*

> ***Effective well delivery scheduling yields substantial economic benefits***

For operators, well delivery scheduling is a complex and critical process, with substantial economic impact. Done well, it maximizes the efficient use of costly resources such as rigs, warns of operational risks (such as offset well violations or continuous drilling provision problems), improves organizational responsiveness to operational or business changes, and yields substantial economic benefits. Done poorly, the consequences can be severe: deferred production, cycle time delays, and increased costs are among the possible outcomes.

Despite its importance—and surprisingly, in view of its complexity—well delivery scheduling is often done manually using unsophisticated software tools. Consequently the scheduler has to make all decisions about how to assemble and manage a schedule on an ongoing basis. This places limitations on the process itself, and its results:

- It's difficult, time-consuming, and error-prone;
- It's not effective because of frequent changes in the operational environment as a result of planned or unplanned events;
- It doesn't provide any objective measure of schedule quality;
- Reporting that would provide key insights into operations efficiency and risks is non-existent;
- It doesn't support effective collaboration; and
- Key aspects of the process are in somebody's head.

Actenum scheduling software: designed for operators and complex operations

> ***Actenum software incorporates capabilities for optimization, analytics, and collaboration to maximize efficiency and shorten cycle times***

Actenum Corporation's **DSO/Upstream** and **DSO/CX** software tools overcome the limitations of manual scheduling, and yield tangible benefits. With capabilities that include integrated optimization and comprehensive scheduling logic, a robust well-based data model, and team-wide schedule visualization and analytics, these tools enable operators to maximize project collaboration and efficiency, shorten cycle times, reduce risk, and achieve predictable and reliable production.

Operators around the world are using Actenum Corporation's software to empower their users to ask and answer questions about how best to structure well delivery projects, to share their insights and suggestions for improvements with each other, and to ensure that all schedule-related data is accurate and consistent, so that reliable decisions result.

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02: INTRODUCTION

*"**Well delivery scheduling**" refers to the assignment of rigs and other equipment to all of the activities related to delivering a producing well in an operating organization, and sequencing those activities in a way that not only satisfies sequencing and timing constraints, but that also meets the organization's business objectives. For example, a well delivery schedule might include the following requirements: Rig A (a resource) is assigned to drill Well 312 (an activity) at Pad C (a location constraint) for a two month period (a timing constraint), but must be moved to drill Well 688 by November 7 (a sequencing constraint with a timing constraint). At the same time, the operator will probably also be scheduling construction and facility-related activities, and will want to ensure that frac/completions and putting wells online are done in a timely way.*

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Scheduling a well delivery project with more than a handful of rigs and wells is a demanding process:

1. Making appropriate decisions about how to assemble and manage the schedule is complex because of the number of possible alternatives at any given point. As activities and resources are added to a schedule, the number of sequencing/timing constraints to be satisfied increases exponentially. For example, while scheduling 2 drilling rigs over 25 wells is reasonably straightforward, as additional rigs, wells, and other well delivery activities are incorporated--together with important milestones (for example, “AFE approval”, “Permit approval”, and “Release to drill”)--the process becomes difficult to manage well.

2. Well delivery scheduling operates in an inherently dynamic environment. Any given schedule will only be valid for a short period. Circumstances change because of planned and unplanned events, and rescheduling has to be done. In the rig example outlined earlier, consider what happens if Rig A encounters more complex geology than expected at Well 312, and must be assigned there for an additional two weeks. The well delivery schedule immediately has to be modified in light of answers to questions such as:

    - If Rig A remains at Well 312 past November 7, where should it then be sent?
    - Is there an available rig that should be assigned to Well 688 to meet the November 7 date?
    - If the Well 688 drilling activity has to be moved to a later time, what’s the risk of causing an offset violation with another well?
    - What are the possible consequences if Rig A has to remain at Well 312 for even longer?
    - Will there be enough water available to frac Well 312 when drilling is finished?

3. Besides the need to reschedule on an ongoing basis, there’s also a requirement to do so quickly. Schedule updates must be prepared rapidly to allow for effective response and recovery from operational disruptions. This puts scheduling staff under additional pressure, as well as intense scrutiny from operations management.

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Commonly-used scheduling software doesn't effectively support well delivery

The software tools most widely-used by operators for well delivery scheduling are Microsoft Excel and Microsoft Project. There are also some simplistic "rig scheduling" applications available on the market.

The use of Microsoft Excel is understandable (it enables rapid import and display of data in a tabular form, and may be used to create and publish a simple Gantt chart), but it's also surprising since it provides no real support whatsoever for making effective decisions about how to schedule. It also has no capabilities for easily examining and improving efficiency in the well delivery lifecycle.

Microsoft Project provides interfaces to a calendar, and to catalogs of activities (all the work that needs to be done), and the resources (people, equipment, and services) needed to complete the various activities. The user interface provides a variety of ways to interact with these catalogs, and to sequence activity and resource assignments in various ways to build a schedule. But the scheduler makes all the decisions--about what to do in any given situation--manually. And, since Microsoft Project is a general-purpose tool, there is no support for well delivery scheduling, where using lease, production, and location information, working with multi-well pads, assessing the risk of offset well violations, and optimizing a schedule to meet a business objective are critical.

> ***Effective scheduling must take lease obligations, off-set wells, cycle times, and production curves into account***

Most "rig scheduling" software tools that are available are simplistic, difficult to use, don't take operator-specific needs into account, and provide poor support for handling location information, offset well violation warnings, and optimization. Integration with other applications which provide data to the schedule is sometimes limited. These tools are often considered to be nothing more than electronic whiteboards.

With the limited support for scheduling available in the most often-used tools, it's reasonable to ask how effectively well delivery scheduling is being done by most operators. The answer is that they are getting the job done, but they are doing it manually, with ineffective tools, and consequently they are probably doing it poorly.

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03: THE LIMITATIONS OF MANUAL SCHEDULING

Using one of the general-purpose scheduling tools, or simplistic "rig scheduling" software that's currently available, requires the scheduler to make all of the decisions about how to assemble a schedule and manage it on an ongoing basis, in terms of matching activities and resources and satisfying constraints and preferences. This reliance on a manual process has fundamental limitations.

Difficult, time-consuming, and error-prone

It is extremely difficult to cope with the large number of possible ways in which activities may be combined, and to avoid undesirable situations such as offset well violations or lease expiration penalties. Preparing a well delivery schedule for more than a few rigs and wells can take several weeks of effort, and ongoing schedule management is laborious. Often the scheduler spends most of the work day wrestling with how best to incorporate schedule updates using the tools available, instead of taking on a more "value add" role that provides reliable insight to other team members and management about how the schedule addresses organizational objectives. Deferred production and increased costs can result if the schedule is not absolutely bulletproof.

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Not effective in disrupted operational environments

When planned or unplanned changes occur rescheduling must be done rapidly to get operations back on track. Yet balancing time pressures against the need for confidence in the reworked schedule can almost deadlock the process: the faster that schedule changes must be done manually, the lower their reliability. The higher the need for reliability, the longer it will take to reschedule.

No objective measures of schedule quality and efficiency

Once a schedule is put together, it's usually the only one used (for the reasons explained above). There's no easy way of knowing whether it will meet cost and production targets, make the most efficient use of resources, lead to offset well violations, or whether there's another, more appropriate schedule, because there is no tight linkage of the schedule to key metrics. Alternatives can't be easily compared to one another and ranked to determine the best. While calculations may be done to ensure that a schedule version meets certain objectives (such as cost), the schedule selected for use is usually chosen by intuition and "gut feel". And when this schedule is put into operational use, it's very difficult to determine where efficiency improvements may be made.

No support for true collaboration

A manual approach to scheduling is not suited to teamwork, nor does it allow for much input from the multiple stakeholder groups involved in well operations. Usually one group is given responsibility for preparing a schedule, and that schedule is then followed by the other groups. This may bias any such schedule in favour of the responsible group's goals, rather than those of the organization as a whole. Effective collaboration is limited because questions that arise in discussion (for example, "What impact will adding these 2 wells into the schedule for next year have on costs and expected production?" or "If we restrict these 2 rigs to only drill in a certain area how will that impact costs?" can't easily be answered without a good deal of manual calculation.

The process is in somebody's head

The detailed knowledge of how to prepare the schedule resides with the scheduling staff. This exposes the organization to the possibility of losing that scheduling knowledge if staff change roles or jobs, re-tire, take vacation, suffer ill-health, or are otherwise unavailable.

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04: ACTENUM DSO SOFTWARE: NEXT-GENERATION SCHEDULING FOR WELL DELIVERY

Actenum Corporation has done much work over the past decade, in conjunction with leading operators around the world, to address the limitations of manual methods of well delivery scheduling.

Rather than placing the scheduling burden solely on the user, Actenum **DSO/Upstream** automates the scheduling process, provides user control over the results, gives the user all information needed to make intelligent and informed decisions about what to do at any given point, and incorporate advances in optimization technology that yield tangible benefits to operators.

DSO/Upstream works in conjunction with **DSO/CX**, which is Actenum's web-based schedule visualization and reporting tool. **DSO/CX** provides access to published well delivery schedules and associated data for all team members, from any Internet-enabled device, and incorporates Gantt chart and tabular views of schedule information, as well as the ability to view scheduled activities on a map.

Both **DSO/Upstream** and **DSO/CX** ease the burden of ongoing schedule management, and result in more reliable and more effective well delivery schedules that directly address organizational objectives.

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Automated, interactive scheduling

Harnessing the power of advanced optimization software and sophisticated scheduling logic automation in the scheduling process provides for accelerated schedule creation and management. **DSO/Upstream** performs the "heavy-lifting" of initial schedule creation—searching the set of activities, resources, sequencing/timing combinations, and preferences/ policy requirements—rapidly and efficiently, to assemble a schedule in far less time than required using a manual approach. What might take days or weeks to complete manually is done with **DSO/Upstream** in minutes. Ongoing schedule management is greatly simplified through the use of automatic scheduling logic.

At the same time, to enable complete user control over a schedule, **DSO/Upstream** provides an interactive capability so that user expertise and judgment may be used to adjust and adapt any schedule to accommodate organizational preferences. In a typical scheduling situation, a scheduler will use **DSO/Upstream** to generate a "first cut" solution automatically, and will then manually manipulate this solution to incorporate preferences and to determine their impact. Or the scheduler will lock the schedule for a specific time horizon (such as "Up to 180 days from today") and use the optimizer to rearrange the sequence of activities outside the locked time horizon to meet a specific objective.

Disruption management

DSO/Upstream is designed to deal with real-world operational changes (when the weather doesn't cooperate, a vital piece of equipment breaks down, or changes to business strategy dictate changes to the schedule). Schedules can be updated in real time—at the speed of business—rather than on a manual basis, much more slowly. This provides a smooth, rapid, and reliable mechanism for coping with disruptions, and reduces the possibility of putting profits at risk as operational circumstances change.

Linkage to key metrics

By linking a schedule to user-defined key metrics, **DSO/Upstream** not only assembles a reliable schedule quickly, but also provides insight into how changes to that schedule will impact costs, production goals, resource use, and risk. This allows a scheduler to create multiple schedule scenarios, which can be compared and analyzed from multiple perspectives, to determine the optimal solution.

DSO/Upstream also provides the capability to generate "what if?" scenarios, that may be used to assess the relative benefits of changes in the operational environment, such as using additional equipment, reducing project budgets, and altering production targets.

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Enhanced reporting and collaboration

The use of **DSO/Upstream** centralizes all schedule-related data in a single database, rather than distributed across collections of spread-sheets and other data sources that may not be trustworthy. With its powerful expression language and reporting capabilities, the software provides timely insights into the efficiency of well delivery operations that are very difficult to obtain by other means.

DSO/CX extends the capabilities of **DSO/Upstream** by providing a web-based platform that supports collaboration among all team members who depend on accurate and timely schedule information and analytics to carry out their work effectively. Any authorized user is able to easily access up-to-date schedules for every well delivery function in real time, create and save reports and report templates, and analyze data from any perspective, so that the quality of decision-making is greatly improved throughout the well delivery organization.

Integrated scheduling logic

DSO/Upstream incorporates sophisticated scheduling logic that greatly simplifies ongoing schedule management. For example, by defining an appropriate set of activity types (for example, “Build pad”, “Spud well”, “Drill lateral”, “Frac well”, and “POL”), linking them in the correct order, and defining the timing constraints between them (“Frac well must be started between 15 and 45 days after Drill lateral has finished”) it’s very easy to insert the development of a new pad into a schedule in one step, with no need to worry about where on the schedule timeline the individual activities for that pad fall.

Integration with other applications

DSO/Upstream may be easily integrated with other applications that either supply data needed for well delivery scheduling, or require schedule data on a timely basis. For example, **DSO/Upstream** has been integrated with workflow software, well operations databases, petroleum economics applications, other project management tools, and Microsoft Excel.

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05: ACTENUM DSO SOFTWARE: THE BENEFITS

The features designed into Actenum DSO software overcome the limitations of manual scheduling described earlier. Operators benefit from:

A faster and more reliable process: The fundamental challenge of coping with the large number of possible ways in which scheduled activities may be combined is dealt with by the software, rather than the user. This speeds up schedule creation, increases consistency in the process—and thereby reliability of the schedule solution—and limits the possibility for errors. As well, "scheduling folklore" can be eliminated from an organization, since the various policies and rules that have evolved over time can be investigated and decisions made about their validity.

Easy handling of disruption and other required schedule updates: Planned and unplanned changes in well delivery operations no longer need cause concern to the scheduling staff. Since disruption management features are designed into **DSO/Upstream**, rapid rescheduling—taking those changes into account—is easy to perform, and disrupted operations get back on track smoothly.

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Scheduling decisions based on reliable information: By linking schedules to key production metrics, **DSO/Upstream** enables users to make informed decisions when selecting the most appropriate schedule alternative to meet operational objectives.

Easy integration with other applications: Actenum software can be linked to other enterprise applications (such as Generwell, Wellview, OpenWells, Aries, and Peep), so that available data concerning well delivery projects can be used to drive informed decision-making and improve operational performance.

A flexible and configurable scheduling platform: **DSO/Upstream** embeds knowledge of the scheduling process, and details of the technical/business context in which it's carried out, in a well delivery operations model that's specific to each organization. This ensures that the scheduling capability is always available, and no longer subject to staff availability. It also means that collaboration between different stakeholder groups is easier than before, since schedule creation may be focused on organization goals, rather than those of a specific group.

Improved collaboration among team members: **DSO/CX** makes each schedule and all of its associated data available to all team members, so that all current information about well delivery operations is accessible in a timely manner.

Actenum software enables operators to smooth out the daily variances in well delivery, and to make effective and informed scheduling decisions. Response times are improved when changes or disruptions occur through the accelerated scheduling capability, and schedulers gain insight into the quality of their scheduling decisions, since they are linked to key metrics. At the heart of each Actenum implementation is a sophisticated business and technical model of organization-specific operations, which captures the knowledge of expert schedulers, and supports operational staff in their daily work. Schedule alternatives that show impact on key operational metrics can be generated, assessed, and ranked very rapidly, providing for accurate and justifiable decision-making. Daily activities are closely linked to organizational strategy so that organization spend and profit expectations are met.

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06: CONCLUSION

Actenum DSO software represents a powerful and automated well delivery scheduling platform that supports operators of any size. By applying the power of sophisticated optimization technology and scheduling logic to well delivery scheduling, the limitations of traditional manual scheduling approaches are overcome.

In addition, Actenum DSO software moves an operator's well delivery organization to an enhanced level of capability. Instead of a process where important decisions are made about how to manage a well delivery schedule with little concrete insight into outcomes, operators equipped with **DSO/Upstream** and **DSO/CX** benefit from a much more agile schedule process that provides reliable input into decision-making at all levels of the organization. By ensuring that well delivery operations are always aligned with business objectives, Actenum software provides substantial economic benefits, maximizes asset ROI, and reduces risk.

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