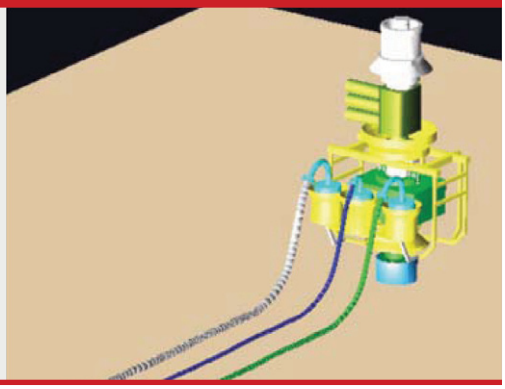
SOLUTION BRIEF

Simulation to Improve Productivity and Enhance Safety in Oil and Gas Industry



Industry Challenges

Petroleum industry currently meets over 60% of world's energy needs and also provides raw materials for several other industries including fertilizers, plastics and various construction materials. As the world's energy demands grow, the industry is in a strong position to provide
cost effective solutions and hence is expected to maintain its dominance for some time to come. However, as the supplies of easily accessible fossil fuels diminish, exploration and extraction efforts are moving to harsher environments, including colder, arctic regions and deep oceans where water depths could exceed more than a mile.

With increased challenges of drilling, extraction and transportation, tools and equipment need to designed to handle multiple design criteria across disciplines. Some of the criteria the systems are expected to meet are: Some of the conditions the systems need to perform with productivity loss are:

1. Multiple environments (cold, hot, humid, dry)
2. Wave and wind loads for offshore systems
3. Corrosive environmental conditions
4. Large structural deformation without failure
5. Large pressure variations

Simulation as a Cost-Effective Solution

Sole reliance on physical testing may lead to longer design times, increased development costs and production based on incomplete data. Simulation provides a safer and cost effective way to virtually test components and systems across the entire spectrum of loading and environmental conditions. Additionally, simulation gives ability to investigate system responses in hard to measure regions and conduct failure studies without costly make and break physical testing.

MSC Software, with its product suite spanning broad-ranged simulation technologies, is well positioned to provide solutions to challenges presented by oil and gas industry. The simulation products have such capabilities encompassing multiple disciplines, including:

- Linear and nonlinear statics and dynamics
- Frequency domain analysis
- Time domain transient analysis
- Nonlinear material models to simulate complex material responses
- Rotary dynamics and acoustic analysis for environmental noise control
- Multibody Dynamics to model entire systems
- System controls
- Fluid structure interaction
- Thermal analysis

MSC Solutions

Simulating Real World Events

The simulation solutions from MSC Software enable engineers to model real-world interactions with higher accuracy. Users can simulate scenarios of any level of complexity that may involve interaction between disciplines. Here are
a few challenges faced by design engineers of oil and gas industry with effective solution from MSC Software.

Seal Analysis: A wide variety of sealing systems are used in oil and gas industry for flow control and isolation. Seal reliability is extremely important in oil and gas industry, both for productivity and environmental safety. The down-hole sealing systems, with wide applications such as subsurface safety valves, casing tie-back, slip-joint and packer seals, need to withstand high pressures and temperatures of the wells.

Wide range of packer seals and blowout preventers used in the industry provide unique challenges to designers because of the magnitude of deformation and compression they experience. Packer seals serve multiple purposes – act as sealing between production tubing and casing, protect casing from corrosive well fluid and high pressure, prevent up and
down movement of tubing, improve fluid flow and provide separation of multiple fluid zones. Solutions from MSC Software efficiently handle large strain contact analysis capabilities along with automatic remeshing functionality to model these highly deformable seals.

Pipeline Devices: Pipeline survey devices (also called pigs) travel through the inside of oil and gas pipelines for multiple purposes, including damage detection, so that pipeline engineers know exactly where critical flaws may be located

Applications:

- Expandable C asing Strings
  - Predict collapse, burst & tensile failure
  - Load required for expansion
  - Metal connectors and threads
- Coiled tubing & pipe
  - Assess fatigue life
  - Maximize impact & torque loads
- Annular Packers
  - Expandable, inflatable & retractable designs
- Oil Seals
  - Performance of elastomers
  - Prevent leakage
- Drilling Oil Risers
  - Fluid-structural interactions
  - Frequency response
  - Manufacturability
  - Metal & Composite integrity
- Oilfield Flanges
- Bolt pattern & gasket profile
- Perforated Oil Wells
- Flow optimization
- Pipeline Tie-in Spools
- Flexibility Assessment
- Valves & Piping Manifold
- Coke Drums
  - Fatigue and fracture mechanics
  - Thermal-structural analysis
- Drill Bits
  - Contact stresses
  - Durability
- Anchoring & Mooring Systems
- Weldments

MSC Software

along hundreds of km of pipeline. Pigs must be designed to navigate through all possible turns and exit at predesigned locations since retrieval of pigs jammed in a pipeline can be very expensive.

Centralizers with bow-springs and spring loaded linkages are commonly used to support many tools as they are passed through oil wells, as many of them need to be centered for appropriate function. They are also used around the casing to center it in the well hole.

Using multibody dynamics modeling capabilities of Adams, users can simulate complete systems
and verify their navigability around all complex turns without resorting to costly physical testing. Ability to model some components as flexible
(with the help of MSC Nastran) also improves fidelity of the solution.

Control Systems: Control systems have a crucial goal of maximizing safety and efficiency. They help control the operation of various mechanical and power systems and process equipment, based on
a combination of sensor inputs and logic. For example, a drilling control system can be used to adjust the impact, rotation and dampening pressures to match the rock conditions. A braking control system is used to control the pipe speed and acceleration going into the well.

Easy5 can be used to model the various mechanisms to simulate complete (digital /analog) control system. By coupling with Adams, mechanical, electrical, hydraulic, and pneumatic systems can be modeled accurately reducing design iterations and optimizing operational efficiency.

Bottom Hole Components: A variety of mechanisms used during different stages of drilling/extraction include drills, coupling, joints, subs, centralizers, etc. Each of the mechanisms provides its own challenges related to their design. For example, drill design has to address drill bit distribution, bit soil interaction, vibration, etc.

Adams enables users to simulate the mechanical system efficiently. By making use of the forces obtained from a motion simulation using Adams, MSC Nastran can perform a detailed FEA analysis for stress and thermal response. Fidelity of system analysis can also be improved by modeling key components of the drilling mechanism as flexible rather than rigid. With the help of MSC Nastran, stress analysis of each of the components, contact interaction and fatigue studies can be performed accurately.

Offshore Platforms: Offshore platform share some of the largest moveable man-made structures in the world. Some of the distinct types of platforms are fixed platforms, compliant towers, semi-submersible platform, and jack-up platforms. These structures experience both
static and dynamic loads and need to be designed to account for wave and wind loads, explosion and fatigue. Pipes, valves and other structural components under the platform also need to be studied for loads, stresses and failure.

The multidisciplinary solutions in MSC Nastran can simulate the complex loading conditions needed to design offshore platforms. FSI capabilities of MSC Nastran help model the fluid pressure loads
in and around the pipes.

User-Friendly Modeling Environment

SimXpert from MSC Software delivers a powerful, easy-to-use simulation workspace environment with a built-in CAE template Studio that provide the tools required to capture and automate user's processes. This technology enables users to cost effectively build customized virtual modeling solutions which allowing users to focus on higher level testing definitions instead of minutiae of a simulation process.

Simulation Process Management

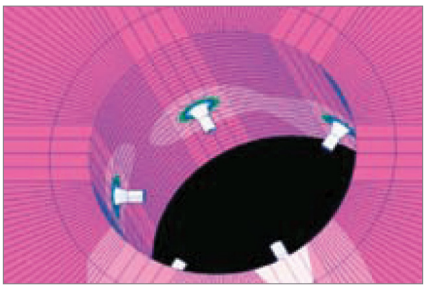
Managing and tracking simulation process is just as important as the process itself.

Since safety is one of the major criteria in design and analysis, it is crucial to maintain an auditable and consistent process built on best practices. Key criteria that guide an effectively managed process include:

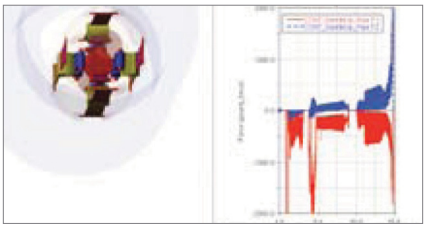
- Maintenance of records of all simulation data
- Revision management and control
- Correlation with physical test results
- Proven repeatable methods
- Software version tracking

SimManager from MSC Software captures the entire simulation process to provide a consistent process across engineering groups. Engineers can then locate models and results instantly, tracing and proving the methods used to create those results.

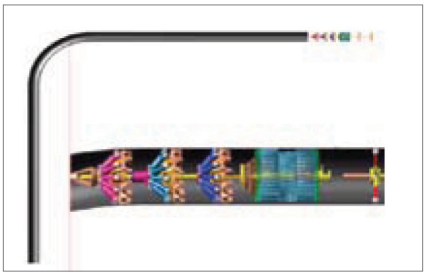
Pipe collapse



Simulation of well perforation



Centralizer kinematics



Pipeline survey device

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