Model + Make

By *ANSYS Advantage* Staff

Scott Parent, vice president of technology at Baker Hughes, provides insight on how a systems engineering approach and simulation-driven design improve product reliability.

Baker Hughes is one of the world's largest oilfield services companies. It provides products and services to international oil companies (IOCs), national oil companies (NOCs), and independents both large and small. Baker Hughes also manages more than 3,000 drilling and production rigs, providing consultation, expertise, equipment and planning.

Scott Parent, vice president of technology at Baker Hughes, leads more than a thousand engineering and science professionals in three major technology centers in the United States and Germany. He also coordinates efforts at two research and engineering organizations in India and Russia. The innovative tools and systems these groups develop incorporate a broad array of fundamental science — including materials, nuclear, resistivity, acoustics, resonance imaging, ballistics and fracture mechanics — as well as traditional electrical and mechanical engineering. Parent has spent more than 20 years in product R&D in automation and robotics, manufacturing, real-time optimization, aircraft engine design and reliability modeling, clean coal technology, and, most recently, products and services for the energy and oil and gas industries. Having used ANSYS products throughout his career, he talked with *ANSYS Advantage* about the importance of engineering simulation in the oil and gas industry.

WHAT ARE YOUR KEY TECHNICAL AND BUSINESS CHALLENGES?

Baker Hughes' major efforts are fairly straightforward: satisfying our customers' needs — including risk mitigation — and developing new products. As a result, we make significant investments in technology development, looking for advanced solutions. Some innovations Baker Hughes is currently working on include drone tools, manless rigs, and sophisticated sensors for high-temperature formation and fluid evaluation. These highly engineered products require a systems engineering approach, rather than the silo one traditional to our industry.

IS THIS MOVE AWAY FROM SILO ENGINEERING SIMILAR TO WHAT HAPPENED IN THE TELECOMMUNICATIONS MARKET?

Yes, this is a great opportunity for us to develop new methods and engineering tools. We need to build new infrastructure, and, clearly, more upfront planning and simulation will help. Baker Hughes has an incredible amount of science knowledge and homegrown simulations across engineers' and scientists' desks, including nuclear, ballistics, electromagnetics, acoustics, imaging, automation, vibration,

electronics, mechanics, thermal and resistivity. My commitment is to bring activities at all of our facilities together by applying toolsets and improving design standardization methods. Specifically, we have created several new analysis teams that bridge multiple product lines. Historically, these products operated together as a final product in our customers' wells, but their subsystems were rarely modeled together — until now. In the first six months of integrated simulations, our team has directly improved operating reliability of legacy products and impacted the successful launch of a new product.

WHAT ARE THE SUCCESS FACTORS FOR PRODUCT DEVELOPMENT?

Successful product development requires numerous things: good project management, talented systems-level thinkers, complex modeling, robust simulation processes and enough computing power to handle it all.

I think our education system trains engineers in a focused way, but we need electrical engineers, in particular, to think more broadly — more like systems engineers. In contrast, chemical engineers seem more likely to have this systems-thinking skill set, possibly due to the amount of formal process engineering education they receive in undergraduate and graduate school. Great simulations are well planned, and with the right systems-thinking team on task, these larger simulations can be performed successfully.

For our simulation process, we use design for six sigma methodology, which includes modeling, testing and analyzing. We start with a systems model and then flow down the requirements. As we step up the process, we become more reliant on increased computing power, which we can, thankfully, accomplish at a relatively low cost. Boosting computing power has become the backbone for complex modeling. It enables us to engage in more simulation-driven product development. Currently, we are partnering with

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Microsoft® to explore the benefits of cloud computing. Some of the first platforms we plan to integrate are ANSYS software. We use ANSYS CFD with the high-performance computing option, allowing expedited solution time.

WHAT OTHER ANSYS PRODUCTS DO BAKER HUGHES' TEAMS USE?

In addition to ANSYS CFD (ANSYS Fluent and ANSYS CFX), we use the ANSYS structural mechanics suite. These programs enable structural and more-sophisticated analyses all in the same environment, providing the opportunity to improve technical communication across all levels of engineering and design. This integrated approach is unique and offers a full-service, soup-to-nuts approach that is important in testing our solutions in the complex and rapidly changing environment in which we find ourselves working today.

We also use ANSYS software for electromagnetics. We'll soon expand into ANSYS Maxwell and ANSYS Simplorer for low-frequency applications, ANSYS HFSS and Ansoft Designer for high-frequency applications, and ANSYS Icepak and ANSYS SIwave for electronic thermal management. With Simplorer and its capabilities to cosimulate with Fluent, HFSS, Maxwell and ANSYS Mechanical, we can build high-fidelity systems-level simulations that make physics and engineering considerations explicit. Because of the seamless connection between ANSYS products, we plan to use ANSYS DesignXplorer and ANSYS nCode DesignLife to ensure reliability, sensitivity and six sigma design, as well as to estimate the life of the simulated tool or component.

HOW DO ANSYS PRODUCTS HELP YOUR MULTIGENERATIONAL MODELING EFFORT?

Now that we can prove the importance of validation, verification and model maturation to our colleagues and the industry, everyone is beginning to recognize the importance of upfront analysis and systems validation.

Validation means that you understand the physics of the design before you build the circuit and test it, for example. As we use field data to validate complex models created with ANSYS products, correcting for missing items or calibrating for issues, we create a record of knowledge, a record of the application's physics. This is our definition of a multigenerational model. When a model has been validated and then proven in this industry, it becomes a valuable asset — a company jewel. Today, we track our models manually, but we are looking at tools to manage this process for us.

For example, we are considering the ANSYS EKM tool to help us index, manage and track our engineering models. What we like about EKM is its capability to quickly search past and current simulations to find appropriate files and extract knowledge in an efficient manner. With EKM, we would not have to repeat a simulation if someone has done it in the past. When an engineer leaves the project, the software stores a copy of all of the simulations, making the files accessible to other team members around the globe.

HOW HAS PRODUCT DESIGN CHANGED AT BAKER HUGHES?

Three years ago, our testing processes consisted primarily of field testing. We designed it, we built it, and we took both new products and systems into the field with less attention paid to lab testing or validating of upfront models.

But in reality, our products must operate with other systems and tools. Before we begin design, we need to understand the operating or application environment, how our products integrate with other products, and the physics of final deployment. We must look beyond a single tool and develop a much better systems design up front.

At Baker Hughes, we have restructured into cross-disciplinary teams that work together to consider submodels, integration and parametric methods. When a team begins to develop a new product or solve an engineering problem, they ask questions such as: Do I have something new, or am I doing something we've already solved? What is my goal — to do something new or to make it better? To make something last longer? It's important to realize that you don't always start with a former product. In many cases, it doesn't save us any time. Instead, we can design a new platform using a new set of tools.

Now I am working to encourage our teams to use simulation earlier in the process. For example, it isn't optimal to test a noisy motor to find out what the problem is. It is far less expensive in time and money to model the motor before building it and avoid the noise in the first place. Validated models enable us to improve first-pass reliability and reduce total time to market.

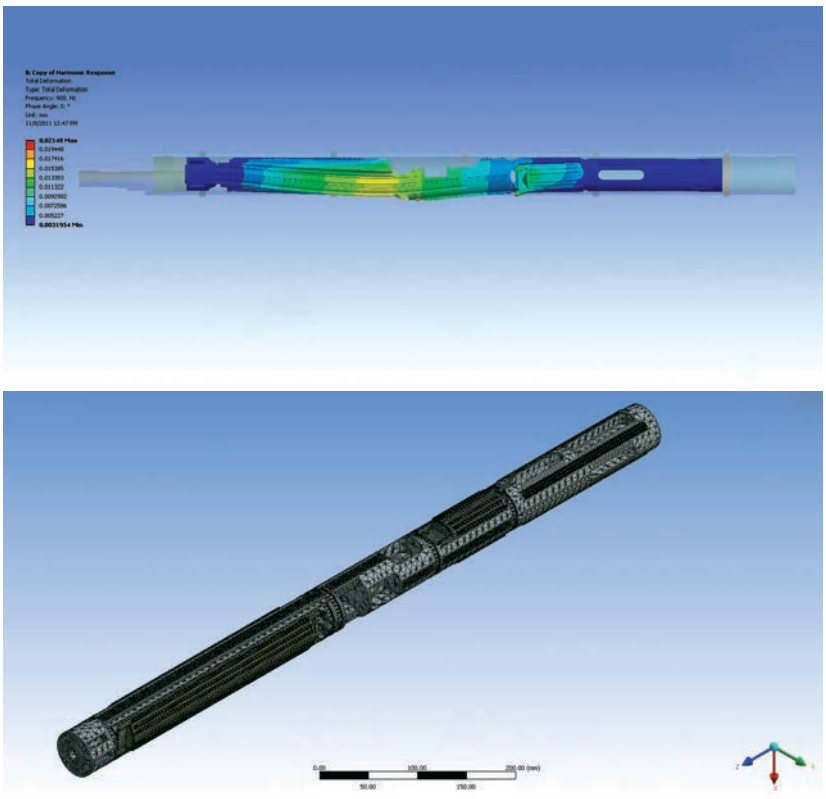
How do we reduce risk? We calculate it up front in simulation stages at both systems and component levels.

ANSYS allows us to try it before we build it.

CAN YOU SHARE AN EXAMPLE OF A RECENT DESIGN?

One task was to create complex simulations involving the bore hole (down-hole environment) in drilling systems deployment. The drilling environment exposes our tools to high-temperature and high-vibration conditions. We needed to better understand how these conditions might change tool performance, and specifically how they contributed to catastrophic failure of embedded electronic circuit boards.

Accessing data collected around root-cause electronics failure (primarily high vibration and temperatures for extended periods), we then used ANSYS products to simulate tools and components in this down-hole environment. Our aim was to improve survivability of the printed circuit board assemblies. By analyzing component mounts, electronics packaging and board mounting scheme in the down-hole tools, we reduced the failure rates of these critical subsystems significantly.



Just one way ANSYS structural technology is used at Baker Hughes is to simulate tools and components in a down-hole environment to improve survivability of the printed circuit board assemblies. This simulation demonstrates high-frequency dynamic deformation (top) and the integrated FEA mesh (bottom) of a down-hole tool.

HOW DO YOU ADDRESS RELIABILITY?

The complex simulations using ANSYS software allow us to improve product reliability. In our industry, nonproductive time on a rig is measured in hundreds of thousands of dollars. It is critical that we continually improve our design capabilities for reliability and manufacturability. ANSYS software enables us to consider these features in the context of trading off design features with performance criteria. We use these capabilities more and more to enhance lifecycle costing, including repair and maintenance, through robust design and failure analysis. The software and other measures we have put in place have helped us to improve reliability and reduced our drilling systems nonproductive time by 25 percent globally in the past 18 months.

OVERALL, HOW DOES THE USE OF ANSYS TOOLS IMPACT YOUR DESIGN PROCESS?

"Model and make vs. build and break" is what I call our initiative around this. Simply put, ANSYS allows us to try it before we build it — to try things on the drafting board and exercise component and system models as though they were in the lab or field application. We can combine multiple scientific and engineering disciplines earlier in the process, creating an environment in which development can evolve creatively and economically. ANSYS tools — and simulations in general — are helping Baker Hughes to take a more aggressive approach in our design processes. We can make decisions earlier in that process, and, with a broader interdisciplinary talent pool, design with increased confidence. Identifying and resolving issues early in the process helps us to mitigate risk, save millions of dollars, reduce development time, and drive customer value. Ultimately, this approach drastically improves first-time yield of products coming from R&D.