POWERING GLOBAL PROSPERITY: NEW ENERGY FOR PRESSING INDUSTRY CHALLENGES

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Global prosperity requires reliable energy at a reasonable cost. To meet this demand, the industry is changing the way it produces energy and power, whether it comes from hydrocarbon, nuclear or renewable means. Supplying it requires sustainable development, environmental stewardship, compliance with regulations and cost management.

Independent of prices, the industry's most pressing challenge is cost per unit of energy. Recent layoffs and out-of-the-ordinary cuts to capital and operating costs are driving the oil and gas industry to produce energy more efficiently, more safely, and with a smaller carbon footprint. Debate over subsidies, reliability and viability have resulted in accelerated development/deployment and widespread innovation in renewable energy, which includes solar, wind and hydropower, fuel cells, wave and tidal, energy storage, the next generation of fission nuclear reactors and advancements in fusion energy.

Engineering organizations face continual challenges to meet new product introduction deadlines and development-time/cost schedules, while ensuring that the resulting product is reliable, sustainable and safe. Complete virtual prototyping and systems-level thinking are proven methods to shorten time to market, minimize costs associated with development, meet government regulations, and solve incredibly complex product design and assessment performance requirements. Engineering simulation technologies enable evaluation and development of next-generation technologies, help eliminate overdesign, provide additional insight into failure analysis and warranty concerns, and bring robust computational physics into predictive analytical initiatives.

Energy industry initiatives include lightweighting, which cuts manufacturing, transportation and installation costs and improves operations via more-reliable components. In this age of smart products, making the switch from mechanical to intelligent electronic equipment comes with game-changing advantages, including better control, automated and remote operations, and lighter weight. The trade-off: Smart product design demands increased collaboration among engineering teams. This collaborative approach results in a design cycle that takes one-ninth the time and incurs one-fourth the overall product costs.

Smart design also builds in capabilities for efficient asset management. Using the data generated by equipment sensors, energy companies can predict real-world behavior of field assets, optimize maintenance plans and avoid unscheduled downtime. Combining big data analytics with physics-based simulation can speed up next-generation product development.

UPSTREAM OIL AND GAS

For drilling, completion and production, the greatest challenge is engineering the well. Cost-cutting takes the form of drilling holes closer together, completing the well in a smarter way, and producing resources with reduced downhole water or heat. Virtual analysis tools lower the cost and risk of evaluating new concepts, and they do so faster than traditional prototyping methods.

To improve performance of separation equipment, Swift Technology Group leveraged multiphase simulation. Researchers found that the time for each design change cycle was approximately eight weeks, with seven changes required. Computer analysis enabled modeling each change in two weeks, requiring only one actual test — saving a total of nearly $500,000.

Electric motors that drive field equipment work around the clock under harsh conditions. WEG engineers applied CFD simulation to deliver new motors with optimal energy efficiency, low operating noise and long bearing life. The company used CFD simulation to substantially reduce lead time and development cost.

Designers use structural and hydrodynamic analyses to ensure that working vessels meet challenging demands in harbor and at sea. Vuyk Engineering Rotterdam relies heavily on engineering simulation to meet government and industry standards, resolve field problems that may arise, and gain greater insight into vessel behavior.

To balance performance and cost, Hyundai Heavy Industries used electrical, thermal and structural simulation tools to design lower-weight oil-immersed power transformers, reducing engineering costs by up to 5 percent.

RENEWABLE ENERGY

Focus on sustainability and environmental stewardship extends to energy production from solar, wind, geothermal and ocean energy resources. Though cost is a primary challenge, energy companies must also deal with intermittency and energy storage issues.

Designing and evaluating wind turbines calls for a systems-level approach. Simulation incorporates tools to tackle aerodynamic design, materials science, structural design, electronic–mechanical control, site selection and farm layout. The industry innovates to increase safety, reliability and remote monitoring; reduce system maintenance; and address regulatory concerns.

Capturing the kinetic power of the world's tides, oceans and rivers is another promising source. One consulting firm used virtual analysis to optimize an innovative tidal-current power generator to produce four times as much power as earlier designs. Complete design optimization took 4 percent of the time required using build-and-test methods, a total of about two weeks.

In working to harness the ocean's thermal energy, reliable analysis models can provide answers in minutes rather than days, without compromising the fidelity of results — resulting in reduced equipment size and costs for heat-engine power plant installations.

NUCLEAR

Nuclear power has its niche because it is carbon free. However, the industry must develop solutions at lower capital cost while overcoming safety concerns. Many plants today are operated with increasingly smart instrumentation, protection and control systems. Engineers leverage advanced analysis tools to investigate seismic activity and predict the behavior of piping, reinforced concrete, welding and fatigue under real-life conditions.

Fusion power-generation innovators are working to produce thermal energy at the level of an electricity-producing power plant. Scientists at CERN used extensive analysis to investigate the Large Hadron Collider's magnet system. The new design saved money on material and reduced the manufacturing lead time by five months without compromising magnet quality.

The energy industry's complex physics and geometry challenges will grow more complicated in the future. To accelerate product development, R&D companies must employ advanced computational simulation tools for component and system design in new ways. Collaboration is key, since it removes functional engineering silos. But collaboration must be combined with reliable physics technologies, HPC/cloud enablers and optimization tools applicable across the entire design cycle, across the entire supply chain, across 24 time zones. The result will be realization of the ultimate customer promise: safe, reliable, environmentally responsible and cost-effective energy solutions.