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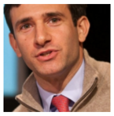

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# Why the DOE Thinks Supercomputing Will Change Our Energy Future

*We sat down for an exclusive interview with U.S. Energy Secretary Steven Chu, who shared his thoughts on the current state of supercomputing. The Nobel Prize-winning scientist is betting that these super machines will play a key role in designing new products and solving longstanding energy challenges: from better engines to advanced nuclear reactors. He's backing his bet with significant resources, offering some of the Department's world-leading supercomputers for use by industry leaders.*

**What gets you excited about the intersection of supercomputing and energy?**

US Energy Secretary Steven Chu (Image credit: AFP/Getty Images via @daylife)

There has been tremendous progress in supercomputing over the last decade. In fact, today's supercomputers are over a million times more powerful than the average desktop computer. Because of those advances, we can now use those computers to achieve qualitatively different objectives. Before, a scientist would use a computer to simply plot a theoretical equation. But with a supercomputer, a scientist can begin to actually simulate situations where there isn't a neat little equation to simplify the problem. A scientist can now simulate the movements, actions and effects of constituent particles – the atoms, molecules and pieces that define a system – with incredible depth. You throw it all into the hopper and let the supercomputer crunch.

**How are these advances being applied to the energy world?**

Increasingly, industries are using these supercomputers to design things like more streamlined aircraft and more efficient jet engines. And if we can streamline an aircraft, we can certainly do the same thing for an 18-wheeler truck. In fact, recently a company called BMI found that by snapping specially-designed pieces of plastic on the underside of a truck where the axles are, one could achieve fuel savings of 6-7% for a piece that would only cost $1,000.

**What type of impact could that have?**

A big truck typically drives over 100,000 miles a year and only gets 6 miles to a gallon. At $4.00 for a gallon of diesel, 7% fuel savings could easily add up to over $5,000 – just by snapping a piece of plastic on the underside of the truck! That was all done by supercomputer simulation to optimize the streamlining. That's just one example.

Another example involves the design of a low-emission diesel engine. Using a simulation to model the complex chemical reactions and turbulent flow inside of the combustion chamber, designers were able to optimize the engine using the computer, and when they actually built the prototype, it performed exactly according to their expectation. They could go from simulation to production in just a single step.

**You've been an advocate for nuclear power in the past. How can supercomputers help design better, safer reactors?**

It's a really great question. One of the mundane problems in nuclear reactors has to do with the formation of corrosion and buildup around the cladding of fuel rods. This is officially known as "CRUD" (an acronym that describes the stuff quite nicely at face value). Once crud starts building up, the cooling of the fuel rods becomes uneven, which can result in heat pockets and additional buildup. In the worst case, this could cause a small leak in the cladding of the fuel rods. You do not want that to happen, because it becomes an expensive cleanup problem.

Now, using supercomputers, we can actually simulate these thousands of fuel rods in these complex flows in a nuclear reactor with all the so-called neutronics: the neutrons flying around, the materials properties, the oxidation and everything else. Doing so can allow one to figure out how to design the flows better to avoid the formation of this crud in the first place. Nobody would have dreamt of doing this ten years ago. And in the nuclear business, any time you make changes to a nuclear reactor, it goes through a very lengthy licensing process because of nuclear safety- that's paramount. So, being able to simulate changes in a new reactor design is a very big deal, because it could mean not just saving months or years, but possibly even a decade of design time.

**It sounds like computers have caught up to our theory, and in some instances even surpassed it. How is supercomputing changing the world of science?**

Remember earlier, I said it used to be that supercomputers were only useful for calculating theoretical equations. These equations could be complex, but by necessity you had to understand the process and provide the equations to begin with. Simulation is very different. You don't need the master set of equations. If you think about simulating something like weather or climate, you have all these little bits and pieces, but it's so complex that you don't actually know the governing rules. So what you do is actually throw in all the bits and pieces and have the computer crunch away. And you watch. So it's an experiment on a computer.

Previously, scientists had two pillars of understanding: theory and experiment. Now there is a third pillar: simulation. Scientists can now simulate live situations with all of their complexity, and begin to get answers that can be verified in the real world. This experimentation in a computer is the third leg of technological development.

**How is the Department of Energy playing a role in this emerging space?**

In every way possible. We have been the leader in the development of supercomputers in the United States for decades. We also help to develop the software to work with these machines, developing new algorithms to increase the calculation ability and make them easier to work with. The DOE is really playing a critical role by maintaining large user facilities and employing a core of computer scientists and applied mathematicians who help industry take full advantage of our supercomputing capabilities.

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