WHERE THE RUBBER MEETS THE ROAD

The Goodyear Tire & Rubber Company collaborates with Sandia National Laboratories on simulation code

The story of how a United States' national security lab and a tire company forged an unlikely relationship begins with the perfect storm. In 1989, as part of a mission to strengthen the country's commercial industry, Congress passed the National Competitiveness Technology Transfer Act, which tasked the Department of Energy (DOE) with bringing technology created in national labs to commercial companies. The appropriations gave DOE research labs the funding to help U.S. industry solve some of its biggest problems, while further developing mutually beneficial technology.

"Tech transfer was an exciting new opportunity for the labs," said Mary Monson, senior manager of Technology Partnerships at Sandia National Laboratories. "The Department of Energy really embraced the tech transfer concept for federal agencies in the late 1980s and early 1990s. Part of the budget from the Office of Defense Programs within NNSA was put aside for U.S. economic security for the nation, as well as enhancing the capabilities of the labs through solving complex real-world problems. Labs identified their capabilities and were authorized to collaborate with partners."

One of the major technological services the DOE had to offer companies was the ability to parallelize analysis codes. That meant building the capacity for a company's computers to execute multiple functions at a time rather than slowly, one after the other. The Goodyear Tire & Rubber Company took note of the opportunity, and in 1992, sent one of its research engineers to Sandia to investigate.

The U.S. government labs seemed like a good place to look for help to keep up with technological advancements in the global industry. The ability to run analysis codes in parallel seemed like a step in the right direction.

After visiting Sandia, however, Goodyear's engineer reported back that there was a lot more to this opportunity than code parallelization. The potential for a collaboration between Goodyear and the DOE was, in fact, vast. There were some surprising similarities between the design codes Sandia was using to apply to nuclear weapons systems and the design software a company like Goodyear might need for developing tires. And that same year, in 1992, President Bill Clinton had put a moratorium on nuclear testing that would later result in the 1996 Comprehensive Nuclear Test Ban Treaty, which prohibited any nuclear weapon test explosion. That meant that Sandia could no longer rely on nuclear testing. If it was going to maintain the nuclear weapons stockpile, it would need to do it through high-tech simulation.

Still, it would take some innovative, outside-the-box conversation to answer the strange question: How would a nuclear weapons lab and a commercial tire company productively collaborate?

Both Goodyear and the NNSA had issues to solve. The tire company, for instance, was facing bottlenecks in its development of new tire products. Histor-

Photos Courtesy Sandia National Laboratories

Empowered by CRADAs, the partnership between Sandia and Goodyear worked to the mutual benefit of both organizations.

ically, new tires were developed by creating a design concept, building a prototype, and then testing it in the lab and on the road.

"Typically it could take three years to develop a new tire design," said Thomas Ebbott, R&D Fellow for Modeling and Simulation at Goodyear. "The design-build-test cycle is complex, lengthy, and expensive. Significant resources are dedicated to experimental tire building and testing."

This three-year process of developing tires had worked in the past, but was becoming outpaced in a faster, more competitive world. Something needed to change.

Sandia had been developing a suite of simulation codes with capabilities for thermal, fluid aerodynamics, solid mechanics and structural dynamics. The code incorporated models relevant to a broad swath of applications, including both weapons and tires.

"The codes incorporate broad concepts of physics," Ebbott said. "Concepts like Newton's Laws and conservation of energy are fundamental to mechanics. There are certain things that are special in tires that weapons don't need and there are certain things in nuclear weapons that tires don't need. But the basic mechanics portion of it is the same for both."

To collaborate, Sandia and Goodyear signed a Cooperative Research and Development Agreement (CRADA) to combine resources and accelerate the process of developing the codes. The CRADA allowed both parties to work on experimental and computational projects, while giving Goodyear the ability to use the codes without the licensing constraints often associated with commercial software codes.

In the early 1990s, this kind of mutual agreement between a government agency and a company with non-defense related goals was unusual. It took some negotiation to figure out how it might work, but eventually the common interests between parties allowed

for a signed agreement. For almost 30 years, Sandia and Goodyear have continued this partnership through the signing of more CRADAs in service to an ever-evolving design code.

For the tire company, the outcome has been an ability to accelerate its product development, and to explore hundreds of designs at a time rather than just a handful. The technology works using numerous inputs. That means inputting information about the materials, the geometry, and the conditions related to the tires. Those inputs can be tweaked and tested in simulation until the company's engineers are able to create a new tire.

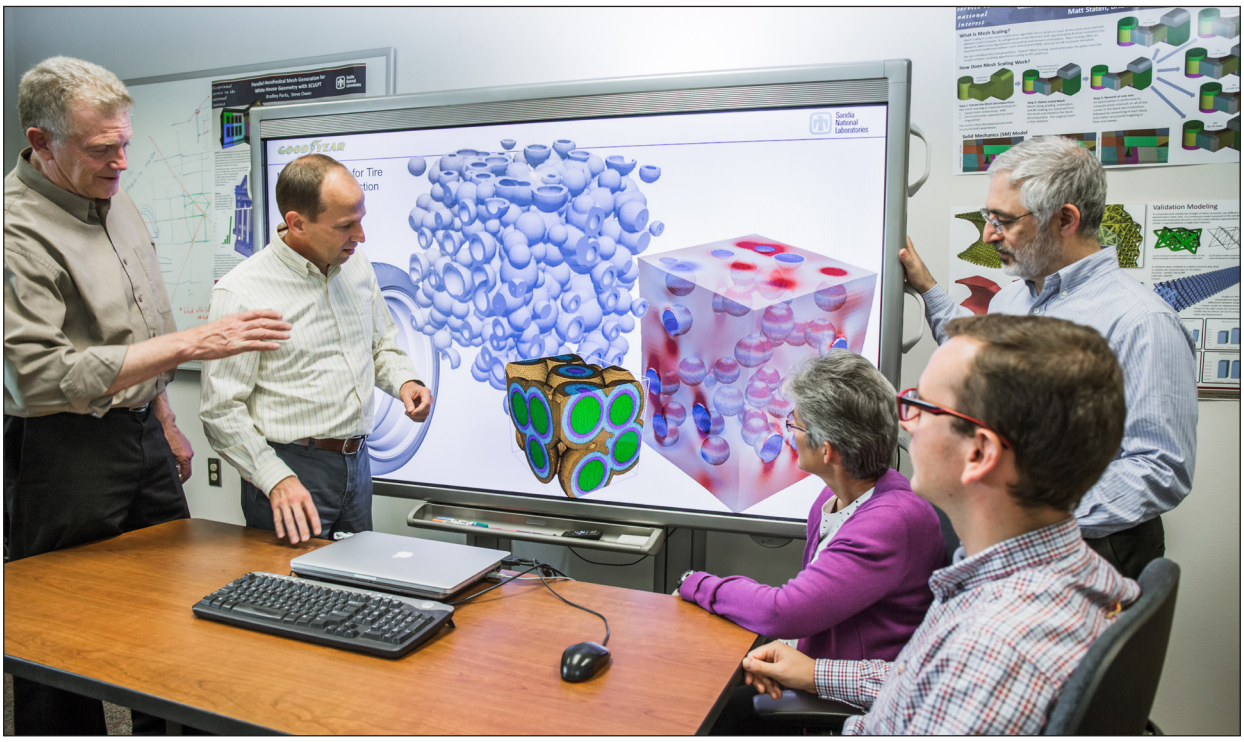
As the code grows more robust through Goodyear's repeated use and modification, the benefits come back to Sandia as well. Enhanced solution algorithms lead to better mechanical simulation for nuclear weapons and other security applications. For instance, the code provides highly accurate curing simulations that test the integrity of polymer seals used in neutron generators, a critical weapon component.

The collaboration between Goodyear and Sandia has been iterative. There have been times when proposed new methods were sidelined until, years later, those same methods turned out to be good solutions. What Goodyear and Sandia learned together is that while some creative technical solutions work well, others should be abandoned in order to keep the process efficient.

"There's always this collaborative effort whenever you get like minds together," Ebbott said. "Something better usually comes out of it. And that happened with us on a regular basis. There was this excitement about being able to utilize modeling and simulation in a way that we hadn't used it before. And this collaboration raised the bar in terms of technology and how we thought about problems at Goodyear. And it helped Sandia come up with ideas about how they could solve the problems on their side."

Ted Blacker, Sandia's manager of Simulation Modeling Sciences, said the partnership has been successful because it is strategic. It has allowed both Goodyear and Sandia to apply the code to real-world problems.

"We focus on strategic technical challenges where advanced technology from both sides can change the future," he said. "Almost without fail, the new capabilities they commission us to develop—for example, to model rotating and twisting tires—helped us with simulations in our national security work."



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