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Review and reflection

A tire is a complex system – one of the most formidable challenges in computational mechanics. Over 25 years ago, Goodyear Tire & Rubber Company had weathered financial challenge at a significant price. They made an effort and proposed an audacious solution: Simulation-based engineering. SBE not only reduces dramatically the overall cost of developing new products, but shortens research and development term as well, which advanced tire science along with computer modeling and simulation. At the same time, the joint work allows Sandia to enhance its software toolkits and improve its capabilities for mission applications while simultaneously addressing Goodyear’s proprietary challenges. The First was to continue to improve the existing development processes by building and testing prototypes more quickly and at lower cost. The second was to develop and deploy more predictive laboratory tests as substitutes for road and track tests. The third was to switch paradigms and perform product tests on the computer using SBE design. Other countries recognized the strategic importance of SBES and allocated significant resources to develop capabilities in close collaboration with their industries.

In addition to the government turning light green for the cooperation between industries and national defense systems so Goodyear and Sandia engineers and scientists began working together, Goodyear could create and test the model by computer simulation using high performance computing facilities.

For simulation, the compute times for commercial solvers scaled roughly as the cube of the model size. However, two Sandia researchers proposed an alternative approach that scales linearly, rather than cubically with model size.

This story tells us, on one hand today’s industries rely heavily on the cooperation with government’s institutes, government’s systems also get beneficial from working together with industries on the other hand. In this way, both industrious technologies and the knowledge of science develop together. Besides, today’s industrious technologies rely heavily on large scale computation simulation. That’s why high performance computing facilities play much more and more significant role in science and engineering.

**Finite element method**: a numerical method for solving boundary value problems for partial differential equations.

**Mesh generation**: the goal is to create a mesh that accurately captures the input domain geometry, with high quality cells, and without so many cells as to make subsequent calculations intractable.

**Verification and validation**: a process of checking that a software achieves its goal without any buys

Petaflops: the ability of a computer to do one quadrillion floating point operations per second.

**Exascale computing**: refers to computing systems capable of at least one exaFLOPS, or a billion billions calculations per second.