CSE415 Homework 01
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In the 1990's Goodyear faced financial trouble and was in desperate need of a new competitive advantage against international powerhouses that had arisen in the tire industry. The teams assembled to tackle these issues decided that either the time to create and test new prototypes needed to come down, the depth and accuracy of testing needed to increase, or the capacity for computed and simulated solution testing should increase.

Enabled by a regulatory act to allow governmental agency contractors to reach into and improve the competitive position of US industry, Goodyear made contact with Sandia, the Department of Energy's nuclear design facility, an agency highly skilled in parallel computing and physical simulation modeling. Also contributing to the partnership was an agreement by the government to fund their side of collaborations with private industry, as opposed to Goodyear paying the salaries of Sandia employee's for work on joint operations. The two companies agreed that their goal would be work that benefitted both parties in their individual endeavours, they came to an agreement on the nature of their relationship and set out to simulate Goodyear's prototype generation.

A full tire modeling was decided to be a cumbersome goal so it was decided to set that goal years ahead and to build up to it by individual test fields starting with tread-wear. The many material properties and forces involved required models and simulation with huge polyhedral meshes with hundreds of thousands of degrees of freedom, the team discovered that model creation was their first major obstacle. After several years of partnership the validation and verification process had been streamlined to the point where the limiting factor was computing power. The teams began a schedule of installing a new Linux cluster at each location about once per year.

While the partnership was fruitful and meeting its goals, in 2002 Goodyear as a whole was facing again a financial crisis. In response, a leap of faith was made to design an entirely new product with software based processes. The project resulted in a revolutionary new tire which received R&D awards for the product itself and the process employed to create it. Goodyear rolled transitioned all of its products in this way and saved an estimated 100 million dollars per year on prototype generation.

This success story speaks to the usefulness of private/public collaboration and the availability of advanced government generated technologies to US industry. Countries around the world are employing policies to encourage this type of benefit and there is fear that if the US does not match their efforts, our industry and technology will fall behind. Without the release of Sandia's technology and subsidy of their partnership, Goodyear, the last original material US tire player, could not have preceded the simulation age by a decade and may not have fought back to market competitiveness.

The Finite Element Method is an approach to solving problems in engineering and mathematical physics by subdividing into smaller simpler parts called finite elements. Simple equations that model the behavior of each finite element are related into a large system of equations which solves the entire problem.

Mesh Generation is the use of polygonal or polyhedral systems to approximate the elements of a problem for simulation, often a finite element solution for modeling physical forces on curved surfaces by amalgamating the results of simple calculations on the many small parts.

Validation evaluates the fitness of the solution for solving the clients problem, i.e. “Are you building the right thing?” Verification ensures that a solution meets the intended design specifications or conditions imposed at the start of it’s development phase - “Are you building it right?”

A Petaflop is one quadrillion FLOPs (Floating Point Operations), order 10^15, typically referring to a system’s capacity for these operations per second.

Exascale Computing is the current goal of the supercomputing industry, it defines a system capable of Exaflop processing, 10^18 FLOPs per second.