2020 Vision: Pervasive Simulation

Simulation has an amazing future: It will be everywhere. Within 10 years, engineering simulation will no longer be a step in the product design process, but it will become the process itself.

Pervasive *adj \ pər-vā-siv, -ziv : existing in or spreading through every part of something*

Simulation *noun \ sim-yə-lā-shən : examination of a problem often not subject to direct experimentation using a virtual environment*

Already, simulation is being used to visualize specific properties and combinations of properties. The ultimate goal of simulation is to evaluate an infinite number of product designs and predict each one's behavior in the real world — a world that includes intended or unintended consumer usage, the environment, and effects from other products — the combination of which can throw flawless designs into chaos and dysfunction. These products do not exist within a vacuum but within systems, systems acting upon systems. When next-generation simulation is used pervasively throughout the product design cycle, it will allow designers to see what is too small or too quick to be observed. It will give development teams the luxury to fail — before failure has any consequences — and to build only the optimal design alternative. An added benefit is heightened innovation.

To ensure that products succeed, development teams are pushing the limits of simulation — along with the principles that guide its use — to new extremes. Key forces, including innovation, speed and precision, oppose each other. Natural tradeoffs in design metrics (such as fast vs. certain) become unacceptable compromises as engineering moves to nano scale; the situation is further complicated as time-to-market demands shrink to days, not months.

With a unique ability to orchestrate unknowns into clarity, software simulation is the new enabler. How it is used – pervasively – becomes the next step.

Enabling trends

Fingertip Supercomputing

→ The computational power required to execute simultaneous multiparameter studies is orders of magnitude greater than it was just five years ago (because parametric studies were not then the norm). Until recently, the software algorithms that drive simulation models were too advanced to run on existing computers. Now computing resources are readily available, and access to immense multicore computational power is becoming commonplace. Mainstream graphics boards have broken the teraflop processing barrier.

In business terms, it is now possible to run large numerical models and, at the same time, apply parametric studies on these large simulations. Because of similar advances in networking — which has enabled components such as 4G mobile and high-speed cloud computing — the precise location of the compute box matters less than ever. Product designers and R&D teams can access almost unlimited compute power from just about anywhere.

→ **Integration of Physics, Resources and Knowledge**
Engineering software historically followed the individual silos of physics, which, in turn, fostered single-discipline virtual engineering. Engineers did not stray far from their fields: They were structural analysts, experts in fluid flow or specialists in electromagnetism, but not all three. Today's trend is multiphysics analysis: fluid–structure interaction, piezoelectric analysis, or interaction among fluid, solid and electromagnetic fields in the same model, to name a few. This trend has been encouraged by physics integration in some high-end software platforms.

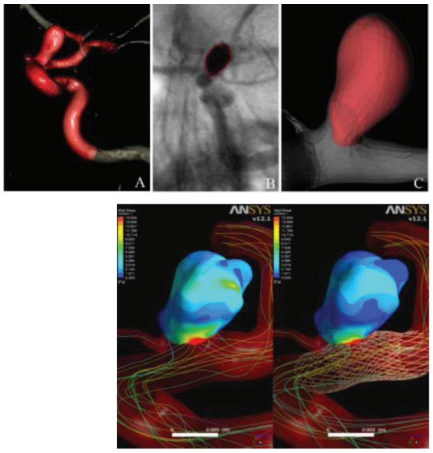
Common communication tools now enable quasi-instant collaboration between members of a virtual team working on the same model from different parts of the world. This process allows efficient knowledge transfer and hive-based problem solving.

→ **Technology and User Maturity**
Engineering simulation technology is maturing rapidly, but it is only 40 years old. A generation is a very short time to reach wide adoption, especially of such a revolutionary technology. As major public successes credited to engineering simulation multiply, more and more companies become aware of the potential benefits of virtual prototyping.

To be applicable to a larger range of potential users, the technology itself needed to mature — becoming faster, more robust and continually easier to use. The combination of success awareness and evolving maturities is now leading to an accelerated pace of adoption.

Market Changes Associated with Pervasive Simulation
As simulation becomes pervasive — offering the ability to model the whole product and its environment — and as technology eliminates guesswork from the design process, two profound concepts will emerge:

→ Greater creativity and innovation, especially as product makers spend less time and money on prototypes and product iterations, including those designed to remedy original design flaws. Fixing a problem — troubleshooting a design — is relatively easy when an engineer can pinpoint the cause of the difficulty and see what is wrong. But seeing the problem is often at the core. In the first phase of pervasive simulation, designers will struggle less with (then eliminate) the problem of the unknown. The next evolution will be characterized by designers having freedom to pursue daring and breakthrough



Preventing cerebral aneurysm rupture

ideas, knowing that the chances of success are higher, the risk of failure lower, and the total cost of the ideation cycle vastly reduced. Furthermore, those resources can be converted to profit or channeled into other endeavors.

→ Transition of simulation from an instrument of design to a product feature. This concept requires some imagination, but so did the idea of putting a microchip on every single product to track inventory, location, price and security status (RFID). Simulation can propagate into the end product, enabling new controls for provider and user. Physicians, for example, diagnose and treat patients based on what they see and hear in the patient's body. Even with advanced imaging systems, they make educated guesses about the cause and effect of treatment. Imagine if, instead, doctors performed real-time what-if scenarios based on a mathematical model of what's going on inside the body? And that the 3-D color renderings of these equations display how the patient will respond? For other everyday scenarios, product developers who use engineering simulation will be able to see imperfections in everything from buildings to automobiles. Office feels a little drafty? Wasting energy? Integrated simulation will identify abnormal airflow and allow an immediate correction, exactly where it is needed.

Conclusion

Software simulation tools powered by new generations of multicore, networked, high-speed compute platforms provide great insight into how products behave — all before they are built, shipped to customers and ushered into history as the next big thing. Or the next disaster that ruined a brand name.

Of course, many design organizations today have yet to implement multi-dimensional simulation strategies. And simulation is not yet pervasively part of the product experience. But the move toward pervasive simulation — used holistically by a design organization and powering new user capabilities — is real and unstoppable. Not because ANSYS says so, but because simulation is backed by the power of an idea whose time has come.