A Platform for Advancement: Bridging the Hardware/Software Gap

Rensselaer Polytechnic Institute (RPI) alumnus Dr. Mark Beall founded Simmetrix (Clifton Park, NY) in 1997 to provide tools and technologies to enable the broader use of simulation in the engineering design process.

Simmetrix is now a leading supplier of high performance software for simulation-based design. Across a broad range of analysis applications, including mechanical, electromagnetic, and fluid simulations, over 30 computer-aided engineering (CAE) software companies use Simmetrix’s mesh generation and geometry access components in their end-user products.

THE CHALLENGE

As simulation-based engineering is critical to 21st century leadership in all aspects of science and technology, including biomedicine, energy, consumer products, national security, and urban infrastructures. Yet, only in the past two decades has simulation technology made inroads into product engineering, lighting the way from traditional prototype construction to simulation-based design and operational processes.

Advances in the speed and complexity of computer architectures have outpaced industry ability to use high performance computing and harness its full potential. Many industries are caught in the hardware/software gap, between advanced computing capabilities and a lack of usable software tools, including new algorithms, codes and solutions tailored to distributed memory parallel systems.

Bridging this gap requires a broad base of high-level expertise, an interdisciplinary fusion of traditional engineering—electrical, fluid, chemical and material—and advanced expertise in mathematics, computer science, computer technology, and physics. The future of simulation-
based engineering design lies at the crossroads of these disciplines. While faster hardware is important, algorithmic improvements are even more critical.

The remarkable potential of simulation-based engineering is out of reach for many industries when open source and commercial toolkits fail to meet the needs of increasingly complex engineering applications. An advanced mode of software development is required to broaden industry’s access to simulation-based engineering: high-caliber teams of researchers working in a collaborative environment, profiting from distributed resources and expertise across a range of disciplines.

Typically available only in national labs and agencies, such a multi-level collaboration has developed—with significant benefit and advancement for New York industry partners—between RPI, HPCNY, and Simmetrix.

NEW SOLUTIONS
Software developers like Simmetrix need access to sophisticated, massively parallel systems to develop and test the flexibility, robustness and efficiency of their software. Facing increasingly complex interdisciplinary problems, they also need access to domain experts to identify methodologies that support the interoperability of individual components, design data-driven, adaptive systems, and develop ways to integrate them.

HPCNY has successfully run Simmetrix tools on highly complex engineering applications on massively parallel computing systems. Since its inception, Simmetrix has received several federal research grants, and established ongoing collaborations with governmental, academic, and industrial researchers, including researchers from HPCNY partners. These collaborations have helped Simmetrix develop powerful algorithms and sophisticated software that effectively support solving a wide range of simulation problems on many different sizes of computers, including the largest-available, leading-edge parallel machines.

MODELING AND SIMULATION
To advance product design for New York manufacturers, HPCNY’s computational scientists work with Simmetrix software engineers to address the manufacturers’ specific application needs. Engineering design studies are increasingly a critical need. As such, HPCNY and Simmetrix have collaborated to define software mechanisms that support the automated specification of simulation inputs across a range of CAD models and operating conditions.

For New York manufacturer ITT: Goulds Pumps, Simmetrix provided software components to support problem set-up automation that HPCNY engineers then adapted to work within the company’s computational fluid dynamics simulation workflows. This simulation-based design process harnesses the throughput capabilities of high performance computing systems to expand the design space and decrease the time to engineering solution. Such advances will free engineers’ time for design creation and analysis, thus improving products.
RESULTS

Simmetrix has advanced the performance, functionality and portability of its high performance computing software through access to CCI’s computational resources, and through research collaborations with RPI. Currently collaborating on two Department of Energy SBIRs, Simmetrix and RPI are developing software to support massively parallel simulations in the areas of magneto hydrodynamics and computational fluid dynamics.

The benefits for New York extend beyond economic growth, increased jobs, and contributions to the innovation economy. The collaboration of HPCNY and Simmetrix is a singular example of the advanced development mode—multidisciplinary teams of software developers, computational scientists and engineers working together—that is required for the broader application and integration of simulation-based engineering, and critical for advancements in science and industry.

“As a leading developer of component-based tools and techniques to support the geometry and meshing requirements of simulation-based design, Simmetrix has been pleased to work with HPCNY for over three years. As part of HPCNY, Simmetrix has provided its full suite of simulation automation components available on the parallel computers at the CCI, and allowed those components to be used to develop demonstration HPC simulation work flows for New York State companies free of charge. To date our components have been used in the development of HPC simulation workflows for ITT: Goulds Pumps, GE, IBM, Blasch Precision Ceramics, and Xerox.

In addition to providing a valuable capability to New York State companies using the HPCNY computing systems, there have been direct benefits to Simmetrix. One of them is that ITT: Goulds Pumps has not only become a Simmetrix customer, but has contracted Simmetrix to do specific extensions that improve their competitive advantage and extend the Simmetrix product line. Working with RPI, Simmetrix has been successful in obtaining SBIR/STTR support to continue the development of these technologies. We have also teamed with RPI on a recently funded NSF grant, and an IBM-supported grant. Both of these grants are focused on developing massively parallel simulation software for use by industry.” — Mark Beall, President of Simmetrix
ABOUT HPCNY

Funded by ESD and NYSTAR, HPCNY is a partnership between NYSENet, a private not-for-profit corporation created to foster science and education in New York, and three supercomputing centers: the Rensselaer Polytechnic Institute Center for Computational Innovations, Stony Brook University/Brookhaven National Laboratory’s New York Center for Computational Sciences, and the University at Buffalo’s Center for Computational Research.

HPCNY provides businesses and research organizations with access to world-class advanced computing expertise through accelerating the engineering and development path of complex, ground-breaking designs to reliable, accurate, innovative product and process performance that can provide a distinct competitive advantage.

ABOUT CCI

The Center for Computational Innovations (CCI) is one of the world's most powerful university-based supercomputer centers. Since opening in 2007, CCI has helped more than 850 researchers in academia and industry tackle scientific and engineering challenges across a wide spectrum of disciplines.

Key to this success has been the CCI’s ability to work with software from 3rd party vendors like ANSYS, and CD-adapco, as well as leverage research software tools and other "open source" software systems. These software systems are utilized by academic users and CCI partners Boeing, Corning, GNS, IBM, Kitware, P&G, and Simmetrix. The CCI provides over one petaflop of peak computational power from a massively parallel 81,920 core IBM Blue Gene Q supercomputer and an Intel Xeon cluster. Coupled to these systems is over one petabyte of high speed, low latency disk storage.

CONTACTS

NYS High Performance Computing Consortium (HPCNY)
Rensselaer Polytechnic Institute

405 Jordan Road, Troy, NY 12180
hpc2-info@rpi.edu
Office: (518) 276-4373
Fax: (518) 276-2392
http://hpc-ny.org

Simmetrix, Inc.
Mark Beall
President

10 Executive Park Drive
Clifton Park, NY 12065
Phone: +1(518) 348-1639
mbeall@simmetrix.com