

High Performance Computing To Enable Next-Generation Manufacturing

White Paper

16 January 2009

HPC: The Real Game-Changer for U.S. Manufacturing

U.S. manufacturers are being challenged today by an unprecedented confluence of global events. This convergence of powerful internal and external forces—financial crisis, global economic contraction, an automotive manufacturing base at risk, and increasing competition from overseas—is challenging U.S. manufacturing leadership like never before. Indeed, these extraordinary circumstances require extraordinary measures, and the U.S. public and private sectors must cooperate strategically, coordinating and investing to repair, reposition, and reaffirm U.S. global leadership in manufacturing.

Research by the Council on Competitiveness presents powerful evidence of the capacity of high performance computing (HPC) to drive innovation and make U.S. companies and the nation more competitive. Indeed, for those who have adopted it, HPC represents a crucial edge that can build and sustain competitive advantage through innovative product design,ⁱ production techniques,ⁱⁱ cost savings,ⁱⁱⁱ improved time-to-market cycles, and overall quality. However, Council research has also shown that many U.S. companies are “stuck at the desktop” and not able to take full advantage of HPC,^{iv} while still others—including many suppliers to U.S. tier 1 companies—have limited, if any, computational R&D capacity (with many not even using desktop workstations).^v

Our situation becomes even more critical when one surveys the competitive landscape that U.S. companies face today—where many foreign governments have established public-private partnerships for the use of HPC in manufacturing. Indeed, sustained national investments in innovation and manufacturing are occurring in China (e.g., China's 863 Program^{vi}), the European Union (PRACE program^{vii}), and in the UK^{viii} to name only a few. Meanwhile, our own national policy regarding HPC is fragmented.

The time is right for the U.S. federal government to take bold steps to leverage HPC for next-generation innovation, manufacturing, and U.S. competitiveness.

A New Game-Changing Approach to Manufacturing

Incorporating support for HPC within the Obama-Biden stimulus plan for manufacturing would constitute a bold, but effective, first step. It would enable U.S. manufacturers to gain the edge they need to stay competitive globally, create new manufacturing jobs at home based on HPC-enabled innovations and breakthroughs, and have long-lasting derivative effects that could be beneficial for the overall economy.

The Council sees public-private sector collaboration as the best and most effective means for quickly advancing HPC in manufacturing. However, to be successful in this effort, much closer coordination between government, national labs, universities, and industry will be needed and must be bolstered by a national strategy that transcends the parochial interests of any single federal agency, department, university, or HPC center. To these ends, the Council offers several recommendations for quick action:

- **Improve coordination** of the federal government's overall approach to advancing HPC (i.e., work toward a more balanced program across DOE labs, NSF-funded supercomputing centers, the DOD, universities, and so on).
- **Increase outreach** to chief executives (the so-called "C-suite") in manufacturing to help them better understand the true benefits of HPC to their bottom lines. Bring together CEOs and CTOs from the nation's manufacturing base, along with U.S. experts in HPC hardware and software, in a national summit to better frame and address the issues surrounding HPC for next-generation manufacturing.
- **Enhance industrial access to HPC resources** by establishing a government-supported HPC center or program dedicated solely to assisting U.S. industrial partners in addressing their research and innovation needs by adopting or improving modeling, simulation, and advanced computation.
 - o The center or program would provide assistance with problem definition; software selection, development, or customization (indeed, software is often the most crucial gap); and access to HPC hardware.
 - o It should feature a task force or working group that would (1) visit all top U.S. manufacturing companies, HPC centers, national labs, and major independent software vendors (ISVs); and (2) work to address major technical hurdles in the manufacturing sector's use of HPC (e.g., software, interoperability, multiphysics, and so on).
 - o It should be overseen by an advisory board with balanced membership from government, university, and industry.
 - o It could be started with initial funding from the federal government, but should be supported in the long term by a broad mixture of support from federal, university, and industrial partners.
- **Invest in U.S. HPC expertise.** Some of our most precious national resources are the people who operate in the HPC domain—from the computational scientists and engineers to the domain experts that apply HPC in their fields (e.g. mechanical, electrical, chemical engineers). The federal government, national labs, universities, and industry need to take concrete steps to educate, train, retrain and retain people with the expertise to take advantage of large HPC systems and manage their application and deployment in new settings, and create the new software and hardware needed to drive innovation.

Conclusion

This document's focus on HPC for the manufacturing sector is intentional, as the Council expects that the return on investment here for U.S. companies and the nation will be both substantial and quick. We also expect that the positive economic effects of increased HPC capabilities and expertise will spill over into other sectors of the economy (e.g., energy, healthcare, and so on) more directly and efficiently if the stimulus begins within our manufacturing base.

In the face of serious global competition and a sobering economic climate, U.S. leadership in high performance computing—in hardware, software, and expertise—stands out as a true national strategic asset. The Council believes that leveraging this leadership to support next-generation innovation and manufacturing is a sure way to advance overall national competitiveness and prosperity.

But the work must begin now.

About the Council on Competitiveness

The Council on Competitiveness is a unique group of corporate CEOs, university presidents and labor leaders committed to the future prosperity of all Americans through enhanced U.S. competitiveness in the global economy and the creation of high-value economic activity in the United States.

- i For example, Goodyear's breakthrough Assurance® all-weather tire, which simply would not have been possible without HPC. [Based on forthcoming Council HPC case study.]
- ii HPC, for example, often replaces expensive physical prototyping, saving precious resources and cutting time-to-market for new products and innovations. Indeed, Boeing needed to produce only 11 physical wing prototypes for the 787 as a result of modeling and simulation with HPC, as opposed to creating over 70 prototypes using earlier design methods.
- iii For example, by performing simulated tests rather than physical tests in an economic environment where costs are intensely scrutinized and can directly impact employment.
- iv See *Reveal* at <http://www.compete.org/publications/detail/420/reveal/>.
- v See *Advance* at <http://www.compete.org/publications/detail/486/advance/>.
- vi http://www.most.gov.cn/eng/programmes1/200610/t20061009_36225.htm
- vii <http://www.prace-project.eu/>
- viii See the UK's Science and Innovation Investment Framework 2004-2014, <http://www.berr.gov.uk/files/file29096.pdf>.