

SOVIET ADVANCED TECHNOLOGY:  
THE CASE OF HIGH-PERFORMANCE COMPUTING

by

Peter Wolcott

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<sup>1</sup>With apologies to Bill Clinton and his campaign staff.

“Everything has become more difficult now,  
but it wasn’t any easier before...”

–*Soviet HPC engineer, 1991*

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## **ABSTRACT**

This study uses Soviet high-performance computing (HPC) as a vehicle to study technological innovation, organizational transformation, and the R&D of advanced technologies in centralized-directive economies in the past and during periods of transition. Case studies are used to identify the factors most strongly influencing the evolution of high-performance systems and the facilities within which they were developed.

Although closely tied to the military, the HPC sector was not able to overcome basic systemic and technological difficulties. HPC illustrates the limits of centralized-directive economic management's ability to coordinate and prioritize development and production of highly complex, rapidly evolving technologies. Projects were delayed by complex bureaucratic structures, the monopolistic nature of the supporting infrastructure, and resistance of production factories. Progress of individual projects was dependent on the degree to which they drove supporting industries, used immature technologies, had an industrial vs. academic orientation, and were developed in conjunction with production facilities.

The benefits of the reforms—direct contacts between organizations, increased local control of finances and research, greater flexibility in the management of R&D, and improved opportunities for international contacts—have been overshadowed by economic decline and fundamental weaknesses in the supporting infrastructure. R&D facilities have been transformed into a collection of loosely-coupled semi-autonomous organizational units, increasing short-term viability, but threatening their ability to carry out large-scale, long-term, integrated development. Links between R&D and production facilities have been disrupted. The upstream infrastructure remains ill-suited for providing the technologies necessary for HPC development. Preconditions to long-term viability are restoration of the integrity of the development-production cycle and reduction of the HPC sector's

dependency on domestic industries. Taking advantage of mass-produced Western technologies will require changes in philosophies of development and architectural approaches.

The concept of a unified sector-wide technological paradigm is not well suited for explaining the diversity of architectural approaches and specific development trajectories. A paradigm consisting of layers of "micro-paradigms" better captures the patterns of continuity and change within projects and features shared between projects.

This study suggests that the nature of the revenue stream and the opportunities for alternative organizational forms have a significant influence on organizational structure.