High Performance Computing

Reveal.

Council on Competitiveness and USC-ISI Broad Study of Desktop Technical Computing End Users and HPC

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Introduction

Reasons Companies Don't Adopt High Performance Computing and the Implications for the Nation

Three years ago, the Council on Competitiveness launched its High Performance Computing (HPC) Initiative to better understand how HPC is being used across the private sector to drive productivity and competitiveness. Through a series of pioneering studies and conferences, the Council confirmed that nearly all companies that have adopted HPC consider it indispensable for their ability to innovate, compete and survive. But the studies also revealed some major gaps in the rapidly growing HPC market—and each gap represents an important opportunity for bolstering U.S. economic and national security strength.

Today, the competitiveness benefits of HPC are unevenly distributed across industry. A relatively small contingent of experienced industrial users is pushing out the frontiers of innovation through modeling and simulation with high-end HPC systems. There are also a large number of firms using entry-level HPC systems to advance their productivity and competitiveness. However, an even larger group of companies have not tapped into the benefits of HPC at all. These firms are using desktop computers (primarily PCs and Macs) to perform technical computing—the same kinds of tasks involved in HPC—but are doing so at a substantially smaller scale and level of complexity. They have not embraced the capabilities of even entry-level HPC servers yet.

To assess the situations of these companies and why they remain "stuck" at the desktop computing level, the Council, along with the University of Southern California's Information Sciences Institute (USC-ISI), the Defense Advanced Research Projects Agency (DARPA), and the Air Force Research Laboratory (AFRL), co-sponsored two complementary studies of desktop technical computing users in industry.

This document, *Reveal: Council on Competitiveness and USC-ISI Broad Study of Desktop Technical Computing End Users and HPC*, presents and analyzes the findings of the first study, a broad-based survey in which 77 companies from 11 different business sectors reported on their technical computing needs and practices.[1] While much is known about the small group of industrial users who are very experienced in the use of HPC—and Council studies in recent years have added considerably to this base of understanding—to the Council's knowledge, no prior public studies have attempted to evaluate the interest in HPC of the large population of industrial "desktop only" technical computing users.

1 The second study, ***Reflect: Council on Competitiveness and USC-ISI In-Depth Study of Technical Computing End Users and HPC*** is available at www.compete.org.

This study investigated the following key questions:

- What are the demographics of "desktop only" technical computing users? What are the environments in which desktop technical computing is being used by businesses?
- Do these companies have important problems that cannot be solved on desktop computers?
- How many of the companies plan to move up to doing HPC on technical servers?
- What are the main barriers to adopting HPC, and what would motivate desktop technical computing users to overcome these barriers?

The study revealed that desktop technical computing users are an extremely diverse group. They exist in settings ranging from several-person engineering services firms to multibillion-dollar global corporations. They are old hands at technical computing on the desktop, but more than half of them have problems that they can not solve on these computers today. They all face systemic barriers to HPC adoption, primarily lack of easy-to-use application software, lack of sufficient human expertise and costs. And while not all companies have problems that could benefit from HPC, about one in 10 already plans to upgrade to HPC servers, and more than half are open to adopting HPC under the right circumstances.

To overcome the systemic barriers, most of these willing firms will need an external "enabling function" that provides low risk access to HPC systems, and especially to the necessary expertise. Whether this enabling function emerges through public-private partnerships or strictly through private sector initiative, the stakes are high for advancing more of these companies to HPC-level computing. Unless and until these firms can learn to apply at least entry-level HPC systems to their unsolved problems, critical U.S. supply chains and the leadership of many U.S. industries will be at greater risk from international competitors—and the U.S. will be missing a rare opportunity to make a quantum leap forward in innovation and productivity for global competitive gain.

WHITE PAPER

Council on Competitiveness and USC-ISI Study of Desktop Technical Computing End Users and HPC

Sponsored by: DARPA, AFRL (Prime Award #FA8750-06-1-0240/Subaward #115664), University of Southern California's Information Sciences Institute, and the Council on Competitiveness

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EXECUTIVE SUMMARY

This study, sponsored by and conducted in collaboration with the Council on Competitiveness, the University of Southern California's Information Sciences Institute (USC-ISI), the Defense Advanced Research Projects Agency (DARPA), and the Air Force Research Laboratory (AFRL), is to our knowledge the first study aimed at understanding why the large group of companies that pursue technical computing on desktop systems (PCs, Macs, workstations) has not advanced in greater numbers to using high performance computing (HPC). The study's higher goal was to identify the potential for using HPC to boost the productivity of these companies as a way of helping to increase the productivity of the U.S. industrial base as a whole.

Investigating and advancing the use of HPC to increase U.S. industrial productivity and global competitiveness are the main purposes of the Council on Competitiveness' HPC Initiative, a coordinated program of original research, conferences, and workshops that began in 2004 and continues in partnership with USC-ISI. Prior Council on Competitiveness studies conducted by IDC (downloadable from **www.compete.org/hpc**) found that virtually all U.S. businesses that have adopted HPC consider this technology indispensable to their competitiveness and corporate survival. Yet the HPC market, from entry-level to high-end systems, represents only about 3% of the overall computing market. The market for entry-level HPC systems has experienced explosive growth in recent years, yet a large group of companies appears to be stalled on desktop computers. What is preventing these companies from realizing the proven benefits of HPC usage: greater scientific and engineering productivity, accelerated innovation, and increased competitiveness? The answer to this question is important not only for these companies but also for the competitiveness of the nation as a whole.

Technical computing users play a key role in designing and improving many industrial products — from automobiles to airplanes, pharmaceutical drugs, microprocessors, computers, implantable medical devices, golf clubs, and household appliances — as well as industrial business processes (e.g., finding and extracting oil and gas, manufacturing consumer products, modeling complex financial scenarios and investment instruments, planning store inventories for large retail chains, creating animated films, forecasting the weather). Technical computing users pursue these activities with *virtual prototyping and large-scale data modeling* (i.e., using computers

to create digital models of products or processes and then evaluating and improving the design of the products or processes by manipulating these computer models). Given their broad and expanding range of high-value economic activities, technical computing users are increasingly crucial for U.S. innovation, productivity, and competitiveness.

But heightened competition from other nations, along with the growing U.S. shortfall in university graduates trained to apply technical computing to business and industrial processes, has made it more urgent to elevate the productivity of *today's* technical computing users in the nation's private sector. The private sector is in the midst of a new type of industrial revolution, driven by the application of computer technology to industrial and business problems. IDC believes that the failure of companies of all sizes to exploit HPC more thoroughly will put major U.S. industries at greater risk — and sacrifice a rare opportunity for the United States to make a quantum leap forward in advancing innovation and productivity for global competitive gain.

This study identified the key barriers to HPC adoption among companies that already use technical computing on desktop systems but are not yet using HPC. The study also suggests ways to lower these barriers for companies that are receptive to the idea of adopting HPC to improve their productivity and competitiveness.

The "desktop-only" companies varied greatly in size and included many firms with more than 1,000 employees and over $1 billion in annual revenue. They were old hands at technical computing on the desktop, having practiced it for 16 years on average. They believe that technical computing is an important driver for their competitiveness. Many had advanced R&D, production, and complex business process problems that were crucial for innovation and exceeded the capabilities of their desktop computers. They responded to this dilemma with innovation — and productivity-reducing compromises — by scaling down the problems to fit their desktop systems, ignoring the problems, or reverting to much slower, more expensive physical testing and prototyping.

The attitudes toward HPC of the 77 companies represented in this study were not one-dimensional. Receptivity to technical computing using entry-level HPC systems was substantial, though by no means universal. Many of the respondents (57%) reported having problems they could not solve with their existing desktop computers. A nearly equal percentage (55%) were open to using HPC under the right circumstances — which typically meant an external mandate in the form of a customer requirement or manifest competitive threat. The remainder (45%) expressed little or no interest in HPC.

This relatively clear split was complicated by the fact that many of the respondents had never heard of HPC or had only secondhand knowledge of the technology through academic journals or presentations, while others said they had tried HPC before (presumably with prior employers). It was not within the scope of the current study to further probe the relationships between understanding of HPC and receptivity to HPC.

In the end, what emerged from the study was evidence of significant need for and receptivity to HPC (about half of the companies), along with important systemic barriers to HPC adoption: lack of application software, lack of sufficient talent/expertise, and cost constraints.

In short, these companies need help to overcome systemic barriers to using HPC, and they need to be guided toward HPC adoption. Many said they were open to working with outside organizations to explore the value of HPC and, depending on their size, were willing to pay annual fees ranging from $25,000 to $200,000 for consulting help.

The large contingents of "desktop-only" companies and entry-level HPC users represent rare, important opportunities to boost U.S. business productivity and global competitiveness. IDC believes that public/private-sector partnering will be the most effective way to exploit these opportunities. Successful HPC-based programs involving public-private partnerships already exist for companies with greater HPC experience, such as the Department of Energy's (DOE) INCITE program (**http://hpc.science.doe.gov**) and programs administered by the National Science Foundation (NSF) and the National Nuclear Security Administration. These and other national programs, as well as programs at the state and regional levels, could provide models for helping companies such as those surveyed in this study make the productivity-enhancing transition to HPC.

DEFINITIONS

Technical Computing

IDC uses the term *technical computing* to encompass the entire market for computers (and related software and services) employed by scientists, engineers, and others to address computationally intensive modeling and simulation problems. Technical computing activities can be found in industry, government, and academia. Industrial activities include automotive and aerospace product development, oil and gas exploration, drug discovery, weather prediction and climate modeling, complex financial modeling, consumer product design and optimization, advanced 3D animation, and others. Technical computers range from single-user desktop computers (PCs, Macs, and workstations) to supercomputers (a continuous spectrum from entry-level to high-end machines). Technical computing is in contrast to commercial computing as used for business operations such as accounting, payroll, sales, customer relations, transaction processing, human resources, and purchasing. Other terms for supercomputers are *technical servers* and *HPC systems.*

High Performance Computing

HPC is the important subset of the technical computing market that addresses the largest, most challenging modeling and simulation problems. The term encompasses both the activities carried out in this market and the computers used to perform these activities: HPC systems (common synonyms: *supercomputers*, *technical servers*). HPC systems include the full spectrum that extends from entry-level to high-end supercomputers, but exclude single-user desktop computers (PCs, Macs, and workstations) that are used for technical computing.

Entry-Level Supercomputers

IDC defines entry-level supercomputers (also called HPC systems) as servers designed for technical computing that are priced from about $5,000 to $250,000. Entry-level supercomputers may be designed as single computers or as so-called *clusters* that link multiple smaller computers.

Virtual Prototyping and Large-Scale Data Modeling

IDC defines virtual prototyping and large-scale data modeling as the use of computers to create digital models of products or processes and to evaluate and improve the design of the products or processes by manipulating these computer models. A growing number of companies and industries have adopted virtual prototyping and large-scale data modeling as part of their R&D, production, and complex business problem–solving process because virtual prototyping and large-scale data modeling typically are much faster, less expensive, and more conducive to new insights than the traditional process of designing and testing a series of physical prototypes.

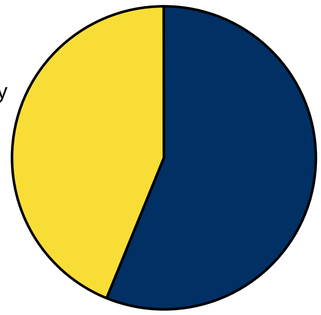
KEY FINDINGS IN THE STUDY

1) "Desktop-Only" Companies Represent Large and Small Firms, Many with Years of Desktop Technical Computing Experience

The companies represented in this study use only desktop systems for technical computing and do not present a simple picture. They come from a broad spectrum of industries. Their employee populations range from under 100 to over 10,000, and their annual revenues range from below $1 million to more than $1 billion in a substantial number of cases (41%). They average 16 years of experience with technical computing. Many have problems that are too complex for their desktop computers and respond to this dilemma with productivity-reducing compromises. As Figure 1 shows, 44% are open to using HPC, but many of these receptive firms do not expect to act unless a customer requires them to use HPC servers for modeling and simulation or a serious competitive threat emerges. Fifty-six percent (56%) believe their desktop computers are good enough and don't aspire to use HPC servers. Others have little knowledge about HPC and how it might help. Still others aspire to HPC but can't justify the move to senior management. Another small group has completed the justification and is ready to apply HPC. (For more on the breakout of groups, see the beginning of the Survey Results section of this study.)

FIGURE 1

Participants' Aspirations to Use HPC Servers



Note: Participants have never used HPC.

Source: IDC, 2007

"PCs fill our needs at this point."

"Customers are not requiring it."

"If our budget allowed, I would definitely use HPC servers."

"Substantiating ROI is the problem."

"HPC is an excellent tool for determining the viability of an idea."

"HPC is very powerful if used properly."

2) Nearly Every Firm Surveyed Uses Digital Virtual Prototyping and/or Large-Scale Data Modeling — the Prerequisites for HPC — and in Many Firms These Activities Are Increasing

The vast majority (97%) of the companies perform virtual prototyping or large-scale data modeling on their desktop computers in designing their products. Virtual prototyping and large-scale data modeling have put a sizable dent in traditional physical prototyping and testing. Virtual prototyping and large-scale data modeling now handle about one-third of the companies' testing and prototyping needs, with the remainder still relying on physical experimentation. The use of virtual prototyping and large-scale data modeling is increasing at a substantial number of the firms, making them more likely prospects for HPC.

"Virtual prototyping is crucial in reducing the development cycle by identifying and correcting design issues before cutting steel. It reduces the amount of physical testing."

"It gives us the ability to build units and test them before hardware is made."

"It is a necessity. We can't design and build testable parts without it."

"We could not compete without it."

"It has not proven itself useful in our situation."

3) Many Companies Have Advanced Problems That They Can't Solve on Their Desktop Computers

Fifty-seven percent (57%) of the companies said that they have problems that they can't solve with their existing desktop computers. A high proportion (53%) of the companies were forced to scale down their advanced problems to fit their desktop computers, resulting in a loss of insight, innovation, and competitive gain. Others are choosing to ignore their advanced problems, with more dire consequences. A third strategy, pursued by more than half the firms, was to increase the amount of slower, more expensive physical prototyping. Previous IDC-Council on Competitiveness studies showed that these alternatives render companies more vulnerable to competitors that have greater determination to employ HPC servers for their proven benefits.

"Design and simulation of business models cannot be explored today."

"We can't do advanced analysis."

"We can't do full chip simulations of larger chips."

"3D modeling is something we can't do today."

"We cannot simulate product shipping."

4) Three Systemic Barriers Are Stalling HPC Adoption: Lack of Application Software, Lack of Sufficient Talent, and Cost Constraints

- **Lack of application software.** The importance for industry of software applications used to model products and processes can hardly be overstated. The users of single-processor desktop computers in this study expressed strong concern about the availability of software that could run their problems on multiprocessor HPC servers. Without knowing whether such software is available, the desktop users cannot assemble technical or return-on-investment (ROI) arguments to persuade senior management to acquire HPC servers. In earlier IDC-Council on Competitiveness studies, the lack of appropriate application software emerged as a paramount concern even among high-end, cutting-edge HPC users. See *Council on Competitiveness Study of ISVs Serving the High Performance Computing Market, Part A: Current Market Dynamics* (July 2005); *Council on Competitiveness Study of ISVs Serving the High Performance Computing Market, Part B: End User Perspectives* (February 2006); and *Council on Competitiveness Study of U.S. Industrial HPC Users* (July 2004). The studies are downloadable from **www.compete.org**.

- **Lack of sufficient talent.** For the desktop users, access to in-house or external HPC experts is another important prerequisite for HPC adoption. Lack of an adequate number of people skilled in using HPC hardware and software systems to run specific business and industrial problems was another frequently cited barrier.

- **Cost constraints.** The third major barrier to HPC adoption was cost, including the aforementioned difficulty of convincing the executive suite to approve HPC budgets and purchases. These same issues have persisted as the top three barriers to (expanded) HPC usage since the initial *Council on Competitiveness Study of U.S. Industrial HPC Users* in July 2004.

"No one has written simple or useful programs for our field."

"We need software that will do the task and management vision to see the value."

"With us, there's a lack of knowledge and a possible lack of software solutions."

"HPC would not be effective due to software unavailability."

"The problem is price and the need for a dedicated technical person."

"Lack of in-house expertise is a problem for us."

"We don't have the time to consider an alternative system."

"At present, risk aversion is so high that our limit to improvement and innovation is the comfort level of management."

"It could be beneficial to our business if an appropriate return on investment could be realized for the acquisition [of] and training on these tools."

5) An "Enabling Function" Is Needed to Help Firms Overcome Barriers to Adopting HPC

The barriers described in key finding #4 constitute serious deterrents to HPC adoption for the entire category of "desktop-only" technical computing companies, and it would be unreasonable to expect individual "desktop-only" firms to tackle these systemic barriers on their own. It is hardly surprising that few of these companies said they are likely to try to overcome these barriers in order to move to entry-level HPC servers without an external customer mandate or manifest competitive threat. Having this whole category of firms confined by systemic barriers to desktop-level technical computing represents a lost opportunity for U.S. competitiveness gain. To exploit this opportunity, firms need an "enabling function," in the form of a larger outside party, or parties, willing to taking a systemic approach to reducing the systemic barriers to HPC adoption. IDC believes public-private partnerships are best suited to provide the requisite enabling function.

"As customers become more sophisticated and model validation is more accepted, I see modeling becoming a best practice."

"The need for HPC is driven by customer requirements. As more customers move to HPC, we will expand our development to those platforms."

"The potential is limited unless customers start to require HPC."

6) A Substantial Minority of the Companies Are Open to Paying an Outside Consulting Organization to Help Them Explore the Benefits of HPC

Of the 77 companies, 22 (29%) said they are willing to pay an outside organization to help them understand HPC and how it can lead to superior, better-selling products. The amounts these companies are willing to pay annually range from $25,000 to $200,000, depending on the size of the firm. The most popular choices for outside assistance are large and small system vendors, engineering services companies, major universities, and local technical experts. Least favored are general IT consulting companies and trade associations. The stated willingness of nearly one in three surveyed firms to pay for outside assistance shows that there is a real desire, at least among this substantial minority, to explore the benefits of adopting HPC.

"We have a lack of knowledge of what software would be required."

"Someone needs to explain the benefit for our company."

"I don't know what's available and how [many] resources and [how much] time would be required initially to develop software solutions."

Implications from the Study

HPC Is a Game-Changing Technology; Desktop Technical Computing Users Who Fail to Adopt It May Be at Significant Competitive Risk.

HPC can be a game-changing technology in that it dramatically accelerates the innovation process, shrinking time to insight and time to discovery. Companies that have made the move to entry-level HPC are realizing top-line and bottom-line benefits, including faster time to market, increased market share, reduced costs, higher-quality products and services, and increased productivity. Companies that fail to investigate this technology and embrace it where appropriate may find their competitive standing eroding. Many "desktop-only" technical computing users are prime candidates for stepping up to HPC. The advanced problems their desktop computers cannot solve today represent lost opportunities for these firms to power ahead of their global competitors. The fast growth in the global market for entry-level HPC servers means that any time, anywhere, some determined non-American company could use one of these computers to leap to the head of the pack. Large companies that use only desktop technical computing may be at even greater competitive risk than smaller firms that have not yet adopted HPC technology. Larger firms often are slower to adopt new and/or different technologies because their current technologies are deeply embedded into complex workflows that can be difficult and costly to revamp.

But despite the potential competitive advantage associated with adopting HPC and the potential competitive disadvantage from failing to adopt the technology, the status quo uncovered by the study can be summed up as follows: More than half (56%) of the companies that have never used HPC believe that their desktop technical computers are adequate, and the remainder (44%) are receptive to HPC but need an external "enabling function" to help them overcome systemic barriers and move forward.

Critical Supply Chains and the Leadership of Many U.S. Industries May Be at Risk if Larger Numbers of "Desktop-Only" Firms Do Not Advance to HPC-Based Modeling and Simulation.

The study implies that the systemic barriers preventing HPC adoption are too difficult for many "desktop-only" firms to overcome without assistance in the form of an "enabling function." If over time they cannot meet more complex requirements — and meet them at a faster pace — they will place themselves, as well as customers who rely on them, in competitive jeopardy. IDC believes that the failure of companies of all sizes to exploit HPC more thoroughly will put major U.S. industries at greater risk — and sacrifice a rare opportunity for the United States to make a quantum leap forward in productivity and competitiveness. Companies that are experienced HPC users are beginning to grapple with this issue, although no clear solution has emerged. For example, Pratt & Whitney, an experienced HPC user, will help suppliers on a select basis that are ready to use HPC learn how to exploit this technology in order to better meet Pratt & Whitney's requirements. This approach benefits both Pratt & Whitney and the suppliers (see *Council on Competitiveness Third Annual HPC Users Conference Report: Moving Beyond Islands of Innovation* at **www.compete.org**). But instructing suppliers in the use of HPC is not the norm among corporations with substantial HPC experience, nor is it commonplace within Pratt & Whitney. Software licenses frequently restrict usage to company employees only, and companies rarely have available time on their HPC systems for their suppliers to use. For these and other reasons, large firms cannot be expected to spend the time and money to provide the enabling function that makes HPC adoption easier for "desktop-only" technical computing users. A new framework is needed.

Unless the Academic Community Responds More Aggressively, the United States Will Continue to Suffer from a Substantial HPC Talent Deficit.

The largest generation of HPC experts is fast approaching retirement age, and colleges and universities are not producing nearly enough graduates with the skills to replace them — much less keep pace with the enormous recent growth of the entry-level HPC market. America's universities have an opportunity to help create this skilled talent to fill the growing HPC job market, as well as to help companies solve their current HPC-level problems. In addition, they can help two-year technical colleges and community colleges, which often have close relationships with the small business community, develop curricula to assist these potential HPC users. In effect, universities could train not only their own students but also other trainers.

In the interim, the talent deficit places even greater emphasis on the need to increase the productivity of current HPC users. The DARPA High Productivity Computer Systems program is organized around this central premise, with a top-down approach in which the most experienced HPC vendors and users will lead the way.

Independent Software Vendors Could Benefit by Helping Their Desktop Computer Users Transition to Entry-Level HPC Servers.

Today, independent software vendors (ISVs) serving technical computing markets depend for the vast majority of their revenue on providing application software for single-processor desktop computers. Prior IDC studies have shown that in many cases, desktop computers represent 95–99% of the ISVs' revenue. Within a few years, desktop technical computers will be multiprocessor, multicore systems. Because ISVs will need to adapt their applications for these parallel computer systems in any case, enterprising ISVs could benefit by taking this one step further — ensuring that their applications will also run on entry-level HPC systems. This could create new, or expanded, revenue streams for the ISVs.

New Partnership Programs May Be Needed to Bring "Desktop-Only" Technical Computing Users into the HPC Fold and to Enable More Entry-Level Users to Exploit HPC More Fully for Competitive Advantage.

Successful public-private partnerships such as the Department of Energy's INCITE program (**http://hpc.science.doe.gov**) are shining examples of the "enabling function" approach, but they are designed for experienced, high-end HPC users rather than neophyte or entry-level users. Since the INCITE program was extended to include private-sector companies in 2005, corporate participants have successfully competed for time on DOE leadership-class HPC systems and have been solving advanced problems critical to their future competitiveness. For example:

- New public-private partnership programs involving national laboratories and/or university-based HPC centers may be needed to help "desktop-only" companies migrate to HPC.

- Partnership programs might also help the desktop companies' customers, who rely on the products and services of the desktop firms to maintain their own competitiveness.

- Experienced HPC users who have suppliers that are ready to move forward with HPC modeling and simulation could guide the suppliers to public-private partnership programs for access to the HPC systems and experts they need to make the transition.

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SITUATION OVERVIEW

Motivations for This Study

This study is the latest in a series of IDC studies conducted for the Defense Advanced Research Projects Agency (DARPA) through the Council on Competitiveness' HPC Initiative, a project started three years ago with the goal of identifying ways to use HPC to boost U.S. industrial productivity and global competitiveness. The study's other sponsors, the University of Southern California's Information Sciences Institute (USC-ISI) and the Air Force Research Laboratory (AFRL), have long-standing interest and involvement in advancing U.S. industrial capabilities.

Prior studies conducted for the Council on Competitiveness' HPC Initiative identified HPC's important contribution to industrial innovation, productivity, and competitiveness — confirming the high value of this technology for experienced HPC users. But the studies also revealed that the market of industrial HPC users is bifurcated, with a relatively small number of experienced HPC users at the high end, a much larger number of HPC users at the entry level, and little in between these two extremes. In addition, IDC research has shown that an even larger number of companies perform technical computing on desktop systems but have not advanced to HPC. These "desktop-only" companies are the focus of this study.

For more information on the Council on Competitiveness, and to download copies of HPC-related Council on Competitiveness reports and other studies in this series, go to **www.compete.org**. The cosponsors' Web sites are **http://hpc.science.doe.gov/**, **http://www.isi.edu/index.php**, and **http://www.afrl.af.mil/**.

Why Aren't More Desktop Technical Users Advancing to HPC?

The main purpose of this study was to find out why more companies that use desktop computers for product design and development, and for large-scale data modeling (for example, in the financial services industry), have not exploited the more powerful capabilities of HPC servers.

Although prior IDC studies have separately and extensively analyzed the markets for desktop-based technical computing and server-based technical computing (i.e., HPC), to date the relationship between these two important markets has remained largely unexplored. In particular, the factors promoting — and obstructing — the adoption of more powerful high performance computers by users of desktop technical systems (scientific/engineering workstations, PCs, and Macs) have not been adequately described. To what extent, for example, is migration to HPC affected by company size, budget considerations, technical computing longevity, in-house expertise, the industry in which the company competes, or the use of HPC by direct competitors?

HPC Has Proven Benefits for Industry

The lagging adoption of HPC among desktop users is important to consider in view of HPC's proven benefits for the vast majority of companies that have learned how to exploit this technology.

Industrial and other business firms are driven by external competition in a never-ending race to be first to market with the best products. In these battles for global market supremacy, more capable computing resources can translate into faster time to market, superior product quality, and novel insights that enable breakthrough competitive advances.

The July 2004 *Council on Competitiveness Study of U.S. Industrial HPC Users*, sponsored by the DARPA, found, among other things, that 97% of the U.S. businesses surveyed could not exist, or could not compete effectively, without the use of HPC. Subsequent IDC-Council on Competitiveness studies of industrial HPC users reaffirmed that for companies that have learned how to exploit HPC-based modeling and simulation, this technology is critical for accelerating innovation and maintaining global competitiveness. Respondents in these studies represented companies with annual revenues ranging from under $1 million to more than $1 billion.

Given the proven competitiveness benefits of HPC for companies of many sizes that have adopted the technology, the current study set out to discover why more firms that already rely on technical computing have not moved off the desktop to embrace HPC. This lack of adoption represents a lost opportunity for competitive advantage, for the companies in question and on a national level. Thus, an important goal of this study was to identify opportunities for more fully exploiting HPC in order to increase the productivity of industrial scientists, engineers, and analysts and, ultimately, to boost national competitiveness.

SURVEY RESULTS

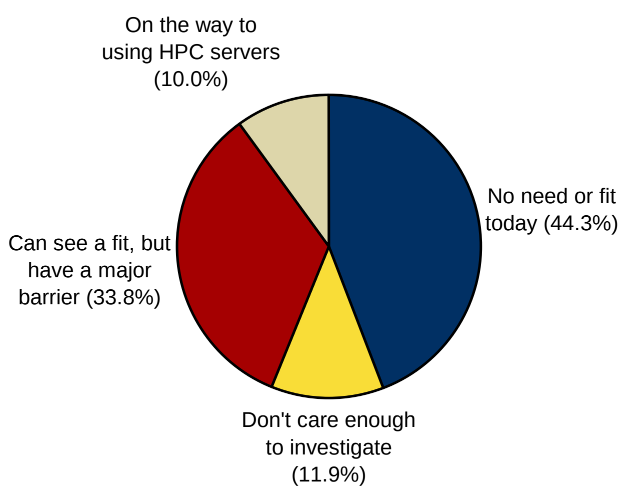
The participants in this study represented a broad range of industries and business sectors that employ technical computing today (see Table 1). IDC uses the term *technical computing* to encompass the entire market for computers (and related software and services) employed by scientists, engineers, analysts, and others to address computationally intensive modeling and simulation problems. Technical computing activities can be found in industry, government, and academia. Technical computers range from desktop systems (scientific/engineering workstations, PCs, and Macs) to small servers costing less than $5,000 and large, high-capability machines valued at tens and, occasionally, hundreds of millions of dollars each. Technical computing is in contrast to commercial computing (also called enterprise computing) that is used for business operations such as accounting, payroll, sales, customer relations, transaction processing, human resources, and purchasing. The HPC market includes servers used for technical computing, but excludes single-user desktop workstations, PCs, and Macs.

The sample sites in the study had very mixed views of using HPC servers and the fit of HPC for their organizations. Figure 2 shows how the sample was divided into four broad categories. (Note: The percentages in Figure 2 are close estimates based on a number of questions. Respondents were not asked a specific question about the fit of HPC for their organizations.) The categories are as follows:

- Sites that see no need or fit today (44.3%), either because they believe their desktop technical computers are adequate for their problems or because the cost of HPC servers is too high.
- Sites that don't care enough about HPC servers to explore their use (11.9%). There may be a fit for HPC in these sites, but there is little or no motivation to find out more about the technology.
- Sites that see the benefits of using HPC, but have one or more major barriers that keep them from using HPC servers (33.8%). These sites would need an outside impetus ("enabling function") to move forward on HPC, and they do not expect to implement HPC servers in the near future.
- Sites that see the benefits of applying HPC servers to gain a competitive advantage and are on the way to implementing HPC servers in the near future (10.0%). These sites have barriers, but feel that they can overcome these roadblocks.

FIGURE 2

Participants' Views of HPC Server Fit



Note: Participants have never used HPC.

Source: IDC, 2007

Participants' Backgrounds

The study's 77 participants provided 83 responses to the following question: "What type of business or industry is your company/department primarily in?" (Multiple responses were allowed.) The 10 business sectors eliciting at least two responses each are listed by name in Table 1. Very strongly represented on this list are the IT and electronics industry (22% of all responses), the aerospace industry (14% of all responses), and general manufacturing (14%). Other industries with long technical computing histories are also represented: petroleum, oil and gas (8%), chemical (8%), pharmaceutical (7%), and automotive (5%). Also on the list, however, are industries that are newer to technical computing, including the entertainment industry.

The "Other" category (10% of all responses) illustrates how pervasive technical computing has become within the private sector — at least on the desktop. This varied group includes representatives from many sectors: mass transit, consumer appliances, environmental instrumentation, antitheft security, industrial controls, power tools, nuclear medicine R&D, power supplies, building products, mining, and optical test equipment.

TABLE 1

Primary Business/Industry

Q. What type of business or industry is your company/department primarily in?

	Number of Mentions	% of Mentions
IT and electronics	17	22.1
Aerospace	11	14.3
General manufacturing	11	14.3
Telecommunications	7	9.1
Petroleum, oil and gas	6	7.8
Chemical	6	7.8
Test, measurement, and control	6	7.8
Pharmaceutical, life sciences, and biomedical	5	6.5
Automotive	4	5.2
Transportation and logistics	1	1.3
Entertainment	1	1.3
Financial services and economic modeling	0	0.0
Other	8	10.4
Total	83	

n = 77

Note: Multiple responses were allowed.

Source: IDC, 2007

On average, the firms have been using desktop technical computing for 16 years (i.e., since about 1990) (see Table 2). As a group, they are very experienced technical computing users. We can reasonably conclude that inadequate exposure to technical computing is unlikely to be a prominent reason for not moving up to HPC.

TABLE 2

Number of Years Using Desktop Technical Computing

Q. How long have you been using desktop technical computing (in years)?

Average	16.4
Median	17.0
Minimum	1
Maximum	26
n =	77

Source: IDC, 2007

Table 3 describes the main application areas (uses) for the respondents' desktop technical computers. (Multiple responses were allowed.) Topping the list were CAD/autocad/3D modeling applications, which represented about one of every six responses (17%). Following at some distance were CAD/engineering design/modeling and other data analysis/simulation (11% each). EDA/electromagnetics (10%) was another popular choice. Other applications varied greatly, but substantially trailed these applications in popularity. Some respondents also cited desktop computer applications, such as email, that are unrelated to technical computing as defined in this study.

TABLE 3

Main Applications for Desktop Technical Computers

Q. What are the main applications or areas of use for your company's desktop technical computers?

Application	Number of Mentions	% of Mentions
CAD/autocad/3D modeling	26	17.0
Other data analysis/simulation	18	11.8
CAE/engineering design/modeling	17	11.1
EDA/electromagnetics	15	9.8
Software/firmware development	12	7.8
Instrument control/data acquisition	11	7.2
Signal/image processing	10	6.5
Spreadsheets	7	4.6
Email/communications	6	3.9
FEA	6	3.9
Technical writing/documentation	6	3.9
Project management	3	2.0
Spectrometry/spec. data integration	2	1.3
MatLab	2	1.3
Statistics	2	1.3
Injection molding simulation	2	1.3
Business applications	2	1.3
CFD	1	0.7
Chromatographic data integration	1	0.7
Nuclear and high energy physics	1	0.7
Database	1	0.7
Other virtual prototyping	1	0.7
Geological/geochemical modeling	1	0.7
Total	153	

n = 72

Note: Multiple responses were allowed.

Source: IDC, 2007

The wide range of company revenue sizes among the respondents (under $1 million to more than $1 billion) should dispel any preconceived notion that technical computing users who have not yet adopted HPC are predominantly from small firms (see Table 4). Four in 10 (41%) of the surveyed group had revenue above the $1 billion mark, and about half (49%) claimed annual revenue of $100 million or more. Only about one in seven of the companies (14%) had revenue in the "small company" range below $10 million. The largest clusters of the respondents fell into the $10 million to $99.9 million (24%) and over $1 billion ranges. Of particular importance for this study, IDC found no strong correlation between company size and the degree to which the companies were using virtual prototyping and large-scale data modeling.

TABLE 4

Company Revenue

Q. Using the following broad categories, what was your company's revenue last year?

	Count	% Noting
Under $1 million	4	5.6
$1 million to $9.9 million	6	8.5
$10 million to $99.9 million	17	23.9
$100 million to $499 million	9	12.7
$500 million to $1 billion	6	8.5
Over $1 billion	29	40.8
Total	71	100.0

Source: IDC, 2007

Employee counts (see Table 5) underscored the wide range of company sizes among the survey respondents. More than half of the group (53%) had more than 1,000 employees, and almost one in six (17%) exceeded 10,000 employees. That said, the ranges of employee counts were spread fairly evenly, with the 1,000 to 10,000 range being cited most frequently (36%).

TABLE 5

Company Size

Q. How many employees are employed at your company/organization?

Number of Employees	Count	% Noting
1 to 100	12	15.8
101 to 500	14	18.4
501 to 999	10	13.2
1,000 to 10,000	27	35.5
Over 10,000	13	17.1
Total	76	100.0

Source: IDC, 2007

Even more important for the purposes of this study, as Table 6 shows, the companies as a group employed substantial numbers of scientists, engineers, or analysts (including financial analysts). More than half the companies (56%) had 100 or more of these technically oriented employees on staff, and one in five of the firms employed more than 1,000 individuals fitting this description. While about one in six of the companies had 10 or fewer scientists, engineers, or analysts, on the whole it seems safe to assume that the companies in this study place substantial emphasis on R&D activities and computational analysis activities.

TABLE 6

Number of Scientists, Engineers, or Analysts Employed

Q. How many scientists, engineers, or analysts (including financial analysts) are employed at your company/organization?

Number of Employees	Count	% Noting
1 to 5	6	8.0
6 to 10	4	5.3
11 to 25	9	12.0
26 to 50	8	10.7
51 to 99	4	5.3
100 to 1,000	29	38.7
Over 1,000	15	20.0
Total	75	100.0

Source: IDC, 2007

Use of Technical Computing Servers or HPC

This group of companies does not need to be educated about the fundamental value of technical computing. Regardless of company size, virtually all of the respondents (97%) saw technical computing as a driver for their competitive success (see Table 7). We mentioned earlier in the document (refer back to Table 2) that the companies averaged 16 years of experience with technical computing. It is hardly surprising then that they would see value in an activity they have continued for so many years.

TABLE 7

Technical Computing as a Driver of Competitive Success

Q. Do you view technical computing as a driver for your competitive success?

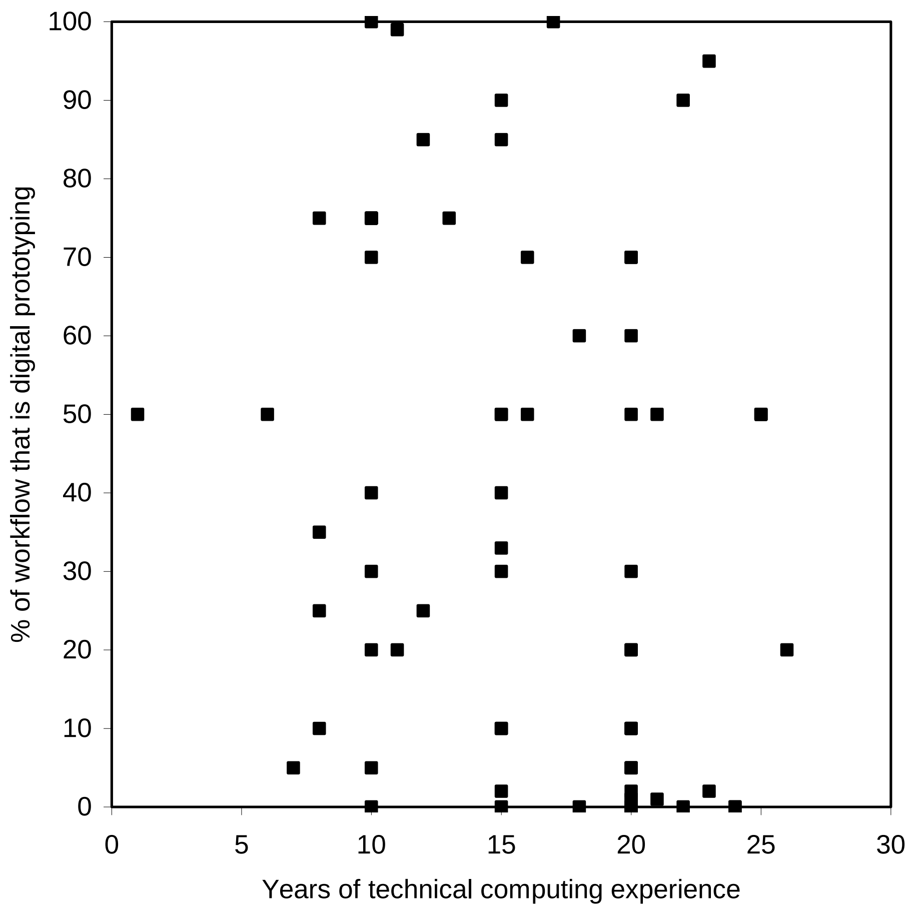
% responding yes	97.3
% responding no	2.7
n =	75

Source: IDC, 2007

Figure 3 shows that there isn't a strong correlation between the number of years a company has been involved in technical computing and the amount of work that is done by computer or through virtual prototyping and large-scale data modeling. A number of comparisons were explored to see if there were attributes that were strongly correlated to the level of virtual prototyping, but none were found. There is a moderate tendency for more experienced technical computing organizations to be more heavily involved in virtual prototyping and large-scale data modeling. There is a small correlation between companies whose workforces are fully or almost fully engaged in virtual prototyping and large-scale data modeling and those that have tried using HPC servers before.

FIGURE 3

Use of Virtual Prototyping and Large-Scale Data Modeling Compared with Years of Technical Computing Experience



Source: IDC, 2007

Why Companies Are Not Using HPC Today

Consistent with responses to other questions in this study, the responses to the question in Table 8 revealed a split between companies that have no need for HPC because their desktop systems are adequate (44%) and companies that might be open to exploiting HPC if current barriers were removed or made less daunting. Chief among those barriers were budget/cost considerations (30%). No other obstacle came close in importance as a response to this question.

TABLE 8

Reasons for Not Using Technical Servers or HPC or Larger-Scale Modeling/Simulation

Q. Why are you not using technical servers or HPC or larger-scale modeling/simulation today?

Reason	Number of Mentions	% of Mentions
HPC not needed/desktops powerful enough	31	44.3
Budget/cost/cost benefit/lacks ROI	21	30.0
Application software readiness/scalability	4	5.7
Using grid/LSF solution/server sharing	3	4.3
Special requirements — embedded solutions, flexibility	3	4.3
Overall expertise/system management/staff	3	4.3
HPC not available	2	2.9
Communications with the server are unreliable	1	1.4
Not familiar with what is available	1	1.4
Lack of vendor support	1	1.4
Total	70	100.0

n = 66

Note: Multiple responses were allowed.

Source: IDC, 2007

Users' Experience with HPC Servers

Just 17 of the 77 surveyed users (22%) responded to the question about whether they had prior experience with HPC. Of that minority, 14 respondents (18% of the 77 surveyed) said they had tried using HPC before (see Table 9). It was not within the scope of the present study to ask whether the respondents had tried using HPC in their current jobs or at some earlier point in their careers. Still, it is worth noting that about one in five of the surveyed group claimed some prior exposure to HPC. These firms may be candidates for adopting HPC on a regular basis.

TABLE 9

Experience with Technical Servers or HPC or Larger-Scale Modeling/Simulation Capabilities

Q. Have you ever tried using the capabilities provided by technical servers or HPC or larger-scale modeling/simulation?

	Number of Respondents	% of Respondents
Yes	14	18.2
No	3	3.9
No response	60	77.9

n = 77

Note: Only 14 respondents said yes.

Source: IDC, 2007

Table 10 reflects the varying levels of awareness about HPC today within "desktop-only" companies. Nearly half (45%) of the respondents said they had never heard of HPC and/or had no interest in or need for HPC. The remaining 55% had at least some awareness of this technology, in many cases secondhand knowledge gleaned from journals and presentations (27%), customers (2%), or other firms (2%) that used HPC. Some of the companies had advanced beyond this baseline awareness and had investigated HPC use to the point of encountering issues, such as a lack of HPC-level software to match the companies' needs (6%) and cost issues (5%). A few respondents (3%) had concluded that they needed HPC and were actively evaluating it. Another 5% reported that they were already using HPC to some extent (partially elevating them above the category of "desktop-only" companies).

For the substantial number of firms that had never heard of HPC or had only secondhand knowledge, it is intriguing to imagine the effect of exposing these companies to some of the experienced HPC industrial users who, in prior IDC-Council on Competitiveness studies, stated that HPC had become indispensable to their competitiveness and survival.

TABLE 10

Awareness About HPC Within "Desktop-Only" Companies

Q. Have you heard much about HPC servers or investigated their usefulness (e.g., heard about examples in your field or talked with colleagues who have used them)?

Response	Number of Mentions	% of Mentions
All no	29	45.3
No — No interest/no need/no comment	22	34.4
No — Never heard about	7	10.9
All yes	35	54.7
Yes — Journals, colleges, presentations, etc.	17	26.6
Yes — Operations/applications do not match	4	6.3
Yes — Cost issues	3	4.7
Yes — Some use	3	4.7
Yes — Need technology/evaluating technology	2	3.1
Yes — Customers use	1	1.6
Yes — Other companies	1	1.6
Yes — Applications tool vendor is beginning to provide codes	1	1.6
Yes — Effectiveness issues	1	1.6
Yes — Use LSF/grids	1	1.6
Yes — No management support	1	1.6
Total	64	100.0

n = 64

Source: IDC, 2007

Participants' Interest in Using HPC Servers

As Table 11 shows, more than half (51%) of the respondents said they would use HPC if it were made easy to access and affordable through outside sources; and when the "maybe" responses are added, this figure climbs modestly to 58%. This may be a "motherhood-and-apple-pie" question, but the reaction demonstrates at least that a substantial fraction of this group of companies is receptive to using HPC under the right circumstances and to using it on an outsourced basis. (The remaining 42% of the respondents are intriguingly similar to the 45% who said, in response to the question in Table 10, that they had never heard of HPC and/or had no interest in it.)

TABLE 11

Interest in Using HPC Servers

Q. If you had easy and cost-effective access to external HPC servers/software, would you use it?

% responding yes	50.7
% responding no	41.8
% responding maybe	7.5
n =	67

Source: IDC, 2007

Table 12 digs deeper into the factors that would motivate the companies to exploit HPC for larger-scale modeling and simulation. The factors, as formulated in the question, fall into three categories: cost, "strategic fit" software, and human talent/expertise. (IDC also encouraged respondents to cite additional factors that might apply to them, but they did not provide additional responses. "Strategic fit" software and cost emerged as the companies' principal criteria for adopting — or not adopting — HPC.)

The two top choices were related to the availability of software. Respondents on the whole rated software availability as a substantially greater enticement for advancing to HPC than even the prospects of free hardware and free expertise. This finding has important implications. First, it implies that giving people a free HPC server or free time on one, along with free help in using this resource, is not sufficient to motivate HPC adoption among "desktop-only" companies. A second implication is that software availability precedes ROI considerations. Unless appropriate software is available, ROI arguments cannot be assembled. For this group of "desktop-only" technical computing companies, software that is capable of running their problems at the HPC level is more important than software ease of use or hardware or human expertise — although access to skilled HPC experts was mentioned by 35 of the 66 respondents (53%) to this question.

It is safe to assume that most of these companies are still using single-processor desktop systems for their technical computing needs; their concerns presumably are about the availability of multiprocessor versions of appropriate software. The primary importance of multiprocessor software and the important role of cost suggest that there may be opportunities for independent software vendors (ISVs) to benefit from facilitating the transition of "desktop-only" companies to HPC.

IDC posed these "strategic fit" software questions because prior IDC-Council on Competitiveness studies of experienced industrial users of HPC (note, not desktop users) highlighted the crucial importance for industry of accurate, relevant software-based models and of easy-to-use third-party software applications incorporating these models. An automaker that wants to forge ahead of its competitors by designing vehicles with quieter, more comfortable passenger cabins, for example, would not be helped by a crash-testing model or application. Only a noise, vibration, and harshness (NVH) application would be a "strategic fit" for this objective. Prior studies include *Council on Competitiveness Study of ISVs Serving the High Performance Computing Market, Part A: Current Market Dynamics* (July 2005); *Council on Competitiveness Study of ISVs Serving the High Performance Computing Market, Part B: End User Perspectives* (February 2006); and *Council on Competitiveness Study of U.S. Industrial HPC Users* (July 2004). The studies are downloadable from **www.compete.org**. Hence, lack of appropriate application software has emerged as a paramount concern among both desktop technical computing users and high-end, cutting-edge HPC users. The desktop users want application software that allows them to advance to entry-level HPC servers, while the cutting-edge users want software that enables them to exploit the largest, most powerful HPC servers, which may have tens of thousands or (soon) hundreds of thousands of processors. Both groups want software not only that presents a strategic fit for their problems but also that is easy to use and does not require specialized expertise.

The importance for industry of accurate, relevant mathematical models of physical processes — and of software applications embodying these models — can hardly be overstated. Solving problems — often by running the same application repeatedly to close in on an optimal solution — can be far more time-critical for industry than for government and university organizations pursuing scientific research. Businesses are driven by external competition in a never-ending race to be first to market with the best products and services. In these battles for global market supremacy, more capable computing resources can translate into faster time to market, superior product quality, and novel insights that create lasting competitive advantage.

Most technical computing users in industry, whether on desktop systems or servers, depend heavily on commercial software available from ISVs. Although competent applications exist in many disciplines, it is safe to assume that applications do not exist for every need and set of circumstances within those disciplines. A Council on Competitiveness HPC software workshop report (*Accelerating Innovation for Competitive Advantage: The Need for Better HPC Application Software*, July 2005), coupled with a two-part study conducted by IDC (*Council on Competitiveness Study of ISVs Serving the High Performance Computing Market, Part A: Current Market Dynamics*, July 2005; and *Council on Competitiveness Study of ISVs Serving the High Performance Computing Market*, *Part B: End User Perspectives,* February 2006), found that a serious gap exists between the needs of commercial HPC users and the capabilities of ISV applications. HPC users want to exploit the problem-solving power of contemporary HPC servers with hundreds, thousands, or (soon) tens of thousands of processors for competitive advantage, yet few ISV applications today "scale" beyond 100 processors and many of the most used applications scale to only a few processors in practice. (The ISVs are not at fault here. The business model for HPC-specific application software has all but evaporated in the past decade.)

The technical computing users in this study may or may not have access to applications, written for desktop systems, that provide a "strategic fit" for all their varied problems (e.g., mass transit, consumer appliances, nuclear medicine R&D). It is even less likely that server-based (HPC) versions of applications exist that fit all these problems. It is a near certainty that easy-to-use and highly scalable versions of the server-based applications are not available for every problem. As prior IDC-Council on Competitiveness studies have demonstrated, there is an urgent need for advances in software applications to meet the demands of HPC users. Where application software is concerned, the findings of the current study mirror those of the 2004 *Council on Competitiveness Survey of U.S. Industrial HPC Users*. Even in cases where competent server-based versions of "strategic fit" applications exist today, desktop technical computing users need training in the use of larger-scale, HPC-based modeling and simulation. In recognition of this important need, survey respondents also assigned substantial importance to the availability of "free or very low-cost expertise to teach us how to use [HPC technical servers] and to help us set up our models on the technical servers."

This mirrors the findings in the previously referenced 2004 Council on Competitiveness study conducted by IDC, which revealed that lack of expertise was preventing experienced HPC users from applying HPC more aggressively.

TABLE 12

Motivating Factors for Using HPC for Larger-Scale Modeling and Simulation

Q. Which of the following statements, if true, would cause you to use technical servers or HPC or larger-scale modeling/simulation?

	First Priority	Second Priority	Third Priority	Total Mentions
Someone created an application that fit my requirements	26	10	6	42
Models (or better models) were easily available that fit our requirements	15	14	11	40
The hardware was free	14	10	11	35
Free or very low-cost expertise to teach us how to use [HPC technical servers] and to help us set up our models on the technical servers	9	11	15	35
Application software was free	6	16	10	32

n = 66

Source: IDC, 2007

Barriers to Companies' Use of HPC Servers

The most important barriers (see Table 13) to HPC adoption for these companies were cost (30% of mentions) and lack of any perceived urgent need that the firms' desktop systems could not meet (25%). If the desktop-system-is-good-enough responses are excluded, the major barriers that emerged are the same three that were cited in the 2004 *Council on Competitiveness Study of U.S. Industrial HPC Users:* the cost/value proposition; lack of easy-to-use, scalable software; and lack of adequate human talent and experience. Lack of knowledge/documentation/ experience about HPC (17%) was another frequently mentioned barrier.

TABLE 13

Barriers to HPC Server Usage

Q. Please explain the barriers or limitations that are holding you back from using technical servers.

Barriers	Number of Mentions	% of Mentions
Cost/cost justification	19	29.7
Not critical, no "must-have" applications, current systems good enough	16	25.0
Lack of knowledge/documentation/experience	11	17.2
No applications/software	9	14.1
Ease of use, code porting	3	4.7
System/operational complexity	2	3.1
Other issues	4	6.3
Total	64	

n = 58

Note: Multiple responses were allowed.

Source: IDC, 2007

Drivers That Would Motivate Participants to Use HPC Servers

Among market-driven criteria motivating a move to HPC (see Table 14), future customer requirements (47%) stood out, closely followed by current customer requirements (41%) and the need to catch up to competitors that have already forged ahead by using HPC (41%). Creating a competitive advantage in a vacuum, without an external customer mandate or competitive threat, proved far less compelling (18%) than the "gun-to-the-head" motivations. To an important extent, then, migration to HPC becomes dependent on the ability of the desktop users to discern customer requirements and perform competitive analysis.

Yet even if a customer mandate or competitive threat should arise, these "desktop-only" firms would still face systemic barriers (availability of adequate software, expertise, and funds) that they will not be able to overcome on their own, without help from an "enabling function" (such as public-private partnerships) that could address the systemic barriers on a systemic basis. Unfortunately, the companies' current confinement to desktop technical computing leaves them vulnerable to more agile, determined competitors in the United States and abroad. And once a competitor gains a distinct advantage in the marketplace, it may be too late for the outdistanced firms to catch up.

TABLE 14

Top Drivers for Using HPC Servers

Q. What are the top drivers that would motivate you or your organization to use HPC servers?

	Count	% Noting
We need to use it to meet future customer requirements	31	47.0
Customers require it	27	40.9
Competitors have used it to create an advantage, and we need to close the gap	27	40.9
My organization doesn't have significant competitive advantage, and I need to create it using HPC	12	18.2
Other	9	13.6
Total	106	

n = 66

Note: Multiple responses were allowed.

Source: IDC, 2007

Computer Tools in Use and Use of Virtual Prototyping and Large-Scale Data Modeling

As Table 15 shows, virtually all of the companies (97%) use engineering design/CAD tools, and nearly as many (84%) employ modeling/analysis tools, which are also used in a wide range of nonmanufacturing industries, including financial services and consumer products. Visualization tools (70%) made up the other popular category.

TABLE 15

Tools Used

Q. Does your company use:

	Count	% Noting
Engineering design aids or CAD tools	71	97.3
Modeling and/or analysis tools	61	83.6
Visualization tools	51	69.9
Total	183	

n = 73

Note: Multiple responses were allowed.

Source: IDC, 2007

Table 16 describes the split within these firms of physical experimentation (testing/prototyping) and computer modeling and simulation (computer virtual prototyping and large-scale data modeling). On average, more than one-third of all testing/prototyping (35%) occurred on computers versus just under two-thirds (65%) via physical experimentation. As expected, almost all (99%) of the companies perform physical testing and prototyping. (In rare instances, industrial processes are not amenable to physical experimentation.) The percentage of companies doing at least some virtual prototyping on desktop technical computers was also extremely high (97%). Clearly, the vast majority of the companies are accustomed to using technical computers for a sizable portion of their testing and prototyping needs.

TABLE 16

Mix Between Physical Testing/Prototyping and Computer Modeling and Simulation

Q. What is the mix of physical testing and prototyping versus computer virtual prototyping in your department?

	Average	Count	% Noting Some Use
% physical testing and prototyping	64.7	72	98.6
% computer virtual prototyping/large-scale data modeling	35.3	71	97.3

n = 73

Note: Multiple responses were allowed.

Source: IDC, 2007

As Table 17 shows, 41% of the respondents said that the use of computer-based virtual prototyping and large-scale data modeling was increasing at their firms. The average annual increase was 12%, with a maximum reported increase of 25%. The substantial rate of increase among these companies makes them more likely to adopt HPC.

TABLE 17

Use of Computer Virtual Prototyping

Q. Is your use of computer virtual prototyping increasing, staying flat, or decreasing, and by what percentage a year?

	Count	% Noting	Average Amount	Minimum	Maximum
Increasing by % a year	28	40.6	12	1	25
Staying flat	38	55.1	–	–	–
Decreasing by % a year	3	4.3	12	10	15

n = 69

Source: IDC, 2007

Companies' Views of Virtual Prototyping and Large-Scale Data Modeling

When respondents were asked how they viewed the whole category of virtual prototyping, data modeling, and simulation, 92% expressed opinions reflecting a positive perspective, while 5% (3 of 58 respondents) had negative responses and the remaining 2 respondents were neutral on the subject (see Table 18). Thirty percent (30%) of the respondents voiced a general positive view of the category. One in seven (14%) said the ability to do virtual prototyping and large-scale data modeling was critical. Another 13% felt positive about virtual prototyping and related activities, but they pointed out the need to justify its considerable cost. The negative opinions had to do with companies' limited need to tackle big problems and the expense and cumbersome training involved. The preponderance of positive opinion is not surprising, given the fact that nearly all of the firms (97%) said they do virtual prototyping or large-scale data modeling at least to some extent (refer back to Table 16).

TABLE 18

Computerized Virtual Prototyping, Modeling, and Simulation as a Productivity Enhancement

Q. What is your view of computerized virtual prototyping, modeling, and simulation as a productivity enhancement?

View	Number of Mentions	% of Mentions
Positive: General	19	30.2
Positive: Critical/required/must have	9	14.3
Positive: But must be cost justified/still to costly	8	12.7
Positive: Time to market/general time saving	6	9.5
Positive: Reduce costs — production, testing, models	5	7.9
Negative: Limited requirements, big problems only	2	3.2
Positive: Benefit in reduced risk, leading to management willingness to innovate	2	3.2
Positive: But application specific	2	3.2
Not applicable/useful to respondent	2	3.2
Positive: Improve design/quality	2	3.2
Positive: But needs some time for acceptance	1	1.6
Negative: Cumbersome, extensive training, expensive	1	1.6
Positive: But hits limit at design optimization	1	1.6
Positive: First-stage design	1	1.6
Positive: But lacks reference to reality versus physical models	1	1.6
Positive: But too time-consuming and expensive	1	1.6
Total	63	100.0

n = 58

Note: Multiple responses were allowed.

Source: IDC, 2007

Problem Limitations Today and How Companies Get Around Using HPC Servers

More than half (57%) of the companies said they have problems that can't be tackled with their current limited computing abilities (see Table 19).

TABLE 19

Limitations to Computational Capability

Q. What can't you do today — that is limited by your computational capability?

	Number of Mentions	% of Mentions
No problems	23	43.4
Problems exist	30	56.6
Total	53	100.0

n = 53

Source: IDC, 2007

The companies were often specific about their currently intractable problems, which ranged from broad categories that are too complex to tackle today (e.g., finite element modeling, quantum mechanics, design and simulation of business models, and 3D modeling) to more detailed descriptions (e.g., simulate large digital and analog circuits at the functional and PBC signal levels, detailed analysis of parasitic effects within chips, high-speed image processing in deeply embedded systems). In total, 32 problems were cited that the companies could not reasonably address with desktop technical computers.

Table 20 strongly affirms that the companies' desktop technical computing systems often are not meeting all their requirements. A high proportion (53%) of the companies reported that they must scale down their problems to fit their desktop computers. IDC knows from its prior research and IT industry experience that scaling down R&D, production computing, and business engineering process problems typically results in reduced insight, innovation, and competitive gain — not to mention that this retrograde activity is a poor use of time for a company's high-priced scientists, engineers, and analysts. An alternative cited by one in six respondents (20%), ignoring the advanced problem or task, can have even more dire consequences for a company. A third option mentioned by 53% of the companies, reverting to more physical tests for challenging problems, sacrifices all the proven benefits of virtual modeling and simulation: faster time to market, superior product quality, and lower cost. All of these alternatives render companies more vulnerable to competitors that have greater determination to aggressively advance their R&D, production-computing, and business process–engineering activities.

TABLE 20

Alternatives to Using HPC Computers

Q. What do you do instead of using HPC computers for these tasks?

	Count	% Noting
We don't do the problem or task	12	20.0
We scale the problem down to fit our current computers	32	53.3
We outsource the computing	8	13.3
We use physical tests instead	32	53.3
Other	10	16.7

n = 60

Source: IDC, 2007

Virtual Prototyping and Large-Scale Data Modeling as Competitive Discriminators

In response to an earlier question (refer back to Table 7), 97% of the companies said they viewed technical computing as a driver for their competitive success. A related question (see Table 21) also elicited strong agreement. The 55 companies that responded to this question agreed that computing, simulation, and virtual prototyping provide important competitive differentiation (22 sites did not respond).

TABLE 21

Competitive Importance of Computing, Simulation, and Virtual Prototyping

Q. Do you see computing, simulation, and virtual prototyping as an important competitive discriminator?

% yes (of those who responded)	100.0
% no	0.0
No response	22 sites
n =	55

Source: IDC, 2007

Ways to Expand Companies' Use of HPC Servers

Table 22 describes the types of external organizations that the survey respondents would prefer to work with as their HPC consultants. The most popular first choice among the respondents was "a small system vendor that understands our needs" (24% of respondents), closely followed by "an engineering services company" and "a large system vendor," both the first choice of about one in 6 (17%) of the respondents. For total number of mentions (first, second, or third choice), aside from these categories, "a major university" and "local technical experts" also scored high. The least favored choices were "a general IT consulting company" and "trade association."

Further analysis of the data for this question (not evident in the table) showed that larger companies that "never used HPC" tended to view large system vendors as their preferred consulting organization.

The responses to this question illustrate that to some extent, one person's meat is another's poison; that is, there is not a single, shared rationality within the respondent group. In addition, the situations of these companies likely differ, calling for different attributes in an ideal consultant. On the whole, however, there was substantial agreement between the "best fit" (first choice) and popularity (total mentions) rankings. The preferences tended toward local resources (e.g., "local technical experts") and those, whether local or not, that were likely to know how to construct a strategic fit between a company's problems and HPC resources (e.g., "a small system vendor that understands our needs," "a large system vendor," "a major university").

TABLE 22

Use of Outside Consulting Organizations

Q. If you were to use outside consulting organizations, which would you be most likely to use? (Please mark 1 = best fit, 2 = second choice, 3 = third choice.)

	Total 1	Total 2	Total 3	n (1, 2, and 3) =
An engineering services company	11	7	7	25
A small system vendor that understands our needs	15	6	3	24
A major university	9	6	8	23
A large system vendor like IBM, HP, Sun, etc.	11	7	2	20
Local technical experts	6	4	9	19
An HPC-specific consulting company	5	4	5	14
A government national laboratory including National Science Foundation (NSF) centers	5	1	2	8

TABLE 22

Use of Outside Consulting Organizations

Q. If you were to use outside consulting organizations, which would you be most likely to use? (Please mark 1 = best fit, 2 = second choice, 3 = third choice.)

	Total 1	Total 2	Total 3	n (1, 2, and 3) =
ISV application software provider	3	4	0	7
Regional economic development center	2	2	0	4
A smaller university	0	1	2	3
A community college or technical school	0	3	0	3
A general IT consulting company	1	0	1	2
Trade association	0	0	1	1

n = 63

Source: IDC, 2007

Table 23 shows the annual dollar amounts the companies would be willing to pay for help in realizing the technical benefits of HPC — running larger problems or running current problems faster. Inevitably, these figures represent some mixture of the value the companies assign to HPC, along with assumptions about the real-world elasticity of their budgets. Although the figures varied widely, in general this group of companies was unwilling (or did not expect to have the freedom) to spend large dollar amounts for help in achieving the technical benefits of HPC. The majority (65%) were not interested in spending more money, meaning that a substantial minority — about 35% of the 63 firms responding to this question (29% of the total 77 surveyed firms) — declared themselves willing to pay at least something for better problem-solving. Of those who declared themselves willing to pay for HPC benefits, three out of four (73%) said they would pay about $25,000 a year. About one in six (16%) of this willing-to-pay subgroup was fine with paying about $200,000 annually for HPC-based technical benefits. Of the 63 respondents to this question, seven (11%) were large firms with annual revenues exceeding $500 million. Further analysis not evident in Table 23 showed that larger firms typically were the ones willing to spend more money for these services.

TABLE 23

Annual Dollar Amounts Companies Would Be Willing to Pay for Outside Help

Q. How much would you pay for outside consulting services (e.g., how much would you be willing to pay to run larger problems or your current problems faster)? (in dollars a year):

	Count	% Noting
None or not interested	41	65.1
Around $25,000 a year	13	20.6
Around $50,000 a year	2	3.2
Around $100,000 a year	2	3.2
Around $200,000 a year	3	4.8
Around $500,000 a year	0	0.0
Around $1 million a year	1	1.6
Over $1 million a year	1	1.6

n = 63

Source: IDC, 2007

Barriers to Using HPC Servers

As Table 24 shows, when IDC again asked about barriers to HPC adoption, financial considerations were the highest-ranking and most frequently cited obstacles. Budget limitations in relation to system costs emerged as the number one constraint, cited by about seven in 10 respondents (69%). Close on the heels of this barrier (53%), however, was the difficulty of educating senior management about HPC's value. The third most important barrier — a formidable one — was the lack of internal HPC expertise (44%), followed by another cost item, the expense associated with third-party software (38%). Not surprisingly, these barriers are similar to those that are preventing experienced HPC users from employing this technology more aggressively (see *Council on Competitiveness Study of U.S. Industrial HPC Users*, July 2004). If experienced users are struggling with these challenges, how much more difficult must they be for "desktop-only" companies? Other salient constraints were application availability and maturity (38%), which turned up earlier (refer back to Table 12) as the primary barrier when this question was posed in a different way — ease of use and system manageability (31%) and the difficulty of expanding the company's computer model for HPC (30%). In sum, these companies, many of which see HPC as a distinct competitive differentiator, currently face an array of barriers to adopting this technology.

TABLE 24

Barriers to Using HPC Servers

Q. What do you see as the barriers to expanding your technical computing from the desktop to using HPC servers in your organization?

	Count	% Noting	Rank
Financial — budgets, system costs, other costs	44	68.8	1
Upper management doesn't appreciate the value/hard to justify the expense with upper management	34	53.1	2
Having a skilled staff and/or other experts available	28	43.8	3
Third-party software costs	24	37.5	4
Application availability/lack of maturity of the solution	24	37.5	4
Ease of use — system management capability — management software	20	31.3	6
Complexity to expand our modeling simulation up to an HPC server	19	29.7	7
Technical limitations — system performance, interconnect performance, complexity/cable, cards, switches, etc.	12	18.8	8
Maintenance/availability issues	9	14.1	9
Space limitations, facility issues (i.e., power, cooling)	8	12.5	10
Supported data storage mechanisms (databases, parallel file systems, etc.)	7	10.9	11
Other	7	10.9	11
Total	236		

n = 64

Note: Multiple responses were allowed.

Source: IDC, 2007

Ability of HPC Servers to Help Companies' Innovation and/or Competitiveness

The question in Table 25 was closely related to previous questions about the competitive value of HPC, except that in this case, IDC asked whether respondents thought HPC could help provide a *dramatic* boost in innovation and competitiveness. Even when we raised the stakes in this fashion, nearly half of the respondents (44%) said yes.

TABLE 25

Role of HPC Technical Servers in Increasing Innovation or Competitiveness

Q. Do you think HPC technical servers play a role in making a dramatic increase in your innovation or competitiveness?

% responding yes	44.2
% responding no	50.0
% responding maybe	5.8
Number of no responses	28
n =	52

Source: IDC, 2007

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