High Performance Computing

Reflect.

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

Compete.
Council on Competitiveness

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

This material is based on research sponsored by DARPA under agreement number FA8750-06-1-0240. The U.S. government is authorized to reproduce and distribute reprints for governmental purposes notwithstanding any copyright notation thereon.

THE COUNCIL ON COMPETITIVENESS is a nonprofit, 501 (c) (3) organization as recognized by the U.S. Internal Revenue Service. The Council's activities are funded by contributions from its members, foundations and project contributions. To learn more about the Council on Competitiveness, visit our Web site at HYPERLINK "http://www.compete.org" www.compete.org.

DESIGN Soulellis Studio

Printed in the United States of America

Reflect.

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

Compete.
Council on Competitiveness

The Potential For Boosting U.S. Competitiveness:

A Closer Look At Why Companies Have Not Embraced High Performance Computing

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 HPC remains a largely underutilized national competitiveness asset.

While a small group of companies have become very experienced applying HPC-based modeling and simulation and consider it essential to their business survival, a much larger group of companies has not advanced beyond using entry-level HPC systems. The gap between these two extremes, sometimes called the "missing middle," represents an enormous productivity loss for the nation. That is not the only gap in the HPC market, however. There is a large group of companies that could benefit from HPC but do not use even entry-level systems. These companies appear to be "stuck" at their desktop computers ("desktop only" users). They rely primarily on Macs and PCs for their technical computing needs. Collectively, these gaps represent an important opportunity for bolstering U.S. business competitiveness.

To better understand the reason for these gaps and how to move more companies forward in the knowledge and use of HPC systems, 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.

The first study[1] examined the technical computing needs and practices across a broad group of 77 "desktop only" companies from 11 different business sectors. This second study, *Reflect: Council on Competitiveness and USC-ISI In-Depth Study of Technical Computing End Users and HPC*, is a "drill-down" into a predefined group of both "desktop only" and entry-level HPC users. This look at users in a specific domain aims to identify any significant differences from the multi-sector group assessed in the first study. The predefined group for this drill-down study consisted of customers of the Edison Welding Institute (EWI) of Columbus, Ohio, an organization with 250 member companies that is dedicated to materials joining (i.e., welding) research and development.

1 See *Reveal: Council on Competitiveness and USC-ISI Broad Study of Desktop Technical Computing End Users and HPC*, available at www.compete.org.

This study investigated the following key questions:

- What are the demographics of EWI member companies? How are they using desktop technical computers? How many are also using entry-level HPC servers?
- 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?
- Are there significant differences between this "drill-down" group of companies and the firms in the broader, multi-sector study of desktop technical computing users?

The study revealed that the EWI members, despite their common focus on welding and joining, are a diverse group. They exist in settings ranging from several-person engineering services firms to multibillion-dollar global corporations. About half used only desktop systems for technical computing related to welding and joining process simulation, while 20 percent also used in-house HPC servers (the rest outsourced some or all of this work to EWI or others). The firms using only desktop computers today cited the same set of systemic barriers named by companies in the broader study of desktop users: lack of application software, lack of sufficient human expertise and costs.

Like their counterparts in the broader study, to overcome the systemic barriers, most of the EWI members firms will need an external "enabling function." Whether this enabling function is provided by EWI or through other private sector/ public-private sector initiatives, the stakes are high for advancing more of these companies to HPC-level computing. Unless and until this happens, critical 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.

Global Headquarters: 5 Speen Street Framingham, MA 01701 USA P.508.872.8200 F.508.935.4015 www.idc.com

WHITE PAPER

Council on Competitiveness and USC-ISI In-Depth Study of Technical Computing End Users

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

Earl Joseph, Ph.D. Steve Conway
Suzy Tichenor, Council on Competitiveness Jie Wu
February 2008

EXECUTIVE SUMMARY

This study was 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). The study was conceived as a follow-on to the broader *Council on Competitiveness and USC-ISI Study of Desktop Technical Computing End Users and HPC* (February 2008). It is a "drill-down" into a predefined group of desktop and entry-level high performance computing (HPC) users in a specific domain to identify any significant differences between the broader and this more specific study. The predefined group for this study consisted of customers of the Edison Welding Institute (EWI), which is located in Columbus, Ohio.

While the Council on Competitiveness, DARPA, USC-ISI, and AFRL are well-known entities in the HPC community, EWI deserves an introduction. EWI (**www.ewi.org**) is a membership-based organization dedicated to materials joining (i.e., welding) research and development (R&D). EWI's approximately 250 member organizations are located throughout North America and represent the aerospace, automotive, government, energy, chemical, heavy manufacturing, medical, and electronics sectors. EWI provides a range of services to its members, including materials joining assistance, contract research, consulting services, and training.

The primary goal of the study for all sponsors was to learn more about the demographics of the 29 surveyed EWI member organizations, their current use of virtual prototyping (as opposed to physical prototyping/experimentation), and their receptivity to using HPC (i.e., performing virtual prototyping on technical servers rather than only on desktop computers).

The exploration of the surveyed firms' interest in HPC has special importance. Prior Council on Competitiveness studies conducted by IDC (downloadable from **www.compete.org/hpc**) found that virtually all U.S. businesses that have already adopted HPC consider this technology indispensable to their competitiveness and corporate survival. It stands to reason that when individual businesses enjoy competitive superiority, the competitiveness of the nation as a whole benefits. For the sake of the companies and the country, then, it is important to identify new opportunities for HPC adoption, as well as any barriers to this adoption.

In addition, the recent *Council on Competitiveness and USC-ISI Study of Desktop Technical Computing Users and HPC* study produced a number of salient findings:

- "Desktop-only" companies represent large firms as well as small firms, many with years of desktop technical computing experience.
- 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.
- Many companies have advanced problems that they can't solve on their desktop computers.
- Three systemic barriers are stalling HPC adoption: lack of application software, lack of sufficient talent, and cost constraints.
- An "enabling function" is needed to help firms overcome barriers to adopting HPC.
- A substantial minority of the companies are open to paying an outside consulting organization to help them explore the benefits of HPC.

These same findings were largely corroborated in the current study, but the surveyed EWI member companies stood out from the broader group of desktop technical computing users in certain respects. The most importance difference is that 20% of the surveyed EWI member firms were already using HPC servers, and another 24% were outsourcing HPC server-based work to EWI or similar services. In sharp contrast, the most advanced users in the desktop-only study, representing just 10% of those surveyed, were about to try HPC but had not done so yet.

Historically, welding (materials joining) has relied on experience and practices gleaned from trial-and-error physical experimentation. But as welds for large metal structures, such as ships and buildings, and for new polymer-based products become more complex, the risks (time and money) of relying solely on trial-and-error methods have become harder to justify. In these and other complex cases, virtual testing with computer simulation can substantially improve the predictability of welds that will produce strong, durable products and structures. Simulating the complex physical behaviors of polymers and metals can easily exceed the capabilities of desktop computers and require access to technical servers and people with expertise in using them effectively.

Welding is not the only field benefiting from the increasing application of technical computing. 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, and 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.

The surveyed companies varied greatly in size. About 5 in 8 (62%) companies claimed annual revenues exceeding $1 billion. Three out of four believed that technical computing helped drive their competitive success. Nearly all performed physical testing and prototyping, as well as virtual prototyping. About half used only desktop systems for technical computing related to welding and joining process simulation, but 20% also used HPC servers. One in six relied on EWI to supplement their technical computing, and about one in 10 relied entirely on EWI or similar services for technical computing.

There was no strong correlation between the size of a company (revenue, number of overall employees, number of technical employees) and whether a company was using HPC servers.

Most of the firms cited specific, desirable things that they could not do with their desktop computers, and about half of the firms believed that HPC technical servers could dramatically boost their competitiveness. For those not using HPC servers yet, the most important business drivers that would motivate them to adopt the technology would be the emergence of a customer requirement or a competitive threat. The most important technical driver would be the availability of "strategic fit" application software that would permit them to run their specific problems on HPC servers.

Yet even if these business and technical drivers were in place, these firms would still face systemic barriers that they would not be able to overcome without help from one or more outside parties. The primary barrier involves costs, especially the costs of HPC hardware, software, and human talent/expertise. Given the required scope of this effort, IDC believes that partnership programs are best suited to addressing the systemic barriers on a systematic basis.

About half of the surveyed firms (48%) would be open to paying for help in realizing the technical benefits of HPC — running larger problems than today or running current problems faster. They would be willing to pay from around $2,000 a month to more than $10,000 a month, and they would prefer to pay on a monthly basis. Their top choices for consulting help were "a non-profit organization like EWI" (first choice) or "a major university" (second choice). Two-thirds of the companies were open to working remotely over the Internet, but the remaining 35% had serious, specific issues with the Internet, related to speed and security.

To help overcome the systemic barriers faced by the surveyed companies and many others like them across the nation, new partnership programs and/or new pricing models may be needed for access to HPC hardware and software resources:

- On-demand access to compute cycles and application software ("utility computing") might be attractive, especially if on-demand offerings were shaped to address the requirements and concerns of companies with little or no HPC experience. Another attractive selling approach might be "try-and-buy" pricing that allow "desktop-only" technical computing end users to cross the HPC threshold by trying HPC resources before having to commit to purchasing them. More flexible pricing of application software offered by independent software vendors to end users is also needed, especially for "desktop-only" and entry-level HPC sites. Current software pricing models for HPC customers are often aimed at firms with many users and/or large HPC systems.

- In addition, new partnership programs tailored to firms with little or no HPC experience could help guide these companies to cross the HPC threshold for the first time or to expand their use of HPC.

Successful HPC-based partnership programs already exist for companies with greater HPC experience, such as the Department of Energy's INCITE program and programs administered by the National Science Foundation 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 new partnership initiatives designed to help companies such as those surveyed in this study make the productivity-enhancing transition to HPC.

In the meantime, the companies' current confinement to desktop technical computing leaves them vulnerable to more agile, determined competitors from 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.

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, analysts, and others to address computationally intensive and data-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.

Technical Servers (Also Called HPC Servers)

IDC uses the terms *technical servers* and *HPC servers* as synonyms to describe servers employed by scientists, engineers, analysts, and others to address computationally intensive and data-intensive modeling and simulation problems. This category excludes single-user desktop PCs and workstations, as well as servers with fewer than four processors.

High Performance Computing

HPC is the important subset of the technical computing market that includes all servers used in technical computing. The term encompasses both the activities carried out in this market and the computers used to perform these activities. HPC systems include the full spectrum that extends from entry-level technical servers (four processors or more) to high-end supercomputers, but exclude single-user desktop computers (PCs, Macs, and workstations) that are used for technical computing.

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) The Surveyed EWI Member Companies Vary Greatly in Size, But the Majority Are $1 Billion-Plus Firms.

The 29 companies represented in this study span a wide range of sizes and have annual revenues ranging from under $10 million to more than $1 billion. But most of them (62%) claim more than $1 billion in annual revenues and more than 10,000 employees.

2) One in Five Firms Uses HPC Servers for Virtual Prototyping Today, and Nearly Half Have at Least Tried This Approach.

About half of the surveyed firms use only desktop systems for technical computing related to welding and joining process simulation, but one in five of the surveyed firms (21%) said they were using technical servers with more than four processors today (i.e., HPC servers). About half of the firms (48%) reported that they had tried using technical servers/large-scale modeling and simulation, either independently or by outsourcing this work to EWI or similar services. Roughly one-quarter of the surveyed firms (24%) had only minimal familiarity with HPC and how it might benefit them.

- *"Simulation capabilities allow for better insight into product quality and effectiveness."*
- *"Shortening product development cycles through virtual prototyping is crucial."*
- *"It is a very effective and cost-saving approach to product development."*

3) There Is No Discernible Correlation Between a Company's Size or Number of Technical Employees and Familiarity with or Use of HPC Servers for Welding-Related Work.

No notable correlation emerged between a company's revenue size or employee population and whether the company knows about or uses HPC servers. Large firms are as likely as small companies to be stalled on desktop technical computers, at least where welding is concerned. IDC knows that although some of the surveyed companies said they don't use HPC for welding, they do use it in other parts of their companies (e.g., automotive firms). Furthermore, although most respondents said their firms have large numbers of technical employees (scientists, engineers, analysts), there was no discernible correlation between the number of technical employees and whether the firms use HPC servers. The explanation, IDC believes, is that HPC has been used for some time in the R&D areas of many companies but is only beginning to be used in the manufacturing area for tasks such as welding. A company may have many technical employees who rely on HPC, but few if any of these employees may be associated with welding-related work.

4) Most of the Companies Identified Problems They Can't Solve on Their Current Computers.

The companies named specific, desirable things they cannot do today, such as running large models, predicting deformation and distortion, accurately predicting microstructures, and many more tasks limited by lack of access to HPC systems and expertise. The firms sometimes handle problems they cannot address on their desktop computers by ignoring the problems, scaling down the problems to fit the desktop systems, or relying more heavily on slower and more expensive physical prototyping. Previous Council on Competitiveness and IDC studies showed that these alternatives render companies more vulnerable to competitors that have greater determination to employ HPC servers for their proven benefits.

- *"We can't calculate deformation in the production of a part."*
- *"We cannot perform predictive distortion analyses."*
- *"Computational fluid dynamics is something we can't do today."*
- *"We can't do heat input simulations."*

5) The Primary Business Driver of HPC Adoption is Current Customer Requirements.

For the majority of the surveyed firms that aren't already using HPC, the main, immediate market-driven motivators were future customer requirements (48%) and current customer requirements (29%), followed by the need to catch up if competitors should forge ahead by using HPC (19%). Creating a competitive advantage in a vacuum, without an external customer mandate or competitive threat, proved far less compelling (5% of mentions) than the immediate motivators. To an important extent, therefore, migration to HPC can depend on the emergence of new customer requirements or competitive threats.

6) The Primary Technical Driver of HPC Adoption Is the Availability of "Strategic Fit" Software (Models and Applications).

Topping the list of technical items that would motivate "desktop-only" companies within the surveyed group to adopt HPC was the availability of "strategic fit" software that closely matches the specific problems the companies would want to tackle on HPC systems. Such items include both application software designed to run these problems and the underlying software models of the problems that form the basis of the application software. The "desktop-only" firms typically were unsure whether HPC-level "strategic fit" software existed for their mission-critical problems.

- *"We can't take a small section of a large-scale model and put it into a model to simulate an ultrasonic inspection."*
- *"We can't handle very large models. For example, in a welding simulation, a structure may be very large and complicated, and we can't afford the time and effort to fully create that model."*

Respondents on the whole rated the availability of highly relevant, strategic fit software as a greater enticement for advancing to HPC than even the prospects of free software, hardware, and expertise. This finding has important implications. First, it implies that giving people a free HPC server or free time on one, along with free (or low-cost) help in using this resource, is not sufficient to motivate HPC adoption among companies doing technical computing only on desktop computers today. A second implication is that software availability precedes return-on-investment (ROI) considerations. Unless appropriate software is available, ROI arguments cannot be assembled.

Prior IDC-Council on Competitiveness studies of experienced industrial users of HPC highlighted the crucial importance for industry of accurate, relevant software-based models and of easy-to-use third-party software applications incorporating these models. For example, an automaker that wants to forge ahead of its competitors by designing vehicles with quieter, more comfortable passenger cabins 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 specific objective.

The importance 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 HPC servers, depend heavily on commercial software available from independent software vendors (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 computer 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.)

Aside from "strategic fit" software, other drivers that would strongly motivate HPC adoption were the availability of sufficient human talent/expertise skilled in exploiting HPC resources and lower costs for these resources.

7) A Fundamental Cost Barrier Is Stalling HPC Adoption.

For the surveyed companies, a fundamental cost barrier is preventing the initial adoption and, in some cases, the expanded use of HPC. The costs of HPC hardware and software are out of reach of many existing budgets, and often the firms do not know enough about HPC to persuade upper management to increase budgets for HPC resources; that is, they are unable to construct convincing ROI arguments.

The companies also face important secondary barriers. The fundamental cost issue is compounded, for instance, by the additional cost that would be incurred to hire people who are skilled in exploiting today's difficult-to-use HPC hardware and software. And many of the companies are uncertain whether software and human expertise exist that can run their specific problems on high performance computers.

Note that in this study, as in everyday life, there is seldom a one-to-one correspondence between drivers/motivators and barriers. The prospect of improving young minds may motivate someone to become a secondary school teacher, but the modest compensation and long hours may be barriers to realizing this ambition. This example explains why software-related concerns emerged as the foremost *driver* in response to this question, while cost-related issues predominated as a *barrier*.

In summary, the barriers were as follows:

- **Main barrier: Overall cost and ROI justification.** Many respondents pointed to the overall cost of HPC as a major barrier and stressed the difficulty of assembling a persuasive ROI argument to convince the "executive suite" to approve HPC budgets and purchases.

  - *"We can't justify the cost for the outcome."*

  - *"Proving the ROI to management [is an important barrier to HPC use]."*

- **Secondary barrier: Availability of easier-to-use, domain-specific 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 domain-specific problems on multiprocessor 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/hpc**.

  - *"Lack of inexpensive application software available."*

  - *"Awareness, and having access to software that will meet our needs."*

- **Secondary barrier: Cost and availability of domain-specific HPC expertise.** Another major barrier cited by surveyed EWI member companies is the lack of an adequate number of people skilled in using HPC hardware and software systems to run their specific problems.

  - *"We don't have experienced personnel to model welding processes."*

  - *"We don't have the expertise to analyze what we need to provide to our industry."*

  - *"The barrier to expanding current use would be in a lack of human resources and capital."*

8) An "Enabling Function" Is Needed to Help Firms Overcome Systemic Barriers to Adopting HPC.

The barriers described in key finding #6 constitute serious deterrents to HPC adoption for the entire category of "desktop-only" technical computing companies, and it would be unreasonable to expect individual firms to tackle these systemic barriers on their own. It is hardly surprising that few of these companies said that they are likely to try to overcome these barriers to move to entry-level HPC servers without a strong business driver, such as 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, companies need an "enabling function" in the form of a larger outside party, or parties, willing to taking a systematic approach to reducing the systemic barriers to HPC adoption. IDC believes that new partnership programs are best suited to provide the requisite enabling function. In addition, new pricing models may be needed that make it easier for "desktop-only" and entry-level users to access HPC resources.

9) About Half of the Companies Are Open to Paying an Outside Consulting Organization to Help Them Explore the Benefits of HPC. They Prefer to Pay on a Monthly Basis.

Eighteen companies, over 60% of the 29 companies surveyed, would be willing to pay for help in realizing the technical benefits of HPC, that is, running larger problems than today or running current problems faster. This is a substantial percentage. The amounts they declared themselves willing to pay ranged from around $2,000 a month to more than $10,000 a month. 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. Their first preference for an outside consulting service is "a nonprofit organization like EWI." Their second preference is for "a major university."

- *"We don't have in-house expertise, so we outsource to EWI."*

10) Most of the Firms Are Willing to Obtain HPC Services Over the Internet, But a Substantial Minority Raise Specific Objections.

Two-thirds of the companies (66%) said they would perform computational simulations and/or design work remotely over the Internet if there were an easy, cost-effective, and secure way to do this. But the remainder (35%) objected that the Internet is too slow to move their data around or not secure enough for their purposes.

Comments

- *"The time frame involved to reeducate the staff on using a different system would be a reason [not to use the Internet]. What we have works well for us."*
- *"I'm concerned about the time to process over the Internet."*
- *"Our simulation and designs require very large files, and the infrastructure on the Internet cannot support timely and adequate transfer of these files."*
- *"Data transfer speeds for large transfers are too slow."*
- *"Our main concern would be one of confidentiality."*
- *"There are too many security issues."*
- *"Our data is considered ITAR — International Traffic in Arms Regulations. We cannot transmit the type of data needed for a simulation over the Internet unless it is a truly secure server."*
- *"Before we did this [work remotely over the Internet], we would contract it out."*

IMPLICATIONS FROM THE STUDY

1) The Surveyed Firms That Already Use HPC May Represent an Advance Wave, with Others Poised to Follow.

Firms performing technical computing only on desktop systems have been doing this for an average of nine years, but the figure drops to only about two years for companies using both desktop systems and HPC servers. (The two years reflects the time they've been using HPC servers, in other words.) The implication is that the latter group, representing 20% of all respondents, may constitute an advance wave of early adopters — organizations that are the first to cross the line into HPC territory — and that other, similar organizations may be poised to follow them over time. IDC knows from its other research that many companies in the same industries as the surveyed group (in fact, many of the same companies) have been employing HPC in their R&D areas for years. HPC usage is much newer in the manufacturing areas of companies, however. In this survey we may be witnessing the initial period of an important new trend.

2) If U.S. Manufacturing Firms Can Adopt HPC, so Can Non-U.S. Firms. U.S. Desktop Technical Computing Users Who Fail to Adopt HPC May Be at Significant Competitive Risk.

Roughly 20% of the surveyed EWI member companies are already using HPC servers on their own for virtual prototyping, and an additional 24% are doing this on an outsourced basis with EWI or similar services. IDC believes that non-U.S. firms have also begun to use HPC in conjunction with manufacturing, as opposed to R&D, although we do not have precise figures to support this finding. It follows then that

U.S. desktop technical computing users who do not adopt HPC may be at significant competitive risk — with respect to both U.S. and non-U.S. competitors that have made this transition. At a higher level, if U.S. firms in this sector fail to exploit HPC as rapidly and as fully as their international counterparts, they could jeopardize America's competitive standing in welding and other manufacturing-related fields. Innovation is the key to competitiveness. Council studies have revealed tight linkage between HPC, innovation and competitiveness. HPC as a key driver of innovation.

3) Desktop Technical Computing Firms That Have Not Yet Adopted HPC May Need Broad-Based Education About HPC.

As mentioned in key finding #2, the study found that some of the respondents had only minimal familiarity with HPC and how it might benefit them. Given this situation, a broad-based education program may be needed to teach end users in this sector more about the proven value of HPC. Professional associations such as EWI could carry out a program of this kind for their members, but given the fragmented nature of the manufacturing sector, a national education program might also be needed.

This study and prior studies indicate that to be effective, an education program needs to be domain-specific and, in some cases, application-specific. Opportunities may exist not only for professional associations but also for major universities and national laboratories to organize appropriate education programs for this constituency. Case studies based on the experiences of the advance wave of early adopters in the welding/manufacturing sector could be especially effective components of education programs.

4) "Desktop-Only" Firms May Also Need Guidance in Making an ROI Case for HPC.

Many of the companies in the desktop-only category are not sufficiently familiar with the proven benefits of HPC and therefore are not in a position to make a compelling business case to upper management for purchasing or otherwise acquiring access to HPC resources. These companies could benefit greatly from guidance given by organizations that are experienced in explaining the ROI benefits of HPC modeling and simulation. This guidance could be built into the education programs described in the prior implication.

5) New Partnership Programs and Pricing Models 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 HPC-based partnership programs already exist for companies with greater HPC experience, such as the Department of Energy's INCITE program and programs administered by the National Science Foundation 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 new partnership initiatives designed to help companies such as those surveyed in this study make the productivity-enhancing transition to HPC.

- New 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.

In addition, new pricing models may be needed to help "desktop-only" technical computing users cross the threshold into HPC usage. Two models that come to mind immediately are:

- **On-demand HPC ("utility computing").** The ability to purchase HPC use on a pay-as-you-go basis, with minimal commitment, is already being offered by a number of HPC vendors (e.g., IBM and Sun Microsystems). Purchasing HPC use using this pricing model is analogous to renting a car: You don't need to buy the car, and you don't need to rent it for a full year. You rent it only for the time that you need it. This minimal-commitment, low-risk model has proven attractive to experienced HPC users who do not want to buy extra HPC equipment for temporary workload spikes. It might also prove attractive to companies that have not used HPC before, especially if providers of on-demand computing also offer expertise in how to make good use of their HPC resources. But today, nonexperienced companies are not being targeted by on-demand HPC programs.
- **"Try-and-buy" HPC.** Another potential pricing model would be to allow end users to try HPC hardware and software resources for a period of time, based on a particular payment scheme, before they decide whether to purchase the systems. Try-and-buy hardware sales have happened on occasion in the HPC industry, typically in cases where a vendor is offering a new, unproven system and has no choice except to offer a free or low-cost trial period. Try-and-buy selling, however, might also help "desktop-only" users cross the HPC threshold despite budget constraints and could provide a low-risk period in which to demonstrate the benefits of HPC hardware and/or software use to senior management.

6) The Internet Has Real and Perceived Limitations for Delivering HPC Services Remotely to Companies.

This study and other IDC research indicate that current broadband Internet speeds are adequate for handling modestly sized problems but may not be sufficient for transferring larger data volumes in reasonable time frames. In addition, this study implies that some companies simply may not have adequate connectivity to the Internet for their data transfer needs. Similarly, while some companies are willing to entrust their data to the Internet, other firms find that their current Internet security measures are inadequate. In a number of cases, companies are actually barred by internal policies, external regulations, or partnership agreements from sending their data over the public Internet.

TABLE OF CONTENTS

P

TABLE OF CONTENTS — Continued

P

LIST OF TABLES

P

LIST OF FIGURES

P

SITUATION OVERVIEW

Motivations for This Study

This study was conceived as a follow-on to the recent *Council on Competitiveness and USC-ISI Study of Desktop Technical Computing End Users and HPC* (February 2008) — a "drill-down" into a predefined group of desktop and entry-level HPC users in a specific domain to identify any significant differences between the broader and more specific study. The target population for this study consisted of representatives of 29 member companies of the Edison Welding Institute (EWI) who volunteered to participate in the study.

EWI is a leading engineering and technology organization dedicated to the research and development of materials joining. The organization works with hundreds of members in the aerospace, automotive, government, energy, chemical, heavy manufacturing, medical, and electronics industries. These firms represent a fertile pool for the study research. EWI provides a range of services to its members. All of the surveyed firms are EWI members that rely on EWI for some services, but not all of these firms turn to EWI for technical computing assistance.

In their continuing effort to promote the use of HPC throughout industry as a competitive enabler, the Council on Competitiveness, the Defense Advanced Research Projects Agency (DARPA), and the University of Southern California's Information Sciences Institute (USC-ISI) seek to understand why desktop-only and entry-level users are not adopting more powerful systems in larger numbers to better solve their computational problems; what is preventing other U.S. companies from using this technology; and whether these companies would move forward in their use of HPC if they had easier access to HPC systems and expertise.

The Council on Competitiveness' High Performance Computing Initiative is a project that was started three years ago with the goal of identifying ways to use HPC to boost U.S. industrial productivity and global competitiveness. The HPC Initiative actively seeks to elevate national competitiveness to the forefront of national consciousness and to draw attention to the potential for companies to use HPC to improve their competitiveness in the global economy, particularly companies that use only entry-level systems and companies that do not use HPC systems at all. The Council on Competitiveness and USC-ISI are leading the National Innovation Collaboration Ecosystem (NICE) partnership to expand access to HPC hardware, software, and expertise across the private sector.

Profiles of the Survey Participants

For this study, IDC interviewed individuals from 29 EWI member companies, representing the five industries shown in Table 1. (Multiple responses were allowed, meaning that respondents could categorize themselves in more than one industry.) A large majority (84%) of the respondents came from the manufacturing and automotive industries. Both of these sectors are heavy users of materials joining — the primary focus of EWI and its member services.

TABLE 1

Industry of Survey Respondents

	Count	% of Respondents
Manufacturing	22	59.5
Automotive	9	24.3
Petroleum, oil and gas	3	8.1
Chemical	2	5.4
Aerospace	1	2.7
Total	37	100.0

n = 29

Note: Multiple responses were allowed.

Source: IDC, 2007

The EWI member companies varied greatly in the size of their annual revenues. As Table 2 shows, nearly five in eight of the surveyed organizations (62%) were large companies with annual revenues exceeding $1 billion. At the other end of the spectrum, none of the surveyed organizations reported revenues of under $1 million. In between these large firms (18) and very small firms (none), companies of varying revenue sizes were represented in the study. It's worthwhile to keep in mind, however, that most of the surveyed organizations fell into the category of large firms.

TABLE 2

Company Revenue

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

	Count	% of Respondents
Under $1 million	0	0.0
$1 million to $9.9 million	3	10.3
$10 million to $99.9 million	3	10.3
$100 million to $499.9 million	4	13.8
$500 million to $1 billion	1	3.4
Over $1 billion	18	62.1
Total	29	100.0

Source: IDC, 2007

The employee counts within the surveyed organizations also varied greatly, as might be expected from companies with such widely different revenues (see Table 3). The same number of companies (18) that reported annual revenue exceeding $1 billion also claimed 10,000 or more employees. (The survey did not ask whether these were the same companies in each case, nor is that especially important for purposes of the study.) There were surveyed companies in the 1 to 100 employees bracket and in each of the brackets between these small firms and those with more than 10,000 employees.

TABLE 3

Company Size

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

Number of Employees	Count	% of Respondents
1 to 100	3	10.3
101 to 500	3	10.3
501 to 999	3	10.3
1,000 to 10,000	2	6.9
Over 10,000	18	62.1
Total	29	100.0

Source: IDC, 2007

Table 4 shows that the employee populations of most of the surveyed firms are rich in scientists, engineers, and analysts. More than half of the firms (55%) have over 1,000 employees in these categories, and when firms with at least 100 of these employees are added, the total rises to 69% of the surveyed organizations. About 10% of the firms, however, have 10 or fewer internal scientists, engineers, and analysts to rely on. The number of scientists, engineers, and analysts employed by the firms is not in itself an indicator of their experience with or receptivity to HPC. Given the large numbers of these employee types present in most of the firms, it is safe to assume that most of the companies place substantial emphasis on R&D activities. And IDC knows from its other research that many of the industries represented in this study (in fact, some of the very companies in this study) rely on HPC in their R&D areas. But HPC is newer to manufacturing areas, such as welding. A company may have many technical employees who rely on HPC, but few if any of these employees may be associated with welding-related work in the manufacturing area.

TABLE 4

Scientists, Engineers, or Analysts Employed

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

Number of Scientists, Engineers, or Analysts	Count	% of Respondents
1 to 5	1	3.4
6 to 10	2	6.9
11 to 25	4	13.8
26 to 50	1	3.4
51 to 99	1	3.4
100 to 1,000	4	13.8
Over 1,000	16	55.2
Total	29	100.0

Source: IDC, 2007

SURVEY RESULTS

The focus of this survey is the application of computing to computational simulation and design for jointing and welding of materials and other related applications.

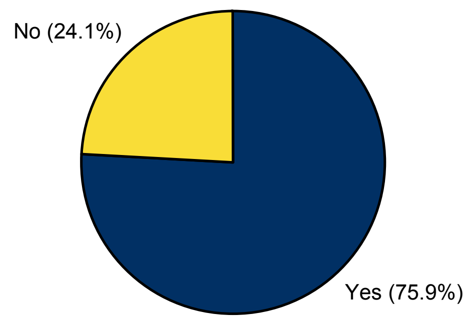
Using Technical Computing for Competitive Success

Most of the surveyed firms do not need to be educated about the value of technical computing. Three out of four (76%) of the companies already believed that technical computing helps drive their competitive success (see Figure 1 and Table 5), while one in four (24%) did not.

FIGURE 1

Technical Computing as a Driver of Competitive Success

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



Source: IDC, 2007

TABLE 5

Technical Computing as a Driver of Competitive Success

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

	Count	% of Respondents
Yes	22	75.9
No	7	24.1
Total	29	100.0

Source: IDC, 2007

Technical Computing Approaches and History

Recent studies sponsored by the Council on Competitiveness and DARPA looked separately at the situations of technical computing users who employ only desktop systems and technical computing users who also rely on entry-level HPC servers. As Table 6 indicates, the firms surveyed in this study represent both of these populations and also include a few companies that outsource all of their technical computing to EWI or other services. Slightly more than half (53%) of the firms reported using only desktop systems for technical computing related to welding and joining process simulation and/or design. More than one in five of the companies (22%) said they also used HPC servers. About one in six (16%) rely on EWI to supplement their own technical computing, and about one in 10 (9%) rely entirely on EWI or similar services for technical computing. In this study, there was no correlation between the size of a company and whether the company performed technical computing only on desktop computers or also on HPC servers.

TABLE 6

Methods of Technical Computing

Q. How do you do your technical computing related to welding and joining process simulation and/or design today?

	Count	% of Respondents
Only on a desktop, PC, or workstation	17	53.1
We use both desktops and HPC servers	7	21.9
We also use EWI services to supplement our technical computing	5	15.6
We use only EWI or EWI-like services or other outside services	3	9.4
Total	32	100.0

n = 29

Note: Multiple responses were allowed.

Source: IDC, 2007

The surveyed organizations' experience with technical computing (using any type of computer system or service) ranged widely, from a minimum of one year to a maximum of 20 years (see Table 7).

- For those performing technical computing only on desktop systems, the average length of time doing this was nearly nine years. This was the largest group responding to this question (45% of respondents).

- Technical computing experience averaged slightly longer (just over 10 years) for companies using both desktop computers and very small servers (two to three processors). This was the smallest group, making up just 10% of the respondents.

- The average length of time dropped significantly to only about two years for surveyed firms that were using both desktop computers and larger servers (i.e., using servers larger than two to three processors for this amount of time). This group represented about 21% of the respondents, however.

- Nearly one in four (24%) respondents said they also use EWI services. For this sizable group, the average length of time during which they had been relying on EWI was just under four years. Note that this percentage (24%) closely matches the total percentage (25%) of firms reporting that they use EWI for all (9.4%) or part (15.6%) of their technical computing needs (refer back to Table 6).

The surveyed firms that already use HPC may represent an advance wave, with others poised to follow them over time. IDC knows from its other research that many companies in the same industries as the surveyed group (in fact, many of the same companies) have been employing HPC in their R&D areas for years. HPC usage is much newer in the manufacturing areas of companies, however. In this survey we may be witnessing the initial period of an important new trend.

TABLE 7

Organizations' Experience with Technical Computing

Q. How long have you been using technical computing for computational simulation and/or design in welding and joining applications? (Check all that apply.)

	Count	% of Respondents	Average Time in Years	Maximum Number of Years	Minimum Number of Years
Only on the desktop	13	44.8	8.69	20	1
Using both desktop and only small, two or three processors servers	3	10.3	10.33	20	5
Using both desktop and larger servers	6	20.7	2.17	6	1
Also using EWI services	7	24.1	3.86	10	1
Total	29	100.0			

n = 26

Note: Multiple responses were allowed.

Source: IDC, 2007

Just one in five (21%) of the surveyed firms said they are using technical servers with more than four processors today (see Table 8). The remainder are using computer systems with fewer than four processors — a category that includes single- and dual-processor desktop systems. As noted earlier (refer back to Table 6), 53% of the respondents reported using only desktop systems for their technical computing needs.

When IDC probed further to identify why so many of the firms had not moved beyond desktop computers, the respondents began to name barriers to HPC adoption. A few mentioned plans for using HPC servers soon (*"We are moving in that direction imminently"*; *"We have plans to use it in the future."*), but others pointed to barriers related to cost, lack of in-house expertise, lack of appropriate software, and, not least of all, the belief that desktop systems are fully capable of handling the firms' requirements.

Comments

- *"We can't justify the cost for the outcome. The tools we use now are sufficient."*
- *"All of the software we do use works fine on the desktop."*
- *"We use a commercial software package that is suitable only on the desktop."*
- *"There is no software to utilize an HPC [high performance computer] that we are aware of."*
- *"Our software for weld design was written in-house and runs adequately on dual-CPU technical desktops."*
- *"We do not need that level of sophistication for the type of welding we do."*
- *"We don't have experienced personnel to model welding processes."*
- *"Standalone units reduce the possibility of a systemwide crash. I don't think we have investigated it at length."*

TABLE 8

Sites Using More Than Four-Processor Technical Servers Today

	Count	% of Respondents
Using at least four processors	6	20.7
Using fewer than four processors	23	79.3
Total	29	100.0

Source: IDC, 2007

Knowledge About HPC Servers

As Table 9 shows, 76% of the firms said they had at least some familiarity with the use of technical servers/HPC in their disciplines. This familiarity is self-evident for the 21% that already employ technical servers with more than four processors, as these servers are clearly in the realm of HPC. For the larger group (55%) that claimed familiarity with HPC and use servers with fewer than four processors (i.e., non-HPC systems), the familiarity with HPC may be less meaningful. And about 24% of the companies said they had not heard (or heard much) about technical servers and HPC. (Keep in mind that this study found no correlation between the size of a company and whether it used HPC.)

This study and prior studies indicate that to be effective, an education program needs to be domain-specific and, in some cases, application-specific. Opportunities may exist not only for professional associations but also for major universities and national laboratories to organize appropriate education programs for this constituency. Case studies based on the experiences of the advance wave of early adopters in the welding/manufacturing sector could be especially effective components of education programs.

TABLE 9

Knowledge About HPC Servers

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

	Count	% of Respondents
Yes — already using over four CPUs	6	20.7
Yes — under four CPUs	16	55.2
No	7	24.1
Total	29	100.0

Source: IDC, 2007

About half of the surveyed firms (48%) reported that they had tried using technical servers/large-scale modeling and simulation either independently or through EWI (or similar services). The remaining firms (52%) said they had not (see Table 10).

TABLE 10

Use of Technical Servers/Large-Scale Modeling and Simulation

Q. Have you ever tried using the capabilities provided by technical servers/HPC or large-scale modeling/simulation, including some of the modeling solutions available at EWI-like organizations?

	Count	% of Respondents
Yes, we previously tried it internally	9	31.0
Yes, we previously tried it through EWI-like services	5	17.2
No, we never have tried using HPC servers	15	51.7
Total	29	100.0

Source: IDC, 2007

Current Use of Computational Tools

As Table 11 illustrates, a high percentage of the 29 surveyed firms use modeling and/or analysis tools (97% of the firms), engineering design aids or CAD tools (86% of the firms), and visualization tools (83% of the firms).

TABLE 11

Current Use of Computational Tools

Q. Does your company use:

	Count	% of Responses
Modeling and/or analysis tools	28	36.4
Engineering designs aids or CAD tools	25	32.5
Visualization tools	24	31.2
Total	77	100.0

n = 29

Note: Multiple responses were allowed.

Source: IDC, 2007

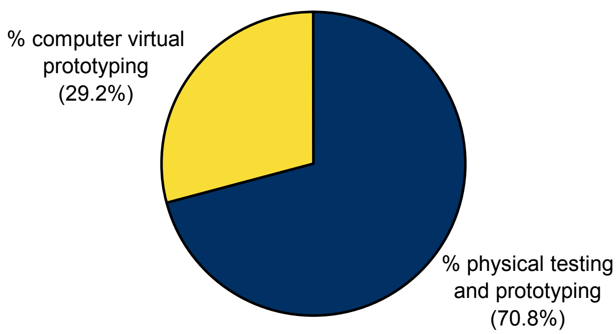
Virtual Prototyping Compared with Physical Prototyping

Figure 2 depicts the split within the surveyed firms of physical experimentation (testing/prototyping) and computer modeling and simulation (computer virtual prototyping and large-scale data modeling). On average, slightly less than one-third of all testing/prototyping (29%) occurred on computers versus just over two-thirds (71%) via physical experimentation.

FIGURE 2

Virtual Prototyping Compared with Physical Prototyping

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



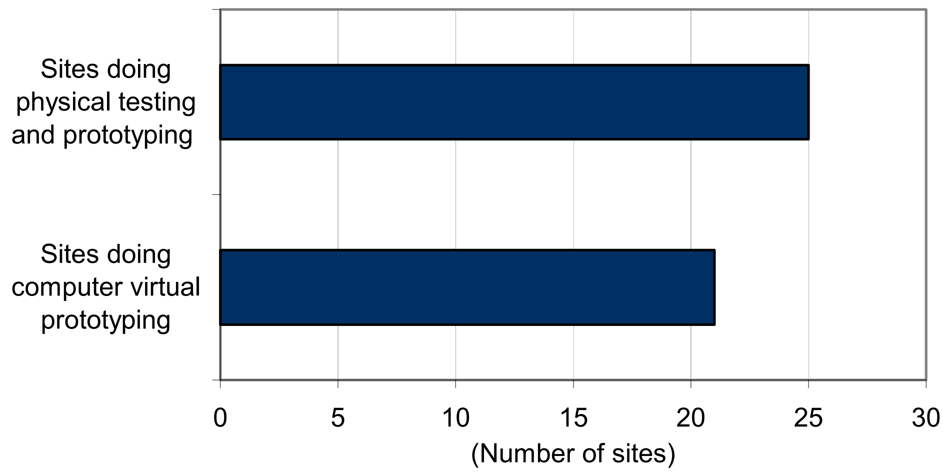
Source: IDC, 2007

Figure 3 shows that 25 of 26 sites responding to this question (96%) perform physical testing and prototyping at least to some extent. (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 high (81%, or 21 of 26 firms).

FIGURE 3

Sites Doing Physical Testing and Virtual Prototyping

Q. Are you doing physical testing and prototyping in your department? Virtual prototyping?



n = 26

Note: Multiple responses were allowed.

Source: IDC, 2007

Clearly, the great majority of the companies are accustomed to using technical computers for some of their testing and prototyping needs (see Table 12).

TABLE 12

Virtual Prototyping Compared with Physical Prototyping

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

	Average % of Testing and Prototyping	Number of Sites Doing Any Amount of Testing and Prototyping
% physical testing and prototyping	70.8	25
% computer virtual prototyping	29.2	21
Total	100.0	

n = 26

Note: One site isn't doing any physical testing at its site.

Source: IDC, 2007

As Table 13 shows, 52% of the respondents said that the use of computer virtual prototyping and large-scale data modeling is increasing at their firms. The average annual increase is 13%. The substantial rate of increase among this group of companies may make them more likely candidates to adopt HPC. Just under half (48%) of the firms reported that their use of computer-based virtual prototyping and large-scale data modeling is flat, and none pointed to decreasing usage.

TABLE 13

Change in 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	% of Sites	Average Annual Increase (%)
Increasing	14	51.9	12.5
Staying the same	13	48.1	0.0
Decreasing	0	0.0	
Total	27	100.0	

Source: IDC, 2007

Table 14 shows that three out of four (76%) of the companies believed that technical computing helped drive their competitive success. A sampling of their comments is more revealing.

Comments

- *"This is a very positive and cost-effective way to reduce the overall cost of a project by decreasing the engineering and prototyping time spent on it in general."*
- *"It is a very effective and cost-saving approach to product development."*
- *"I see it as the way of the future. More of it is needed."*
- *"It is a great tool but needs to be balanced with proper boundary conditions and used by people who understand the limitations of the software. It also needs to be baselined to real-world results."*
- *"It's an excellent tool as long as it's accurate."*
- *"It's great if it can be validated. We need more confidence in the simulation process. If we can confidently use a model or software to reduce the costs of design, that would be great."*
- *"It works pretty well. Depends on the program you use."*
- *"It needs to continue to evolve."*

TABLE 14

Competitive Importance of Computing, Simulation, and Virtual Prototyping

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

	Count	% of Respondents
Yes	22	75.9
No	7	24.1
Total	29	100.0

Source: IDC, 2007

What Can't Be Done Today That Is Limited by Access to HPC Resources?

When IDC asked the companies to be more specific about the things they could not do today because of their limited access to HPC resources and expertise, a few of the firms expressed confidence in their current methods (*"Don't think we have any limitations at this time"*) or doubts about the value of HPC (*"The simulations are not validated by reality"*). But the vast majority of the companies provided specific examples of things they could not do, as the following comments illustrate.

Limitations Related to the Lack of Access to HPC Systems

- *"We can't handle very large models. For example, in a welding simulation, a structure may be very large and complicated, and we can't afford the time and effort to fully create that model."*
- *"We can't take a small section of a large-scale model and put it into a model to simulate an ultrasonic inspection."*
- *"We can't calculate deformation in the production of a part."*
- *"We cannot perform predictive distortion analyses." (two comments)*
- *"We can't accurately predict microstructures because of welding operations." (two comments)*
- *"Computational fluid dynamics is something we can't do today."*
- *"We can't do heat input simulations."*
- *"Modeling of new tools is a thing we can't do."*
- *"We can't develop every aspect of the physical process."*
- *"We can't put a flaw into a weld area and simulate the effect on a product."*

Limitations Related to the Lack of HPC Expertise/Knowledge

The companies also cited things they couldn't do because they lacked sufficient expertise or knowledge about HPC:

- *"We don't understand which systems are appropriate."*
- *"We don't have experience running such elaborate software."*
- *"Complex simulations — we don't have experience on the modeling applications."*
- *"Welding engineers are not trained to run some of the very technical applications."*
- *"New processes are still getting ready for mass production due to a learning curve."*
- *"We have a lack of certainty in various aspects of the inputs to the processes."*
- *"We don't have the expertise to analyze what we need to provide to our industry."*
- *"We can't run multiple scenarios efficiently."*

Table 15 shows how the companies handled tasks they were not addressing with computer simulation. Slightly more than two-thirds of the respondents to this question (67%) said they used physical tests, which IDC knows from other research are typically much slower and more expensive than computer simulation (although some degree of physical testing is usually appropriate or legally required in many industries). An alternative cited by 16.7% of respondents, ignoring the advanced problem or task, can have even more dire consequences for a company. Ten percent of the firms said that although they don't perform computer simulations themselves; rather, they outsource the computer work (presumably to EWI or similar services). Two of the companies (7%) scaled down the problems to fit the capabilities of their desktop computers — a practice that, like ignoring the problems, can deprive companies of insights that are crucial for driving competitive gains.

TABLE 15

Alternatives to Using HPC Computers

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

	Count	% of Respondents
We use physical tests instead	20	66.7
We don't do the problem or task	5	16.7
We outsource the computing	3	10.0
We scale the problem down to fit our current computers	2	6.7
Total	30	100.0

n = 26

Note: Multiple responses were allowed.

Source: IDC, 2007

Technical Drivers That Would Motivate "Desktop-Only" Users to Move to HPC

Table 16 depicts the factors that would motivate the companies to exploit HPC for larger-scale modeling and simulation than they can do on the desktop. The factors, as formulated in this question, fall into three main categories: more "strategic fit" software, more human talent/expertise, and lower costs. (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.)

Note that in this study, as in everyday life, there is seldom a one-to-one correspondence between drivers/motivators and barriers. The prospect of improving young minds may motivate someone to become a secondary school teacher, but the modest compensation and long hours may be barriers to realizing this ambition. This example explains why software-related concerns emerged as the foremost *drivers* in this question, while in later questions about *barriers*, cost-related issues predominated.

The two most popular motivators pertained to the availability of software closely matching the specific problems the companies needed to solve (i.e., "strategic fit" software). IDC asked about two related types of software: application software designed to run specific types of problems and the underlying software models of the problem that form the basis for application software. In both cases, the responses were stronger than for any of the other potential drivers/motivators respondents were given to rate. More than three-quarters (78%) of the 27 companies responding to this question named the availability of a strategic fit application ("Someone created an application that fit my requirements") as their first, second, or third choice, and over two-thirds of the firms (70%) cited the availability of strategic fit software models as one of their top three choices. These two strategic fit software choices substantially outpolled cost-related items. The totals (first, second, and third choice selections) for these items were as follows: free/low-cost expertise (52%), free application software (48%), and free hardware (30%).

Hence, respondents on the whole rated the availability of highly relevant, strategic fit software as a greater enticement for advancing to HPC than even the prospects of free software, hardware, and expertise. As Table 7 shows, nearly half (45%) of the companies do their technical computing only on desktop systems. Comments related to Table 8 reveal that some of these firms did not know whether strategic fit software existed to run their problems on technical servers (*"We use a commercial software package that is suitable only on the desktop"; "There is no software to utilize an HPC [high performance computer] that we are aware of"; "Our software for weld design was written in-house and runs adequately on dual-CPU technical desktops").*

TABLE 16

Technical Drivers That Would Motivate "Desktop-Only" Users to Move to HPC

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

	Number of Responses				% of Responses	
	Rated #1	Rated #2	Rated #3	Total for #1, #2, and #3	% for #1, #2, and #3	% for #1
Someone created an application that fit my requirements	9	7	5	21	77.8	33.3
Models (or better models) were easily available that fit our requirements	8	10	1	19	70.4	29.6
Application software was free	5	4	4	13	48.1	18.5
Free or very low-cost expertise to teach us how to use [HPC technical servers] and help us set up our models on the technical servers	5	1	8	14	51.9	18.5
The hardware was free	2	2	4	8	29.6	7.4
Total	29	24	22	75		

n = 27

Note: Multiple responses were allowed.

Source: IDC, 2007

Business Drivers That Would Motivate "Desktop-Only" Users to Move to HPC

Table 16 depicts the main technical drivers that would motivate desktop-only technical computing users to exploit HPC for more advanced virtual prototyping: more strategic fit software, more human talent/expertise, and lower costs. Yet, a more immediate set of business drivers would propel many desktop-only users into the HPC realm, as Table 17 illustrates. For the majority of the surveyed firms that aren't already using HPC, the main, immediate market-driven motivators were future customer requirements (48%) and current customer requirements (29%), followed by the need to catch up if competitors should forge ahead by using HPC (19%). Creating a competitive advantage in a vacuum, without an external customer mandate or competitive threat, proved far less compelling (5%) than the immediate motivators. To an important extent, therefore, migration to HPC can also depend on the emergence of new customer requirements or competitive threats.

As noted earlier, major drivers/motivators seldom have a one-to-one correspondence with key barriers to adopting technologies. As Table 18 shows, cost-related issues will emerge as the chief barriers to HPC adoption among the surveyed firms that are using only desktop technical computers today.

- *"This is necessary to rapidly develop products in order to meet our customer requirements and to gain market share."*

TABLE 17

Business Drivers That Would Motivate "Desktop-Only" Users to Move to HPC

Q. What are the top drivers that would motivate you or your organization to use HPC servers for computational simulation and design?

	Count	% of Respondents
We need to use it to meet future customer requirements	20	47.6
Customers require it	12	28.6
Competitors have used it to create an advantage, and we need to close the gap	8	19.0
My organization doesn't have significant competitive advantage, and I need to create it using HPC	2	4.8
Total	42	100.0

n = 29

Note: Multiple responses were allowed.

Source: IDC, 2007

Barriers to Expanded Use of HPC

Tables 16 and 17 describe the main drivers/motivators that would cause "desktop-only" companies to adopt HPC. The commentary accompanying those tables explains that positive drivers/motivators seldom correspond precisely to barriers to adoption. As Table 18 illustrates, when IDC asked about barriers to HPC adoption, financial considerations were the highest-ranked and most frequently cited obstacles. Budget limitations in relation to system costs emerged as the number one constraint, cited by about one in four respondents (23%). Not far behind this barrier, however, were the difficulty of educating senior management about HPC's value (15%) and ease-of-use and system management issues (15%). They were followed by third-party software costs (10%) and the costs and availability of sufficiently skilled internal or external experts (10%). 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 must be for "desktop-only" and entry-level HPC users? In sum, these companies, many of which see HPC as a distinct competitive differentiator, currently face an array of barriers to adopting this technology, and the chief barriers are related to costs and budgets.

Comments

- *"Right now we haven't identified needs for this kind of modeling. We aren't aware of models that can help us at this time."*
- *"We do not have the need for it in the welding technology area."*
- *"There are no barriers holding us back. The technical desktops that we use meet our needs."*
- *"We are using them [high performance computers] now. In the future we may be limited by cost."*
- *"We use HPC for many other things, but not welding-related."*
- *"Understanding the application to our processes to justify the use."*
- *"Proving the ROI to management."*
- *"Appropriate applications and the know-how to use their capabilities."*
- *"Lack of inexpensive application software available."*
- *"Awareness, and having access to software that will meet our needs."*
- *"The barrier to expanding current use would be in a lack of human resources and capital."*
- *"We don't have in-house expertise, so we outsource to EWI."*
- *"Getting qualified personnel to use it."*

TABLE 18

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	% of Respondents
Financial	33	47.8
Financial — lack of funds, budgets, etc.	16	23.2
Financial — budgets — business case, upper management doesn't appreciate the value	10	14.5
Financial — third-party software costs	7	10.1
Ease of use — system management capability — management software	10	14.5
Having a skilled staff and/or other experts available	7	10.1
Application availability/lack of maturity of the solution	6	8.7
Technical limitations — system performance, interconnect performance, complexity/cable, cards, switches, etc.	5	7.2
Complexity to expand our modeling simulation up to an HPC server	2	2.9
Supported data storage mechanisms (databases, parallel file systems, etc.)	1	1.4
Maintenance/availability issues	1	1.4
Other	4	5.8
Total	69	100.0

n = 26

Notes:

- "Other" responses included security, data accuracy concerns, and customer requirements are missing.
- Multiple responses were allowed.

Source: IDC, 2007

Willingness to Use Remote HPC

IDC then asked the firms whether they would perform computational simulations and/or design work remotely over the Internet if there were an easy, cost-effective, and secure way to do it — that is, if assumed major barriers were removed for them. Two-thirds of the companies (66%) answered yes, and the remainder (35%) said no (see Table 19). When we probed further, the comments of the minority who said no were especially instructive (a representative sampling appears in the following Comments section). A few of the companies that were unwilling to use the Internet said they were happy with their current technical computing situation, but most cited specific issues, which ranged from the time it would take to reeducate staff to the Internet's speed (too slow, in their view) and security (not strong enough). One firm said it would make more sense to outsource the work entirely than to do it remotely over the Internet.

Comments

- *"The time frame involved to reeducate the staff on using a different system would be a reason [not to use the Internet]. What we have works well for us."*
- *"I'm concerned about the time to process over the Internet."*
- *"Our simulation and designs require very large files, and the infrastructure on the Internet cannot support timely and adequate transfer of these files."*
- *"Data transfer speeds for large transfers are too slow."*
- *"Our main concern would be one of confidentiality."*
- *"There are too many security issues."*
- *"Our data is considered ITAR — International Traffic in Arms Regulations. We cannot transmit the type of data needed for a simulation over the Internet unless it is a truly secure server."*
- *"Before we did this [work remotely over the Internet], we would contract it out."*

TABLE 19

Willingness to Use Remote HPC

Q. If you had an easy, cost-effective, and secure ability to perform computational simulation and/or design work over the Internet, would you do that?

	Count	% of Respondents
Yes	19	65.5
No	10	34.5
Total	29	100.0

Source: IDC, 2007

Interest in Using Outside Help

Table 20 describes which types of external organizations the survey respondents would prefer to work with if they decided to use HPC consultants. The most popular first choice among the respondents was "a nonprofit organization like EWI" (27% of the "rated #1" responses and 29% of all responses to this question). Other popular choices were "a major university" (21% of the "rated #1" responses), "a small system vendor that understands our needs" (15% of the "rated #1" responses), and "an engineering services company" (12% of the "rated #1" responses). Least favored were "an ISV application software provider" and "a community college or technical school."

TABLE 20

Use of Outside Consulting Organizations

Q. If you were to use outside consulting organizations, which would you be most likely to use?

	Number of Responses				% of Responses	
	Rated #1	Rated #2	Rated #3	Total for #1, #2, and #3	% for #1, #2, and #3	% for #1
A nonprofit organization like EWI	9	11	4	24	28.9	27.3
A major university	7	3	2	12	14.5	21.2
A small system vendor that understands our needs	5	2	3	10	12.0	15.2
An engineering services company	4	5	5	14	16.9	12.1
A government national laboratory including NSF centers	3	1	3	7	8.4	9.1
A large system vendor like IBM, HP, Sun, etc.	3	1	0	4	4.8	9.1
A smaller university	1	1	3	5	6.0	3.0
Local technical experts	1	1	2	4	4.8	3.0
ISV application software provider	0	1	1	2	2.4	0.0
A community college or technical school	0	0	1	1	1.2	0.0
Total	33	26	24	83	100.0	100.0

n = 28

Note: Multiple responses were allowed.

Source: IDC, 2007

About one-third of the companies (32%) IDC asked about paying for outside services to help them move to HPC said they had no interest in doing this (see Table 21). More than half of the respondents to this question (52%) would prefer monthly payments, while one in six (16%) would rather pay on an annual basis.

TABLE 21

Willingness to Pay for Outside Help

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

Q. Would you prefer to pay on a month-by-month basis or step up to a yearly agreement?

	Count	% of Respondents
Not interested or zero	8	32.0
Prefer monthly payments	14	52.0
Prefer yearly payments	4	16.0
Total	26	100.0

Note: The four sites that said yearly payments preferred to pay around $25,000 a year.

Source: IDC, 2007

Table 22 shows that of the 14 companies that preferred to pay for services on a monthly basis, 50% would like to pay around $2,000 a month, 21% would pay around $5,000 a month, 21% would pay around $10,000 a month, and 7.1% (one site) would pay over $10,000 a month.

TABLE 22

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

Q. What is the size of preferred monthly payments?

	Count	% of Respondents
Around $2,000 a month	7	50.0
Around $5,000 a month	3	21.4
Around $10,000 a month	3	21.4
Over $10,000 a month	1	7.1
Total	14	100.0

Source: IDC, 2007

Can HPC Provide a Dramatic Increase in Competitiveness?

Asked whether HPC could dramatically boost their competitiveness, half of the surveyed firms (48%) responded in the affirmative and the rest (52%) responded in the negative (see Figure 4). The emphasis was on the "dramatic," which helps explains why about half of the firms answered yes to this question, while earlier in the study 76% said they viewed technical computing as a driver of their competitive success (refer back to Figure 1).

Comments (Affirmative)

- *"For us, HPC is already instrumental in our business, but it is incremental since the entire industry uses it already."*
- *"It will handle the larger problems in less time."*
- *"Simulation capabilities allow for better insight into product quality and effectiveness."*
- *"Shortening product development cycles through virtual prototyping is crucial."*
- *"The computational power is nothing without the expertise to harness the power appropriately."*
- *"It will especially help with innovation."*
- *"It can be based on customer needs and clear identifications of needs and output."*

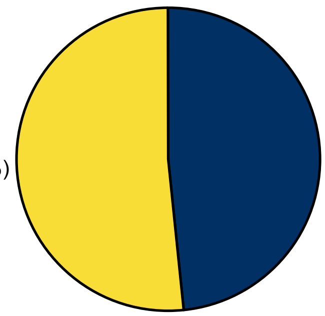
Comments (Negative)

- *"We have limited application for the use of these servers. It's limited to small increases in productivity."*
- *"It would have to give us a novel equipment design advantage."*
- *"Not at this time, but maybe in the near future."*

FIGURE 4

Role of HPC Technical Servers in Increasing Innovation or Competitiveness

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



Source: IDC, 2007

Council on Competitiveness
1500 K Street NW, Suite 850, Washington, D.C. 20005 T 202 682 4292
Compete.org

Compete.
Council on Competitiveness