High Performance Computing

# Advance.

## Benchmarking Industrial Use of High Performance Computing for Innovation

Compete.

Council on Competitiveness

# Benchmarking Industrial Use of High Performance Computing for Innovation

This material is based on research sponsored by DARPA under agreement number F30602-00-D-0221/0025, and by the U.S. Department of Energy under grant number DE-FG02-06ER25795. The U.S. government is authorized to reproduce and distribute reprints for governmental purposes notwithstanding any copyright notation thereon.

The views and conclusions contained herein are those of the authors and should not be interpreted as necessarily representing the official policies or endorsements, either expressed or implied, of DARPA, the Department of Energy or the U.S. government.

**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 www.compete.org.



**DESIGN** Soulellis Studio

Printed in the United States of America

# Advance.

## Benchmarking Industrial Use of High Performance Computing for Innovation

Introduction

# Transforming Competitiveness with HPC-Driven Innovation: How U.S. Firms Are Faring

**During the past three years, a series of pioneering studies and conferences conducted under the Council's High Performance Computing (HPC) Initiative confirmed the vital role this technology plays in driving private-sector competitiveness. Study after study showed that virtually all businesses—large and small—that adopt HPC consider it indispensable for their ability to compete and survive. The reason is simple: HPC is a proven game-changing technology.**

HPC-based virtual prototyping and large-scale data modeling provide breakthrough insights that dramatically accelerate and streamline not only "upstream" R&D and engineering, but also "downstream" business processes such as data mining, logistics and custom manufacturing. To cite a few examples:

- Boeing used HPC modeling and simulation in many design areas for its new, highly successful Boeing 787 Dreamliner aircraft. Thanks to HPC, the company needed to perform expensive "live" experimental tests on only 11 prototype wing designs, versus 77 wing designs for the prior-generation Boeing 777 plane.
- Whirlpool found that an unacceptably high percentage of its washing machines were being dented between the factory and the retailer. Through modeling and simulation with HPC, the company saved millions of dollars by redesigning packaging materials and even the clamps used by the firm's global network of distributors.
- HPC gives Wal-Mart the capacity to manage its stores worldwide from its headquarters in Bentonville, AR, right down to turning on the lights. Wal-Mart uses HPC not only for purposes like this, but for shelf space determinations, store planning and resource management.
- HPC was crucial in enabling Chevron and two partners to discover a new field in Gulf of Mexico deepwater that could yield 3-15 billion barrels of oil, boosting U.S. reserves by up to half. Processing the massive data sets needed for this discovery was impossible before recent advances in HPC capabilities and related visualization technologies.

While Council studies have confirmed the tight linkages between use of HPC and private sector competitiveness (http://www.compete.org), no study has attempted to understand whether U.S. businesses are applying this technology to advance innovation for competitive gain or how deeply within an industry's supply chain HPC has been embraced. And yet extensive Council research has shown that in the 21st century economy, innovation is the surest path to competitive success. HPC is a proven innovation accelerator, shrinking time to insight and time to discovery.

If the United States is going to compete successfully in the global economy, HPC usage must be pervasive across industries and within industries. It is therefore crucial to understand the extent of that penetration, particularly to improve innovation, as well as how the U.S. companies' use of HPC measures up against international competitors. It was to fill this important knowledge gap that the Council and IDC collaborated for this study. We believe this is the first study to benchmark these innovation and competitiveness indicators.

For this study, IDC targeted four economically important industries whose leading firms have known histories of HPC usage: the aerospace, automotive,

bio-life sciences and energy sectors. In addition to examining whether firms in these industries use HPC to accelerate innovation, the study also examined the penetration of HPC usage within their supply chains as a gauge for the innovation readiness of the broader industry. Finally, the study compared HPC usage among leading U.S. firms and select, "best-in-class" international competitors.

What emerges from this benchmarking exercise is a picture of mixed progress and strong opportunity for the U.S. business community to bolster its competitiveness by applying HPC more pervasively and aggressively. A decade ago, the use of HPC in the private sector was limited to a handful of industries. The HPC market has grown dramatically since then. And while the United States remains the largest consumer of HPC—overall and within industry—the study revealed that U.S. firms as a group are not applying HPC as aggressively as they could.

In any benchmarking exercise, it is important to understand what is being compared. While the category of tier 1 U.S. companies includes hundreds of businesses (of which 14 provided in-depth interviews for this study), the best-in-class international firms category is far narrower—it includes only the top 2-3 companies in any business sector. This is not an exact, apples-to-apples comparison. The primary value for benchmarking purposes is in revealing the level of international competition U.S. businesses are facing at the top of the innovation pyramid.

The most noteworthy finding was that U.S. tier 1 energy firms are outpacing other U.S. industries in integrating HPC into critical business functions. They have moved more aggressively in applying HPC beyond traditional R&D into manufacturing, production and large scale data management. They also have moved more aggressively in applying HPC to drive innovation in these activities.

The most unexpected finding was that few suppliers to U.S. tier 1 companies in the surveyed industries use HPC (or even desktop workstations) today. So few suppliers to U.S. tier 1 firms have adopted HPC that it was difficult to find examples for this study. This suggests that although the market leaders are embracing the best technologies, the innovation readiness of these industries as a whole is not very deep.

Other key findings include:

- Tier 1 U.S. firms and international best-in-class firms agree that HPC can dramatically boost their ability to innovate.
- Costs, especially related to software, and scarcity of talent are the biggest barriers to broader HPC use among U.S. tier 1 firms and their suppliers. These barriers have been highlighted in prior Council reports.
- Despite the energy industry's assertive use of HPC, international best-in-class firms apply HPC beyond traditional upstream R&D functions more frequently. International best-in-class firms are also pushing HPC through their supply chains more than U.S. tier 1 firms. This does not mean that tier 1 U.S. firms are lagging behind their international direct counterparts in exploiting HPC—only that the smaller, more select group of best-in-class international firms is setting a higher standard. They are demonstrating the major opportunity U.S tier 1 firms and their suppliers have to boost their innovation and competitiveness by exploiting HPC more fully.

To seize this important opportunity, U.S. businesses (and their customers and investors) need to increase their understanding of HPC's potential for propelling innovation and transforming competitiveness. To maintain differentiated value and stay ahead of the competitiveness pack, U.S. firms must repeatedly reinvent themselves through continuous, rapid innovation. Prior Council studies and conferences have demonstrated the direct linkages between modeling, simulation and data analysis with HPC and increased competitiveness. This benchmarking study breaks significant new ground by revealing the importance of applying HPC to accelerate innovation in order to gain competitive advantage, and where key U.S. industries stand in doing this.

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 Study of Innovation, Competitiveness, and HPC

Sponsored by: DARPA, DOE, and Council on Competitiveness

Earl Joseph, Ph.D.
Steve Conway
Jei Wu
Suzy Tichenor, Council on Competitiveness

May 2008

## EXECUTIVE SUMMARY

Investigating and advancing the use of high-performance computing (HPC) to increase U.S. industrial productivity and global competitiveness is the main purpose of the Council on Competitiveness' HPC Initiative, a coordinated program of original research, conferences, and workshops that began three years ago. This study, sponsored by the Council on Competitiveness, the Defense Advanced Research Projects Agency (DARPA), and the Department of Energy (DOE), was designed to measure the penetration of HPC among leading U.S. industrial companies and their suppliers in selected industries as a way to help determine whether they are adequately equipped to accelerate innovation and competitiveness. In addition, this study compares tier 1 U.S. companies and their supplier firms in each of four economically important industries with each other and with best-in-class international tier 1 competitors. Prior Council on Competitiveness studies conducted by IDC (downloadable at **www.compete.org/hpc**) found that virtually all U.S. businesses that have adopted HPC consider this technology indispensable for their competitiveness and corporate survival.

American industry is in the midst of a new, 21st century industrial revolution driven by the application of computer technology to industrial and business problems. HPC plays a key role in designing and improving many industrial products — including automobiles, 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). HPC users typically 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, HPC users are increasingly crucial for U.S. innovation, productivity, and competitiveness.

The study gathered concrete information on the role HPC has already played as an innovation driver in the surveyed companies, on important problems HPC could enable these companies to solve in the future, and on the barriers to HPC adoption and expansion. With the help of the information and metrics gathered in this study, the Council hopes to establish HPC as a gauge to evaluate the country's capacity for innovation.

For this study, IDC conducted surveys of 51 U.S. firms and six international "best in class" firms in four important industries known to make substantial use of HPC: the aerospace, automotive, bio-life sciences, and energy sectors. Of the U.S. firms, 14 were tier 1 industry leaders and the remaining 37 were suppliers to the tier 1 companies.

To identify 37 supplier firms to be surveyed, more than 300 other suppliers were disqualified because they did not make use of technical computing even on desktop workstations. HPC has hardly penetrated the supply chains of these critical industries. Only 13 of the 37 surveyed U.S. suppliers had substantial HPC experience. This situation represents a major opportunity for future productivity enhancement. The risks without HPC, according to the surveyed firms that employ it today, include the inability to meet product regulations, falling behind competitors, and "being priced out of the market completely." A large majority of the surveyed firms said expanded use of HPC could help bring about a dramatic increase in their future innovation.

U.S tier 1 energy firms are outpacing other U.S. industries in integrating HPC into critical business functions. While 100% of the U.S. tier 1 firms surveyed are using HPC in the traditional, “upstream” applications of R&D and/or design-engineering, the energy industry has moved more aggressively in applying HPC to key “downstream” business functions. Tier 1 energy firms are also ahead of their counterparts in applying HPC to large scale data management, an emerging application area with enormous business payoff potential beyond even the industries included in this survey. Despite the fact that U.S. tier 1 energy firms are exploiting HPC more broadly than their counterparts in other industries, they rated themselves lower when asked if they use it as aggressively as they could, suggesting they may see more innovative applications on the horizon than do other industries.

Suppliers to the tier 1 U.S. firms are notably lagging behind their customers in using HPC at all, and (for those that do) in applying this technology aggressively. This situation is troublesome in view of the fact that the surveyed firms that exploit HPC reported that it reduces the costs of engineering and testing and makes possible new ideas and insights, superior products, faster time to market, and a host of industry-specific advances.

The results differ by industry, but in general, tier 1 firms, whether U.S. companies or their international best-in-class rivals, rated HPC substantially higher than did U.S. suppliers as a strategic asset that is directly linked to their ability to compete and innovate. And a much larger proportion of suppliers than tier 1 and international best-in-class firms conceded that they are not using HPC as aggressively as they could. Higher percentages of tier 1 and international best-in-class companies than tier 1 supplier firms reported that HPC can play a dramatic role in increasing their innovation.

International best-in-class firms are driving HPC through their supply chains more aggressively than U.S. tier 1 firms. 100% of the best-in-class firms in the aerospace, auto, and bio-life sciences industries indicated that they require their suppliers to use HPC. This is far more aggressive than in the United States, where only 50% of the tier 1 aerospace and auto firms and none of the tier 1 bio-life sciences firms do so. (The picture in the energy sector is identical for international best-in-class and U.S.

tier 1 firms: Neither requires its suppliers to use HPC.) The U.S. approach may be best reflected in one firm's comment: "Customers are focused more on the end product than how we get to the end product." The percentage of U.S. firms whose customers require them to use HPC varies greatly by industry, from 25% of tier 1 firms (and 13% of their suppliers) in the bio industry to 67% of tier 1 firms (60% of suppliers) in the automotive sector.

High proportions (87–100%) of companies of all types surveyed — tier 1 U.S. firms and their suppliers as well as international firms in all of the industries — believe that their competitors use HPC. This result is interesting given that so many suppliers in the study were disqualified due to not using HPC today. Perhaps many have international competitors that use HPC. U.S. firms (tier 1 companies and suppliers) tend to see their HPC use as equal to or worse than that of competitors. The international best-in-class firms more often view their HPC usage as equal to or better than that of competitors.

Of the major factors motivating the surveyed companies' most recent HPC system purchase, three of the top 4 are related to providing new insights or making new problems tractable. Costs (particularly software costs), and lack of talent are the biggest barriers to broader HPC use among U.S firms. 71% of U.S. tier 1 firms and 92% of their suppliers cited overall costs as a major obstacle to expanded use of HPC within their organizations. Software costs in particular emerged as a key barrier for many of the U.S. firms (except the bio sector, which relies more on shareware), with 100 % of the tier 1 auto firms noting this obstacle. Lack of staffing resources also emerged as a significant barrier for U.S. tier 1 firms, with three fourths of bio, two thirds of the aerospace and auto and half of the energy highlighting this as a problem. It also was a stumbling block for the suppliers to tier 1 energy, auto and aero companies. These barriers also have been highlighted in other Council reports (see www.compete.org/hpc )

This study reaffirms the central findings of prior IDC research conducted for the Council on Competitiveness, which revealed that virtually all U.S. businesses that have already adopted HPC consider this technology indispensable for their competitiveness and corporate survival. The current study expands on earlier research by illuminating HPC's specific role in driving innovation and the extent to which supplier companies have adopted this technology.

Heightened competition from other nations has made it more urgent to accelerate innovation and elevate productivity within the U.S. private sector. IDC believes that the failure of companies of all sizes to exploit HPC more thoroughly for increased innovation 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 innovation, productivity, and competitiveness.

## METHODOLOGY

This is a study comparing the use of HPC, particularly for driving innovation, among three groups of businesses:

- **Tier 1 U.S. companies:** This refers to the primary companies within a given industry in the United States, and the data reflects an average level across these companies.
- **U.S. suppliers to tier 1 U.S. companies:** The data reflects an average level across these companies.
- **International best-in-class companies:** This refers to foreign companies that are viewed as the best in the world in their industry.

For this study, IDC targeted four economically important industries with known histories of HPC usage: the aerospace, automotive, bio-life sciences, and energy sectors. This list deliberately excluded some industries that employ HPC (e.g., weather/environmental, entertainment, financial services) because the primary purpose of the study was not to produce an exhaustive catalog of HPC usage in industry, but instead to see how far HPC has penetrated the supply chains of leading companies, and also to compare HPC usage among leading U.S. firms and their international competitors.

Identifying tier 1 U.S. firms and international best-in-class companies that employ HPC was easy enough; most were well known to IDC or the Council from the start. Finding suppliers that make use of HPC proved to be a daunting task, however. After soliciting the names of many suppliers from tier 1 firms participating in the study, IDC had to contact more than 300 supplier companies in order to identify 37 supplier firms that actively use technical computing, and some of these do so only on desktop workstations today (meaning they don't currently use HPC servers). Consequently, one of the study's key findings from this supplier qualification process is that HPC, despite its proven benefits for tier 1 companies that employ it, has so far barely scratched the surface of these firms' supply chains.

## 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 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, and advanced 3D animation. Technical computers range from single-user desktop computers (PCs, Macs, and workstations) to supercomputers. Technical computing is in contrast to commercial or enterprise computing, which is used for business operations such as accounting, payroll, sales, customer relations, transaction processing, and so on.

### HPC

IDC uses the term *HPC* to cover all servers used for technical computing tasks. These servers can be priced as low as $5,000–10,000 each up to hundreds of millions of dollars each. *HPC* is used the same way as the term *technical server.*

### Innovation

IDC uses the term *innovation* to refer to creating new ideas, products, inventions, manufacturing processes, risk modeling, supply chain optimization, services, business process innovations, and so on. An innovation is something new that creates value for the innovating organization or its customers. In this study, IDC is interested in innovations that were achieved using HPC, especially those that would have been difficult or impossible to accomplish without HPC. Organizations range from entire companies to single departments within a company.

### 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 number of companies and industries have adopted virtual prototyping and large-scale data modeling as part of their R&D, production computing, and complex business processes 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.

## Tier 1 Sites, Suppliers (to Tier 1 Sites), and International Best-in-Class Organizations

For this study, IDC defines *tier 1 companies* as U.S. firms that are primary companies in their industries. The term *suppliers* refers to U.S. companies that supply tier 1 sites. *International best-in-class organizations,* sometimes also called *best-in-class companies,* are international firms that have been repeatedly identified in IDC and other studies as among the most successful and innovative in their market sectors over time. Note that the data reflects an average level across these companies.

## HPC Experience

The study also frequently distinguishes among companies based on their reported years of experience with HPC resources. Thirty-three of the 57 surveyed firms said they have major HPC experience. This group included 14 U.S. tier 1 firms, 13 U.S. suppliers, and six international best-in-class firms. The remaining 24 U.S. suppliers have little or no HPC experience but are doing modeling and simulation on desktop workstations.

## KEY FINDINGS

### 1) Leading U.S. and International Industrial Firms Agree That HPC Can Dramatically Boost Their Innovation

One hundred percent of the surveyed international best-in-class firms and U.S. tier 1 auto and aerospace firms, along with a strong majority of U.S. tier 1 energy firms (75%), agreed that HPC can play a role in dramatically increasing their innovation. The majority of the international best-in-class and U.S. tier 1 companies purchased their most recent HPC systems to provide new insights and spur new ideas (i.e., innovation) as well as to address intractable problems.

This result is consistent with prior Council studies in which the majority of firms that used HPC considered it essential to compete and survive. Confidence in the ability of HPC to dramatically boost innovation was lower in the U.S. bio-life sciences sector, which is newer to HPC usage, but comments from these firms indicate they recognize that HPC is often indispensable:

- *"Can dock thousands of molecules into proteins; no way we could do it without HPC hardware."*
- *"Chemical compound modeling; had to make by hand and test them."*
- *"We would be relegated to working with microscopes and test tubes without HPC."*
- *"Simulate large-scale clinical trials; able to search for new bio markers."*

And from one supplier:

- *"First thing we bought with investment money was the HPC system."*

Surveyed firms were also asked to consider whether HPC contributed to profitability, competitiveness, and/or productivity:

- All international best-in-class and U.S. aerospace tier 1 firms indicated that HPC has directly benefited their companies in each of these critical business benchmarks.
- All U.S. auto tier 1 companies saw more benefit to profits and competitiveness.
- All U.S. energy tier 1 companies attributed HPC benefits more strongly to productivity.
- U.S. bio tier 1 firms were mixed in their assessment of HPC's contribution to these business benefits.

Firms provided a long list of risks they would face if they no longer had access to HPC, including the inability to compete, stifled R&D, delayed products, and inferior or

unmarketable products. Any one of these risks could result in an inability to compete and survive:

- *"It would be fundamentally impossible to pursue research in biotechnology without HPC."*
- *"Their would be no way to keep up with the rest of our industry; HPC gives us a leg up."*
- *"We wouldn't be able to create new products in a timely manner."*
- *"We would not be able to continually improve products."*
- *"We would have inferior, uncompetitive products."*
- *"We would stagnate."*

## 2) U.S. Tier 1 Energy Firms Are Outpacing Other U.S. Industries in Integrating HPC into Critical Business Functions

While 100% of the U.S. tier 1 firms surveyed are using HPC in the traditional, "upstream" applications of R&D and/or design engineering, the energy industry has moved more aggressively in applying HPC to key "downstream" business functions. Seventy-five percent of the tier 1 energy firms are employing HPC in manufacturing, compared with roughly a third of the tier 1 firms in auto and aerospace, and none in bio-life sciences. Tier 1 energy firms are also ahead of their counterparts in these other industries in applying HPC to large-scale data management, an emerging application area with enormous business payoff potential beyond even the industries included in this survey.

Energy was ahead of the other three industries in applying technical computing downstream to help drive innovation. Despite the fact that U.S. tier 1 energy firms are exploiting HPC more broadly than their counterparts in other industries, they rated themselves lower when asked if they use it as aggressively as they could, suggesting they may see more innovative applications on the horizon than do other industries.

## 3) International Best-in-Class Firms Apply HPC Beyond Traditional R&D Functions More Frequently than Do U.S. Tier 1 Firms

Despite the U.S. energy industry's aggressive use of HPC, the international best-in-class industrial firms have pushed HPC usage much deeper into their organizations on average than the surveyed U.S. tier 1 firms — more frequently extending its use from traditional upstream applications in R&D and design engineering into high-value downstream uses, such as manufacturing, production, and large-scale data

management. The international firms closely associate their HPC usage, whether upstream or downstream, with improved innovation of their products and industrial processes. Every one (100%) of the international best-in-class firms views HPC as a strategic asset that directly benefits its profits, competitiveness, and productivity, while only the auto tier 1 firms were unanimous in indicating this same assessment**.**

## 4) Few Suppliers to U.S. Tier 1 Companies Use HPC (or Even Desktop Workstations) Today

During the survey process, more than 300 suppliers to the tier 1 companies were disqualified because they do not substantially use technical computing today. And of the modest number of suppliers (37) in this study that do use technical computing, only 13 reported having major HPC experience, versus 24 that have little or no HPC experience, and do modeling on the desktop only. The troublesome finding is that most industrial suppliers, even in industries where most tier 1 customers have used HPC for more than a decade and consider it indispensable, are not taking advantage of HPC today. The rare use of HPC among suppliers represents a major opportunity for future productivity enhancement.

## 5) International Best-in-Class Firms Are Driving HPC Through Their Supply Chains More Aggressively than U.S. Tier 1 Firms

One hundred percent of the best-in-class firms in the aerospace, auto, and bio-life sciences industries indicated that they require their suppliers to use HPC. This approach is far more aggressive than in the United States, where only 50% of the tier 1 aerospace and auto firms and none of the tier 1 bio-life sciences firms do the same. (The picture in the energy sector is identical for international best-in-class and U.S. tier 1 firms: Neither requires suppliers to use HPC.) The U.S. approach may be best reflected in one firm's comment: *"Customers are focused more on the end product than how we get to the end product."*

Interestingly, the international best-in-class firms are more driven by customer expectations to use HPC than their U.S. tier 1 counterparts. Their customers did not always require the surveyed international best-in-class firms to use HPC; in every case HPC was cited by customers as a major reason for doing business with these firms. The customers view HPC as a distinct advantage. In the United States, none of the aerospace or auto tier 1 firms cited their use of HPC as a major reason their customers did business with them, while only a third of the tier 1 energy firms and only half of the tier 1 bio firms offered this as a reason.

## 6) The Majority of the Surveyed Firms Have Unsolved Problems Whose Solution Could Boost Their Competitiveness

Most of the 57 U.S. and international survey respondents (80%) described currently intractable problems they would like to pursue with HPC in order to accelerate their innovation and competitiveness.

The comments from sites with little or no HPC experience fell into two categories: the need to do current work faster or better and the desire to do entirely new things:

- *"We want to do electromagnetic modeling of larger arrays."*
- *"We want to do more complex modeling."*
- *"[We'd like to do] 3D modeling and mechanical stress analysis."*
- *"[We'd like to do] automatic code generation, and simulation of control systems for ABS and electrical stability programs."*
- *"We're on the cutting edge already."*

Some of these firms felt that current systems are satisfactory:

- *"Today's PCs can handle almost anything."*

Nearly all of the comments from the experienced HPC sites (U.S. tier 1 firms and suppliers and international best-in-class firms) pointed to a desire for major leaps forward in innovation and product design:

- *"We could create better airplane designs, more derivative designs, and improved fuel economy."*
- *"Big leaps would be possible."*
- *"We could have reduced product development time and higher-quality products."*
- *"It would provide a competitive advantage to be able to solve problems that other companies cannot."*
- *"It would help in defining our future."*
- *"It would get us past the limitation to the 'holy grail' of designing the broad-spectrum antiviral."*
- *"If we could analyze the whole genome, it would be a huge advantage."*

## 7) Costs (particularly software costs), and lack of talent are the biggest barriers to broader HPC use among U.S firms

71% of U.S. tier 1 firms and 92% of their suppliers cited overall costs as a major obstacle to expanded use of HPC within their organizations. Software costs in particular emerged as a key barrier for many of the U.S. firms (except the bio sector, which relies more on shareware), with 100 % of the tier 1 auto firms noting this obstacle. This may be because the automotive industry is highly dependent on third party software. Software costs were not an important consideration among the international companies in the same industries.This may simply mean that the international firms are more realistic about software costs in their budgeting processes.

Lack of staffing resources also emerged as a significant barrier for U.S. tier 1 firms, with three fourths of bio, two thirds of the aerospace and auto and half of the energy highlighting this as a problem. It also was a stumbling block for the suppliers to tier 1 energy, auto and aero companies.

These barriers also have been highlighted in other Council reports (see www.compete.org/hpc).

## TABLE OF CONTENTS



## TABLE OF CONTENTS — Continued

## LIST OF TABLES



## LIST OF TABLES — Continued

## LIST OF FIGURES



# SITUATION OVERVIEW

## Motivations for This Study

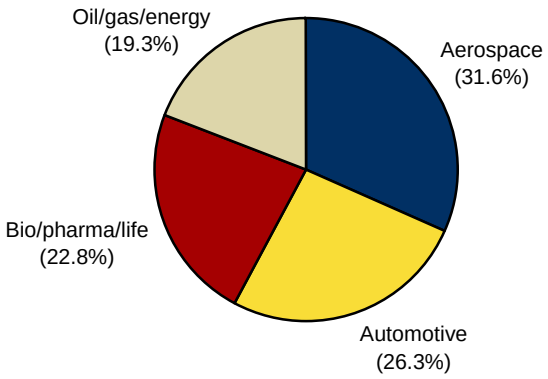
The aim of this study was to measure the penetration of high-performance computing (HPC) among leading companies and their suppliers in selected industries as a way to determine whether they are adequately equipped to accelerate innovation and competitiveness. In addition, comparisons are made with leading best-in-class international tier 1 companies. Prior Council on Competitiveness studies conducted by IDC (downloadable at **www.compete.org/hpc**) found that virtually all U.S. businesses that have adopted HPC consider this technology indispensable for their competitiveness and corporate survival. Therefore, it is important to take a new reading on the extent to which leading U.S. firms are exploiting HPC technology. The study also gathered concrete information on how HPC has helped the surveyed companies and their industries to innovate (success stories) and how their HPC usage has changed over the years. With these metrics, the Council hopes to establish HPC as a gauge to evaluate the country's capacity for innovation. For this study, IDC conducted surveys of firms in the aerospace, automotive, bio-life sciences, and energy industries.

## Survey Profile

For this study, IDC first surveyed 14 leading U.S. tier 1 companies in the aerospace, automotive, biotechnology, and energy industries, then interviewed U.S. suppliers in the same industries. Six best-in-class international tier 1 firms were also interviewed. Figure 1 and Table 1 show the industry mix among the total of 57 survey respondents.

**FIGURE 1**

Survey Respondents by Industry




**n = 57**

Source: IDC, 2008

**TABLE 1**

Survey Sample Mix

| | Number Surveyed |
|---|---|
| **Summary** | |
| Tier 1 | 14 |
| Suppliers to tier 1 | 37 |
| International best in class | 6 |
| Total | 57 |
| **By industry and category** | |
| Aerospace tier 1 | 3 |
| Aerospace suppliers | 14 |
| Foreign aerospace best in class | 1 |
| Auto tier 1 | 3 |
| Auto suppliers | 10 |
| Foreign auto best in class | 2 |
| Bio tier 1 | 4 |
| Bio suppliers | 8 |
| Foreign bio best in class | 1 |
| Energy tier 1 | 4 |
| Energy suppliers | 5 |
| Foreign energy best in class | 2 |
| Total | 57 |

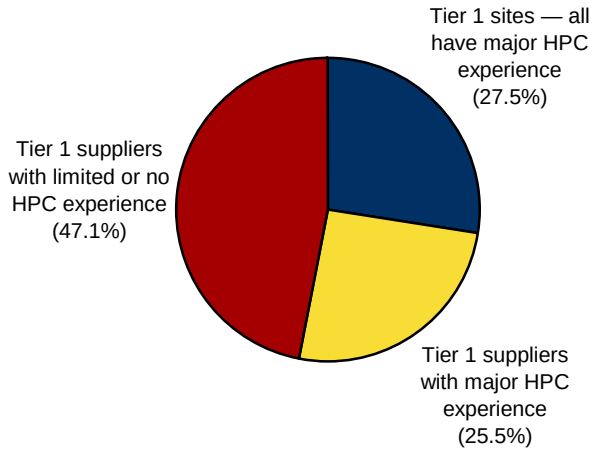
Source: IDC, 2008

Figure 2 depicts the HPC experience of the 51 U.S. firms participating in the survey. One hundred percent of the tier 1 companies (representing 28% of the 51 surveyed U.S. firms) have major HPC experience, but only 35% of their suppliers (representing 26% of the surveyed U.S. firms) reported that level of HPC experience. In other words, two out of every three surveyed suppliers to the tier 1 U.S. firms have limited or no HPC experience, relying on desktop workstations to conduct their modeling and simulation.

## FIGURE 2

Share of U.S. Sites with HPC Experience



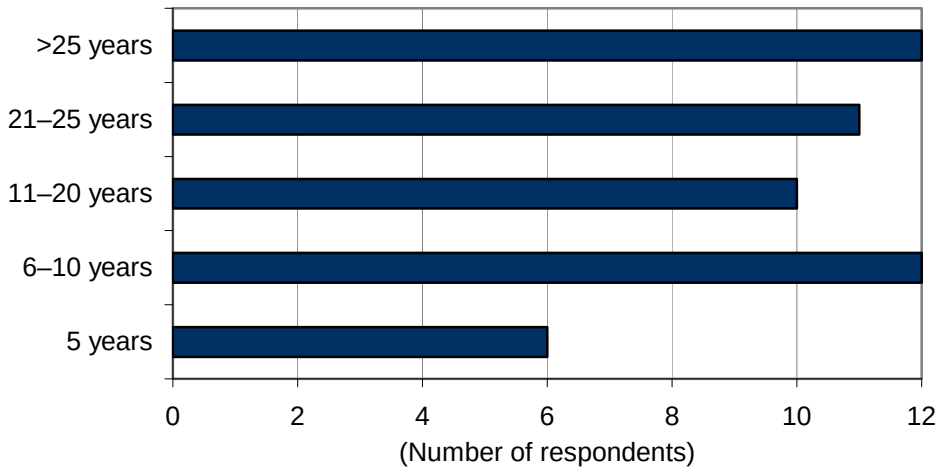

**n = 51**

Source: IDC, 2008

Figure 3 shows that two-thirds of the U.S. companies (33 of 51) have employed technical computing on workstations and/or servers for more than 10 years. Only 18 of the firms (35%) have used technical computing for five years or less.

## FIGURE 3

Length of Time U.S. Sites Have Used Technical Computing (Workstations to High-End Servers)




n = 51

Source: IDC, 2008

Table 2 breaks out the technical computing experience by industry and company category (tier 1, supplier, and international best in class). As expected, the aerospace, automotive, and energy industries are veteran technical computing users that average more than 20 years of experience. But even the relative newcomers in the bio sector average nearly a decade of technical computing experience. Technical computing experience levels are similar for tier 1 firms, their suppliers, and their best-in-class international competitors, except in the automotive sector, where U.S. tier 1 firms reported substantially more technical computing experience than either their suppliers or their international competitors. (Remember that technical computing experience may mean experience on desktop computers only.)

**TABLE 2**

Length of Time Using Technical Computing (Workstations to High-End Servers) by Industry and Category

*Q. How long has your company been using technical computing or HPC?*

| | Average Number of Years |
|---|---|
| Aerospace tier 1 | 22.5 |
| Aerospace suppliers | 25.4 |
| Aerospace best in class (international) | 26.0 |
| Auto tier 1 | 25.0 |
| Auto suppliers | 15.9 |
| Auto best in class (international) | 18.0 |
| Bio tier 1 | 6.3 |
| Bio suppliers | 9.3 |
| Bio best in class (international) | 10.0 |
| Energy tier 1 | 25.5 |
| Energy suppliers | 23.2 |
| Energy best in class (international) | 25.5 |

n = 57

Source: IDC, 2008

## SURVEY RESULTS

### Use of HPC

Tables 3 and 4 show that more than one in five respondents (22%) have accessed HPC cycles on an outsourced basis, while nearly four in five (78%) have not. The percentage using outsourced HPC cycles, though still a distinct minority, was considerably higher in this study than in IDC's global study *New Perspectives on HPC Usage, Trends, and Applications for Industrial Users* (IDC #33829, August 2005). The August 2005 study found that industry use of grid computers linking multiple organizations and of compute cycles purchased from external sources and delivered via networks together amounted to just 3.9% of total HPC industry cycles in 2005 and was projected by respondents to grow marginally to 4.4% in 2006. Regarding the majority of firms in this study and the prior study that do not use external HPC cycles, IDC research has shown that for industrial firms, concerns about network security often constitute a barrier to using HPC on an outsourced basis.

The greater use of outsourced HPC cycles among suppliers in all of the industries (see Table 4) appears to reaffirm findings in prior Council and IDC studies that tier 1 firms are very reluctant to allow their data and workloads (their "crown jewels") to travel outside of their own sites. Even in the energy industry, which makes substantial use of outsourced HPC server cycles, outsourced resources typically are physically located very near the firms' sites and are closely controlled by the firms. For this reason, these outsourced cycles may not be considered external.

**TABLE 3**

Use of External HPC Cycles

| | Number of Respondents | % of Respondents |
|---|---|---|
| Yes | 11 | 21.6 |
| No | 40 | 78.4 |

n = 51

Source: IDC, 2008

**TABLE 4**

Use of External HPC Cycles by Industry and Category

| | % of Respondents |
|---|---|
| Aerospace tier 1 | – |
| Aerospace suppliers | 20 |
| Aerospace best in class (international) | – |
| Auto tier 1 | – |
| Auto suppliers | 30 |
| Auto best in class (international) | – |
| Bio tier 1 | – |
| Bio suppliers | – |
| Bio best in class (international) | – |
| Energy tier 1 | 50 |
| Energy suppliers | 60 |
| Energy best in class (international) | 50 |

n = 57

Source: IDC, 2008

As for the more extreme measure of outsourcing not just access to HPC but the HPC work itself, some firms believed that doing this would sacrifice the learning and quality control needed for innovation and competitive survival:

- *"Some companies do their processing out of house, but we feel when this is done out of house you can lose the understanding of the results."*
- *"If we outsourced HPC, we'd be totally dependant on contractors and there would be lack of quality control over their work."*

In general most sites don't use very many external HPC cycles, although tier 1 supplier companies show the most usage.

## Size of HPC Systems

Table 5 displays the broad range of installed HPC systems used by the surveyed U.S. firms that have substantial experience with HPC. On average, the technical (HPC) servers within this group had 1,330 processors and peak performance of 12,996 gigaflops, or about 9.8 gigaflops per processor. The average central memory size was 3.7TB. The average number of nodes on the industrial users' largest installed computers was 514, which translates to an average of about 2.6 processors per node (1,330 processors/514 nodes).

It is worth noting that we had to contact more than 300 supplier sites in order to find a modest number of companies (37 firms) that use technical computing today. And even among that modest total, only 13 reported having major HPC resources onsite, versus 24 that have few or no HPC resources. The industrial users' suppliers often have HPC servers with fewer than 100 processors (in one case just eight processors), although the processor count exceeded 2,000 in one supplier firm. The figures for industrial users and suppliers pale next to the average 4,148-processor, 954-node configuration that IDC found for the entire technical computing market (government, university, industry) in its multiclient study *The Cluster Revolution in Technical Computing Markets* (IDC #06C4775, March 2006). Because of their greater dependence on ISV applications with limited scalability, and not least because of their more modest HPC budgets, industrial HPC users typically acquire smaller versions of HPC computer servers than do, for instance, leading government user organizations, such as national laboratories, and large university-based HPC centers.

**TABLE 5**

System Profiles for U.S. Sites with HPC Experience

| | Maximum | Average |
|---|---|---|
| Total number of HPC processors | 9,984 | 1,330 |
| Peak performance (gigaflops) | 73,000 | 12,996 |
| Main memory (GB) | 49,984 | 3,708 |
| Number of nodes | 3,000 | 514 |

n = 27

Note: Many sites had multiple systems. Some sites fully outsource their HPC servers.

Source: IDC, 2008

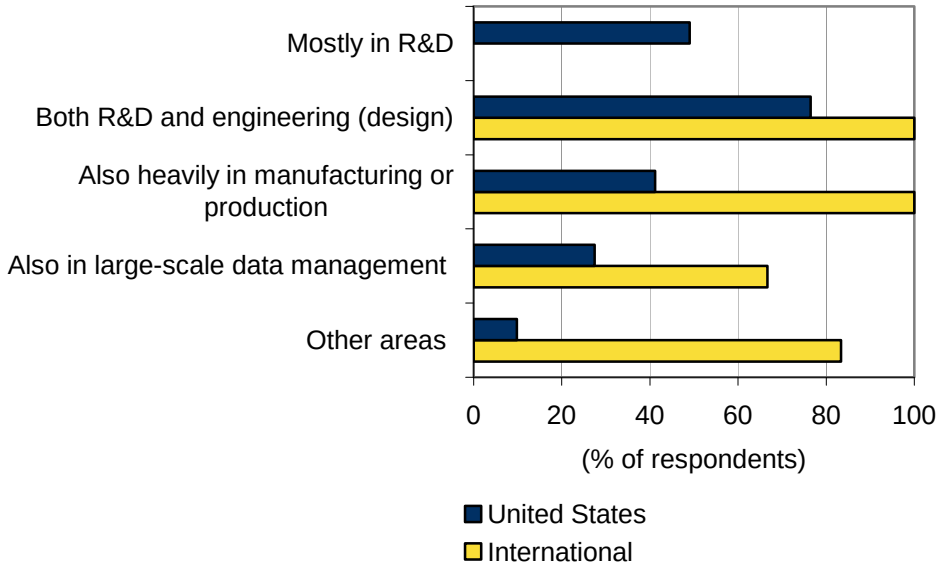
## HPC Usage and Innovation

Figure 4 shows where technical computing is being applied within the 57 surveyed U.S. and international firms. For the purposes of interpreting Figure 4 and the tables that follow it (Tables 6–9), keep in mind that R&D and design engineering historically have been the first places where technical computing is applied in industrial firms. These upstream uses of technical computing may then be followed in time by applications that are farther downstream, such as manufacturing/production and large-scale data management. Figure 4 indicates that the international best-in-class firms have pushed HPC usage much deeper into their organizations on average than the surveyed U.S. firms. Given the proven benefits of technical computing and HPC for innovation and competitiveness, as identified in prior Council studies, the international firms' downstream leadership should serve as a warning to U.S. industrial firms.

## FIGURE 4

Use of Technical Computing (Workstations to High-End Servers) by Site Location

*Q. How broadly is HPC or technical computing used in your organization (all sites)?*




n = 57

Note: Multiple responses were allowed.

Source: IDC, 2008

Table 6 looks at the applications of technical computing only at the 51 surveyed U.S. firms, bracketing out the international competitors for a moment. About half of the firms (49%) apply technical computing mainly in R&D, while three-quarters (77%) also apply it in design engineering. Technical computing usage in manufacturing is less frequent but still substantial (41%), while using it for large-scale data management is far less common (28%).

Only 20% of the U.S. respondents required their suppliers to line up with them technologically by using compatible technical computing hardware and software.

**TABLE 6**

Use of Technical Computing (Workstations to High-End Servers) at U.S. Sites

*Q. How broadly is HPC or technical computing used in your organization (U.S. sites)?*

| | Responses | % of Respondents |
|---|---|---|
| Mostly in R&D | 25 | 49.0 |
| Both R&D and engineering (design) | 39 | 76.5 |
| Also heavily in manufacturing or production | 21 | 41.2 |
| Also in large-scale data management | 14 | 27.5 |
| We also require our suppliers to use compatible computers/software | 10 | 19.6 |
| Other areas | 5 | 9.8 |
| Total | 114 | |

n = 51

Note: Multiple responses were allowed.

Source: IDC, 2008

Table 7 splits out the same technical computing usage areas by industry and looks at all 57 U.S. and international firms. While 100% of the U.S. tier 1 firms surveyed are using HPC in the traditional, upstream applications of R&D and/or design engineering, the energy industry has moved more aggressively in applying HPC to key downstream business functions. Seventy-five percent of the tier 1 energy firms are employing HPC in manufacturing, compared with roughly a third of the tier 1 firms in auto and aerospace, and none in bio-life sciences. Tier 1 energy firms are also ahead of their counterparts in these other industries in applying HPC to large-scale data management, an emerging application area with enormous business payoff potential beyond even the industries included in this survey.

Note that some U.S. tier 1 suppliers in the automotive and aerospace sectors conduct a sizable amount of technical computing on the desktop that isn't at the HPC server level in areas such as CAD. This may account for their higher numbers in the manufacturing column in Table 7.

One apparent anomaly in the results is that the bio suppliers applied technical computing more aggressively than the tier 1 firms they were supplying. This finding may be related to the situation that the tier 1 bio category includes pharmaceutical firms that have been comparatively slow to adopt computational methods within their traditional "wet lab" bench chemistry cultures.

**TABLE 7**

Use of Technical Computing (Workstations to High-End Servers) by Industry and Category (% of Respondents)

*Q. How broadly is HPC or technical computing used in your organization (all sites)?*

| | R&D Only | Both R&D and Engineering | Also Heavily in Manufacturing or Production | Also in Large-Scale Data Management | Other Areas |
|---|---|---|---|---|---|
| **Summary** | | | | | |
| All tier 1 | 51.3 | 69.2 | 35.9 | 28.2 | 7.7 |
| Tier 1 suppliers | 48.6 | 78.4 | 43.2 | 27.0 | 10.8 |
| Best in class (international) | – | 100.0 | 100.0 | 66.7 | 83.3 |
| **By industry and category** | | | | | |
| Aerospace tier 1 | 33.3 | 100.0 | 33.3 | 33.3 | – |
| Aerospace suppliers | 35.7 | 92.9 | 35.7% | 28.6 | 7.1 |
| Aerospace best in class (international) | – | 100.0 | 100.0 | – | – |
| Auto tier 1 | – | 100.0 | 33.3 | 33.3 | – |
| Auto suppliers | 50.0 | 90.0 | 80.0 | 30.0 | 10.0 |
| Auto best in class (international) | – | 100.0 | 100.0 | 100.0 | 100.0 |
| Bio tier 1 | 100.0 | – | – | – | – |
| Bio suppliers | 75 | 37.5 | 12.5 | 12.5 | 12.5 |
| Bio best in class (international) | – | 100.0 | 100.0 | 100.0 | 100.0 |
| Energy tier 1 | 50.0 | 100.0 | 75.0 | 50.0 | 25.0 |
| Energy suppliers | 40.0 | 80.0 | 40.0 | 40.0 | 20.0 |
| Energy best in class (international) | – | 100.0 | 100.0 | 50.0 | 100.0 |

n = 57

Note: Multiple responses were allowed.

Source: IDC, 2008

### *Using Technical Computing for Innovation*

Tables 8 and 9 look more specifically at the uses of technical computing for innovation. Table 8 does this for the subset of 27 U.S. firms (14 tier 1 firms and 13 suppliers) that reported having major HPC experience. Virtually all firms in this

category (93%) employed technical computing (presumably including HPC in the case of these 27 firms) for production as well as R&D, and more than half (56%) also used it at least to some extent in supply chain management related to innovation.

**TABLE 8**

Use of Technical Computing (Workstations to High-End Servers) for Innovation at U.S. Sites

*Q. Where do you focus your use HPC for innovation (U.S. sites)?*

| | Responses | % of Respondents |
|---|---|---|
| Only in R&D | 10 | 37.0 |
| R&D and in production | 25 | 92.6 |
| R&D, production, and supply chain management | 15 | 55.6 |
| Large-scale data mining and/or analysis | 3 | 11.1 |
| Other areas | 4 | 14.8 |
| Total | 57 | |

n = 27

Note: Multiple responses were allowed.

Source: IDC, 2008

Table 9 reviews all 33 firms with major HPC resources, including the six international best-in-class firms in the mix. The first three rows once again show that the international firms led the U.S. tier 1 companies in moving technical computing usage to downstream functions within their organizations, and that U.S. suppliers were far more likely to apply technical computing for supply chain management than tier 1 firms in the United States or abroad. Energy was ahead of the other three industries in applying technical computing downstream to help drive innovation.

**TABLE 9**

Use of Technical Computing (Workstations to High-End Servers) for Innovation by Industry and Category (% of Respondents)

*Q. Where do you focus your use HPC for innovation (U.S. and foreign sites with HPC experience)?*

| | R&D Only | R&D and Production | And Supply Chain Management | And Data Mining | Other |
|---|---|---|---|---|---|
| **Summary** | | | | | |

**TABLE 9**

Use of Technical Computing (Workstations to High-End Servers) for Innovation by Industry and Category (% of Respondents)

*Q. Where do you focus your use HPC for innovation (U.S. and foreign sites with HPC experience)?*

| | R&D Only | R&D and Production | And Supply Chain Management | And Data Mining | Other |
|---|---|---|---|---|---|
| All tier 1 | 30.8 | 65.4 | 3.8 | 17.9 | 10.3 |
| Tier 1 suppliers | 15.5 | 38.1 | 46.4 | 2.2 | 5.7 |
| Best in class (international) | – | 83.3 | 16.7 | 50.0 | 83.3 |
| **By industry and category** | | | | | |
| Aerospace tier 1 | – | 75.0 | 25.0 | – | – |
| Aerospace suppliers | 14.3 | 50.0 | 35.7 | 7.1 | 7.1 |
| Aerospace best in class (international) | – | 100.0 | – | – | – |
| Auto tier 1 | – | 100.0 | – | – | – |
| Auto suppliers | 10.0 | 60.0 | 30.0 | – | 10.0 |
| Auto best in class (international) | – | 50.0 | 50.0 | – | 100.0 |
| Bio tier 1 | 100.0 | – | – | 25.0 | – |
| Bio suppliers | 12.5 | 25.0 | 62.5 | – | – |
| Bio best in class (international) | – | 100.0 | – | 100.0 | 100.0 |
| Energy tier 1 | – | 100.0 | – | 33.3 | 33.3 |
| Energy suppliers | 50.0 | 25.0 | 25.0 | – | 25.0 |
| Energy best in class (international) | – | 100.0 | – | 100.0 | 100.0 |

n = 33

Note: Multiple responses were allowed.

Source: IDC, 2008

### *Innovation and Other Benefits Already Being Achieved with HPC*

#### Sites with Major HPC Experience

Nearly all of the comments from respondents from the sites with major HPC experience focused on important new innovations, capabilities, and benefits already

realized by using HPC (as opposed to areas where they are focusing HPC to achieve new breakthroughs):

- *"HPC allows our user community to run larger problems than they would be able to on their desktop, which allows them to be creative in the types of problems they try to tackle. With each new HPC system we bring into the facility, they grow their problems and create new problems that they previously could not tackle."*
- *"We can dock thousands of molecules into proteins. There's no way we could do this without HPC hardware."*
- *"As HPC becomes faster, better, and cheaper, we are able to reduce (product) cycle time in proportion. We are able to reduce physical testing (wind tunnel and flight tests)."*
- *"The short answer is that we can now do analysis before we build the first (product) prototype."*
- *"We have more information. When you shoot seismic data (for oil exploration), you need to position properly."*
- *"We would be relegated to working with microscopes and test tubes without HPC."*

### *Innovation Work the Companies Would Like to Pursue*

Most of the 57 U.S. and international survey respondents (80%) provided comments on the kinds of currently intractable problems they would like to pursue with HPC in order to accelerate their innovation.

#### Sites with Major HPC Experience

Nearly all of the comments from the experienced HPC sites (U.S. tier 1 firms and suppliers and international best-in-class firms) pointed to major leaps forward in innovation and product design:

- *"We could create better airplane designs, more derivative designs, and improved fuel economy."*
- *"Big leaps would be possible."*
- *"We could have reduced product development time and higher-quality products."*
- *"It would provide a competitive advantage to be able to solve problems that other companies cannot."*
- *"It would help in defining our future."*
- *"It would get us past the limitation to the 'holy grail' of designing the broad-spectrum antiviral."*
- *"If we could analyze the whole genome, it would be a huge advantage"*

**Sites with Little or No HPC Experience (i.e., Using Desktop Workstations)**

The comments from sites with small or no HPC servers fell into three categories:

- Do what we are doing today, only faster or better:
  - *"We're limited on the number of problems we can model simultaneously. We want to do electromagnetic modeling of larger arrays."*
  - *"We want to do more complex modeling."*
  - *"Better analysis. The time is still too long."*
- Do entirely new things:
  - *"We want to do computational fluid dynamics."*
  - *"Complex finite element analysis."*
  - *"3D modeling and mechanical stress analysis."*
  - *"Automatic code generation, and simulation of control systems for ABS and electrical stability programs."*
- Do nothing new/different:
  - *"We're on the cutting edge already."*
  - *"Today's PCs can handle almost anything."*

### *Specific Innovation Goals*

Some respondents also offered more specific comments on how solving currently intractable problems would make their firms more innovative and/or competitive:

- *"The adverse events and side effects of drugs. If we could address those issues better, that would be a colossal leap forward."*
- *"Being able to simulate ligands in a more biologically relevant way — for instance with explicit salvation, charge polarization, and protein flexibility — would enable us to better feed the chemistry department with potential hit/lead molecules."*
- *"Better airplane designs, more (design) derivatives, improved fuel efficiency."*
- *"The combination of computer power and (overcoming) software limitations (would allow us) to do real time co-development across our supply chain."*
- *"We could cut down on actual prototyping and stress testing on automotive parts."*
- *"If the currently unsolvable problems could be solved, it would improve the safety and security of the residents of the USA."*

- *"It could get us past current limitations to reach the 'holy grail' of the broad spectrum antiviral."*
- *"It would allow our company to take advantage of finding more natural resources (oil and gas deposits) within our current geographical boundaries. It allows us to find the leftover resources older technology was unable to see."*
- *"We could do larger systems-level integrated analysis, versus individual component analysis. We could use scenario analysis, versus end-item functionality."*
- *"Physical models could be more accurate. Engineers could try different algorithms or approaches and even try to solve computational problems that they could not have even thought of solving in the past."*

### *Use of HPC via International Resources or Subsidiaries*

Tables 10 and 11 show that more than two-thirds (69%) of the U.S. firms with major HPC experience (tier 1 firms and some suppliers) use HPC only in the United States or at their international subsidiaries (31%). None of the firms entrusts its HPC cycles or workloads to international parent firms in cases where there are international owners. This is consistent with findings in prior studies that industrial firms are very reluctant to let their crown jewels move outside of their own tight control. A notable exception (Table 11) is tier 1 automotive companies, which presumably have no choice except to share HPC chores (and data) with their international parent firms.

**TABLE 10**

Geographic Location of HPC Usage

*Q. If you have international subsidiaries or parents, do you primarily do HPC in the U.S., outside the U.S., or at multiple locations in multiple countries?*

| | Number of Respondents | % of Respondents |
|---|---|---|
| United States only | 18 | 69.2 |
| United States and international subsidiaries | 8 | 30.8 |
| Via international parents | – | — |

n = 26

Note: Question was asked only of U.S. sites with HPC experience.

Source: IDC, 2008

## TABLE 11

Geographic Location of HPC Usage by Industry and Category (Number of Responses)

*Q. If you have international subsidiaries or parents, do you primarily do HPC in the U.S., outside the U.S., or at multiple locations in multiple countries?*

| | United States Only | Also International |
|---|---|---|
| Aerospace tier 1 | 2 | 0 |
| Aerospace suppliers | 4 | 0 |
| Auto tier 1 | 0 | 3 |
| Auto suppliers | 1 | 1 |
| Bio tier 1 | 3 | 1 |
| Bio suppliers | 5 | 1 |
| Energy tier 1 | 3 | 1 |
| Energy suppliers | 0 | 1 |
| Total | 18 | 8 |

n = 26

Note: Question was asked only of U.S. sites with HPC experience.

Source: IDC, 2008

In Table 12 companies were asked whether they view HPC as a strategic asset. International best-in-class firms along with the U.S. auto and bio tier 1 companies unanimously agreed that HPC is a strategic asset. Only two-thirds (67%) of the surveyed aerospace tier 1 companies and only half of the energy firms reached the same conclusion.

The responses also show that tier 1 firms, whether U.S. or international, consistently rated HPC as a strategic asset two to three times more frequently than the group of suppliers that have major HPC experience — with the exception of suppliers in the bio-life sciences sector, 75% of which consider HPC a strategic asset. It was beyond the scope of this study to determine why so many suppliers do not consider HPC a strategic asset, but this may be related to the fact that they typically are aligning their HPC usage with that of their tier 1 customers. The suppliers may therefore believe that HPC is a strategic asset belonging to the tier 1 firms, and merely an important derivative asset for themselves.

## TABLE 12

HPC Viewed as a Strategic Asset by Industry and Category (% of Respondents)

*Q. Do you view computational capability or HPC as a strategic asset, and do you link it to your overall competitiveness and innovation within your industry?*

| | Yes | No or Uncertain |
|---|---|---|
| **Summary** | | |
| All tier 1 | 79.5 | 20.5 |
| Tier 1 suppliers | 52.6 | 47.4 |
| Best in class (international) | 100.0 | – |
| **By industry and category** | | |
| Aerospace tier 1 | 66.7 | 33.3 |
| Aerospace suppliers | 38.5 | 61.5 |
| Aerospace best in class | 100.0 | – |
| Auto tier 1 | 100.0 | – |
| Auto suppliers | 30.0 | 70.0 |
| Auto best in class | 100.0 | – |
| Bio tier 1 | 100.0 | – |
| Bio suppliers | 75.0 | 25.0 |
| Bio best in class | 100.0 | – |
| Energy tier 1 | 50.0 | 50.0 |
| Energy suppliers | 20.0 | 80.0 |
| Energy best in class | 100.0 | – |

n = 31

Source: IDC, 2008

## Benefits of HPC

Twenty-one out of the 27 U.S. tier 1 and supplier sites (78%) with major HPC experience (14 tier 1 sites and 13 suppliers with major HPC experience) stated that HPC has made an impact on their bottom-line profits. Seventy percent said that HPC has increased their competitiveness, 70% said that HPC has increased their productivity, and 70% said that HPC has increased their innovation (see Table 13). In summary, most sites with strong HPC experience are convinced of the value of this technology.

**TABLE 13**

Benefits of HPC at U.S. Sites

*Q. What has been the direct benefit of HPC on your organization (U.S. sites)?*

| | Number of Responses | % of Respondents |
|---|---|---|
| Impact to bottom-line profits | 21 | 77.8 |
| Increased competitiveness | 19 | 70.4 |
| Increased productivity | 19 | 70.4 |
| Accelerated innovation | 19 | 70.4 |

n = 27

Note: Multiple responses were allowed.

Source: IDC, 2008

Surveyed firms were asked to consider whether HPC contributed to profitability, competitiveness, and/or productivity (see Table 14); in every industry and in every category (profits, competitiveness, productivity, and innovation), the international best-in-class firms unanimously applauded the benefits of HPC, with just one exception: innovation in the energy sector:

- All international best-in-class and U.S. aerospace tier 1 firms indicated that HPC has directly benefited their companies in each of these critical business benchmarks.
- All U.S. auto tier 1 companies saw more benefit to profits and competitiveness.
- All U.S. energy tier 1 companies attributed HPC benefits more strongly to productivity.
- U.S. bio tier 1 firms were mixed in their assessment of HPC's contribution to these business benefits.
- In general, though not in every industry and category, tier 1 U.S. firms saw greater benefits from HPC than did their suppliers.

## TABLE 14

Benefits of HPC for Sites with HPC Experience by Industry and Category (% of Respondents)

*Q. What has been the direct benefit of HPC on your organization?*

| | Profits | Competitiveness | Productivity | Innovation |
|---|---|---|---|---|
| **Summary** | | | | |
| All tier 1 | 82.1 | 66.7 | 76.9 | 84.6 |
| Tier 1 suppliers | 73.3 | 73.3 | 64.6 | 57.9 |
| Best in class (international) | 100.0 | 100.0 | 100.0 | 66.7 |
| **By industry and category** | | | | |
| Aerospace tier 1 | 100.0 | 100.0 | 100.0 | 100.0 |
| Aerospace suppliers | 80.0 | 80.0 | 60.0 | 80.0 |
| Aerospace best in class | 100.0 | 100.0 | 100.0 | 100.0 |
| Auto tier 1 | 100.0 | 100.0 | 33.3 | 33.3 |
| Auto suppliers | 66.7 | 66.7 | 100.0 | 66.7 |
| Auto best in class | 100.0 | 100.0 | 100.0 | 100.0 |
| Bio tier 1 | 75.0 | 25.0 | 75.0 | 100.0 |
| Bio suppliers | 66.7 | 83.3 | 66.7 | 50.0 |
| Bio best in class | 100.0 | 100.0 | 100.0 | 100.0 |
| Energy tier 1 | 66.7 | 66.7 | 100.0 | 100.0 |
| Energy suppliers | 100.0 | – | – | – |
| Energy best in class | 100.0 | 100.0 | 100.0 | – |

n = 33

Note: Multiple responses were allowed.

Source: IDC, 2008

## How HPC Helps Companies Create Value and Remain Competitive

According to the survey respondents, HPC helps companies to create new value and remain competitive primarily by speeding up the R&D process. As a result, companies can test more designs in a given time frame, or evaluate each design for a longer period of time (i.e., more deeply). Hence, HPC offers the dual possibilities of speeding time to market for new products and creating competitively superior products. Companies using HPC can choose to place more emphasis on speed improvement or quality improvement. Some of the companies stressed that HPC has become indispensable to their product design processes.

### *Comments*

- *"HPC reduces computation time, which adds quality and value to the product we sell. We ensure that we are using the latest HPC technology to create maximum value."*
- *"HPC reduces product development time and cost."*
- *"With HPC, we can test more ideas to help set priorities for work that gets done."*
- *"We are able to pursue promising leads that we couldn't without HPC."*
- *"We can eliminate some testing and evaluate more alternatives."*
- *"HPC lets us get faster to market and get the patent first."*
- *"HPC increases the complexity of designs, increasing the number of patented products and protecting the designs. Design and project turn around is reduced because of HPC use."*
- *"Because of HPC we can improve our design process to produce better products and reduce cost of development."*
- *"The use of HPC improves the throughput of our customers' designs and thus improves their productivity and ability to innovate." (From a supplier.)*
- *"HPC is integral to the design of vehicles. It is no longer possible without HPC!"*
- *"HPC is an indispensable tool for biotech research. We could not do the work without HPC."*

## Innovation from HPC

Respondents were asked the following question: "From an innovation viewpoint, what can you do today that you couldn't do before you had HPC computers?" Some of their responses are provided below:

- *"We have used HPC since inception. As HPC becomes faster, better, and cheaper, we are able to reduce cycle time in proportion; we are able to reduce physical testing (wind tunnel and flight tests) with improved HPC simulation."*
- *"Ability to predict safety performance in a variety of scenarios. Component durability prediction."*
- *"Not that we couldn't do it, but now in more reasonable times; test more complex ideas and thoughts in reasonable time."*
- *"Can doc thousands of molecules into proteins; no way we could do it without HPC hardware."*
- *"Solve larger and more complex problems sets and reduce time or iterations to solution."*
- *"We have more information. When you shoot seismic data, you need to position properly. Historically, this was done in two-dimensional (x and y) grids; in the '90s better hardware allowed for x, y, and z. This provides better understanding of velocity, and better resolution."*
- *"Yes, we could not even run the high-fidelity models we are running today."*
- *"We are better able to test the validity of ideas in the computer before going to the field. This was crucial in the development of our Wide Azimuth towed streamer seismic acquisition breakthrough."*
- *"Chemical compound modeling; had to make by hand and test them."*
- *"First thing we bought with investment money was the HPC system."*
- *"Hard to say — eight years ago we developed algorithms for pre-stack depth migration; without HPC couldn't have applied algorithm. Data sets keep growing and we need HPC to stay current and fresh."*
- *"Analyze for that couldn't before; better understanding and more accurate; don't know how we could do the complexity that we are now doing."*
- *"We are running 3D CFD and performing unsteady 3D CFD analysis and bringing more advanced modeling into the design process. We are making similar advances with mechanical analysis using finite element analysis."*
- *"More calculations in a shorter amount of time. This allows us to perform more experiments."*

- *"We would be relegated to working with microscopes and test tubes without HPC."*
- *"Simulate large-scale clinical trials; able to search for new bio markers."*
- *"HPC allows our user community to run larger problems than they would be able to on their desktop, which allows them to be creative in the types of problems they try to tackle. With each new system we bring into the facility, they grow their problems and create new problems that they previously could not tackle."*
- *"3D computational fluid dynamics — from production sense, impossible without HPC."*
- *"We can quickly collaborate design with customer created models and match our products to surfaces of car. Can perform structural analysis, determining potential failures in designed product. Mold creation accuracy is increased, and models can be shared between departments increasing accuracy of incidental product."*
- *"The use of techniques such as genetic algorithms is a key part of HPC within my group. These computer-intensive applications require massive numbers of cycles to reach convergence which would be inaccessible with serial computers. Also, molecular dynamics simulations of protein targets can now be carried out over biologically relevant timescales."*
- *"Test more new ideas."*
- *"Nonlinear work; high level of deformation doing model on material behavior, too time intensive, now we can make predictions of how materials will behave."*

## Innovation Risks Without HPC

What innovation risks would the companies incur if they did not have access to HPC resources? The survey respondents provided a long list of risks that fell into the categories of stifled research progress, delayed products, or inferior/unmarketable products. Each of these risks might result in an inability to compete and survive. The responses from tier 1 and tier 1 supplier companies were similar in nature.

### *Comments*

#### Inability to Compete/Exist

- *"We could not compete (without HPC)."*
- *"There would be no way to keep up with the rest of our industry; HPC gives us a leg up."*
- *"Being left behind by competitors and therefore seen by potential users as not relevant or current."*
- *"Smaller competitions could get to finish line faster if they had HPC and we didn't. We'd be left behind."*

- *"Our company built around HPC. We can't function without it."*
- *"We couldn't operate without HPC."*
- "Assuming all of our competitors had HPC and we didn't, then we'd be displaced by out competitors."
- *"Without HPC, we would be priced out of the market, completely."*

**Impaired R&D**

- *"We wouldn't be able to create new products in timely manner."*
- *"We would have delayed time to implementation of ideas."*
- *"Research would become too theoretical, creating too "Ivory Tower" algorithms; without HPC we'd not be able to see if it works in practice."*

**Impaired Product Development**

- *"We would lose competitive advantage and have a delayed pipeline for drug discovery."*
- *"It would take much longer to perform experiments. Some experiments are not feasible HPC."*
- *"It would be fundamentally impossible to pursue research in biotechnology without HPC, particularly research into systems biology, since it would be impossible to work with the volumes of raw lab data or engage in exploratory modeling and simulation."*
- *"Problem sizes would be severely limited, and it would limit the scope and breadth of things the engineers can model."*
- *"We wouldn't be able to validate ideas, and we might not be able to justify big field trials."*

**Risks**

- *"If we didn't have access to HPC, the risk is that we would fail government regulations for safety and emissions."*
- *"One incident can shut down our business for years. We use HPC to identify risk factors. We could not think of not having HPC."*

## Organization and Competitive Risks Without HPC

Some of the same themes emerged when respondents were asked about risks to their organizations and competitiveness in the absence of HPC. (It was not easy for respondents to separate risks to innovation from organizational and competitive risks, as all of these risks can be tightly linked to each other.)

### *Comments*

**Competitive Risks**

- *"The lack of HPC resources would make it difficult for us (catch up to competitors), particularly at the early stages of a project."*
- *"The competition would take over our place in the market."*
- *"We could not compete."*

**Inferior Products**

- *"Customers would not buy from us. Our products (would be) substandard and too simplistic for modern design."*
- *"We'd be smaller company."*
- *"We would stagnate."*

**Loss of Timeliness/Slower to Market**

- *"In the race to be first to discover a new drug, you need every possible asset to be innovative. We would lose business if not first to market. First and novel are key."*
- *"We would not be able to design improved airplanes in a timely manner."*

**Inferior Innovation**

- *"We could not move on to the next level of complexity when (competitors) could."*
- *"We would not be able to compete without new ideas. New ideas have allowed us to move into deeper waters to explore. Our competitive position allows us to earn a position with national oil companies when we compete for access to new resources."*

**Loss of Talent**

- *"We would lose the parallel programming skills our developers have. They'd leave us and go to our competitors."*

## Product Risks Without HPC

Similarly, the question about risks to products in the absence of HPC resources caused respondents to speculate about competitive and organizational risks.

### *Comments*

- *"We could not develop products without HPC."*
- *"We could not compete."*
- *"We use a lot of exotic materials, and we must understand how they behave. That makes it difficult without HPC."*

- *"We would have inferior, uncompetitive products."*
- *"We would not be able to continually improve products."*
- *"Our (product) pipeline would dry up."*
- *"We would have possible fit and performance issues, and increased risk of structural failure."*
- *"It would take longer to get to market. The first (product) to market usually gets 60% of the business, even if #2 and 3 are better products."*
- *"We might drill unnecessary or poor wells, a very costly problem."*

## Customers

A substantial minority of all the U.S. tier 1 and supplier firms (43%) said their customers require them to exploit HPC (see Table 15), but most (57%) said no such requirement exists for them.

**TABLE 15**

HPC Usage Required by Customers at U.S. Sites

*Q. Do your customers require you to use HPC (U.S. sites)?*

| | Number of Respondents | % of Respondents |
|---|---|---|
| Yes | 22 | 43.1 |
| No | 29 | 56.9 |

n = 51

Source: IDC, 2008

Customer requirements to use HPC were most frequent among the international best-in-class firms (67%), somewhat less common among the U.S. tier 1 companies (51%), and less likely among the U.S. suppliers (41%), as Table 16 indicates. These results varied greatly by industry and tier, however. Among the international best-in-class firms, those in the aerospace and energy sectors cited customer requirements to use HPC, while only half of the automotive firms noted this and none of the firms in the bio sectors did. In the United States, customer requirements were strongest for the tier 1 energy firms (75%) and tier 1 auto firms (67%).

## TABLE 16

HPC Usage Required by Customers by Industry and Category (% of Respondents)

*Q. Do your customers require you to use HPC (all sites)?*

| | Yes | No |
|---|---|---|
| **Summary** | | |
| All tier 1 | 51.3 | 48.7 |
| Tier 1 suppliers | 40.5 | 59.5 |
| Best in class (international) | 66.7 | 33.3 |
| **By industry and category** | | |
| Aerospace tier 1 | 33.3 | 66.7 |
| Aerospace suppliers | 50.0 | 50.0 |
| Aerospace best in class | 100.0 | – |
| Auto tier 1 | 66.7 | 33.3 |
| Auto suppliers | 60.0 | 40.0 |
| Auto best in class | 50.0 | 50.0 |
| Bio tier 1 | 25.0 | 75.0 |
| Bio suppliers | 12.5 | 87.5 |
| Bio best in class | – | 100.0 |
| Energy tier 1 | 75.0 | 25.0 |
| Energy suppliers | 20.0 | 80.0 |
| Energy best in class | 100.0 | – |

n = 57

Source: IDC, 2008

Table 17 probes more deeply into how customers of the U.S. tier 1 and supplier firms with major HPC experience view the importance of HPC. About one in four of the 26 firms said HPC is a major reason (23%), or at least a reason (27%), why their customers do business with them. The most frequent response (46%) was that customers are not aware or do not care whether the firms use HPC as long as their requirements are met.

**TABLE 17**

Customers' Views of HPC at U.S. Sites

*Q. Do your customers view your use of HPC as an advantage or just required to be competitive (U.S. sites)?*

| | Number of Responses | % of Respondents |
|---|---|---|
| They see our use of HPC as a major reason they do business with us | 6 | 23.1 |
| They see our use of HPC as a reason they do business with us | 7 | 26.9 |
| They see our use of HPC as a similar to others in our industry | 6 | 23.1 |
| They are *not* aware of our use of HPC or they don't care as long as we meet their requirements | 12 | 46.2 |

n = 26

Note: Multiple responses were allowed.

Source: IDC, 2008

Table 18 pulls in the six international best-in-class companies and looks at how customers view HPC usage at these firms, along with at the U.S. tier 1 and supplier firms that have major HPC experience. The first three rows of the table provide a summary view and show that, although customers do not require the international firms to use HPC in every case (refer back to Table 16), HPC is always "a major reason" why the customers do business with these firms. In other words, in the international arena, the customers view HPC as a distinct advantage. This was the case for only about one-quarter of the U.S. tier 1 and supplier firms. About half of these firms said their customers are unaware of their HPC use, or they don't care about it. Not one of the international best-in-class firms said this. The implication is that industrial use of HPC carries more prestige and respect outside of the United States.

## TABLE 18

Customers' Views of HPC by Industry and Category (% of Respondents)

*Q. Do your customers view your use of HPC as an advantage or just required to be competitive (all sites)?*

| | Yes, a Major Reason | Yes, It Is a Reason | Yes, Everyone Uses It | Not Aware or Don't Care |
|---|---|---|---|---|
| **Summary** | | | | |
| All tier 1 | 25.6 | 15.4 | 38.5 | 51.3 |
| Tier 1 suppliers | 26.2 | 24.1 | 5.1 | 49.7 |
| Best in class (international) | 100.0 | – | – | – |
| **By industry and category** | | | | |
| Aerospace tier 1 | – | 33.3 | 66.7 | – |
| Aerospace suppliers | 60.0 | 20.0 | – | 20.0% |
| Aerospace best in class | 100.0 | – | – | – |
| Auto tier 1 | – | – | 33.3 | 66.7 |
| Auto suppliers | – | 66.7 | 33.3 | 33.3 |
| Auto best in class | 100.0 | – | – | – |
| Bio tier 1 | 50.0 | – | – | 50.0 |
| Bio suppliers | 16.7 | 16.7 | – | 66.7 |
| Bio best in class | 100.0 | – | – | – |
| Energy tier 1 | 33.3 | 33.3 | 66.7 | 66.7 |
| Energy suppliers | – | – | – | 100.0 |
| Energy best in class | 100.0 | – | – | – |

n = 32

Note: Multiple responses were allowed.

Source: IDC, 2008

### *Comments*

- *"Customers require us to supply electronic models of our product in car coordinate systems."*
- *"Our contract exists because of HPC."*

- *"We get contracts to do drug discovery based on our ability to use HPC for efficient drug design."*
- *"We have partnerships with our automotive OEM customers in which we share engineering drawings and therefore must have compatible systems."*
- *"Our military customers require it; most others don't care as long as we meet their requirements."*
- *"We must support our customers' hardware configurations, which are HPC based."*
- *"It's expected, but not required in contracts. We couldn't do without it."*
- *"it's not required, they customers assume we use HPC."*
- *"Customers are focused more on the end product than how we get to the end product."*
- *"With PCs, we can do what we need."*

## Suppliers

About one in four (26%) of the U.S. firms with major HPC experience requires its suppliers to use HPC (see Table 19). The remaining 74% do not.

**TABLE 19**

Requirements on Suppliers to Use HPC at U.S. Sites

*Q. Do you require your suppliers to use HPC (U.S. sites)?*

| | Number of Respondents | % of Respondents |
|---|---|---|
| Yes | 6 | 26.1 |
| No | 17 | 73.9 |

n = 23

Source: IDC, 2008

Table 20 shows that 100% of the best-in-class firms in the aerospace, auto, and bio-life sciences industries indicated that they require their suppliers to use HPC. This is far more aggressive than in the United States, where only 50% of the tier 1 aerospace and auto firms and none of the tier 1 bio-life sciences firms do so. (The picture in the energy sector is identical for international best-in-class and U.S. tier 1 firms: Neither requires its suppliers to use HPC.) The U.S. approach may be best reflected in one firm's comment: *"Customers are focused more on the end product than how we get to the end product."*

## TABLE 20

Requirements on Suppliers to Use HPC by Industry and Category (% of Respondents)

*Q. Do you require your suppliers to use HPC?*

| | Yes | No |
|---|---|---|
| **Summary** | | |
| All tier 1 | 19.2 | 80.8 |
| Tier 1 suppliers | 33.3 | 66.7 |
| Best in class (international) | 66.7 | 33.3 |
| **By industry and category** | | |
| Aerospace tier 1 | 50.0 | 50.0 |
| Aerospace suppliers | 66.7 | 33.3 |
| Aerospace best in class | 100.0 | – |
| Auto tier 1 | 50.0 | 50.0 |
| Auto suppliers | 33.3 | 66.7 |
| Auto best in class | 100.0 | – |
| Bio tier 1 | – | 100.0 |
| Bio suppliers | 16.7 | 83.3 |
| Bio best in class | 100.0 | – |
| Energy tier 1 | – | 100.0 |
| Energy suppliers | – | 100.0 |
| Energy best in class | – | 100.0 |

n = 29

Source: IDC, 2008

## Investors

Interestingly, 35% of the U.S. firms with major HPC experience reported that they are required to use HPC by their investors/shareholders/other owners (see Table 21). The shareholders of most public companies are not this closely involved in the

companies' operations. It is not uncommon, however, for venture capital firms and individual owners to impose this specific requirement.

## TABLE 21

HPC Usage Required by Investors, Shareholders, or Owners at U.S. Sites

*Q. Do your investors, shareholders or owners require you to use HPC (U.S. sites)?*

| | Number of Respondents | % of Respondents |
|---|---|---|
| Yes | 9 | 34.6 |
| No | 17 | 65.4 |

n = 26

Source: IDC, 2008

Investor requirements for HPC usage were far more common with tier 1 U.S. and international best-in-class firms than they were for suppliers (see Table 22):

- One hundred percent of aero, bio, and energy best-in-class firms and 50% of auto best-in-class firms are required by their investors to use HPC.
- None of the U.S. aero, auto, or energy suppliers are required by their investors to do so, and only a third of the bio firms must use HPC.

## TABLE 22

HPC Usage Required by Investors, Shareholders, or Owners by Industry and Category (% of Respondents)

*Q. Do your investors, shareholders or owners require you to use HPC (U.S. and foreign sites)?*

| | Yes | No |
|---|---|---|
| **Summary** | | |
| All tier 1 | 61.5 | 38.5 |
| Tier 1 suppliers | 15.4 | 84.6 |
| Best in class (international) | 83.3 | 16.7 |
| **By industry and category** | | |
| Aerospace tier 1 | 50.0 | 50.0 |
| Aerospace suppliers | – | 100.0 |

## TABLE 22

HPC Usage Required by Investors, Shareholders, or Owners by Industry and Category (% of Respondents)

*Q. Do your investors, shareholders or owners require you to use HPC (U.S. and foreign sites)?*

| | Yes | No |
|---|---|---|
| Aerospace best in class | 100.0 | – |
| Auto tier 1 | 66.7 | 33.3 |
| Auto suppliers | – | 100.0 |
| Auto best in class | 50.0 | 50.0 |
| Bio tier 1 | 75.0 | 25.0 |
| Bio suppliers | 33.3 | 66.7 |
| Bio best in class | 100.0 | – |
| Energy tier 1 | 50.0 | 50.0 |
| Energy suppliers | – | 100.0 |
| Energy best in class | 100.0 | – |

n = 32

Source: IDC, 2008

## Competitors

Nearly seven in eight of all the U.S. respondents (86%) reported that their competitors use HPC (see Table 23), and only 6% said they are certain the competitors do not. It is interesting that many of the tier 1 suppliers said that their competitors are using HPC, but it took more than 300 surveys to find this small number of suppliers using HPC. Perhaps many of their international competitors are using HPC more aggressively.

## TABLE 23

Use of Technical Computers by Competitors (U.S. Sites)

*Q. Do your competitors use HPC/technical computers (U.S. sites)?*

| | Number of Respondents | % of Respondents |
|---|---|---|
| Yes | 44 | 86.3 |
| No | 3 | 5.9 |
| Uncertain | 4 | 7.8 |

## TABLE 23

Use of Technical Computers by Competitors (U.S. Sites)

*Q. Do your competitors use HPC/technical computers (U.S. sites)?*

| | Number of Respondents | % of Respondents |
|---|---|---|

n = 51

Note: Twenty-six out of the 27 experienced HPC users have competitors that use HPC.

Source: IDC, 2008

Table 24 shows the results when all 57 survey respondents were asked this same question, including suppliers that said they themselves have little or no HPC experience and are performing modeling and simulation on desktop workstations. All of the U.S. tier 1 and international best-in-class firms said their competitors use HPC.

Table 25 captures how U.S. tier 1 and supplier firms with major HPC experience view their use of HPC in comparison with that of their competitors. Half of the firms (56%) believe that they and their rivals use HPC with about the same effectiveness. Another third of the respondents (30%) believe they are behind competitors in exploiting HPC. Only about one in eight of the companies (15%) consider themselves ahead of the competitive pack where HPC usage is concerned. Note that this study found that most U.S. suppliers aren't using HPC, so supplier firms when referring to competitors with HPC could be referring to international competitors.

## TABLE 24

Use of Technical Computers by Competitors by Industry and Category (% of Respondents)

*Q. Do your competitors use HPC/technical computers?*

| | Yes | No |
|---|---|---|
| **Summary** | | |
| All tier 1 | 100.0 | – |
| Tier 1 suppliers | 86.5 | 13.5 |
| Best in class (international) | 100.0 | – |
| **By industry and category** | | |
| Aerospace tier 1 | 100.0 | – |
| Aerospace suppliers | 85.7 | 14.3 |
| Aerospace best in class | 100.0 | – |

## TABLE 24

Use of Technical Computers by Competitors by Industry and Category (% of Respondents)

*Q. Do your competitors use HPC/technical computers?*

| | Yes | No |
|---|---|---|
| Auto tier 1 | 100.0 | – |
| Auto suppliers | 90.0 | 10.0 |
| Auto best in class | 100.0 | – |
| Bio tier 1 | 100.0 | – |
| Bio suppliers | 87.5 | 12.5 |
| Bio best in class | 100.0 | – |
| Energy tier 1 | 100.0 | – |
| Energy suppliers | 80.0 | 20.0 |
| Energy best in class | 100.0 | – |

n = 57

Source: IDC, 2008

## TABLE 25

Effectiveness of HPC Use at U.S. Sites Compared with U.S. Competitors and International Competitors

*Q. Do your use HPC more or less effectively than your competitors do (U.S. sites)?*

| | Number of Respondents | % of Respondents |
|---|---|---|
| More effectively | 4 | 14.8 |
| Same, on average | 15 | 55.6 |
| Less effectively | 8 | 29.6 |

n = 27

Source: IDC, 2008

Table 26 shows interesting differences of opinion between international best-in-class firms and U.S. tier 1 firms regarding whether they employ HPC more effectively than their competitors do:

- In aero, 100% of the best-in-class firms see themselves as more effective; half of the U.S. tier 1 firms agree, and half think they are equal.
- In auto, 100% of the U.S. tier 1 firms see themselves the same; half of the auto best-in-class firms agree, but half think they are better.
- None of the international best-in-class firms said their competitors are better at exploiting HPC, whereas half of U.S. tier 1 aero firms said that.
- A third of energy firms and a quarter of bio firms said their competitors are more effective.
- As the split-outs by industry and tier show, U.S. auto suppliers are an exception, considering their HPC usage superior to that of competitors.

## TABLE 26

Effectiveness of HPC Use Compared with U.S. Competitors and International Competitors by Industry and Category (% of Respondents)

*Q. Do you use HPC more or less effectively than your competitors do (compared to U.S. competitors)?*

| | We Are Better | About the Same | They Are Better |
|---|---|---|---|
| **Summary** | | | |
| All tier 1 | 17.9 | 56.4 | 25.6 |
| Tier 1 suppliers | 12.3 | 53.3 | 34.4 |
| Best in class (international) | 33.3 | 66.7 | – |
| **By industry and category** | | | |
| Aerospace tier 1 | – | 50.0 | 50.0 |
| Aerospace suppliers | 40.0 | 40.0 | 20.0 |
| Aerospace best in class | – | 100.0 | – |
| Auto tier 1 | – | 100.0 | – |
| Auto suppliers | – | 66.7 | 33.3 |
| Auto best in class | 50.0 | 50.0 | – |
| Bio tier 1 | 25.0 | 50.0 | 25.0 |
| Bio suppliers | – | 50.0 | 50.0 |
| Bio best in class | – | 100.0 | – |
| Energy tier 1 | 33.3 | 33.3 | 33.3 |

**TABLE 26**

Effectiveness of HPC Use Compared with U.S. Competitors and International Competitors by Industry and Category (% of Respondents)

*Q. Do you use HPC more or less effectively than your competitors do (compared to U.S. competitors)?*

| | We Are Better | About the Same | They Are Better |
|---|---|---|---|
| Energy suppliers | – | 100.0 | – |
| Energy best in class | 50.0 | 50.0 | – |

n = 33

Source: IDC, 2008

***Comments***

- *"Almost all computational chemistry groups have access to some form of HPC. It has become almost a basic requirement from a technology standpoint."*
- *"Competitors use HPC as a customer requirement, the same as we do."*
- *"The aircraft engine business is very competitive. Our competitors use HPC for advanced numerical analysis as well."*
- *"They are also HPC integrators, users and support organizations that use it to support their customers HPC requirements."*
- *"They must use HPC/technical computers or they would not be able to compete."*
- *"We sell to large commercial and military organization. Others in our industry do more sophisticated product development than we do."*
- *"I suspect that many of them do technical computing over a server, versus our doing it at the workstation level."*
- *"Some do, some don't, especially not the smaller ones because of cost."*
- *"We don't know for sure."*

## Are Firms Using HPC Very Aggressively?

One-quarter of the U.S. firms with major HPC experience (27%) gave themselves high grades for using HPC aggressively, while most (55%) awarded themselves at least mixed marks (see Table 27). Only four of the 22 firms responding to this question (18%) believed they are decidedly not using HPC as fully as they should. The reasons behind the self-grading are evident in the comments that follow Table 28. The barriers noted earlier in this study — costs and the availability of adequate software and human expertise — are cited as important obstacles to more aggressive HPC use.

## TABLE 27

HPC Tools Used Fully at U.S. Sites

*Q. Is your organization using HPC tools as aggressively as it could (U.S. sites)?*

| | Number of Respondents | % of Respondents |
|---|---|---|
| Yes | 6 | 27.3 |
| No | 4 | 18.2 |
| Mixed — yes and no | 12 | 54.5 |

n = 22

Source: IDC, 2008

Table 28 shows the differences in the usage of HPC tools:

- In aerospace, 100% of the international best-in-class firms and 100% of the U.S. tier 1 firms believe they *are* using HPC tools as aggressively as possible — indicating a dead heat?
- In bio, 100% of the best-in-class firms and 100% of the U.S. tier 1 firms believe they are *not* using HPC tools as aggressively as possible.
- For auto, the picture is split: Two-thirds (67%) of auto tier 1 firms believe they *are* using HPC tools as aggressively as possible, but 100% of international best-in-class firms think they *are not!*
- While 100% of energy best-in-class firms have "mixed feelings," two-thirds of U.S. energy tier 1 firms and 100% of suppliers are clear they are *not* using HPC tools as aggressively as possible.
- Suppliers in auto, aero, and bio feel they are doing well or gave mixed responses, while suppliers in energy clearly feel that they need to use HPC more aggressively.

## TABLE 28

HPC Tools Used Fully by Industry and Category (% of Respondents)

*Q. Is your organization using HPC tools as aggressively as it could?*

| | Yes | No | Mixed |
|---|---|---|---|
| **Summary** | | | |
| All tier 1 | 30.8 | 28.2 | 41.0 |
| Tier 1 suppliers | 33.3 | 7.7 | 59.0 |
| Best in class (international) | 16.7 | – | 83.3 |
| **By industry and category** | | | |
| Aerospace tier 1 | 100.0 | – | – |
| Aerospace suppliers | 33.3 | – | 66.7 |
| Aerospace best in class | 100.0 | – | – |
| Auto tier 1 | 66.7 | 33.3 | – |
| Auto suppliers | – | – | 100.0 |
| Auto best in class | – | – | 100.0 |
| Bio tier 1 | – | – | 100.0 |
| Bio suppliers | 50.0 | – | 50.0 |
| Bio best in class | – | – | 100.0 |
| Energy tier 1 | – | 66.7 | 33.3 |
| Energy suppliers | – | 100.0 | – |
| Energy best in class | – | – | 100.0 |

n = 28

Source: IDC, 2008

### *Comments*

- *"We are particularly aggressive about recognizing the competitive advantage and continue pushing for HPC where it makes sense."*
- *"We deploy the latest HPC technologies, both at the high end and in clusters. We also test our new applications at Oak Ridge under the INCITE program."*
- *"We could do more with HPC for reservoir engineering. We could do more in-house."*

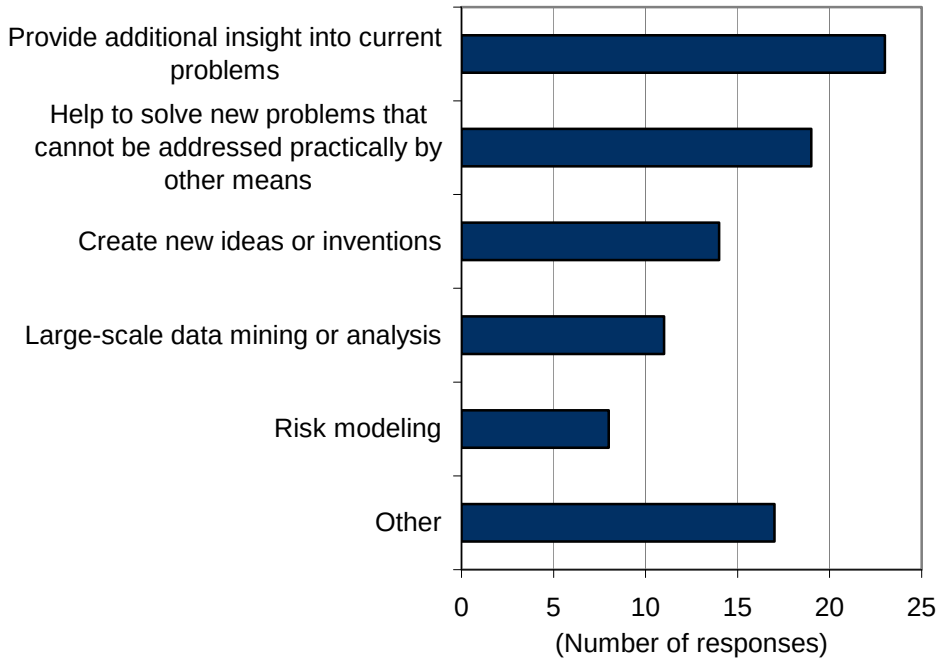
- *"Gaining access to large HPC systems is expensive and possibly cost prohibitive."*
- *"If we had more financing, we'd bolster areas that could use it."*
- *"It's the software application and an understanding of the underlying theories that hold us back."*
- *"Our HPC usage is subject to budget and human capital constraints."*
- *"If we had trained personnel infrastructure, we could do more."*
- *"With more head count, more basic research could be carried out to improve/invent tools to assist the drug discovery process. Demands of everyday support responsibilities prevent us making full use of our HPC tools."*

## Reasons for Purchasing HPC System

Figure 5 and Table 29 depict the main purchase criteria for the HPC systems acquired most recently by the 27 U.S. tier 1 and supplier firms that have major HPC experience. The chief criteria were providing new insights into existing problems (23 of the firms) and helping to solve otherwise intractable problems (19 firms).

**FIGURE 5**

Reasons for Purchasing Last HPC System at U.S. Sites




n = 27

Source: IDC, 2008

**TABLE 29**

Reasons for Purchasing Last HPC System at U.S. Sites

*Q. What were the major reasons for purchasing your last HPC system (U.S. sites)?*

| | Number of Responses | % of Respondents |
|---|---|---|
| Provide additional insight into current problems | 23 | 85.2 |
| Help to solve new problems that cannot be addressed practically by other means | 19 | 70.4 |
| Create new ideas or inventions | 14 | 51.9 |
| Large-scale data mining or analysis | 11 | 40.7 |
| Risk modeling | 8 | 29.6 |
| Meet external requirements | 5 | 18.5 |
| Develop new services or business process innovations | 5 | 18.5 |
| Create new manufacturing processes | 4 | 14.8 |
| Supply chain optimization | 0 | – |
| Other | 3 | 11.1 |
| Total | 92 | |

n = 27

Note: Multiple responses were allowed.

Source: IDC, 2008

Table 30 shows that 100% of the surveyed international best-in-class firms and U.S. tier 1 auto and aerospace firms, along with a strong majority of U.S. tier 1 energy firms (75%), agreed that HPC can play a role in dramatically increasing their innovation. The majority of the international best-in-class and U.S. tier 1 companies purchased their most recent HPC systems to provide new insights and spur new ideas (i.e., innovation) as well as to address intractable problems.

These results are consistent with prior Council studies in which the majority of firms that used HPC considered it essential to compete and survive. Confidence in the ability of HPC to dramatically boost innovation was lower in the U.S. bio-life sciences sector, which is newer to HPC usage, but comments from these firms indicate they recognize that HPC is often indispensable:

- *"Can doc thousands of molecules into proteins; no way we could do it without HPC hardware."*
- *"Chemical compound modeling; had to make by hand and test them."*

- *"We would be relegated to working with microscopes and test tubes without HPC."*
- *"Simulate large-scale clinical trials; able to search for new bio markers."*

And from one supplier:

- *"First thing we bought with investment money was the HPC system."*

## TABLE 30

Reasons for Purchasing Last HPC System by Industry and Category (% of Respondents)

*Q. What were the major reasons for purchasing your last HPC system (top reasons)?*

| | Provide Insight | Solve New Problems | New Ideas | External Requirements |
|---|---|---|---|---|
| **Summary** | | | | |
| All tier 1 | 74.4 | 71.8 | 53.8 | 30.8 |
| Tier 1 suppliers | 87.2 | 88.7 | 54.4 | 6.2 |
| Best in class (international) | 100.0 | 100.0 | 100.0 | 33.3 |
| **By industry and category** | | | | |
| Aerospace tier 1 | 100.0 | 100.0 | 100.0 | 50.0 |
| Aerospace suppliers | 100.0 | 80.0 | 60.0 | 20.0 |
| Aerospace best in class | 100.0 | 100.0 | 100.0 | – |
| Auto tier 1 | 33.3 | 66.7 | 33.3 | 100.0 |
| Auto suppliers | 66.7 | 66.7 | 33.3 | – |
| Auto best in class | 100.0 | 100.0 | 100.0 | 100.0 |
| Bio tier 1 | 100.0 | 100.0 | 66.7 | – |
| Bio suppliers | 83.3 | 100.0 | 66.7 | – |
| Bio best in class | 100.0 | 100.0 | 100.0 | – |
| Energy tier 1 | 66.7 | 33.3 | 33.3 | – |
| Energy suppliers | 100.0 | 100.0 | – | – |
| Energy best in class | 100.0 | 100.0 | 100.0 | – |

n = 33

Note: Automotive sites have to meet external federal crash requirements.

Source: IDC, 2008

The majority of the international best-in-class and U.S. companies with major HPC experience purchased their most recent HPC systems to provide new insights, address intractable problems, and spur new ideas (i.e., innovation). External requirements (e.g., from customers or investors) were cited less frequently as purchase criteria, occurring about one-third of the time for tier 1 U.S. and international firms, and rarely (6% of cases) for supplier companies. In the split-outs by industry and tier, there was one notable finding: Only 33% (i.e., one of three) U.S. tier 1 automotive firms cited providing new insights or new ideas as a purchase criterion.

Among all the U.S. sites (see Table 31), the top reasons for adopting HPC were numerous and closely ranked. On a scale of 1–5, where 5 meant most important, seven reasons received a rating of 4.0 or higher, with "ability to test ideas faster compared to live tests" leading the pack at 4.42.

**TABLE 31**

Importance of Reasons for Adopting HPC at U.S. Sites

*Q. Rate the following reasons for adopting HPC (U.S. sites) (5 = most important; 1 = least important).*

| | Average Rating | Number Responding |
|---|---|---|
| Ability to test ideas faster compared to live tests | 4.42 | 48 |
| Ability to do new more/better analysis, engineering, or science | 4.41 | 49 |
| Ability to build better products and/or services | 4.38 | 47 |
| Increased competitiveness | 4.35 | 48 |
| Ability to improve quality | 4.04 | 48 |
| Faster time to market | 4.03 | 49 |
| Accelerate innovation | 4.00 | 49 |
| Increase profitability, or lower costs | 3.79 | 48 |
| Large scale data mining and/or analysis | 2.91 | 47 |
| Supply chain optimization | 2.07 | 45 |

n = 49

Source: IDC, 2008

Table 32 depicts the top reasons for adopting HPC among all 57 survey respondents, in general and then by industry and category. In the first three rows of the table (summary), the international firms and the U.S. suppliers rated the ability to conduct tests faster as the supreme reason for adopting HPC, whereas for the U.S. tier 1 firms it is the ability to get more work done. In sum, however, each of the four criteria is highly rated by all of the firms, no matter which industry or tier they belong to.

**TABLE 32**

Importance of Reasons for Adopting HPC by Industry and Category (Average Rating)

*Q. Rate the following reasons for adopting HPC (5 = most important; 1 = least important).*

| | Test Faster | Do More | Better Products | Competitiveness |
|---|---|---|---|---|
| **Summary** | | | | |
| All tier 1 | 4.31 | 4.46 | 4.23 | 4.23 |
| Tier 1 suppliers | 4.45 | 4.38 | 4.40 | 4.39 |
| Best in class (international) | 5.00 | 4.67 | 4.83 | 4.83 |
| **By industry and category** | | | | |
| Aerospace tier 1 | 5.00 | 5.00 | 5.00 | 4.00 |
| Aerospace suppliers | 4.46 | 4.31 | 4.54 | 4.38 |
| Aerospace best in class | 5.00 | 4.00 | 5.00 | 5.00 |
| Auto tier 1 | 4.00 | 3.67 | 5.00 | 4.33 |
| Auto suppliers | 4.30 | 4.20 | 4.50 | 4.50 |
| Auto best in class | 5.00 | 4.50 | 5.00 | 5.00 |
| Bio tier 1 | 4.75 | 4.75 | 3.50 | 4.75 |
| Bio suppliers | 4.43 | 4.50 | 4.29 | 4.50 |
| Bio best in class | 5.00 | 5.00 | 5.00 | 4.00 |
| Energy tier 1 | 3.75 | 4.50 | 4.00 | 3.75 |
| Energy suppliers | 4.75 | 4.75 | 4.00 | 4.00 |
| Energy best in class | 5.00 | 5.00 | 4.50 | 5.00 |

n = 55

Source: IDC, 2008

## Barriers Keeping Sites from Acquiring HPC

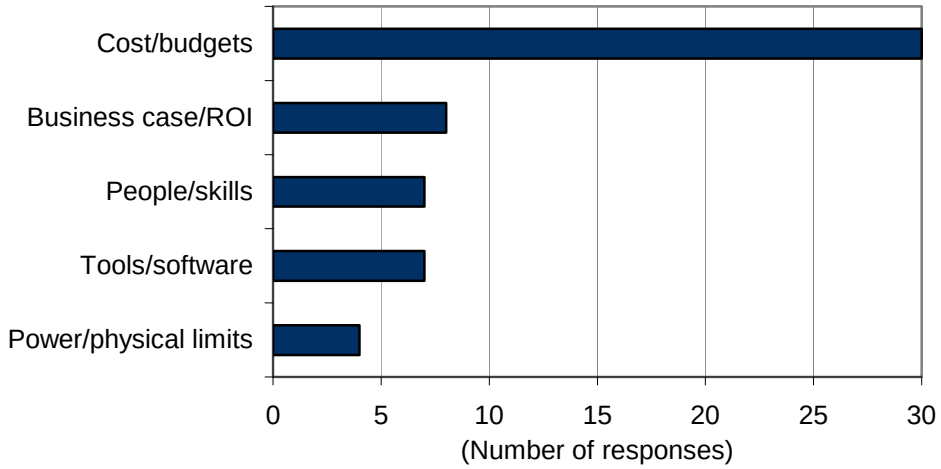
Figure 6 and Table 33 show the principal barriers preventing the U.S. firms from acquiring HPC resources (including additional resources). The greatest barrier, by far, is related to cost constraints and budget limitations (cited as the largest barrier by 64% of respondents). Running a distant second in popularity, and related to the cost barrier, is the challenge of making a ROI-based business case with upper

management for acquiring HPC resources (17% of respondents). Other barriers cited were the lack of software and other tools (15%), inadequate human expertise (15%), and limits on power consumption and physical space (9%).

## FIGURE 6

Barriers to Acquiring HPC Resources at U.S. Sites

*Q. What is keeping you from acquiring the HPC resources to solve your key problems (U.S. sites)?*




n = 47; 4 had no barriers

Note: Multiple responses were allowed.

Source: IDC, 2008

## TABLE 33

Barriers to Acquiring HPC Resources at U.S. Sites

*Q. What is keeping you from acquiring the HPC resources to solve these problems (U.S. sites)?*

| | Number of Responses | % of Respondents |
|---|---|---|
| Cost/budgets | 30 | 63.8 |
| Business case/ROI | 8 | 17.0 |
| People/skills | 7 | 14.9 |
| Tools/software/applications | 7 | 14.9 |
| Power/density/physical limits | 4 | 8.5 |
| Total | 56 | |

n = 47; 4 had no barriers

Note: Multiple responses were allowed.

Source: IDC, 2008

Tables 34 looks more closely at the barriers to broader HPC adoption at the 51 surveyed U.S. sites and confirms that overall costs, and third-party software costs in particular, outweighed all other factors. Other important obstacles were the lack of HPC-knowledgeable onsite staff and the difficulty of making the budget case for HPC with upper management.

**TABLE 34**

Barriers to Broader HPC Adoption at U.S. Sites

*Q. What do you see as the barriers to broader HPC adoption for your organization (U.S. sites)?*

| | Number of Responses | % of Respondents |
|---|---|---|
| Financial — budgets, system costs, other costs | 44 | 86.3 |
| Third-party software costs | 35 | 68.6 |
| Having a skilled staff and/or other experts available | 26 | 51.0 |
| Upper management doesn't appreciate the value/hard to justify the expense with upper management | 25 | 49.0 |
| Application availability/lack of maturity of the solution | 23 | 45.1 |
| Ease of use — system management capability — management software | 19 | 37.3 |
| Technical limitations — system performance, interconnect performance, complexity/cable, cards, switches | 18 | 35.3 |
| Space limitations, facility issues power, cooling | 13 | 25.5 |
| Complexity to expand and/or use | 13 | 25.5 |
| Maintenance/availability issues | 11 | 21.6 |
| Supported data storage mechanisms (databases, parallel file systems, etc.) | 7 | 13.7 |
| Total | 234 | |

n = 51

Note: Multiple responses were allowed.

Source: IDC, 2008

Table 35 examines the barriers to broader HPC adoption among all 57 surveyed U.S. and international firms. The international best-in-class firms unanimously cited overall costs as a major obstacle, whereas this was the case for 71% of U.S. tier 1 firms and 92% of their suppliers. While the international best-in-class aero, auto, and energy firms did not identify lack of staff resources as a barrier, it emerged as a significant

barrier for U.S. firms. Three-fourths of U.S. tier 1 bio firms, two-thirds of U.S. tier 1 aerospace firms, two-thirds of U.S. tier 1 auto firms, and half of U.S. tier 1 energy firms noted this as a barrier. It also was a stumbling block for the suppliers to tier 1 firms in energy, auto, and aero. Software costs emerged as a key barrier for many of the U.S. firms (less so in the bio sector, which relies more on shareware), with 100 % of the tier 1 auto firms noting this barrier. This may be because the automotive industry is highly dependent on third party software. Software costs were not an important consideration among the international companies in the same industries. This may simply mean that the international firms are more realistic about software costs in their budgeting processes. Gaining upper management support for HPC generally was a less formidable barrier for the U.S. tier 1 and international firms than it was for the suppliers.

### *Comments*

- *"Money. There is hardware cost, but also developing and refining the numerical tools that use the increased computing capability."*
- *"Cost and physical/ environmental limits."*
- *"Cost of the acquisition, plus the cost of the supporting infrastructure (power and cooling)."*
- *"The cost of software licenses."*
- *"Budgets, and people to effectively use these tools."*
- *"Cost/benefit. Management feels the cost of the investment may be greater than the actual benefit."*
- *"The cost of these systems is significant. If you cannot predict the outcome in advance, the cost justification becomes too subjective and speculative."*
- *"Money constraints, but even more time and talent constraints."*
- *"Understanding the software and how to model problems."*
- *"Human capital — engineers who can exploit the HPC resources."*
- *"Human brainpower, not computing power."*
- *"Computer floor space."*

**TABLE 35**

Barriers to Broader HPC Adoption by Industry and Category (% of Respondents)

*Q. What do you see as the barriers to broader HPC adoption for your organization (top reasons)?*

| | Financial | Software Costs | Staff Resources | Upper Management Support | Applications |
|---|---|---|---|---|---|
| **Summary** | | | | | |
| All tier 1 | 71.8 | 56.4 | 64.1 | 35.9 | 46.2 |
| Tier 1 suppliers | 91.9 | 73.0 | 45.9 | 54.1 | 45.9 |
| Best in class (international) | 100.0 | 33.3 | 16.7 | 33.3 | 33.3 |
| **By industry and category** | | | | | |
| Aerospace tier 1 | 66.7 | 66.7 | 66.7 | 33.3 | – |
| Aerospace suppliers | 100.0 | 85.7 | 42.9 | 64.3 | 50.0 |
| Aerospace best in class | 100.0 | – | – | – | 100.0 |
| Auto tier 1 | 66.7 | 100.0 | 66.7 | 33.3 | – |
| Auto suppliers | 100.0 | 80.0 | 60.0 | 70.0 | 60.0 |
| Auto best in class | 100.0 | 100.0 | – | – | – |
| Bio tier 1 | 75.0 | – | 75.0 | – | 75.0 |
| Bio suppliers | 75.0 | 50.0 | 12.5 | 25.0 | 25.0 |
| Bio best in class | 100.0 | – | 100.0 | – | 100.0 |
| Energy tier 1 | 75.0 | 75.0 | 50.0 | 75.0 | 75.0 |
| Energy suppliers | 80.0 | 60.0 | 80.0 | 40.0 | 40.0 |
| Energy best in class | 100.0 | – | – | 100.0 | – |

n = 57

Note: Multiple responses were allowed.

Source: IDC, 2008

## Can HPC Increase Innovation?

When they were asked what it would take to dramatically increase the level of innovation in their firms (not just HPC-based innovation), the respondents provided a range of thoughts and ideas.

Not surprisingly, the largest category had to do with money/funding and making the ROI case to management:

- *"Higher budgets."*
- *"Commitment of $2–3 million for emphasis on HPC."*
- *"Increased R&D budget."*
- *"Money, budget, and company structure."*
- *"Free access to HPC systems for experimentation."*
- *"Cheaper software licenses."*
- *"Lower cost of ownership [for HPC systems]."*
- *"Management change mentality to 'If you build it, they will come.'"*
- *"Change [our] management."*

Adequate human expertise was another frequently cited factor for driving dramatic innovation advances:

- *"Better theoretical understanding of the limiting processes involved in our work. More head count to investigate solutions."*
- *"People with imagination and technical skills."*
- *"Human capital: the volume and expertise of engineers."*
- *"More good scientists and support in IT for getting good results."*
- *"We really struggle to find people with the right experience."*
- The need for more physical space was also mentioned:
- *"[Being] jammed in like sardines makes it hard to think."*

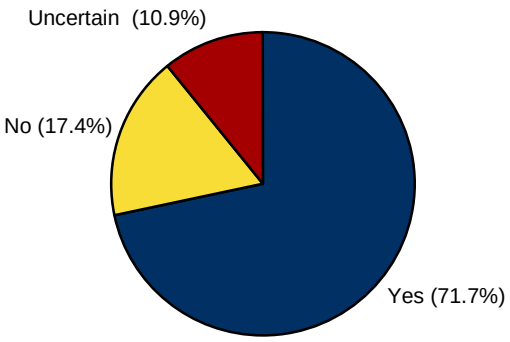
After expressing their thoughts on what could dramatically accelerate innovation in their firms, the survey respondents were asked whether HPC could play any role in bringing about these dramatic increases. Nearly three-quarters (72%) of the respondents answered yes (see Figure 7 and Table 36).

## FIGURE 7

Ability of HPC to Play a Role in Increasing Innovation at U.S. Sites

*Q. Can HPC play any role in making a dramatic increase in your innovation (U.S. sites)?*




**n = 46**

Source: IDC, 2008

## TABLE 36

Ability of HPC to Play a Role in Increasing Innovation at U.S. Sites

*Q. Can HPC play any role in making a dramatic increase in your innovation (U.S. sites)?*

| | Number of Respondents | % of Respondents |
|---|---|---|
| Yes | 33 | 71.7 |
| No | 8 | 17.4 |
| Uncertain | 5 | 10.9 |
| Total | 46 | 100.0 |

Source: IDC, 2008

As Table 37 illustrates, 100% of the surveyed international best-in-class firms and U.S. tier 1 auto and aerospace firms, along with a strong majority of U.S. tier 1 energy firms (75%), agreed that HPC can play a role in dramatically increasing their innovation. The majority of the international best-in-class and U.S. tier 1 companies purchased their most recent HPC systems to provide new insights and spur new ideas (i.e., innovation) as well as to address intractable problems.

This result is consistent with prior Council studies in which the majority of firms that used HPC considered it essential to compete and survive. Confidence in the ability of HPC to dramatically boost innovation was lower in the U.S. bio-life sciences sector, which is newer to HPC usage.

**TABLE 37**

Ability of HPC to Play a Role in Increasing Innovation by Industry and Category (% of Respondents)

*Q. Can HPC play any role in making a dramatic increase in your innovation?*

| | Yes | No | Uncertain |
|---|---|---|---|
| **Summary** | | | |
| All Tier 1 | 76.9 | 15.4 | 7.7 |
| Tier 1 suppliers | 66.8 | 20.0 | 13.3 |
| Best in class (international) | 100.0 | – | – |
| **By industry and category** | | | |
| Aerospace tier 1 | 100.0 | – | – |
| Aerospace suppliers | 61.5 | 38.5 | – |
| Aerospace best in class | 100.0 | – | – |
| Auto tier 1 | 100.0 | – | – |
| Auto suppliers | 87.5 | – | 12.5 |
| Auto best in class | 100.0 | – | – |
| Bio tier 1 | 50.0 | 25.0 | 25.0 |
| Bio suppliers | 66.7 | – | 33.3 |
| Bio best in class | 100.0 | – | – |
| Energy tier 1 | 75.0 | 25.0 | – |
| Energy suppliers | 40.0 | 40.0 | 20.0 |

**TABLE 37**

Ability of HPC to Play a Role in Increasing Innovation by Industry and Category (% of Respondents)

*Q. Can HPC play any role in making a dramatic increase in your innovation?*

| | Yes | No | Uncertain |
|---|---|---|---|
| Energy best in class | 100.0 | – | – |

n = 52

Source: IDC, 2008

***Comments***

- *"HPC has done this already and will continue to do so."*
- *"Once the funding and direction is there, HPC is necessary to perform the complex analysis."*
- *"Yes. It would allow us to build larger network for evaluations."*
- *"Yes. HPC would allow us to analyze various scenarios much more quickly and efficiently, thus make better-informed decisions."*
- *"Yes, if coupled with new approaches to research that really take advantage of the power."*
- *"Yes. If we drive turnaround time down a lot, into hours from days and weeks, we could do a lot more things that are not currently practical."*
- *"Yes, but it takes the people too, not just hardware."*
- *"Funding to modernize legacy codes to enable use of more concurrent processors or accelerators would enable increased fidelity and larger problem sizes with reasonable times-to-solution."*
- *"HPC plays an important role, but I'm not sure 'dramatic' is the word that would describe its role."*
- *"I doubt it. We'd be helped by better applications but necessarily by the hardware."*

## Use of External Grid Resources

Table 38 delves more deeply into the ways in which the U.S. firms access external HPC resources. Only four firms stated that they used a grid to access HPC resources from outside their own firms (9% of respondents). Of the majority who obtained resources from within their companies, most did so through network connections to

other groups within the company (65% of respondents); others had grid connections to other groups within their own organization (9% of respondents).

## TABLE 38

Method Used to Access HPC Resources at U.S. Sites

*Q. Do you use HPC resources over a grid or network (U.S. sites)?*

| | Number of Responses | % of Respondents |
|---|---|---|
| We use a grid to access HPC resources from other organizations. | 4 | 8.7 |
| We use a grid to access HPC resources from other parts of our organization. | 4 | 8.7 |
| We have a network connection to HPC resources from other parts of our organization. | 30 | 65.2 |
| We only use the HPC resources within our group. | 12 | 26.1 |
| Total | 50 | |

n = 46

Note: Multiple responses were allowed.

Source: IDC, 2008

As Table 39 shows, the U.S. tier 1 firms as a group were less likely than their suppliers or than the international firms to employ internal grids or network to others in their organizations. Conversely, they were four to five times more likely to use only their own HPC resources. The notable exception was tier 1 U.S. aerospace firms, which were just as likely as their international competitors to network to other groups within their organization, and not to rely solely on their own HPC resources.

## TABLE 39

Method Used to Access HPC Resources by Industry and Category (% of Respondents)

*Q. Do you use HPC resources over a grid or network?*

| | External Grids | Internal Grids | Network to Others in Our Organization | Only Use Our HPC |
|---|---|---|---|---|
| **Summary** | | | | |
| All tier 1 | – | 7.7 | 38.5 | 53.8 |
| Tier 1 suppliers | 12.8 | 9.7 | 75.7 | 13.5 |
| Best in class (international) | 8.3 | 16.7 | 91.7 | 8.3 |
| **By industry and category** | | | | |

## TABLE 39

Method Used to Access HPC Resources by Industry and Category (% of Respondents)

*Q. Do you use HPC resources over a grid or network?*

| | External Grids | Internal Grids | Network to Others in Our Organization | Only Use Our HPC |
|---|---|---|---|---|
| Aerospace tier 1 | – | – | 100.0 | – |
| Aerospace suppliers | 7.7 | 7.7 | 69.2 | 10.5 |
| Aerospace best in class | – | – | 100.0 | – |
| Auto tier 1 | – | 33.3 | – | 66.7 |
| Auto suppliers | 12.5 | 12.5 | 87.5 | 12.5 |
| Auto best in class | – | 50.0 | 100.0 | – |
| Bio tier 1 | – | – | 50.0 | 50.0 |
| Bio suppliers | 14.3 | – | 57.1 | 28.6 |
| Bio best in class | 50.0 | – | 50.0 | 50.0 |
| Energy tier 1 | – | – | 25.0 | 75.0 |
| Energy suppliers | 25.0 | 25.0 | 100.0 | – |
| Energy best in class | – | – | 100.0 | – |

n = 54

Note: Multiple responses were allowed.

Source: IDC, 2008

## Outsourcing of HPC Work by U.S. Firms with Limited or No HPC Experience

Table 40 shows that 44% of the 23 U.S. sites that have limited or no HPC in-house experience today outsource some of their HPC work.

## TABLE 40

Outsourcing of HPC Work By U.S. Sites with Limited or No HPC Resources Installed

*Q. Do you outsource any of your work to organizations that use technical computers for the work?*

| | Number of Respondents | % of Respondents |
|---|---|---|

## TABLE 40

Outsourcing of HPC Work By U.S. Sites with Limited or No HPC Resources Installed

*Q. Do you outsource any of your work to organizations that use technical computers for the work?*

| | Number of Respondents | % of Respondents |
|---|---|---|
| Yes | 10 | 43.5 |
| No | 13 | 56.5 |

n = 23

Note: Question was asked only of U.S. sites with little or no HPC experience.

Source: IDC, 2008

## Source of HPC Applications

Table 41 looks at application codes by source, according to the percentage of the sites' aggregate CPU hours utilized by applications from each type of source. The first three rows of the table (summary) show that the sources of application codes differ somewhat, but not greatly, for the U.S. tier 1 firms, their suppliers, and the international best-in-class companies. For all of these categories, codes developed in-house and purchased third-party codes are the two largest sources of applications, while freeware and codes developed collaboratively are far less important sources. The international firms make somewhat less use of in-house codes and greater use of purchased codes than do the U.S. companies. At one extreme, the auto firms in all tiers purchased almost all of their applications software (87–95%) from third-party companies (ISVs). At the other extreme, tier 1 U.S. and international bio firms relied on ISVs for only a minor portion of their applications software (25–30%) and developed much more of their software in-house.

## TABLE 41

Applications Purchased Externally Versus Developed In-House by Industry and Category (% of Respondents)

*Q. What percentage of the applications are purchased from external companies/ISVs or developed in-house (based on CPU hours)?*

| | In-House | Purchased/ISV | Free Software | Collaboration |
|---|---|---|---|---|
| **Summary** | | | | |
| All tier 1 | 47.8 | 45.9 | 6.9 | 8.1 |
| Tier 1 suppliers | 40.9 | 57.1 | 15.1 | 6.4 |

## TABLE 41

Applications Purchased Externally Versus Developed In-House by Industry and Category (% of Respondents)

*Q. What percentage of the applications are purchased from external companies/ISVs or developed in-house (based on CPU hours)?*

| | In-House | Purchased/ISV | Free Software | Collaboration |
|---|---|---|---|---|
| Best in class (international) | 30.0 | 61.7 | 0.8 | 7.5 |
| **By industry and category** | | | | |
| Aerospace tier 1 | 21.5 | 47.0 | 20.0 | 21.5 |
| Aerospace suppliers | 43.0 | 25.4 | 26.6 | 5.0 |
| Aerospace best in class | 50.0 | 45.0 | – | 5.0 |
| Auto tier 1 | 5.0 | 95.0 | – | 5.0 |
| Auto suppliers | 37.7 | 87.5 | 4.0 | 8.0 |
| Auto best in class | 10.0 | 90.0 | – | – |
| Bio tier 1 | 58.8 | 30.0 | 12.5 | 6.7 |
| Bio suppliers | 54.2 | 66.7 | 15.0 | 7.5 |
| Bio best in class | 50.0 | 25.0 | 5.0 | 20.0 |
| Energy tier 1 | 82.0 | 24.5 | – | 5.0 |
| Energy suppliers | 20.0 | 70.0 | 5.0 | 5.0 |
| Energy best in class | 30.0 | 60.0 | – | 10.0 |

n = 53

Note: Multiple responses were allowed.

Source: IDC, 2008

## APPENDIX A: QUESTIONS ASKED IN THE STUDY

Please respond for your division or your company overall based on how your group uses HPC within your organization (e.g., if your group is a separate division with its own HPC resources, respond based on only your division).

### Background Questions

1. How long has your company been using technical computing or HPC (in years)?

   _____ (years)

2. Do you purchase HPC cycles outside of your group or company?

   ___ Yes ___ No

3. What is the size of your largest technical computer?

   - ❑ In number of processors: _____
   - ❑ In peak GFLOPS: _____
   - ❑ In total memory (GBs): _____
   - ❑ In number of nodes: _____

4. What are the main applications or areas of use for your company's HPC computer?

5. How broadly is HPC or technical computing used in your organization?

   - ❑ ____ Mostly in R&D
   - ❑ ____ Both R&D and engineering (design)
   - ❑ ____ Also heavily in manufacturing or production
   - ❑ ____ Also in large-scale data management
   - ❑ ____ Also in _____
   - ❑ ____ We also require our suppliers to use compatible HPC computers/software

6. Where do you focus your use HPC for innovation?

   - ❑ ___ Only in R&D
   - ❑ ___ R&D and in production

- ❑ ___ R&D, production, and supply chain management
- ❑ ___ Large-scale data mining and/or analysis
- ❑ ___ Please list all areas that you use HPC for innovation:

7. If you have international subsidiaries or parents — Do you primarily do HPC in the U.S., outside the U.S., or at multiple locations in multiple countries? Please explain.

## The Linkage of HPC and Innovation

8. Do you view computational capability or HPC as a strategic asset and do you link it to your overall competitiveness and innovation within your industry?

   ___ Yes ___ No

9. What has been the direct benefit of HPC on your organization?

   - ❑ ___ Impact on bottom line — can you quantify:
   - ❑ ___ Increased competitiveness — describe how:
   - ❑ ___ Increased productivity — in what way:
   - ❑ ___ Accelerate Innovation — in what way:
   - ❑ ___ Other: _____

10. Thinking about how your organization creates value/remains competitive — How does HPC help accomplish these goals? (for either your company or your business unit or your department)

11. Innovation and HPC:

    - ❑ From an INNOVATION viewpoint, what can you do today that you couldn't do before you had HPC computers?
    - ❑ What INNOVATION risks do you have if you DON'T have access to HPC computers systems/tools?
    - ❑ What ORGANIZATION OR COMPETITIVE concerns do you have if you DON'T have access to HPC computers systems/tools?
    - ❑ What PRODUCT risks do you have if you DON'T have access to HPC computers systems/tools?

12. Do others recognize HPC as a driver for your innovation?

    - ❑ Does your management believe that HPC drives innovation? ___ Yes ___ No
    - ❑ Do your customers recognize it? ___ Yes ___ No

- ❑ Do your investors, shareholders, or owners recognize it? ___ Yes ___ No

13. Do your customers require you to use HPC? ___ Yes ___ No — Please explain.

14. Do your customers view your use of HPC as an advantage or just required to be competitive?

    - ❑ ___ They see our use of HPC as a **major reason** they do business with us
    - ❑ ___ They see our use of HPC as a **reason** they do business with us
    - ❑ ___ They see our use of HPC as similar to others in our industry
    - ❑ ___ They are NOT aware of our use of HPC or they don't care as long as we meet their requirements

15. Do you require your suppliers to use HPC? ___ Yes ___ No — Please explain.

16. Do your investors, shareholders, or owners require you to use HPC?

    ___ Yes ___ No — Please explain.

17. Do your competitors use HPC? ___ Yes ___ No — Please explain.

18. Do your competitors **in the U.S.** use HPC more effectively or less effectively than your group? ___ Better ___ Less ___ Same — Please explain.

19. Do your **INTERNATIONAL** competitors use HPC more effectively or less effectively than your group? ___ Better ___ Less ___ Same — Please explain.

20. Is your organization using HPC tools as aggressively as it could?

    ___ Yes ___ No — Please explain.

21. What would be the additional benefits to innovation if you could increase your use of HPC overnight?

22. Thinking about the important computational problems that you have today, that you can't solve today — If you could solve these problems, how would it make you more innovative and/or competitive?

23. What is keeping you from acquiring the HPC resources to solve these problems?

24. What **<u>were the major reasons</u>** for purchasing your last HPC system? (Multiple responses are allowed.)

    - ❑ ____ Help to solve new problems that cannot be practically addressed through other means
    - ❑ ____ Provide additional insight into current problems (i.e., better understanding of problem characteristics and solution spaces prior to

physical test or experimentations), or to address current problems more efficiently (i.e., faster time to solution, lower cost, etc.)

- ❑ ____ Meet external requirements (i.e., regulatory data requirements, standards of practice, etc.)
- ❑ ____ Create new ideas or inventions
- ❑ ____ Create new manufacturing processes
- ❑ ____ Risk modeling
- ❑ ____ Large-scale data mining and/or analysis
- ❑ ____ Supply chain optimization
- ❑ ____ Develop new services and/or business process innovations
- ❑ ____ Other; please explain: _____

25. Please rate the following **potential reasons** for adopting HPC computers or expanding your use of HPC systems, in terms of their importance to your organization or division.

    Use the following scale:

    5 = Very important

    4 = Important

    3 = Sometimes important

    2 = Rarely important

    1 = Unimportant

    - ❑ ____ Increased competitiveness
    - ❑ ____ Ability to build better products and/or services
    - ❑ ____ Ability to improve quality
    - ❑ ____ Ability to test ideas faster compared to live tests
    - ❑ ____ Ability to do new more/better analysis, engineering, or science
    - ❑ ____ Faster time to market
    - ❑ ____ Increase profitability or lower costs
    - ❑ ____ Large-scale data mining and/or analysis
    - ❑ ____ Supply chain optimization

- ❑ ____ Accelerate innovation
- ❑ ____ Other: _____

26. Do you also use HPC resources over a Grid or network?

- ❑ ___ We use a Grid to access HPC resources from other organizations
- ❑ ___ We use a Grid to access HPC resources from other parts of OUR organization
- ❑ ___ We have a network connection to HPC resources from other parts of OUR organization
- ❑ ___ We use this approach to access other HPC resources
- ❑ ___ We only use the HPC resources within our group

27. What do you see as the **barriers** to broader HPC adoption for your organization? Check all that apply:

- ❑ _____ Financial — budgets, system costs, other costs
- ❑ _____ Third-party software costs
- ❑ _____ Budgets — upper management doesn't appreciate the value/hard to justify the expense with upper management
- ❑ _____ Space limitations, facility issues, power, cooling
- ❑ _____ Ease of use — system management capability — management software
- ❑ _____ Complexity to expand and/or use
- ❑ _____ Technical limitations — system performance, interconnect performance, complexity/cable, cards, switches
- ❑ _____ Application availability/lack of maturity of the solution
- ❑ _____ Supported data storage mechanisms (databases, parallel file systems, etc.)
- ❑ _____ Maintenance/availability issues
- ❑ _____ Having a skilled staff and/or other experts available
- ❑ _____ Other (please specify _____)

28. What percentage of the applications are purchased from external companies/ISVs or developed in-house (based on CPU hours)?

- ❑ ____ % applications developed in-house

- ❑ ____ % applications PURCHASED from external companies (e.g., ISVs)
- ❑ ____ % applications obtained at no cost from external sources
- ❑ ____ % applications acquired through collaborations with academic or research consortia

Note: Must add up to 100%

## Summary Questions

29. What would it take to dramatically increase your level of innovation?

30. Can HPC play any role in making a dramatic increase in your innovation?

## Copyright Notice

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

Compete.
Council on Competitiveness