

HIGH PERFORMANCE COMPUTING

Partnering for Prosperity

Harnessing Our HPC Assets for Competitive Strength

Industrial Partnerships through
the National Science Foundation's
Supercomputing Resources



Council on Competitiveness



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America's capacity to innovate has become the single most important determinant of future prosperity. And, our leadership in technologies, such as high performance computing (HPC), create an innovative competitive edge.

For decades after World War II, America enjoyed unchallenged preeminence in science and technology, a comfortable cushion of leadership which fueled economic growth. But, as the Council's *Innovate America* report highlighted, two critical factors have changed. First, the number of innovator nations is growing—and global competition at the high end of the science and technology spectrum is unquestionably more robust. Second, the nature of innovation itself is changing. Its pace is faster, its scope multidisciplinary and technologically complex. Most importantly, it requires collaborative partnerships to create a fusion between insight, ideas, and invention.

While the competition is getting better in many areas, America's leadership in high performance computing remains one of its unique competitive strengths. High performance computing creates high leverage opportunities for scientific breakthrough to solve many of America's national as well as industrial grand challenges and faster, cheaper validation and deployment of new products and services. But, HPC capabilities are expensive, complex and knowledge intensive—and not always readily available or affordable for America's private companies.

The public-private partnerships jumpstarted by the National Science Foundation (NSF) through the university supercomputer centers it funds constitute best practice innovation prototypes that will drive America's competitiveness in the 21st century. They lay the groundwork to leverage HPC capabilities through collaborative, multidisciplinary networks that are at the cutting-edge of innovation leadership.

Because of their critical importance in advancing America's capability to leverage its HPC leadership, the Council launched a survey of the industrial partners of these NSF-funded HPC centers of excellence to explore what worked—and what needs work. As the survey responses indicate, these collaborations create new value opportunities for the country and the companies alike. But, they also highlight areas where we can do better. The lessons learned through this effort generate the kinds of insights that will be critical to capture and capitalize on an unique national asset.

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WHITE PAPER

Council on Competitiveness Study of Industrial Partnerships with the National Science Foundation (NSF)

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EXECUTIVE SUMMARY

This was a collaborative study conducted by the Council on Competitiveness and IDC on behalf of the National Science Foundation (NSF). The study evaluated the experiences of industrial HPC user organizations engaged in partnerships with the NSF Centers at the National Center for Supercomputing Applications (NCSA), the Pittsburgh Supercomputing Center (PSC), the San Diego Supercomputer Center (SDSC), and the Texas Advanced Computing Center (TACC). The study included 40 industrial partners and was conducted from December 2005 to January 2006.

The partnership program between NSF Centers and U.S. businesses clearly has been successful. All 40 of the companies interviewed for this study were overwhelmingly positive about the expertise of the NSF Centers, and 95% said they would like to partner with the same NSF Center in the future (78% said they already had plans in place for continuing to work with NSF Centers). Virtually all (93%) said the NSF Center partnerships advanced their research and development efforts, 88% said the collaboration had "solved a specific problem," and the vast majority (80%) concluded that the partnerships with the NSF Centers had met their objectives. That percentage could climb even higher, since 13% of the projects were still in progress when this study was conducted.

Even more noteworthy is how often the partnerships directly benefited the companies financially, competitively, or both. More than half the sites (55%) reported that the partnerships had advanced new product development, and 60% said the collaborations with the NSF Centers helped them get products to market faster. Related areas of value included revenue growth (38% of the sites), increased market share (30%), and the ability to respond to actual competitive threats (33%). Perhaps even more impressive, over half (55%) of the 40 sites reported that their partnerships had "achieved a breakthrough or discovered something totally new." This is particularly important in today's global marketplace, where competitive advantage is increasingly driven by the ability to create new value through innovation.

A major theme (cited by 43% of the sites) was how little was known in the business community about the valuable resources of the NSF Centers that were available to companies. They see the Centers as "one of America's best kept secrets/national treasures — and shouldn't be kept secret." Respondents felt that NSF has both a great opportunity and a responsibility to share these important resources.

A major theme (cited by 43% of the sites) was how little was known in the business community about the valuable resources of the NSF Centers that were available to companies.

For most of the NSF Center business partners, HPC is indispensable. More than three-quarters of the sites (77%) stated that they could not operate as businesses without access to HPC resources, and 80% said they could not compete effectively or bring products to market fast enough without HPC. The most frequently cited benefits of HPC were time savings and better science.

Three out of four (75%) of the companies entered into partnerships with the NSF Centers to advance critical strategic work, that is, ongoing work central to their missions. The primary motivator for the remaining 25% was to solve an immediate problem. Sixteen of the sites (40%) were able to assign a dollar value to their partnerships, ranging from \$100,000 to \$57 million. The most common objective for the partnerships (78% of the sites) was access to the scientific and HPC expertise of the Centers. Next in importance was access to the Centers' HPC systems. Although 33 of the 40 respondents (83%) reported having technical servers or supercomputers at their sites, they placed high value on being able to use much larger systems. This access to systems and expertise was deemed so important that 22 sites paid for aspects of the partnership, with costs ranging from \$25,000 to \$7 million. It is noteworthy that 15 sites (38%) installed HPC systems after their experiences with the NSF Center partnerships, although study data did not indicate whether these were system upgrades or first-time purchases.

Seven in 10 of the sites described their HPC work within the NSF partnerships as primarily research-oriented, while the remaining 29% said they were mainly focused on production work.

The companies' primary suggestions for improvement concerned access to the Centers' HPC resources, the cultural gap between businesses and universities, and red tape related to intellectual property issues. The cultural differences ranged from difficult-to-address broad issues to specific problems open to consideration (*"We needed some help during a school break, which caused big problems."*). Red tape issues were mentioned by just 15% of the sites, but in at least some of these cases, they became substantial impediments.

Key Findings in the Study

- ☑ The companies view the NSF Centers' HPC resources as a hidden gem and believe NSF has not just an opportunity, but a responsibility to market and promote these resources far more aggressively to U.S. businesses that exploit or wish to exploit HPC.
- ☑ The partnerships between NSF Centers and businesses have been remarkably successful. Companies that partner with NSF Centers are achieving real results, from shorter time-to-market to higher quality products to better visualization and breakthrough insights. In more than half the cases, the partnerships directly benefited the companies financially, competitively, or both. Even more impressive, over half (55%) of the 40 sites reported that their partnerships had "achieved a breakthrough or discovered something totally new." All 40 of the

The companies view the NSF Centers' HPC resources as a hidden gem.

surveyed firms were overwhelmingly positive about the scientific and HPC-related expertise of the NSF Centers, and 95% of the firms want to partner with the same NSF Center again.

- ☒ The aspects of the partnership the companies rated most important were access to HPC resources and expertise (scientific and HPC) within the NSF Centers. More than three-quarters of the sites said they could not operate as businesses without HPC.
- ☒ Recommendations for improvement focused on enhancing technical support (especially documentation), narrowing the cultural gap between businesses and universities, alleviating red tape (particularly related to intellectual property rights), and choosing HPC systems with the needs of industry in mind.

Implications For NSF

- ☒ NSF and the University HPC Centers it funds have a strategic opportunity to provide a competitive lift to the country by better promoting to industry the availability of the Centers' advanced HPC systems and expertise. Current industry partners see these centers as hidden gems whose HPC systems and expertise could be used to accelerate innovation for competitive advantage if they are publicized more widely. Further, by helping industry solve its most complex, competitively important problems, NSF also is advancing its own mission of supporting "high-risk, high pay-off" ideas and novel collaborations.

"One of America's best kept secrets/national treasures — and shouldn't be kept secret."

"There is untapped potential at the Centers for many organizations and businesses."

"More people need to know about these resources."

"Do a better job of promoting this resource to the business community."

"NSF needs to do a better job of promoting the availability of these tremendous resources."

"We've advanced our R&D efforts dramatically."

"Advanced our understanding of the dynamics within the solar interior."

"It has offered tremendous advancements in our research and our understanding of HPC."

"More people need to know about these resources."

- ☒ By further promoting this availability and reaching out to industry, NSF and the Centers can also help to grow the HPC market by stimulating increased private

sector HPC usage among experienced users, periodic users, and even companies that have "never ever" used HPC. Survey data indicated that 38% of the industrial partners purchased HPC systems after partnering with the NSF Centers. Although study data did not indicate whether these were system upgrades or first-time purchases, clearly the industrial users saw value in increasing their in-house HPC capabilities after exposure to the systems and expertise at the NSF-funded University Centers. Such market growth will help reduce the cost of HPC systems and software, benefiting NSF, academia, U.S. industry, and the country. Respondents even suggested a new NSF-sponsored grant program to support the proliferation of HPC into new industries.

Survey data indicated that 38% of the industrial partners purchased HPC systems after partnering with the NSF Centers.

"NSF does not focus on how they can contribute to the American economy."

"NSF's contribution to private industry in the U.S. is not nearly as great as it should/could be."

"Expend resources into tools for traditional industrial apps rather than leading-edge apps."

"An untapped resource that many in industry don't know about."

"A competitive grant program to encourage companies and universities to think seriously about partnership opportunities (like an SBIR program)."

- ☒ Data from the study confirms that the NSF Center-industry collaborations are helping to address two important barriers that studies from the Council on Competitiveness indicate are preventing more widespread private sector usage of HPC: lack of access to large-scale systems and the need for "talent."

- ☐ This NSF-funded Centers program can provide much-needed access to large HPC systems not generally available to industry.

"We can run larger jobs (instead of many smaller jobs) — more efficient."

"We've advanced [our research] much faster than we dreamed we could."

"This is a critical resource for the research community."

"We've advanced [our research] much faster than we dreamed we could."

- ☐ Companies were stimulated to partner with the NSF Centers to gain access to expertise. Their comments about what they learned reflected this:

"Immeasurable value from the Center's personnel."

"It's been a great opportunity to meet and learn from others in our field."

"The Centers provide access to great technical experts."

"Success in HPC is more about access to people and relationships than it is about hardware. That's what makes huge breakthroughs possible. 'A supercomputer unused is a useless supercomputer. Partnering with the right people in a team is what makes a supercomputer useful.' I've seen a lot

more emphasis on hardware than on people. This needs to change — people are the magic ingredient."

- Clearly industry sees partnering with the NSF-funded University Centers as a way to access the larger HPC systems and added expertise it needs to solve some of its most difficult problems for competitive gain. And more competitive U.S. companies help the country to maintain national security and economic strength.

"We've advanced [our research] much faster than we dreamed we could."

"HPC has allowed us to make several scientific breakthroughs."

"It dramatically reduces our costs for [oil and gas] exploration."

"We've been able to discover many new things about the brain and contribute this to the world."

"It's a telescope into the future."

"It's a telescope into the future."

- ☒ NSF and the Centers could make this valuable program even more successful by working to create a more user-friendly environment for industry, from including industry requirements in HPC system procurements to improving technical support and documentation and ensuring that industry researchers can obtain adequate priority and access to HPC resources. NSF and the Centers could use the results of this study as a partial road map and supplement this with face-to-face planning meetings with participating businesses to set expectations and address issues in advance, where feasible.

"We needed some help during a school break, which caused big problems."

"Machines need to be balanced between memory, disk, and CPU speeds."

"Keep improving documentation and procedures."

"The University stopped listening to industry."

- ☒ Red-tape related to intellectual property (IP) issues was a significant show-stopper for a small number of users. These IP barriers prevented companies from publishing results and showcasing their partnerships with the NSF-funded Centers. Addressing these would help the broader industrial community understand the benefits of using HPC, provide wider access to research results beyond the partnership company, and help the Centers to receive wider recognition for these valuable partnership programs.

Red-tape related to intellectual property (IP) issues was a significant show-stopper for a small number of users.

"Intellectual property issues were the ultimate problem."

"IP has been a major stumbling block."

"We would use it much more if IP issues were resolved."

TABLE OF CONTENTS	
	P
SITUATION OVERVIEW	1
Corporate Partners' Current Usage of and Attitude Toward HPC	1
Importance of HPC to Industrial Participants and the Nation.....	2
Benefits of HPC to the Organizations	3
Partnership Framework	3
CORPORATE MOTIVATION FOR PARTICIPATION IN THE PARTNERSHIP	5
Objectives for the Partnership	6
RESULTS ACHIEVED FROM PARTNERSHIPS WITH NSF CENTERS	7
BENEFITS FROM PARTNERSHIPS WITH NSF CENTERS	8
IMPEDIMENTS TO THE PARTNERSHIPS	10
RECOMMENDATIONS FOR IMPROVEMENT	12
SUMMARY	14
APPENDIX: ADDITIONAL TABLES	15

LIST OF TABLES

	P
1 Timing of Partnerships	5
2 Areas that the Partnership Provided Value	8
3 Important Areas Of The Partnerships	10
4 Industries in the Survey	15
5 Organization Size	15
6 Acquiring Accesses to HPC	16
7 Partnership Approach	16

LIST OF FIGURES

P

1	Which NSF Centers Have You Partnered With?	4
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SITUATION OVERVIEW

This was a collaborative study conducted by the Council on Competitiveness and IDC on behalf of the National Science Foundation (NSF). The study included 40 users of NSF-funded University HPC Centers and was conducted from December 2005 to January 2006. It evaluated the users' experiences at the National Center for Supercomputing Applications (NCSA), the Pittsburgh Supercomputing Center (PSC), the San Diego Supercomputer Center (SDSC), and the Texas Advanced Computing Center (TACC). It explored how industrial companies have worked with these Centers (what worked well and what didn't) in order to identify and collect ideas on how to make these partnerships work better in the future.

The 40 users of the NSF-funded University HPC Centers interviewed for this study represent a broad spectrum of organizations that exploit high-performance computing for competitive advantage. Thirty-eight were a mix of for-profit and not-for-profit organizations conducting HPC research in support of business or business-like activities, one was in higher education and one was a not-for-profit engaged in environmental modeling. Throughout this report we refer to the set of sites as firms or businesses, since the vast majority of the sites interviewed were industrial sites, and the two exceptions had experiences and views that matched the responses of the industrial users. The firms are established or emerging leaders in their industries. Of the sites, 75% are large companies with annual revenues of \$100 million or more, and 40% earn more than \$1 billion annually. The study also includes the perspectives of smaller firms with revenues in the \$1 million to \$100 million range. There was especially strong representation in the combined pharmaceutical, biological, life sciences, and biomedical category (13 of the 40 respondents). This category has seen a proliferation of companies in recent years.

Corporate Partners' Current Usage of and Attitude Toward HPC

Most of the respondents to this study were experienced users of HPC. Twenty-three of the 40 sites (58%) had used HPC before the partnerships began. It is noteworthy that 15 sites (38%) installed HPC systems after their experiences with the NSF Centers began, although study data did not indicate whether these were system upgrades or first-time purchases.

- ☑ Thirty-three of the 40 respondents (83%) reported having technical servers or supercomputers installed at their own sites. For the remaining 17%, this does not rule out the possibility that technical computing systems may be installed at other sites within their companies.
- ☑ Five out of six (83%) of the respondents said they purchase or lease HPC computing resources (e.g., systems and application software) and install them in company facilities. An even greater percentage (93%) use HPC resources located in partners' facilities (which may include government labs and University-based Centers). More than one in three (35%) of the sites access HPC resources via a grid or the Internet. The response categories are not mutually exclusive.

- ☑ Virtually all of the firms (98%) said they currently have access to the application software they need.

Importance of HPC to Industrial Participants and the Nation

As the comments below indicate, access to HPC resources was often considered indispensable for the commercial firms involved in the NSF partnerships. This reaffirms the July 2004 *Council on Competitiveness Study of U.S. Industrial HPC Users* (report available at http://www.compete.org/pdf/HPC_Users_Survey.pdf), which found that 97% of the U.S. businesses surveyed could not exist, or could not compete effectively, without the use of HPC. In the current NSF study, more than three-quarters of the industrial partners (77%) stated that they could not operate as businesses without access to HPC resources (see comments below). Of the companies surveyed, 80% said they could not compete effectively or bring products to market fast enough without HPC. Risks mentioned less frequently included inadequate product quality (13%), poorer science (5%) and higher costs (5%).

More than three-quarters of the industrial partners (77%) stated that they could not operate as businesses without access to HPC resources.

Comments also reflect the importance of HPC to solving national grand challenges such as energy security and sustainability and breakthrough medical science.

"Our company cannot survive without HPC."

"Without HPC, there would be no further discoveries of oil and gas."

"We would be scooped by competitors."

"The U.S. would fall behind the rest of the world in neuroscience."

"We cannot conduct our primary mission without HPC"

"We would be out of business — it's our core mission."

"There would be no way to carry out our work."

"We would be out of a job. This is what we do."

"We would fall behind technically."

"Our R&D will take light years longer."

"Competitive labs could beat us to market."

"We couldn't be competitive with our products."

"We're in a highly competitive industry. Without HPC, we run serious competitive risks."

"We would lose market share to competitors."

"Without HPC, there would be no further discoveries of oil and gas."

Benefits of HPC to the Organizations

The most frequently cited benefits of HPC for the companies had to do with time savings (time-to-market, research productivity) and better science. Almost three-quarters (73%) of the business partners highlighted time savings, and nearly as many (63%) mentioned scientific advantages ranging from improved methodology to breakthroughs. Benefits mentioned less often were access to the Center's expertise (23% of the sites), cost savings (10%), and, at 1% each, higher product quality, better visualization, and reduced staffing requirements.

The most frequently cited benefits of HPC for the companies had to do with time savings (time-to-market, research productivity) and better science.

"Rapid development of prototype products."

"Reduced time for evaluation of new products/processes."

"Getting answers when needed with respect to new product design."

"Much faster discovery and achievements."

"We can do more work and do it faster."

"Better models with finer resolution."

"HPC has allowed us to make several scientific breakthroughs."

"It dramatically reduces our costs for [oil and gas] exploration."

"We've been able to discover many new things about the brain and contribute this to the world."

"We can pursue multiple alternative solutions simultaneously."

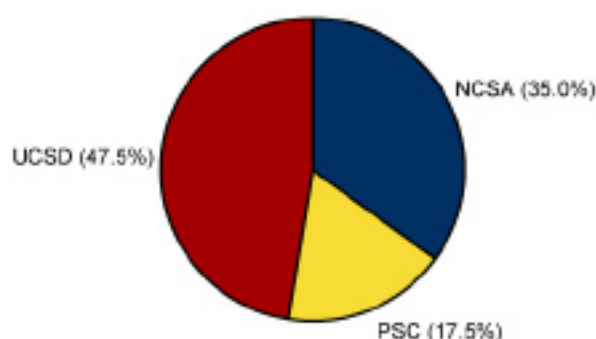
"It's a telescope into the future."

Partnership Framework

The majority of the collaborations represented in the study were with the University of California, San Diego (48%) and the National Center for Supercomputing Applications (35%), but the Pittsburgh Supercomputing Center (18%) was also well represented in the combined experience of the 40 companies (Figure 1). The Texas Advanced Computing Center is in the process of ramping up its industrial partnership program, so its partners were not yet ready to discuss their collaboration.

FIGURE 1

Which NSF Centers Have You Partnered With?



Total = 40

Source: IDC, 2006

How the Partnerships Were Conducted

Travel between the NSF Centers and the companies was substantial in both directions. Thirty-one of the 40 commercial sites (78%) reported sending personnel to the Centers, and 20 (50%) said the Centers sent people to the companies. (Respondents were permitted to provide multiple answers.) These responses indicate that the partnerships relied heavily on face-to-face collaboration, which is costly and time consuming. This also implies that collaboration tools are still immature or not readily accessible.

The partnerships relied heavily on face-to-face collaboration, which is costly and time consuming.

Initiation of Partnership

In 7 of 10 instances (69%), the companies approached the NSF Centers about entering into partnerships. In the other cases, the Centers approached the businesses (17%), or other channels (14%) helped bring about the collaborations.

Length of Partnership

The firms' partnerships with the NSF Centers have been in place for more than 8 years each on average, with the longest-running partnership now at 22 years (Table 1). The longevity of these relationships in itself confirms that they have continuing value for the participants. In the aggregate, the partnerships amounted to about 300 years of collaboration.

TABLE 1**Timing of Partnerships***How many years did you work with the NSF Centers?*

Period	Years
Average length	8.1
Minimum length	1
Maximum length	22
Number of longer partnerships (18–22 years)	10
N =	36

Source: IDC, 2006

Corporate Funding Contributions

Twenty-two firms indicated that they paid for aspects of the partnership. Costs ranged from \$25,000–7 million per firm. Total direct payments from these 22 partners to the NSF Centers or in support of the collaborations amounted to \$14.9 million. Only 5 sites paid over \$100,000 each. Costs covered software licensing, compute time, and in-kind contributions.

Security

Thirty sites (75%) stated that security related to systems access (passwords, etc.) was handled by their NSF partner Center. No major issues or concerns were mentioned. A few sites said that security provisions took longer to deal with than expected.

CORPORATE MOTIVATION FOR PARTICIPATION IN THE PARTNERSHIP

Seven in 10 of the sites (71%) described their HPC work within the NSF-Center partnerships as primarily research-oriented, while the remaining 29% said their NSF collaborations were mainly focused on production work. For the purposes of this study, IDC defines HPC-related research within industry as work aimed primarily at creating new or improved methodologies to benefit future product development or manufacturing. IDC defines production work as HPC-related activity using current methodologies to produce current products to meet market demand. It is not surprising that most of the industrial partners would turn to the NSF Centers for assistance with future-oriented research.

When questioned further about their motivation for working with the Centers, the most frequent response (75%) was to advance critical strategic work, that is, ongoing work

central to their missions. The primary motivator for the remaining 25% was to solve an immediate problem.

Objectives for the Partnership

- ☒ The two most widely stated objectives for the partnerships were to tap into the expertise of the Centers (78% of the firms) and gain access to systems (65% of the sites). As the representative comments below indicate, some of the businesses hoped to exploit scientific expertise and others HPC expertise. This hunger for outside expertise and better HPC tools echoes the findings of the July 2004 *Council on Competitiveness Study of U.S. Industrial HPC Users*, which revealed that companies are not using HPC as aggressively as they could because of a shortage of experts able to apply the HPC resources effectively and a lack of access to systems. Comments related specifically to gaining expertise in HPC:

"Learn from the Center's experts."

"Learn how to optimize code."

"Learn more about modeling and possibilities."

"Gain practical experience with HPC."

"Gain experience with HPC modeling techniques."

... as well as accessing larger HPC hardware systems:

"Streamline new product development."

"Solve problems we couldn't solve internally."

"Run larger jobs (instead of many smaller jobs) — more efficient."

"On-demand access to computing resources."

"Rapid implementation of the solution."

In addition, some of the partners stated specific business objectives:

"Faster product development."

"Streamline new product development."

"Access for benchmarking of software performance."

The two most widely stated objectives for the partnerships were to tap into the expertise of the Centers (78% of the firms) and gain access to systems (65% of the sites).

RESULTS ACHIEVED FROM PARTNERSHIPS WITH NSF CENTERS

The vast majority (80%) of the businesses concluded that the partnerships with the NSF Centers met their objectives. That impressive figure is likely to climb even higher, since another 13% of the firms could not respond because their projects are still in progress. Sixteen of the sites (40%) were able to assign a dollar value to the results of their partnerships with the University Centers, ranging from \$100,000–\$57 million. Three of the sites identified a partnership net value greater than \$10 million at \$25 million, \$50 million, and \$57 million. Results included things like new product development, accelerated research breakthroughs, faster time-to-market, etc. The aggregate value assigned to these 16 partnerships was \$158 million dollars.

"We've advanced [our research] much faster than we dreamed we could."

"We learned everything we set out to learn, and much, much more."

"Advanced our understanding of the dynamics within the solar interior."

"We learned everything we set out to learn, and much, much more."

Table 2 (below) lays out the specific areas in which the companies achieved results, with multiple responses possible for each site (226 responses were provided by the 40 sites). Virtually all of the respondents (93%) agreed that the partnerships advanced their firms' research and development efforts, and 88% said the collaboration had "solved a specific problem." Even more noteworthy is how often the partnerships directly benefited the companies financially, competitively, or both.

- ☑ A significant number of sites (73%) reported that the partnership had helped them achieve cost reduction and/or increased profitability.
- ☑ More than half the sites (55%) reported that the partnerships had benefited new product development, and (60%) said the NSF collaborations helped them get products to market faster.
- ☑ Related areas of value included revenue growth (38% of the sites), increased market share (30%), and the ability to respond to actual competitive threats (33%).
- ☑ Perhaps even more impressive, over half (55%) of the 40 sites reported that their partnerships had "achieved a breakthrough or discovered something totally new." There is very likely a correlation between these breakthroughs and previously mentioned financial and competitive benefits. This is particularly important in today's global marketplace, where competitive advantage is increasingly driven by the ability to create new value through innovation.

Over half (55%) of the 40 sites reported that their partnerships had "achieved a breakthrough or discovered something totally new."

TABLE 2**Areas that the Partnership Provided Value***In what areas did the partnership/project provide value to your organization? (Multiple responses were allowed.)*

Value Areas	Number of Responses	Percentage of Sites
Advanced our research R&D	37	93
Solved a specific problem	35	88
Cost reduction and/or increased profitability	29	73
Getting products to market faster	24	60
Achieved a breakthrough or discovered something totally new	22	55
New product development	22	55
Provided revenue growth	15	38
Helped us in system acquisition and/or evaluations	15	38
Allowed us to respond to a competitive threat (market pressures)	13	33
Provided increased market share	12	30
Other	2	5
N =	226	

Source: IDC, 2006

Publication of the Results

Twenty-two sites published the results of the partnership. Two sites indicated that lengthy University procedures and delays in obtaining University approvals for publication ultimately forced them to keep the data private or confidential.

BENEFITS FROM PARTNERSHIPS WITH NSF CENTERS

Industry participants described the main benefits stemming from their partnering with the NSF Centers (Table 3). These ratings are consistent with the great importance the companies assigned to HPC access and NSF Center expertise as objectives for the partnerships. It appears that for many of the companies, these objectives were largely met:

- ☒ The aspect of the partnership the partnering companies rated most beneficial was access to larger HPC systems (8.8 average rating on a scale where 10 is most important).

"We learned a great deal about HPC."

"NCSA provided the horsepower we needed."

This work has helped establish credibility for our software/data standard."

"It has offered tremendous advancements in our research and our understanding of HPC."

"Getting our own in-house personnel to see the potential of HPC."

"It saved a lot of money and taught us a great deal about HPC."

"It has dramatically accelerated our work."

"It's a cost-effective way to access leading-edge HPC systems."

"It has offered tremendous advancements in our research and our understanding of HPC."

The importance of access to large HPC computers is not surprising. Prior IDC research, especially for the July 2004 Council on Competitiveness Study of U.S. Industrial HPC Users (a copy of the report is available at http://www.compete.org/pdf/HPC_Users_Survey.pdf), also indicated that many firms do not have access to the HPC tools they want and need because financial constraints often force them to purchase substantially smaller versions of HPC systems than their counterparts in government and academia. Access to larger HPC systems not only allows more work to be done in a given timeframe; as we have seen from earlier responses in this study, larger HPC systems can sometimes solve problems that are intractable on smaller systems and can lead to new, competitively important insights.

- ☒ Closely following this (7.0 rating) was access to experts within the Centers. When respondents were asked, "What did you learn from the partnership?" their comments reinforced that access to expertise/knowledge transfer was crucial:

"We learned that the Center has great people."

"We learned a lot of modeling techniques/methodologies."

"We've advanced our R&D efforts dramatically."

"Great people/expertise —invaluable benefit."

"Immeasurable value from the Center's personnel."

"The Centers provide access to great technical experts."

"It's been a great opportunity to meet and learn from others in our field."

"The scientific exchange has been valuable."

"Immeasurable value from the Center's personnel."

"Their experts really helped accelerate our software development cycle."

"The Centers provided substantial expertise in visualization."

TABLE 3

Important Areas Of The Partnerships

What aspects of the partnership were the most important to your organization? (10 = most important)

Area	Average Rating
Access to larger HPC computer systems	8.8
Access to experts within the Center	7.0
Access to larger or special storage, or I/O	5.8
Access to special software	5.2
Access to training	4.1
Access to special data or databases	3.4
N =	40

Source: IDC, 2006

- ☐ In addition to access to Center personnel, respondents also noted in their comments the high quality of these interactions. The good will shown in these relationships, on both the science and support side, was the glue that held the partnerships together and allowed them to work.

"It's seamless partnership."

"The people are great."

"The staff has been quite helpful and valuable."

"The Center has bent over backwards to support us."

"The Center has bent over backwards to support us."

IMPEDIMENTS TO THE PARTNERSHIPS

Nineteen of the sites surveyed (48%) said they have active partnerships with institutions outside of the NSF (one site listed five such active partnerships). About half of these (9 of 19) were described as better than their collaborations with the NSF-funded University Centers. Here are representative comments on why those partnerships were considered more successful in some cases:

"The others have provided more dedicated and reliable access to the systems on a timely basis."

"They are more focused on our specific needs."

"They all understand that we must own the rights to IP that we create."

Not surprisingly, these comments were later reflected in the recommendations that respondents made to improve the partnering relationship.

- ☑ Of the businesses, 45% said that access was one of the things that worked well, yet 63% of the sites pointed to some problems with access (e.g., machine reliability and priority issues). This should be taken as an indication of the great importance to the companies of access to the Centers' HPC resources.

"One of their systems (newest and cheapest system) has major reliability issues."

"The center took our system out of production unexpectedly — frequently."

"Broad mix of apps/users on these systems causes major reliability issues."

"The allocation process is somewhat inflexible (yearly process)."

"[Not until the center fixes the] reliability/uptime issue on a specific machine."

- ☑ Of the firms interviewed, 40% cited cultural differences between businesses and the Centers. These ranged from broad to specific issues.

"University administration created a culture of competition vs. cooperation."

"There's been a wide gap between batch-oriented computing versus real-time philosophies."

"The culture clash between academics versus industry is and always will be an issue."

"Remember they're not the only game in town. Others out there with similar capabilities are hungry for relationships with industry."

"Their staff's mindset regarding storage. Our data is priceless, and the center didn't really appreciate that."

"The culture clash between academics versus industry is and always will be an issue."

- ☑ Despite the quality of the interactions noted above by some respondents, 22 sites — over half (55%) of the partnerships — felt that responsiveness of the Centers was an issue.

"We needed some help during a school break, which caused big problems."

"Universities work on a different clock than small businesses with urgent deadlines."

"The University stopped listening to industry."

"We found it very difficult to make it work. Passwords expire. Files disappear."

- ☒ Red tape and legal issues, particularly intellectual property rights, were mentioned by just 15% of the sites, but in some of these cases they became substantial impediments.

"Red tape with regard to IP issues was a problem."

"Joint ownership/IP issues have been difficult."

"Some significant IP and confidentiality issues harmed the relationship."

"We can't develop or work on software (and get the Center's help) due to IP issues."

"Tech transfer and legal issues can be a major impediment and slow progress dramatically."

"Tech transfer and legal issues can be a major impediment and slow progress dramatically."

"Scientists work faster than lawyers."

- ☒ Of the 40 sites, only three reported that their objectives were not fully met, and two of these three firms described the collaborations as partial successes. Their comments were as follows:

"We learned a lot, but never really got off the ground."

"HPC is not easy."

"For the big runs our objectives were met. But we had many small jobs, and the site was not responsive."

RECOMMENDATIONS FOR IMPROVEMENT

Although the partnerships were viewed overall as highly successful and worth continuing or repeating ("It's very convenient, very useful. I'm very happy."), there were many useful recommendations for the future.

- ☒ One of the most prevalent recommendations was that NSF and the University Centers increase their marketing efforts to publicize the availability of HPC resources. A surprising 68% of the firms viewed these resources as a hidden gem that is generally unfamiliar to U.S. businesses. They believe the NSF has not just an opportunity, but a responsibility to market and promote these valuable resources far more aggressively to the business community.

"One of America's best kept secrets/national treasures — and shouldn't be kept secret."

"One of America's best kept secrets/national treasures — and shouldn't be kept secret."

"They need to market it more aggressively."

"NSF does a poor job of outreach to American industry."

"NSF needs to do a better job of promoting the availability of these tremendous resources."

"NSF's contribution to private industry in the U.S. is not nearly as great as it should/could be."

"NSF does not focus on how they can contribute to the American economy."

"The Center's people and systems are a secret to many people."

- ☐ Respondents even suggested a new NSF-sponsored grant program to support the proliferation of HPC into new industries.

"A competitive grant program to encourage companies and universities to think seriously about partnership opportunities (like an SBIR program)."

- ☒ By far the most frequent recommendation (93% of the firms) was to improve technical support, especially documentation related to policies and procedures at the Center.

"Better documentation (how-to) — it's out of date."

"Some of the procedural documentation is outdated."

"More updated documentation on system procedures."

- ☐ In addition, respondents suggested that the Centers provide workshops and training for partners, which would improve the relationship and possibly reduce the need for technical support.

"Workshops on facilities, systems, procedures, etc. would be good."

"More and better information (advertising, how-to, use cases, models available, training, etc.)."

"Workshops on facilities, systems, procedures, etc. would be good."

- ☒ Many of the firms (58%) recommended that NSF and the Centers work harder to narrow the cultural gap between industry and universities, particularly related to the Centers' responsiveness to industry needs.

"Researchers don't easily grasp the problems of private industry."

"They need people who understand industry (timetables, costs, deliverables, goals, profit motive)."

- ☒ Additionally, the firms suggested that NSF and the Centers reevaluate future HPC hardware system purchases in order to address industrial requirements.

"The Center may need to reevaluate whose hardware they use."

"Machines need to be balanced between memory, disk, and CPU speeds."

"Buy a vector computer (NEC) for the smaller jobs."

"NSF should put more weight on software and less on hardware. Hardware is easily outdated, but software lasts much longer."

"We would like to see some 64-bit clusters."

"Expand the resources available. Ensure machines are balanced (CPU to memory, etc.) to meet appropriate project needs."

- ☒ Finally, many of the sites felt hindered by "red tape" issues, particularly related to intellectual property, and recommended that these issues be resolved so that future partnerships could run more smoothly.

"Ease up on the intellectual property issues/remove red tape."

"Contract issues. Make it easier for for-profits to work with the Centers."

"NSF should put more weight on software and less on hardware. Hardware is easily outdated, but software lasts much longer."

SUMMARY

The partnership programs between NSF-funded University Centers and U.S. businesses have been very successful. All 40 of the companies interviewed for this study were overwhelmingly positive about the expertise of the NSF Centers, and 95% said they would like to partner with the same NSF Center in the future. Virtually all (93%) said the NSF Center partnerships advanced their research and development efforts, and 80% concluded that the partnerships had met their objectives. That percentage could climb even higher, since 13% of the projects were still in progress when this study was conducted. Even more impressive, over half (55%) of the 40 sites reported that their partnerships had "achieved a breakthrough or discovered something totally new."

The aspects of the partnership the companies rated most important were access to HPC resources and expertise (scientific and HPC) within the NSF Centers. More than three-quarters of the sites said they could not operate as businesses without HPC. It is noteworthy that 15 sites (38%) installed HPC systems after their experiences with the NSF Center partnerships.

Recommendations for improvement focused on enhancing technical support (especially documentation), narrowing the cultural gap between businesses and universities, alleviating red tape issues (particularly related to intellectual property rights) and choosing HPC systems with the needs of industry in mind.

The companies view the NSF Centers' HPC resources as a hidden gem and believe NSF has not just an opportunity but a responsibility to market and promote these resources more aggressively to U.S. businesses that exploit or wish to exploit HPC.

"We've advanced our R&D efforts dramatically."

"This is a critical resource for the research community."

"There is untapped potential at the centers for many organizations and businesses."

"It's been a very valuable partnership. We want it to continue."

APPENDIX: ADDITIONAL TABLES

TABLE 4

Industries in the Survey

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

Industry	Number of Responses
Pharmaceutical, biological, life sciences & biomedical	13
Aerospace and astrophysics	6
Software company	6
Chemical	1
IT and electronics	1
Other	13
N =	40

Note: "Other" included general manufacturing, research, and nuclear

Source: IDC, 2006

TABLE 5

Organization Size

How large is your organization (in yearly sales revenue)?

Size in Sales	Number of Responses
Under \$1 million	3
\$1 million–10 million	2
\$10 million–50 million	2
\$50 million–100 million	3
\$100 million–1 billion	14
Over \$1 billion	16
N =	40

Source: IDC, 2006

TABLE 6**Acquiring Accesses to HPC***How does your organization acquire access to HPC computing resources and/or application code?*

Approach	Number of Responses
Purchase (or lease) them and install them in our facilities	33
Use systems installed in partner facilities (including universities & labs)	37
Use resources over a grid or from an Internet provider	14
Other	0
(Multiple responses allowed) N =	84

Source: IDC, 2006

TABLE 7**Partnership Approach***How did you do the project with the Center?*

Approach	Number Of Responses
Sent our people to the Center	31
They sent people to our location(s)	20
Ran problems remotely	37
Used resources over a grid	15

Source: IDC, 2006

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