Partnering for Prosperity

Harnessing Our HPC Assets for Competitive Strength

Industrial Partnerships through
the NNSA's Academic Strategic
Alliance Program

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 Department of Energy's National Nuclear Security Administration (NNSA) 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 that collaborate with the universities engaged in NNSA's Academic Strategic Alliance Program. The goal of this survey was to explore what worked—and what needs work. Although not an original Program goal, the survey responses indicate that the Alliance Program creates new value opportunities for the participating companies as well as the country. 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 U.S. Department of Energy/NNSA

Sponsored by: NNSA and Council on Competitiveness

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EXECUTIVE SUMMARY

This collaborative study was conducted by the Council on Competitiveness and IDC on behalf of the U.S. Department of Energy/National Nuclear Security Administration Office of Advanced Simulation and Computing (DOE/NNSA/ASC). The main study included 12 industrial partners and was conducted from December 2005 to January 2006. It is a testament to the perceived value of the NNSA/ASC Academic Strategic Alliance Program (ASAP) that when we asked the 12 companies interviewed for this paper to give us their summary recommendations (positive or negative) about working with the Alliance Centers, the vast majority (83%) of the respondents reported that their collaborations had met their objectives, and none claimed their objectives had not been met. Six of the 12 sites were able to assign an actual dollar value to the partnership results. The values ranged from $200,000 to $1 million.

All of the respondents agreed that the partnerships advanced their firms' research and development efforts. Even more remarkable is how frequently the partnerships directly benefited the companies financially or competitively, or both. An impressive one-third (33%) of the sites reported that their partnerships had "achieved a breakthrough or discovered something totally new." All 12 sites responded "yes" when asked about their willingness to partner with the Centers in the future.

Access to high-performance computing (HPC) resources is indispensable for the 12 commercial firms. Three of the firms stated outright that they could not operate as businesses without HPC, while many of the others said essentially the same thing in other ways. The benefits of HPC for the companies extend far beyond time and cost savings in the product development process. For many of the firms, HPC provides valuable new insights — breakthroughs in thinking that can result in superior products with important competitive advantages.

An impressive one-third (33%) of the sites reported that their partnerships had "achieved a breakthrough or discovered something totally new."

Nearly two-thirds of the partnerships had existed for at least five years (many are still in progress). Six of the sites provided funding for certain aspects of their partnerships. Nearly seven in eight of the respondents' projects are primarily research-oriented, with the remainder focused on production work. In most cases (57%), the Advanced Simulation and Computing (ASC) Alliance Centers approached the commercial firms about partnering, but in about one-third of the cases, the businesses were the initiators. The primary benefit the firms anticipated was knowledge transfer based on the assumed (or confirmed) greater scientific expertise of the Centers' personnel. The expectations for knowledge transfer were very specific in some instances ("to make use of turbo machinery code").

The aspect of the partnership the largest contingent (50%) of respondents considered important was access to experts within the Alliance Centers. Access to large HPC computers emerged as the second-most-popular benefit. Three-quarters of the commercial sites rated the responsiveness of the Centers as either "excellent" (42%) or "very good" (33%). The remaining 25% of the sites expressed at least some level of dissatisfaction with responsiveness.

A full 89% of the responses to the question "What worked well?" had to do with the quality of the human interactions with the Centers' personnel. It speaks well for the Centers that such a high percentage of the commercial firms reported that these interactions "worked well."

The commercial firms offered constructive criticism as well. Disappointment with the pace of the projects can be attributed, at least in part, to cultural differences between the commercial firms and the universities. The focus or fit of the project was sometimes a problem, and inevitably some of the results were unwelcome surprises. By far, the largest criticism (59% of all responses) concerned inadequate communication — the need for better advance planning and more regular, structured communication throughout the projects. Another important criticism was about "flying blind," that is, not understanding the universities and their resources before starting the projects. There were also some calls for improved technical communications.

Key Findings in the Study

- ☑ A full 83% of the commercial partners said the partnerships had met their expectations. All 12 of the firms said that the collaborations advanced their R&D efforts and that they would be willing to partner with the Centers again in the future.

- ☑ The primary benefit of the partnerships (anticipated and actual) was knowledge transfer from the Centers to the commercial firms. The firms planned to use this knowledge to gain competitive advantages in their businesses.

- ☑ Access to HPC resources is indispensable for all 12 firms. HPC provides not just time and cost savings but also valuable new insights that can result in superior products.

- ☑ What worked best were the human interactions between the companies and the Centers.

☑ What worked least well was bridging the cultural differences between the companies and universities, especially (from the companies' perspectives) the lack of adequate communications before and during the projects.

Implications for NNSA

☑ Although it was never a program goal, ASAP demonstrates that strategic public-private sector partnerships can provide significant value by lifting the country to a higher level of competitiveness. In particular, ASAP provides an opportunity for NNSA to demonstrate in quantifiable terms that it can successfully leverage its HPC resources to both meet national security mission needs and accelerate the nation's economic security and global competitive position — providing an enhanced return on the government's investment in HPC assets.

☑ ASAP benefits the NNSA by attracting (and providing the opportunity to attract) not only leading academic research organizations but also experienced industrial HPC users who can contribute some of the best thinking industry has to offer. These individuals are accustomed to using HPC in sophisticated ways.

"HPC provides enhanced insight into our problems."

"It allows us to solve more complicated problems in a reasonable amount of time."

☑ Data from the study confirms that ASAP can help 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."

❑ ASAP and its Alliance Centers can provide much-needed access to large HPC systems not generally available to industry.

"Most companies cannot afford supercomputers at this time. It's not something the average large company can afford."

"We entered into this partnership to acquire technical and computational resources."

❑ By providing this access, ASAP is helping companies achieve breakthrough insights needed for competitive gain.

"It gives us a glimpse of the future."

❑ Companies were stimulated to partner with the Alliance Centers to gain access to expertise. Their comments about what they learned reflected this desire.

"More knowledge of advanced algorithms."

"Mathematical models themselves and how to apply them to large-scale computing."

"New approaches to solving problems."

❑ Clearly, industry sees partnership with the NNSA Alliance Centers as a way to access the larger HPC systems and the added expertise it needs to solve some of its most difficult problems for competitive gain. More competitive U.S. companies help the country to maintain national security and economic strength and raise the standard of living.

⊠ Travel between the Alliance Center experts and industry participants was often substantial, indicating that collaboration tools are immature or not used. The program could provide a test bed for more mature collaboration tools in order to accelerate program accomplishments and reduce costs.

"Usually innovation took place through meetings and conference calls. That process takes longer than doing it in a collaborative fashion. We need to move from serial to collaborative innovation."

⊠ ASAP and its Alliance Centers could achieve better outcomes if industry is brought into the program "from the start." In addition, industry could help identify problems whose solutions would benefit both NNSA and industry, enhancing NNSA's ability to meet its mission-critical needs and at the same time accelerate innovation for national gain. Small modifications to the program would bring about a major competitive lift.

❑ NNSA could specify in future RFPs that it will select a certain number of proposals that include industry participation. This will not preclude academic institutions from submitting proposals that do not need industry input, but it would encourage some universities to draw industry into the process at the beginning.

❑ NNSA could further specify that any proposals that include industry participation must explain the competitive gain that industry anticipates from its participation, such as reduced costs, solving a currently intractable problem that will stimulate development of new products or processes for itself or its customers, faster time to market, and so forth.

⊠ By continuing to engage industry in ASAP, NNSA can stimulate increased HPC usage within the private sector and provide a much-needed HPC market stimulant. The resulting market growth will help reduce the cost of HPC systems and software, benefiting NNSA, U.S. industry, and the country.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

P

SITUATION OVERVIEW

This collaborative study was conducted by the Council on Competitiveness and IDC on behalf of the U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA). The main study included 12 industrial partners and was conducted from December 2005 to January 2006. Four in-depth case studies were conducted from January to March 2006. This study examines the requirements, needs, and experiences of HPC users related to partnerships with the NNSA Office of Advanced Simulation and Computing (ASC) Alliance Centers at Stanford University, University of Utah, and University of Illinois at Urbana-Champaign on behalf of the Council on Competitiveness and NNSA. It explores how industrial companies have worked with these Centers and identifies what worked well and what didn't in order to collect ideas on how to make these partnerships work better in the future.

Background on the DOE/NNSA/ASC Academic Strategic Alliance Program

In the summer of 1997, the ASC program initiated the Academic Strategic Alliance Program (ASAP) by creating long-term strategic alliances with five U.S. universities (the Centers) to focus on high-fidelity, scalable, three-dimensional, multidisciplinary computational science problems.

Note that the industrial partners were brought into the ASAP partnerships after the initial partnership programs were established with the university partners to help advise and guide the research into areas that would be mutually beneficial.

Although the computing problems tackled by ASAP do not involve nuclear weapons research, the computational science, computer science, and computational mathematics methodologies and tools developed do provide benefits to the DOE. In addition, they demonstrate to a wide scientific community that such validated simulations can be carried out, using unclassified problems similar in complexity to those the national laboratories face for the Stockpile Stewardship Program (SSP). Further, they provide training for graduate students and postdoctoral fellows who are potential candidates for laboratory, teaching, and industrial employment.

This program is unique in that each Center focuses on problems that support the ASC strategic goals:

- Involve complex simulations and supporting tools that require the integration of a number of academic disciplines and software components

- Involve the integration of multiple scales in both time and space

- Address the difficult problem of verification and validation of the simulations

The research projects and areas of investigation are described at the following Web site: **www.sandia.gov/NNSA/ASC/pubs/pdfs/3642-Krell%20ASC%20Pub.pdf.**

Background on the Industrial Participants and Their Partnerships with the Alliance Centers

The 12 companies interviewed for this survey span four important industries: aerospace, automotive, energy, and software. Not surprisingly, the majority of the firms are in the aerospace industry, which has a long history of HPC-related partnerships with government labs and Centers. These 12 firms are leaders in their industries. With one exception, their annual sales revenues exceed $100 million, and for six of the 12 firms, revenues are over $1 billion. In addition, six sites have active university partnerships with other institutions besides the Alliance Centers and presumably have brought those experiences to this program for the benefit of the Centers and NNSA.

The 12 respondents have been partnering under the NNSA ASAP program for multiple years, some of them with more than one Alliance Center partner (17 partnerships in total). The majority of the 17 instances of collaboration were with the University of Illinois at Urbana-Champaign (41%), but Stanford University and the University of Utah (29% each) were also strongly represented in the combined experience of the 12 companies.

Six of the 12 companies said they began partnering with NNSA ASAP Centers at or near the inception of the Alliance program in 1997. For the other six firms, these collaborative relationships began later in the program (see Table 1). In most cases (57%), the Alliance Centers approached the commercial firms about partnering, but in about one-third of the cases, the businesses were the initiators.

In total, there have been 67 years of partnerships. These figures suggest that overall, the commercial firms and the NNSA ASAP Alliance Centers have found these collaborations to be worthwhile.

Overall, the commercial firms and the NNSA ASAP Alliance Centers have found these collaborations to be worthwhile.

As noted earlier, a number of these collaborations began when the Alliance Centers were well under way with their projects. While collaboration with industry was not a requirement for participation in the Alliance program, some of the industrial partners indicated that had they been included "up front," they could have provided more assistance in shaping the projects for greater benefit to NNSA and industry.

"Have them sit down with industry to gauge areas of interest earlier in the process."

"Better communication. Get to industry earlier in process to design the scope of work and project."

TABLE 1

Timing of Partnerships

Q. What years did you work with the NNSA ASC Alliance Center?

Period	Number of Responses
1997 to present	3
1998 to present	3
1999 to present	1
2000 to present	1
2001 to 2004	1
2002 to present	1
2003 to present	1
2004 to present	1

n = 12

Source: IDC, 2006

How the Partnerships Were Conducted

Travel between the Centers and the companies was substantial in both directions. Eight of the 12 commercial sites reported sending personnel to the Centers, and seven said the Centers sent people to the companies. One-third of the companies said they ran problems remotely, and two of the 12 firms used resources over a grid. (Respondents were free to provide multiple responses to this question.) These responses indicate that the partnerships relied heavily on face-to-face collaboration, which is costly and time-consuming. This reliance on face-to-face collaboration also implies that collaboration tools are still immature or not readily accessible.

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Responsiveness of the Partners

Three-quarters of the commercial sites rated the responsiveness of the Centers as either "excellent" (42%) or "very good" (33%). The remaining 25% of the sites expressed at least some level of dissatisfaction with responsiveness. Four of the sites also mentioned that there were cultural differences that caused issues or delays in the partnerships. These findings are explained further in the Benefits from Participating in the Alliance Program section and the Impediments to the Partnerships section of this study.

Three-quarters of the commercial sites rated the responsiveness of the Centers as either "excellent" (42%) or "very good" (33%).

Corporate Funding Contributions

Six of the sites provided funding for certain aspects of their partnerships. Costs ranged from $40,000 to $900,000 per site. Fees covered software licensing costs, compute time, and in-kind contributions.

How Sensitive Information Was Handled

Five of the 12 sites (42%) said the collaborations did not involve sensitive information; in most of these cases, secure data was not shared with the other party (see comments below). In other cases, sensitivities were addressed by using university security procedures and personnel, by confining the tests to the commercial partner's facility, by excluding non-U.S. students from the projects, or through a licensing agreement that covers intellectual property rights.

> "Relied on university security."

> "Managed input/output data in nonclassified format."

> "Did not share any sensitive data."

> "Excluded some foreign students from the project."

> "Nondisclosure agreements sanitized the models we gave them."

> "Avoided using secure data."

> "Did everything within the ITAR enclave within the center."

> "They were only allowed to witness their test at our facility."

> "Most of the work is open domain, but we also have a licensing arrangement to cover intellectual property issues."

"Most of the work is open domain, but we also have a licensing arrangement to cover intellectual property issues."

Corporate Partners' Current Usage of and Attitude Toward HPC

As a group, the respondents to this study were experienced and, in many cases, highly experienced users of HPC. Ten of the 12 sites had been using HPC before partnering with an Alliance Center. Of the two sites that had not, one continued using HPC after the collaboration was completed.

☑ Half of the respondents said they have technical servers or supercomputers installed at their own sites. This finding does not rule out the possibility that the other half of the respondents may have installed technical computing systems at other sites within their companies.

☑ One-third of the respondents (four of 12) use HPC resources located in partners' facilities (which may include government labs and university-based Centers). One in four (25%) access HPC resources via a grid or the Internet. The response categories are not mutually exclusive.

☑ Virtually all (92%) of the respondents reported having access on their own to the application software they need — though, as we see later, many of the sites highly valued other types of advanced software to which they gained access through the partnerships.

Importance of HPC to Industrial Participants

As the following comments indicate, access to HPC resources is indispensable for the 12 commercial firms involved in partnerships under ASAP. This finding reaffirms the July 2004 *Council on Competitiveness Study of U.S. Industrial HPC Users*, which found that 97% of the U.S. businesses surveyed could not exist, or could not compete effectively, without the use of HPC. (The 2004 study is available at **www.compete.org/pdf/HPC_Users_Survey.pdf.**) In the current NNSA study, three of the firms stated outright that they could not operate as businesses without HPC, while many of the others said essentially the same thing in other ways. For example, an automaker that couldn't meet federal requirements for selling cars without HPC would face a bleak future — as would the companies that could no longer compete because their product development times or business processes would slow down markedly without HPC.

> *"We could not be in business [without HPC]."*

> *"[Automotive] crash simulations would not meet federal requirements for selling cars."*

> *"Development time would increase and we would get to market late, which is not good."*

> *"It would slow down our business process."*

Benefits of HPC to the Organizations

What is also clear from the respondents' comments (see below) is that the benefits of HPC for these commercial companies extend far beyond time and cost savings in the product development process, although both of these advantages can be crucially important. It is not just a matter of doing the same thing faster and at lower cost. For many of the firms, HPC provides valuable new insights — breakthroughs in thinking that can result in superior products with important competitive advantages.

> *"HPC provides enhanced insight into our problems."*

> *"HPC gives the people I consult for a better global idea of their problem."*

> *"HPC gives us answers without [physically] testing complicated problems."*

> *"It allows us to solve more complicated problems in a reasonable amount of time."*

> *"It reduces risk on new aircraft developments."*

> *"It reduces risk."*

CORPORATE MOTIVATIONS FOR PARTICIPATION IN THE PARTNERSHIPS

A full 86% of the respondents' projects related to the NNSA Alliance Program are primarily research-oriented, with the remaining 14% focused on production work. This finding is not surprising because industrial firms generally do not approach universities for most of their production problems.

When we questioned respondents further about their motivation for working with the Centers, the most frequent response (50%) was to conduct investigative research, that is, fundamental science (see Figure 1). More closely defined strategic work accounted for one-third of the collaborations, and the remainder (about one in 12) combined investigative and strategic goals.

FIGURE 1

Reasons for Partnering with the Centers

Q. *Why did you partner with the Centers?*

Strategic work and investigative studies (8.3%)

Strategic work (33.3%)

Investigative studies (50.0%)

For an immediate problem (8.3%)

n = 12

Source: IDC, 2006

Objectives for the Partnership or Project

Not surprisingly, the primary benefit the firms anticipated from their work with the Centers was knowledge transfer based on the assumed (or confirmed) greater scientific expertise of the Centers' personnel (e.g., "to be up to date on the most advanced developments in the combustion field," "to stay abreast of progress in the solid propellant rocket field"). The reassurance that they would be operating their businesses at a state-of-the-art level because of this knowledge transfer also proved to be a powerful incentive. The expectations for knowledge transfer were very specific in some instances ("to make use of turbo machinery code").

The primary benefit the firms anticipated from their work with the Centers was knowledge transfer based on the assumed (or confirmed) greater scientific expertise of the Centers' personnel.

This hunger for outside expertise echoes the findings of the July 2004 *Council on Competitiveness Study of U.S. Industrial HPC Users*, which revealed that one of the main reasons companies were not using HPC as aggressively as they could was a shortage of experts able to apply the HPC resources effectively.

"To acquire technical and computational resources."

"To make use of turbo machinery code."

"To be part of the most modern, advanced modeling and simulation efforts in solid rocket propulsion."

"To tap into their expertise."

"To get a performance advantage for our software and to extend its capabilities."

RESULTS ACHIEVED FROM THE COLLABORATIONS

The vast majority (83%) of the respondents stated that their collaborations with the NNSA ASAP Alliance Centers had met their objectives, and none claimed their objectives had not been met. (The remaining 17% indicated that it was too soon to draw conclusions because their projects were still in progress.) Six of the 12 sites were able to assign an actual dollar value to the partnership results. In total, the value was $2.5 million for these six sites, with a low of $200,000 and a high of $1 million.

Table 2 lays out the areas in which the companies achieved results, with multiple responses possible for each site, resulting in a total of 53 separate responses from the 12 sites. All of the respondents (100%) agreed that the partnerships advanced their firms' research and development efforts. Even more remarkable is how frequently the partnerships directly benefited the companies financially or competitively, or both.

All of the respondents (100%) agreed that the partnerships advanced their firms' research and development efforts.

☐ More than half the sites (58%) said the ASAP collaborations helped them get products to market faster.

☐ An equal percentage said they were able to solve a specific targeted problem through the partnerships.

☐ Half reported reduced costs and/or higher profitability.

☐ One in three (33%) said the collaborations helped them address competitive threats.

☐ One in four cited revenue growth.

☐ An impressive one-third (33%) of the 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.

TABLE 2

Areas in Which the Partnership Achieved Results

Q. In what areas did the partnership/project provide value to your organization?

Value Areas	Number of Responses	Percentage of Sites
Advanced our research R&D	12	100
Solved a specific problem	7	58
Getting products to market faster	7	58
Cost reduction and/or increased profitability	6	50
New product development	5	42
Achieved a breakthrough or discovered something totally new	4	33
Allowed us to respond to a competitive threat (market pressures)	4	33
Provided revenue growth	3	25
Provided increased market share	2	17
Helped us in system acquisition and/or evaluations	2	17
Other: safety	1	8
n =	53	

Source: IDC, 2006

BENEFITS FROM PARTICIPATING IN THE ALLIANCE PROGRAM

Industry participants described the main benefits stemming from their participation in the ASAP program (see Table 3).

☑ The aspect of the partnership the largest contingent of respondents (50%) considered important was access to experts within the NNSA ASAP Alliance Centers. This hunger for outside expertise (especially HPC expertise) mirrored the finding in the July 2004 *Council on Competitiveness Study of U.S. Industrial HPC Users* that there is a shortage within industry of people able to use HPC resources effectively. It appears that for many of the companies in the NNSA partnerships, their expectations for access to outside expertise were largely fulfilled.

It appears that for many of the companies in the NNSA partnerships, their expectations for access to outside expertise were largely fulfilled.

TABLE 3

Important Benefits from the Partnerships

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

Area	Average Rating	Percentage of Respondents Rating Aspect a 9 or 10
Access to experts within the center	8.2	50
Access to special software	6.7	8
Access to larger HPC computer systems	6.0	25
Access to special data or databases	3.4	8
Access to training	3.3	8
Access to larger or special storage or I/O	3.0	8

n = 12

Source: IDC, 2006

☒ When respondents were asked "What did you learn from the partnership?," their comments reinforced that access to expertise/knowledge transfer was paramount:

"New approaches to solving problems."

"We became more familiar with state-of-the-art modeling."

"We learned more about modeling physical processes."

"Approaches for modeling phenomena related to our business area."

"New turbulence models."

"More knowledge of advanced algorithms."

"Mathematical models themselves and how to apply to large-scale computing."

"The evolution of combustion technology."

"Numerical methods."

☒ Access to large HPC computers emerged as the second-most-popular choice for "important aspects" of the collaborations. This aspect was mentioned by 25% (three of 12) of the sites. Prior IDC research, especially for the July 2004 *Council on Competitiveness Study of U.S. Industrial HPC Users*, also indicated that many firms do not have access to the HPC tools they want and need because

"We became more familiar with state-of-the-art modeling."

budgetary constraints force them to purchase substantially smaller versions of HPC computers than their counterparts in government and academia. Access to larger HPC computers not only allows more work to be done in a given time frame, but 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. One respondent remarked that it was "nice to talk to somebody who has the resources to do what we don't have the resources to do."

☐ In addition to the benefits described in Table 3, 89% of industry participants remarked favorably on the quality of the human interactions with the Centers' personnel. In fact, all of the industry participants responded "yes" when asked about their willingness to partner with the Centers in the future. When asked "What worked well with the partnership?," respondents stressed the quality of the human interactions:

"Access to professors and students."

"Technical communication."

"Interaction with professors and students."

"Their enthusiasm in working on our specific problem."

"Access to the researchers."

"Communications with the academic community."

"Responsiveness of professors and students."

"Technical cooperation was excellent."

"Good cooperative relationship."

"Good quality content from Stanford to aid software development."

"Enthusiasm of the researchers."

"Effective relationships."

"Professionalism."

"Their understanding of our problem and our contribution is excellent."

All of the industry participants responded "yes" when asked about their willingness to partner with the Centers in the future.

IMPEDIMENTS TO THE PARTNERSHIPS

Respondents identified several areas that did not work well and impeded progress on their projects:

☐ The most frequent frustration was with the pace of the project. Disappointment with the pace of the project can be attributed, at least in part, to cultural differences between the commercial firms and the universities.

"We would have done things faster."

"Lots of schedule slip."

"Project has been slow to start up."

☑ Respondents cited other cultural differences as impediments.

"Industry is motivated by deadlines and profits, while universities are driven by research for the sake of research."

"We had to be aggressive in drawing out information from the university."

☑ The focus or fit of the project was sometimes a problem.

"The turbo project at the university lab was too broad for an industry focus."

"Incorporation of their developed software into our design [didn't work well]."

☑ An interesting lesson learned by two of the sites was that it is difficult to hire non-American postdoctoral students for the partnerships because they are considered security risks.

"Postdoctoral foreign nationals pose a security issue."

"It's difficult for American universities to hire non-American [postdoctoral students]."

☑ Inevitably, there were also some unwelcome surprises.

"The problem was harder to solve than we thought."

"There was an unexpected result from the cook-off test."

RECOMMENDATIONS FOR IMPROVEMENT

Although in general the partnerships were viewed as very successful and worth continuing or repeating ("can't get any better"), there were many useful recommendations for the future (see comments below).

☑ The most common recommendation (59% of all responses) concerned communication — the need for better advance planning and more regular, structured communication throughout the projects. It is important to note that when communication did happen, it was overwhelmingly positive; the quality of human interactions with the Centers was cited as one of the greatest benefits of the partnerships.

"Systematic, regular interaction; more regular meetings."

"Be in more communication and attend review sessions in person."

"Increase coordination between the two entities."

"Increase communication between industry and university researchers."

An interesting lesson learned by two of the sites was that it is difficult to hire non-American postdoctoral students for the partnerships because they are considered security risks.

The quality of human interactions with the Centers was cited as one of the greatest benefits of the partnerships.

"More onsite face-to-face collaboration."

"Consider putting one of our engineers on site at the university lab."

"More structured communications."

"Schedule more regular meetings and communications."

"Have them sit down with industry to gauge areas of interest earlier in the process."

"Better coordination."

"Better communication. Get to industry earlier in process to design the scope of work and project."

"Improved communication, more structure to the relationship, project management."

"Have more face-to-face interaction."

"Provide more structure and project management on the university side."

"You have to be tenacious to get the project in place and going."

- Another important recommendation was to provide companies with a better understanding of the universities and their resources before starting the projects.

"Increase the resources from the DOE to the University of Illinois and the solid rocket community."

"Industry needs to understand what resources are available."

"In general, 'shopping trips' to gauge resources available."

"They could take the initiative to inform key industries of their capabilities."

"Could do more with more resources. Issue of security with so many foreign nationals in their research programs."

"Industry lacks awareness of university and ASC resources."

- There were also some calls for improved technical communications.

"To have remote access to computational resources!"

"Easier electronic exchange of data."

"Remote access!"

"Continue to emphasize verification and validation of their software products."

"Remote access should be added! We want to try it out on our own!"

IMPLICATIONS FOR NNSA

- Although it was never a program goal, ASAP demonstrates that strategic public-private sector partnerships can provide significant value by lifting the country to a higher level of competitiveness. In particular, ASAP provides an opportunity for NNSA to demonstrate in quantifiable terms that it can successfully leverage its HPC resources to both meet national security mission needs as well as accelerate the nation's economic security and global competitive position — providing an enhanced return on the government's investment in HPC assets.

- ASAP benefits the NNSA by attracting (and providing the opportunity to attract) not only leading academic research organizations but also experienced industrial HPC users who can contribute some of the best thinking the industry has to offer. These people are accustomed to using HPC in sophisticated ways.

  "HPC provides enhanced insight into our problems."

  "It allows us to solve more complicated problems in a reasonable amount of time."

- Data from the study confirms that ASAP can help 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."

  - ASAP and its Alliance Centers can provide much-needed access to large HPC systems not generally available to industry.

    "Most companies cannot afford supercomputers at this time. It's not something the average large company can afford."

    "We entered into this partnership to acquire technical and computational resources."

  - By providing this access, ASAP is helping companies to achieve breakthrough insights needed for competitive gain.

    "It gives us a glimpse of the future."

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

    "More knowledge of advanced algorithms."

    "Mathematical models themselves and how to apply to large-scale computing."

    "New approaches to solving problems."

- ❑ Clearly, industry sees partnership with the NNSA Alliance Centers as a way to access the larger HPC systems and the added expertise it needs to solve some of its most difficult problems for competitive gain. More competitive U.S. companies help the country to maintain national security and economic strength and raise the standard of living.

- ☒ Travel between the Alliance Center experts and industry participants was often substantial, indicating that collaboration tools are immature or not used. The program could provide a test bed for more mature collaboration tools in order to accelerate program accomplishments and reduce costs.

  "Usually innovation took place through meetings and conference calls. That process takes longer than doing it in a collaborative fashion. We need to move from serial to collaborative innovation."

- ☒ ASAP and its Alliance Centers could achieve better outcomes if industry is brought into the program "from the start." In addition, industry could help identify problems whose solution would benefit both NNSA and industry, enhancing NNSA's ability to meet its mission-critical needs and at the same time accelerating innovation for national gain. Small modifications to the program would bring about a major competitive lift.

  - ❑ NNSA could specify in future RFPs that it will select a certain number of proposals that include industry participation. This will not preclude academic institutions from submitting proposals that do not need industry input, but it would encourage some universities to draw industry into the process at the beginning.

  - ❑ NNSA could further specify that any proposals that include industry participation must explain the competitive gain that industry anticipates from its participation, such as reduced costs, solving a currently intractable problem that will stimulate development of new products or processes for itself or its customers, faster time to market, and so forth.

- ☒ By continuing to engage U.S. industry in ASAP, NNSA can stimulate increased HPC usage within the private sector and provide a much-needed HPC market stimulant. The resulting market growth will help reduce the cost of HPC systems and software, benefiting NNSA, U.S. industry, and the country.

By continuing to engage U.S. industry in ASAP, NNSA can stimulate increased HPC usage within the private sector and provide a much-needed HPC market stimulant.

SUMMARY

It is a testament to the perceived value of the NNSA ASC Alliance Centers' program that the vast majority (83%) of the respondents reported that their collaborations with NNSA ASC Alliance Centers had met their objectives, and not one claimed their objectives had not been met. All 12 sites responded "yes" when asked about their willingness to partner with the Centers in the future. Six of the 12 sites were able to assign an actual dollar value to the partnership results. The values ranged from $200,000 to $1 million.

All of the respondents agreed that the partnerships advanced their firms' research and development efforts. Even more remarkable is how frequently the partnerships directly benefited the companies financially or competitively, or both. An impressive one-third of the sites reported that their partnerships had "achieved a breakthrough or discovered something totally new." The benefits of HPC for the companies extend far beyond time and cost savings in the product development process. For many of the firms, HPC provides valuable new insights — breakthroughs in thinking that can result in superior products with important competitive advantages.

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The commercial firms offered recommendations as well. Disappointment with the pace of the projects can be attributed, at least in part, to cultural differences between the commercial firms and the universities. The focus or fit of the project was sometimes a problem, and inevitably some of the results were unwelcome surprises. By far, the most common criticism (59% of all responses) concerned inadequate communication — the need for better advance planning and more regular, structured communication throughout the projects. Another important criticism was about "flying blind," that is, not understanding the universities and their resources before starting the projects. There were also some calls for improved technical communications.

The following comments reflect the overwhelmingly positive tone of the partnering experience:

"We would encourage everybody to use them."

"Can't get any better."

"We think it is a great opportunity for industry."

"It is worthwhile. We would recommend it."

"It is a very good relationship for the government and industry."

"Our experience has been good."

"It is a good value."

"It is a very good relationship for the government and industry."

APPENDIX: ADDITIONAL BACKGROUND DATA AND ANALYSIS

Survey Profiles

Tables 4 and 5 provide details about the respondents' industries and organization size.

TABLE 4

Industries in the Survey

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

Industry	Number of Responses
Petroleum, oil and gas	1
Aerospace	9
Automotive	1
Software company	1
n =	12

Source: IDC, 2006

TABLE 5

Organization Size

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

Size in Sales	Number of Responses
Under $1 million	1
$1 million to $9.9 million	0
$10 million to $49.9 million	0
$50 million to $99.9 million	0
$100 million to $999.9 million	5
$1 billion or more	6
n =	12

Source: IDC, 2006

How Sites Acquire HPC Resources

As Table 6 indicates, five out of six (83%) of the respondents said they purchase or lease HPC resources (e.g., systems and application software) and install them in company facilities — which, as noted earlier, may not mean the specific sites where the respondents themselves work. One-third of the respondents (four of 12) use HPC resources located in partners' facilities (which may include government labs and university-based Centers). One in four (25%) access HPC resources via a grid or the Internet. The response categories are not mutually exclusive.

TABLE 6

Acquiring Access to HPC

Q. How does your organization acquire access to HPC resources and/or application code?

Approach	Number of Responses
Purchase (or lease) them and install them in our facilities	10
Use systems installed in partner facilities (including universities and labs)	4
Use resources over a grid or from an Internet provider	3
Other	3
n =	20

Source: IDC, 2006

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