FY 2009 REPORT FOR
NSF COMMITTEES OF VISITORS (COVs)

Date of COV: May 19-21,2009
Program/Cluster/Section: Division of Information & Intelligent Systems
Division: IIS
Directorate: CISE
Number of actions reviewed: 149 **Awards: 79** **Declinations: 70** **Other:**
Total number of actions within Program/Cluster/Division during period under review: 5163 **Awards: 1256** **Declinations: 3907** **Other:**
Manner in which reviewed actions were selected: **The selection biased toward awards (approximately 50% of the proposals in the sample are awards where success rate is approximately 23%). The selection is roughly proportioned to the number of proposals submitted to each program, biased toward programs with few submissions (e.g. ALT and CRCNS).**

Executive Summary

COV Members: *Ron Brachman (Yahoo!), Steve Chien (JPL), Tom Dean (Google), Sue Dumais (Microsoft), Mark Fox (U of Toronto), Katrin Kirchhoff (U of Washington), Tom Henderson (U of Utah), Charles Isbell (Georgia Tech), Ron Larsen (U of Pittsburgh), Gary Marchionini (U of North Carolina Chapel Hill), Dan Olsen (Brigham Young), Martha Pollack (U of Michigan Ann Arbor), Jennifer Preece (U of Maryland College Park), Mehran Sahami (Stanford U), Gio Wiederhold (Stanford U)*

The COV met for two and half days of intense discussion and analysis to review the performance of the Information and Intelligent Systems (IIS) Division of the National Science Foundation (NSF) Directorate of Computer and Information Science and Engineering. In the process of our study and the writing of this report, we used laptops, software, databases, and web tools, which it may be noted, are all technologies that were enabled by fundamental research supported by NSF.

We examined nearly 150 jackets of proposals with associated reviewer materials (a stratified sample of half declined and half awarded, chosen with a statistical bias toward accepts), the previous IIS COV 2006 report, and many more reports of IIS-funded workshops and meetings, together with content from presentations of IIS Program Directors. We also analyzed various collections of numeric data, and computed statistics to assess trends in funding, especially with an eye toward assessing how NSF IIS is able to support the current and prepare the next generation of innovators, keeping in mind the particular challenges raised by the current global economic, social and climate conditions.

We have three main findings:

- The IIS Division is very well managed, with a reviewing process that has high integrity and quality.
- The portfolio of research being funded by IIS is exciting, innovative, interdisciplinary, and far-reaching. It covers the broad range of fundamental research questions about the interactions of people, computers, and information within a range of contexts—questions whose answers are critical to solving problems in areas from energy to education, from health-care to sustainability to economic well-being.
- The amount of funding for research in these fields, and the amount of staff support for the IIS team, have not kept pace with the growing importance and concomitant needs of IIS research.

We were pleased to find in the IIS staff a team of dedicated stewards acutely aware of the scientific challenges of the field, constantly adapting their processes to adjust to its fast pace of change, and willing to listen and take risks when appropriate. We found integrity, ingenuity, intelligence, and excellence in the program's processes and management. The enthusiasm, creativity and energy of the team were inspiring.

IIS outcomes are products of research that include new enabling technologies, fundamental theoretical advances, and new capabilities that expand people's abilities to learn, make decisions, communicate, collaborate and achieve goals. We identified outcomes that affect users of information technologies, personal computers, educational technologies, health informatics, web-based search and information retrieval, digital libraries, robotics, mobile devices and much more. We learned about new programs that cut across disciplinary boundaries as well the artificial boundaries that often separate different funding agencies.

One aspect that we found particularly compelling concerns how IIS research aligns with our national priorities. It is well known that our air traffic control systems, electric power transmission grid, and

communications infrastructure are now almost completely dependent on systems that combine massively complex software that operates with humans in the loop to monitor, provide overall guidance and intervene when need be. The research on automated planning and logistics addresses many of our current and future needs in this arena and the area of human computer interaction and collaboration addresses the problem of how human experts and computerized systems can work together most effectively and the impact of these systems on the citizens using them.

Moreover, the availability of a robust workforce in information technology is a critical factor for maintaining US global competitiveness. IIS's active support of educational initiatives at a variety of levels plays an important role in both the direct education of the IT workforce as well as the development of technology infrastructure to promote learning in a broad variety of contexts. Given the dramatic declines in US computer science enrollments in the first half of this decade, we believe that IIS's support of research and education in computing and information systems should continue to play an important role in addressing the national priority of technology innovation and leadership.

Health care is another area where critical problems exist. There are high expectations of the benefits of moving to Electronic Health Records, but these expectations will only be realized if there are concomitant advances in human-computer interaction and effective infrastructures. Healthcare providers and patients alike have to be able to trust that their information systems will be available, up-to-date, secure, and reliable—all topics of concern to IIS researchers.

There is a shift occurring in the nature of computing research that is important to consider. Over the last 5 to 10 years the compelling questions have shifted from "What can we build?" to "What should we build?" and "How should we design it so that it meets users' needs?" Advances in computing and networking have unleashed vast power and overwhelming volumes information, leaving us with questions of how to deal with it all. IIS is the focus for understanding how computing can best serve human needs. This shift is illustrated by a substantial increase in proposals over the last 3 years despite restrictions in CISE on the number of proposals that any PI can submit. This emphasis on leveraging human intelligence will continue to grow as further needs and opportunities draw new researchers into this area; particularly with the strong interest in Web 2.0 technologies inspired by inter- and multi-disciplinary collaborations between computing and information specialists and researchers from the social sciences. These collaborations are essential for addressing the national priorities mentioned above, and they are to be encouraged but a concomitant increase in NSF resources (funding and personnel) is needed if NSF is to continue to operate effectively. Many of the issues identified in this document flow from this ongoing growth in IIS research.

IIS also covers the areas of robotics and computer vision which are becoming increasingly important as we move to automate areas of the health care system, design more efficient transportation systems, and develop autonomous and teleoperated robotic systems to monitor our ports, borders and aid in humanitarian relief and military operations overseas. We saw numerous examples of robotic systems designed to make the elderly and infirm more independent, assist wounded veterans and the physically disabled, and even allow an expert surgeon perform operations with robotics assistance from a remote location when time is of the essence.

As an example of an innovative interdisciplinary direction, we learned about a program called Collaborative Research in Computational Neuroscience (CRCNS) which is jointly funded by NSF and NIH and brings together cognitive and molecular neuroscientists, computer scientists, and mathematicians to study the brain. The collaborative efforts that characterize this program are designed to leverage the huge amounts of data now being produced by functional magnetic resonance imaging (fMRI) as well as new, high resolution technologies such two-photon excitation laser scanning microscopy (TPLSM). There is much joint work to be done to create standards for

registering the brains of different subjects as well as the mundane problems of massaging data into common formats. This work has been facilitated by advances in statistical models and machine learning which IIS has funded over the last decade, and where it continues to fund much of the most cutting edge research in these areas.

The direction of CRCNS is characteristic of much of the research in IIS, which increasingly seeks to work across scientific boundaries to integrate ideas and find new applications. The work in robotics and human-computer collaboration has given rise to assistive technologies that will revolutionize health care. The outcomes from brain imaging research have already pointed to possible new therapies for treating autism, depression, addiction, senile dementia, Alzheimer's disease, and a host of other disorders of the brain and nervous system. As the world becomes knit together by webs of communication, IIS sponsored research in human language, speech, cross cultural communication, cultural norms, scientific and cultural practices is making significant strides toward reducing language and communications barriers not by forcing people to sacrifice their cultural identities by limiting the languages of global commerce and entertainment but rather by allowing translation between almost any language either written or spoken and by facilitating cross-cultural understanding and communication. This work is also making it easier for us to communicate with computers using a range of modalities including human language (speech, gesture, touch) and visualizations, thereby facilitating hybrid systems that exploit the different strengths of humans and computers.

Increasingly, progress is made by combining very large datasets with high-performance computing. IIS is involved in CluE which pairs academic institutions with industry (e.g., IBM and Google) to make large clusters of computers augmented by high-speed, high-capacity data storage to perform analyses that would be impossible otherwise. In this case, CISE is thinking ahead about the many academic institutions that they fund, identifying trends in industry, and anticipating the needs of academia both in terms of research tools and in terms of preparing their students for the future.

Throughout our two and a half day visit we saw such examples of facilitating, anticipating and partnering with academic, government and commercial entities to accelerate the pace and improve the quality and relevance of research. The progress we witnessed, however, only suggests what could be achieved were the Division's resources to grow in proportion to its demonstrated successes to date and evident potential. Funding has not kept pace with the growth of the field, and acceptance rates have dropped noticeably. This trend must be carefully monitored.

We also saw signs of a dedicated staff spread thin and being forced to make compromises in terms of the time they spend in the field and the effort they can devote to developing new programs. Despite these constraints, we observed few compromises in the areas of soliciting carefully targeted proposals, selecting expert reviewers, and managing the complicated process of selecting the best proposals through the effective means of expert panels. These are critical areas to the success of the IIS mission and, while the relevant processes can always be improved as suggested in this report, we were generally quite pleased with the processes and outcomes.

In summary, we applaud the extraordinary quality and integrity of the work conducted by IIS during the past three years. The IIS Division Director, Program Directors, and staff have implemented substantial changes and improvements despite enormous budget pressures and unprecedented growth. We additionally recognize a large number of IIS scientific and technological outcomes that have contributed to significant innovations in technology worldwide, impacting education, health, science, engineering, business and everyday computing experiences. We encourage NSF to act on our findings and especially to look for future opportunities to increase funding rates for IIS. In so doing, they will not only support the outstanding work that IIS is doing to fuel the Nation's future innovation, but also the diverse and growing number of researchers who are naturally attracted to the important areas that IIS supports.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: Yes. The current process of combining panels, ad hoc reviews (especially via mail), and site visits are effective methods for review. The broad use of panels mitigates the effect of receiving reviews that are not as deep as desirable, since the panel discussion can focus on the critical issues and integrate specific and general feedback, Additionally, current on-going experimentation in remote, distributed reviewing (e.g., teleconferencing, video conferencing, etc.) appear to be quite promising ways to broaden reviewer participation, for example, to increase the number of reviewers geographically removed from NSF. We encourage such continued experimentation, and advocate the broader utilization of the methods that are determined to be effective means of distributed reviewing. To this end, we also make suggestions regarding means of distributing the reviewing process beyond NSF headquarters in our general comments (Question #8, below). Of course, care should be taken that remote reviewing does not lead to a reduction in the overall quality of the reviewing process or compromise the integrity of the review processes.	
2. Are both merit review criteria addressed a) In individual reviews? Yes, both intellectual merit and broader impacts are addressed in the individual	

[1] If "Not Applicable" please explain why in the "Comments" section.

reviews. The intellectual merit criteria are generally reviewed substantively, with reviews varying from reasonable to exceptional. Moreover, the fact that each proposal receives 4 to 5 reviews on average helps guarantee that there are several substantial reviews per proposal. The broader impact reviews appear to generally be much shorter and less well defined than the intellectual merit portion of the review. Indeed, it seems that the definition of broader impacts appears to be somewhat ambiguous to PIs (and, in turn, to reviewers) as there appears to be considerable variability between what proposers/reviewers view as broader impacts. b) In panel summaries? Yes, the panel summaries address both merit criteria. As a reflection of the individual reviews, the evaluation of intellectual merit is generally more substantial than that of broader impacts in the panel summary. c) In Program Officer review analyses? Yes. The Program Officer review analyses are generally quite substantial and well done. The review analysis helps link together important details from the individual reviews and provides important details to PIs regarding follow-up steps from the proposal. The Program Officers should be commended both for successfully soliciting 4 to 5 reviews for each proposal, as well as providing a detailed analysis of the overall proposal review.	

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: The reviews were generally substantive and careful to explain the basis of their recommendations. Though there were a number of short or unhelpful reviews, the number of reviews per proposal generally ensured that authors received some useful and substantive feedback. In the case of panels that span one or more disciplines one might expect reviews that appeal to the lowest common denominator. However, we found quite the alternative; in the case of the proposals submitted to the Collaborative Research in Computational Neuroscience, the panels were populated by stellar scientists and the reviews reflected broad understanding of the collaborating fields.	
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: The panel summaries reflect considerable thought. If the reviewers started out with divergent opinions it wasn't apparent in the final summary; apparently they	

were able to reach consensus and summarize their consensus view succinctly. This was particularly apparent in the cross-disciplinary programs.	
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) Comments: Yes - the documentation in the jackets provides a good rationale for the award/decline decisions. The whole range of criteria and evaluations was generally covered in the documentation of the rationale. The reviewers/panelists/program managers are to be commended for their thoroughness.	

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: The documentation to the PI contains a good rationale for the award/decline decision.	
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals.	

Comments: The provided statistics (Dwell Time) show that IIS meets the NSF goal of having 70% of the proposals reviewed and the result returned to the proposer within 6 months. Providing rapid feedback on the large fraction of declined proposals helps IIS achieve that rate. If the rate of submitted proposals increases and the acceptance rate of submitted proposals increases as well, the-70%-in-6-months constraint will be hard to meet with existing staff. To reduce the workload IIS has instituted a policy of limiting PIs to one or two proposals within a year. Having few proposals in the pipeline will make PIs anxious to get rapid feedback. Other factors to monitor in order to maintain a good response time to proposal submissions are the scheduling of panels and the availability of reviewers. The number of proposals not acted on within a year has reduced to a nominal percentage. This reduction correlates with the reduction of mail-only reviews, where reviewers may be tardy. IIS provides good feedback now, but its resources are stressed.	

8. Additional comments on the quality and effectiveness of the program's use of merit review process:

IIS is effective in maintaining the quality of the merit review process in a scientific area that is undergoing rapid change. We expect the load to increase as the volume and the applicability of information systems to other disciplines increases; health care is certainly one area where rapid dissemination will bring new research challenges. Of concern in such a future will be the load on staff at NSF and an adequate availability of reviewers.

There has been ongoing experimentation at IIS to find new ways of managing panels, including guided telephone panels, panels on Second Life, and having panels on the West Coast. All these experiments require innovative guidance, and a subsequent assessment of problems encountered, how the problems could be overcome, and the scalability of the approach.

A persistent presence on the West Coast could help in attracting reviewers and reducing travel burdens and costs. While applicable to IIS in particular, all of NSF could profit from having a West Coast site.

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]**

[2] If "Not Applicable" please explain why in the "Comments" section.

1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: Most of the proposals we reviewed had at least two reviewers whose expertise was well-aligned with the topic. That said, there was a significant minority of reviewers who demonstrated a lack of expertise in the proposal's subject area, resulting in superficial feedback to the investigators. The 2006 COV anticipated that the transition to cluster-based solicitations could make it difficult to mount panels with appropriate expertise, and at least to some extent, this worry has materialized. We applaud the PDs for working hard to find intellectually diverse panels, and believe that they face a difficult challenge in providing sufficient coverage for all proposals. We suggest that a mechanism be implemented where reviewers rate their competency in the area of each proposal in advance of the panel meeting, to allow solicitation of additional reviews where needed.	
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: Yes. The reviewers were well-balanced with regard to the specified criteria. We found nothing that was out of line with the distribution of CISE researchers.	
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: Based on the information available, we saw no problems with conflict of interest.	

4. Additional comments on reviewer selection: We were surprised that NSF does not have a database of qualified reviewers and their expertise.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: The quality of funded research is high; this is evidenced by the number of reported high quality journal and conference publications, best paper awards, spinoff activities (e.g., fraud detection in electronic auctions), competition results, as well as the artifacts produced, including systems, codes, languages, and datasets.	
2. Does the program portfolio promote the integration of research and education? Comments: Where specifically required as a major component of the solicitation (e.g., CAREER), a strong plan for the integration of research and education is given. Most of these proposals describe efforts in curriculum development, K-12 and public outreach, and recruitment from underrepresented groups. Other types of awards generally lack specific curriculum development plans, but most describe some form of dissemination activities or outreach efforts to underrepresented groups. In addition, a critical educational function of NSF is the production of PhD students and IIS does an excellent job at this level. IIS also considers the educational pipeline that leads to research scientists in several ways.	
3. Are awards appropriate in size and duration for the scope of the projects? Comments: The review process monitors that awards are appropriate in size and duration for the scope of the projects, and when award budgets are reduced, most provide a proportionate reduction in the planned work.	

[3] If "Not Appropriate" please explain why in the "Comments" section.

The data available to the COV shows that only 52% of the funded proposals receive 90% or more of the requested budget; it would seem that this is impacting the scope of individual projects while allowing funding of a generally broader set of proposals over a range of budget scales (small, medium and large).	
4. Does the program portfolio have an appropriate balance of: • Innovative/potentially transformative projects? Comments: The IIS Division has taken several steps to meet the goal of creating ``an environment that is more open to and encourages transformative research proposals'' (from “2020 Vision for the NSF” the National Science Board, 2005), as well as to support work based on its potential impact on prevailing paradigms, to create new fields of science and technology, and open new frontiers as espoused in the National Science Board report ``Enhancing Support of Transformative Research at the NSF'' May 2007. These steps include: (1) specific instructions to the review panels to consider the transformative aspect of proposals, (2) solicitations which push the frontiers of research, (3) advice to panels to avoid implicit bias, and (4) the creation of programs which require potentially transformative research (e.g., CDI). The panel summaries of funded awards indicate that most of these are ``innovative,'' “transformative,” “high impact,” etc. The IIS Division is to be commended for its efforts in this area.	
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: One of the strengths of IIS is its interdisciplinary and multidisciplinary portfolio that includes PIs from computer and information science, psychology, linguistics, engineering, and allied fields. PIs often work on projects that address the challenges that arise when humans, computers, and information resources interact. Many projects are situated in application domains that include the humanities (e.g., music, anthropology), social sciences (education, government services, economics) as well as the natural sciences (e.g., biology, neuroscience, ecology).	

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: With the end of ITR as a priority area, funding for large projects with IIS-	

related research programs declined somewhat. IIS has taken up this slack by funding several new large proposals, as well as small and medium proposals. This is reflected in the larger average award size but a constant median award size. Overall IIS has a nice portfolio of programs for different scopes of research.	
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant. Comments: IIS has done a good job of supporting new investigators through CAREER grants and awards to first-time investigators. The funding rate for first-time recipients is lower than that of prior recipients, and that ration was roughly constant during 2006-2008. Acceptance rates for both new and previously funded investigators have dropped during this period. One consequence of this is that the overall acceptance rate for proposals submitted in response to NSF RFPs by new PIs has decreased to 15%, which is quite low in absolute terms. For new PIs funded in 2007, the median time since PhD was 5 years. If we take into account the rate for SGERs and workshops, etc. the rate is somewhat higher. These awards therefore help to mitigate the impact on morale of new PIs. However, we suggest that continued vigilance and creativity are desirable to encourage promising new investigators.	
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: There appears to be a good distribution of investigators relative to centers of population and institutions of higher education.	
9. Does the program portfolio have an appropriate balance of: • Institutionnel types? Comments: Diversity of institutional types has been steady during 2006-2008, with approximately 75% of the awards going to research-intensive PhD institutions. Awards to other PhD institutions have increased slightly, with a small decrease in awards to masters and local institutions.	

10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? Comments: The IIS reorganization into clusters is now complete and brings together diverse perspectives from researchers in many areas of computer and information sciences. The portfolio for the period includes more than 650 collaborative proposals from multiple disciplines and institutions.	
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: IIS has made good efforts to attract and support researchers from underrepresented groups, although this is difficult to track completely since it depends on self-reported status. Over the 2006-2008 period, the percentage of proposals submitted by minority and female PIs have both increased slightly (4%, 5%, 5% minority; 17%, 19%, and 19% females). The funding rate for minority and female PIs is somewhat higher than that for non-minority PIs.	
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: IIS directly addresses the agency mission of discovery though its cluster programs and large portfolio of research grants. The other agency missions of learning and research infrastructure are addressed through IIS leadership roles in cross-cutting and agency-wide programs such as ALT, CluE, CRCNS, CreativeIT, and SEIII, and participation in cross-directorate and division programs such as CDI, SoD, HSD, and REU. Computing is a fundamental lever that magnifies the efforts of human intelligence. Computing has expanded the capabilities of biologists, health care researchers and engineers as well as business and industry. This leverage comes from the ability of computing to adapt to the needs of human beings in all that they do. IIS is focus precisely on fundamental research into the interaction between computers and people.	
13. Additional comments on the quality of the projects or the balance of the portfolio:	

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments:

Given its broad purview and the rapid evolution of science, technology, and applications of information, intelligent, robotic, Web 2.0, information visualization and use-centered interactive systems IIS is at a particularly exciting and complex time in its existence. Management of the Division is a delicate balance of top-down priority-setting, the provision of adequate autonomy to the Program Directors, dealing with a huge workload, assimilating a wide variety of inputs on areas/subject matter worthy of consideration, and day-to-day management of a sizable staff and a budget of $140M. The senior management of the Division seems to have an excellent big picture view of the Division's mission and the areas of computing in need of its stewardship. One FY08 innovation that is promising along these lines is the requirement that each core program present an overview of its recommended awards, expressly to capture the "big picture" for the Division Director. Given the volume of awards in the Division, this is an essential element in maintaining and managing a strategic view of the field and the role of the Division.

Among the other strong IIS leadership assets is significant passion about the scientific work and the mission of the Division. This is likely to be important for Division morale (although we did not have a direct basis on which to judge) and successful advocacy to higher management in NSF. Understanding the big picture is especially noticeable in HCC and RI.

Workload across the Division is extremely high, with the concurrence load on the Division Director being especially daunting. The Division is to be lauded for its recent move to install a bona fide Deputy Director. For a variety of reasons this should have a significant positive effect on the efficiency and effectiveness of IIS. Between 2006 and 2008 the number of proposals has risen substantially despite limitations on numbers of proposals per PI. During that same period the scientific staff in IIS has risen but not keeping up with the workload. This is an important problem that should be addressed.

The Division has employed multiple methodologies for reviewing proposals (including, for example, multi-phase review processes, "mini-panels," increased use of telepresence for review panels, ad hoc reviews when necessary, etc.), and these seem to quite adequately cover the needs in handling proposals at various scales. Of particular interest to the COV is the Division's willingness to experiment with new review processes to help it deal with various problems and potential biases of the standard panel review process. Given that one of its core emphases is the interaction between humans and technology in collaborative settings, it would be unfortunate if the Division missed an opportunity to use its own technology. We note also that the Division takes special care to deal fairly with interdisciplinary proposals, by engaging other divisions and securing more reviews than in the normal review process. The initiative within the Division to look aggressively for transformative proposals is also laudable.

The move to a smaller number of more broadly defined research areas (which now receive the majority of the Division's funds) appears to be working well along multiple dimensions. For one thing, the opportunity to take a large view and solicit proposals that fit into a well thought-out broader context should elicit more meaningful proposals and move the field ahead more rapidly (this would

need to be borne out by the data). For another, this move necessitates collaboration amongst Program Directors, which guarantees a diversity of opinion in the creation of the program as a whole. This is healthy. The main costs of this model are likely to be increasing dwell time for proposals and less discretionary funding for individual Program Directors. Somewhat making up for the latter is the Division Director's policy of leveraging a Program Director's 25% support for Large programs by 75% from the DD's central budget.

2. Responsiveness of the program to emerging research and education opportunities.

Comments:

IIS sustains an active program of engagement with the research community to assure its responsiveness to emerging trends and ideas. Evidence of this is succinctly documented in the annual reports that document the number and breadth of SGERs and workshops. The program solicitations clearly lay out domains of interest that enable broad interpretation and creativity among proposers, thereby affording opportunities even beyond those likely envisioned by the program directors. IIS is also attentive to both challenges and opportunities in education, trying new approaches (e.g., solicitations including curriculum development), reviewing the outcomes, and refining the approach. Sustained engagement between IIS and the broad research community continues to be critically important to ensure such responsiveness. Program Directors are actively engaged with the research community beyond the review and program management activity itself. The disproportionate growth in IIS proposals over the 3-year review period provides strong evidence to the responsiveness of IIS to the emerging and evolving interests of the research and education communities.

The growth in IIS proposals may have unanticipated consequences, however. Program Directors' workloads appear to be growing, without a commensurate increase in staffing. This may potentially reduce their opportunities to interact with the broader research community. The declining award rate may also negatively impact the responsiveness of the greater research community to future program announcements.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:

As before, the Division continues to pay significant attention to the evolution of its portfolio. However, it is not clear whether there is a carefully orchestrated process for strategic planning and for portfolio development, or whether evolution is left to being more organic. Usually provoked by external events (hiring of a new CISE Director, requests from the NSF Director, etc.), the Division has managed regular consideration of its broader program structure and coverage of the field. Significant thought has gone into the set of core programs for the Division as well as the emphases within those programs, although the picture in the III cluster seems less cohesive than those in HCC and RI. Given the breadth of research within III, we suggest that its scientific portfolio and priorities receive periodic attention, with the objective of discovering new relationships, opportunities, and directions.

The mechanisms within the Division for driving prioritization are manifold. They include direct attention (usually via CISE) to stated issues of national priority (which may come from PCAST, OSTP, Congress, or other government sources), *ad hoc* input from the community, IIS-driven workshops, and bottom-up ideas from Program Directors. On the latter front, the Division Director empowers the Program Directors to come to him with portfolios reflecting their priorities, to argue for their support. So far, these mechanisms have resulted in what appears to be a reasonable prioritization across the Division. However, since the broad division-wide strategic thinking has recently been driven by separate and unrelated external events, it would be worthwhile considering a more regular Division-level portfolio analysis, possibly through meetings of the entire Division staff with adequate time for reflection and planning. To date, PD workload appears to have prevented this and it may be worth investigating alternative mechanisms to achieve this goal. The COV can perform this function in part, but every three years may be too infrequent for adequate analysis. Fortunately, given the attentiveness of the scientific community, important gaps in coverage and recommendations on emerging areas are likely to be brought to the Division's attention without any prompting, and so far, the mechanisms for achieving timeliness and coverage of the portfolio appear to have been adequate.

4. Responsiveness of program to previous COV comments and recommendations.

Comments:

The last IIS COV met at NSF on December 14-15, 2005 and covered the period from FY2003 to FY2005. The report presented a series of observations and recommendations. For the purposes of this report, we can think of them as falling into one of two broad categories: (1) encouragement for IIS to fund high-risk, high-payoff research, including broader interdisciplinary research and (2) encouragement for IIS to continue to invent new ways of broadening participation in all demographic categories.

Generally, IIS has responded well to the 2005 COV, being both earnest and creative in their efforts. IIS has instituted a variety of ways to encourage high-risk research. We are particularly impressed by the creative thinking in the merit review process. IIS has shown an admirable willingness to experiment to find ways to guide panels to think explicitly about transformative proposals in such a way that allows program directors an appropriate level of autonomy. We encourage IIS to continue along this path.

For broadening participation, IIS has participated in BPC and taken the admirable step of including outreach in performance plans for its program directors; however, it is difficult to assess the progress of IIS (and, indeed, NSF as a whole) in soliciting proposals, funding proposals, hiring program directors, and engaging reviewers from underrepresented groups. For example, in FY2007 and FY2008, over 50% of reviewers are listed as having unknown minority status and over 50% are listed as having their gender as "not available." This is startling. Are more than half of reviewers intentionally withholding such information? If so, why? If not, why is there so little participation?

We encourage IIS and NSF to think as creatively about ways to gather, track, and act upon such data as they have with improving the merit review process.

5. Additional comments on program management:

PART B. RESULTS OF NSF INVESTMENTS

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The NSF mission is to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship. The COV should look carefully at and comment on (1) noteworthy achievements based on NSF awards; (2) ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals; and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio as it relates to the three outcome goals of Discovery, Learning, and Research Infrastructure. The COV is not asked to review accomplishments under Stewardship, as that goal is represented by several annual performance goals and measures that are monitored by internal working groups that report to NSF senior management.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*

Comments:

During the past three years, the IIS program has done an exemplary job at funding transformative research that advances the frontiers of knowledge and supports leadership in fundamental science and engineering. The awards funded by IIS have led to advances both in core computational thinking and in emerging fields at the intersection of computer science and other disciplines. They have also made a strong contribution to areas of national priority. Information technology is now an essential component of all other sciences and other disciplines too (particularly the social science) and that means that advancing information sciences will have broad effects throughout all sciences and resulting technologies. The COV was impressed with the strong and growing record of collaborations with other divisions within CISE and NSF (e.g., the Human and Social Dynamics Program) as well as other agencies (e.g., the Computational Neuroscience Program in which NIH participates). It should be noted that the core computational developments funded by IIS are also increasingly being adopted by other fields (e.g., health care and energy) for which similar collaborations and programs might be possible, and we encourage the growth of these opportunities. Below we highlight some of the most noteworthy areas of ongoing research within IIS, together with examples of particular projects.

Interaction in virtual worlds. As more and more online collaborations and communities develop, it is increasingly important to understand and support human-human interactions in a virtual world. "Exploring the Behavioral and Facial Similarities of Humans and their Virtual Representations" (IIS-0741753, Jeremy Bailenson, Stanford Univ.) has demonstrated that the way people are represented in virtual environments can substantially change their verbal, nonverbal, and task-related behavior. "Collaborative Research in Immersive Design Environments: A Tablet Based Immersive Architectural Design Tool" (IIS-0313226, Victoria L. Interrante, Univ. of Minnesota-Twin Cities) studies how immersive virtual environments technology can be used to enhance conceptual design in applications such as architecture.

Digital augmentation of physical worlds. Increasingly the boundaries between physical and digital words are blurring. Research in human-robot interaction, for example, seeks to develop principles and algorithms to allow more natural and effective communication between humans and robots in diverse applications such as search and rescue, military engagements, scientific exploration and hospital care. Example projects include "Human dynamics of robot-supported collaborative work" (IIS-0624275, Sara Kiesler and Pamela Hinds, CMU/Stanford), "Modeling fundamental interactions in robotic, simulated, and real surgery" (IIS-0712595, Frank Tendick, UC San Francisco), and "Personalized Assistive Human-Robot Interaction for Socially-Assistive Post-Stroke Rehabilitation" (IIS-0793617, Maja Mataric, USC). Research in tangible computing examines fundamental design principles ("Designing and Evaluating Ambient-Tangible Displays for Collaboration" (IIS-712890, Paul Dourish, Univ. California Irvine), as well as how physical objects, such as tables, can be digitally enhanced to support collaboration ("Tangible Tracking Table and Spinning Screen", IIS-0705569, Keith Edwards, Georgia Tech) to allow the fluid movement of information and collaborative artifacts from the physical domain to the digital, and vice versa.

Understanding and enhancing human perceptual and cognitive capabilities. IIS supports the development of new interaction techniques (e.g., touch, gestures, etc.) and cognitive/activity modeling techniques, including brain-computer interaction. Examples include "Multi-Finger High Fidelity Haptic Exploration" (IIS-0713028, Blake Hannaford, Univ. of Washington), "Large Lexicon Gesture Representation, Recognition, and Retrieval" (IIS-0705749, Stan Sclaroff, Boston Univ.), "Adapting to technology in minimally invasive surgery" using a new vibrotactile device (IIS-0238284, Caroline Cao, Tufts Univ.), "Enabling Practical Human Activity Modeling for Interactive Applications" (IIS-0713509, Scott Hudson, CMU), and "Continuous Control Brain-Computer Interfaces for Creative Expression" (IIS-0705679, Melody Moore, Dennis Proffitt, Georgia Tech, Univ. Virginia).

Universal access and assistive technologies. IIS supports several research programs aimed at making computing technologies more widely accessible to diverse populations. Exemplary projects highlight the breadth of research in this area: "Interactive and enriched haptic graphical representations for people who are blind and visually impaired" (IIS-0712936, Dianne Pawluk, Virginia Commonwealth Univ.), "Mobile ASL: Providing mobile video communications to the deaf community through user-centered design and deployment" (IIS-0811884, Eve Riskin, Univ. Washington), "Assistive listening devices and voice processing platforms for the deaf and hard of hearing" (IIS-0812576, Lawrence Saul, UC San Diego), "Easy-to-Learn and Easy-to-Use Eye-Controlled Musical Expression For Children with Severe Disabilities" (IIS-071368, Anthony Hornof, Univ. Oregon), "Social-Emotional Intelligence Prosthetic" (IIS-0555411, SGER: Rosalind Picard, MIT), "Intelligent Interfaces to Empower People with Disabilities to Participate in the Information Society" (IIS-0713229, Betke Margrit, Boston University).

Privacy and trust. As information technology becomes increasingly integrated with everyday life, questions addressing privacy become more important. An example project in this area is "Protecting individual privacy in mobile networks" (IIS-0742811-SGER, Cyrus Shahabi, USC) addresses location privacy for mobile devices and has generated novel research on "stronger privacy for snapshots of user locations" and "provable privacy guarantees against correlation attacks."

Social computing and social networks. The use of computational technology to enhance social networking and communication is a relatively recent but vibrant research area. "Next Generation Instant Messaging: Communication, Coordination, and Privacy for Mobile, Multimodal, and Location-Aware Devices" (IIS-0534406, Jason Hong, CMU) creates a location-aware mobile social system to support awareness and coordination needs in families. Research on developing and supporting contributions to online communities can help increase the effectiveness and efficiency of such collaborations ("Helping Hands: Computer Support for Community-Maintained Artifacts of Lasting Value", IIS-0534420, Riedl et al., Univ. Minnesota; "Participation Lifecycles in Online Communities", IIS-0812429, Clifford Lampe, Michigan State Univ.; "Information Exchange and Social Factors in Human-Computer-Teamwork Decision Making", IIS-0705406, Barbara Grosz, Sarit Kraus, Harvard Univ., Univ. Maryland).

Networking. Examples of work in this area include the study of emergent properties of networks of connected agents, which identified some of the dangers of loss of diversity through massive connectivity in such networks (IIS-0537720, David Lazer, Harvard Univ.), and "The Analysis and Modeling of Large Linked Networks" (IIS-0514429, John Hopcroft, Cornell Univ.) which developed methods for detecting spam networks.

Retrieval and analysis of large, diverse data sources. Extracting knowledge from diverse, large-scale raw data sources for further investigation is an important tool in discovery. Such research has been supported in proposals such as "Projection and Interactive Exploration of Large Relational Data" (IIS-0535085, Li Yang, Western Michigan Univ.), "Scalable, Multimodal Algorithms for Multimedia Information Retrieval" (IIS-0513678, Edward Chang, UC Santa Barbara), and "MotionEye: Querying and Mining Large Datasets of Moving Objects" (IIS-642771, Jiawei Han, Univ. of Illinois Urbana-Champaign).

Robotics and computer vision. Robotics has branched out to address distributed sensing applicable to problems of the EPA, robotic and robot-assisted operated surgery, and robots that mimic biological creatures. For example, "Measuring Human Skill in Surgery" (IIS-0534359, Greg Hager, Johns Hopkins Univ.) is producing a human motion model – a "language of surgery" – that allows comparison of surgeons in a skill space, and allows improved surgical training and evaluation. "Solar Vehicles for Environmental Monitoring" (IIS-0329837, Art Sanderson, RPI) runs the RiverNet project, which includes a distributed sensor network and systems for complex and geographically extended regions, and has provided useful data to the EPA. We were pleased to see that projects have impact on a broad set of scientific areas; for example, "3D Models from Images" (IIS-0237533, Marc Pollefeys, Univ. of North Carolina) applies to archaeology, architecture, forensics and others. 3-D models are generated from data obtained from handheld video cameras, for example a Medusa head from the ancient city of Sagalassos has been modeled.

Collaborative research in computational neuroscience. CRCNS draws researchers from several disciplines including computer science, computational neuroscience, and the cognitive sciences to address the opportunities arising from new methods, sensors and datasets. Noteworthy examples are "Computational modeling of spatial activation patterns in fMRI" (IIS-0642971, Polina Golland, MIT), which uses a combination of cognitive neuroscience, modern brain imaging and machine learning to provides new insights into the functional organization of the brain and identification of areas that are likely to be involved in schizophrenia, Alzheimer's disease, or brain tumors. Golland's work analyzing the brain's functional activity and organization can be thought of as part of the larger machine learning revolution that is transforming cognitive and computational neuroscience by coupling new techniques for data analysis with very large dataset. "Hippocampal place cell plasticity" (IIS-0546478, Mayank Mehta, Brown Univ.) works on understanding the role of sleep in learning and in particular how the evolutionarily older parts of the brain interact with newer parts of the brain. This work not only changes how scientists think about sleep and learning but provides new directions for therapies dealing with learning disorders. "Using machine learning and cognitive

modeling to understand the fMRI-measured brain activation underlying the representations of words and sentences" (IIS-0423070 Tom Mitchell and Marcel Just, CMU – also CDI-III #0835797) is developing statistical machine learning algorithms to analyze brain imaging data related to the representations of words and sentences. The investigators are specifically interested in algorithms that can learn to identify and track the cognitive processes arising from hearing words and see images of objects that give rise to observed functional magnetic resonance imaging (fMRI) activation patterns. This is a methodological leap for data analysis in fMRI. In addition to extensive education benefits, the work also benefits society in understanding learning and developing neurological diagnostics. Mitchell and Just were able to reliably associate localized human brain activity associated with different semantic categories of objects and actions (i.e., nouns and verbs), and provide some preliminary insight into the extent to which brain activity associated with semantic categories can be partitioned into more primitive semantic components (e.g., the visual appearance of a tool vs. the motor action associated with it).

Human language technology. In the area of human language technology IIS has been funding not only projects that advance the state of the art of computational modeling of language and speech, but also projects that increasingly attempt to model the social and affective e.g., "Graph-based learning from text" (IIS–0329064, Lillian Lee, Cornell Univ.), which is aimed at automatically extracting opinions or sentiments from written text, and "A High Performance Speaker Verification System Incorporating Prosodic Information**"** (IIS-0710833, Robert Gray, Stanford University), which utilizes information about speakers' characteristic intonation, rhythm, and other vocal properties to automatically identify them. This development supports the general movement towards applying core IIS technology to modeling social interactions and dynamics and represents a transformational step towards the more pervasive integration of human language technology into real-world environments, which will eventually benefit large sectors of the U.S. population.

B.2 <u>OUTCOME GOAL for Learning:</u> "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"

Comments:

IIS programs are critical to the development of human resources at all levels, and have been successful in furthering the goal of "cultivating a world-class, broadly inclusive science and engineering workforce and expanding the scientific literacy of all citizens." This goal is addressed through a blend of methods from IIS's broad funding portfolio, including standard proposals, REUs, CAREER awards, and special initiatives.

IIS has substantial impact on advancing learning through support for PhD education, which is incorporated into most of the grants it supports. Indeed, IIS's support for PhD education continues to be a critical factor in developing the next generation of scientific leaders. Moreover, through specialized support for consortia, conferences, workshops and other venues (discussed below), IIS continues to broaden its reach in supporting learning activities.

Furthermore, progress reports from many grants documented cross-institutional collaborations beyond the original proposing teams. These collaborations include both domestic and international researchers (primarily within academia). This scientific interplay should be commended as it plays an important role in scientific process.

IIS also participates in EPSCoR (Experimental Program to Stimulate Competitive Research), which is designed to "strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education."

Below we provide specific examples of ways in which IIS has supported the expansion of science education and learning. We organize these achievements by target population.

K-12: IIS research has a natural appeal to younger students, and a number of IIS programs have components directly aimed at engaging K-12 students in research. For example:

- The *Computational Linguistics Olympiad* (SGER IIS-0838845, Dragomir Radev, University of Michigan) is a particularly noteworthy project, where a team of six American High School students was coached to take part in an international competition on language analysis and translation. The team achieved top prizes in the competition, demonstrating how IIS funding can contribute to world-class education. This project also addresses national priorities as the low level of foreign language competency of Americans has been identified as problematic for national security and global competitiveness.
- *Collaborative Research: Telling the Story – Learning Math, Science, and Engineering through Animation* (IIS-0511965, Chris Rogers, Tufts University) focuses on developing tools that help students quickly and easily predict, represent, and explore ideas in STEM topics by creating animated movies.

Undergraduate Education: Maintaining a healthy pipeline of students well-versed in information technology will continue to be a critical element of US global competiveness. One mechanism for engaging undergraduates more deeply in information technology is the REU program, which within IIS also helps promote diversity by specifically encouraging undergraduate women and minorities to participate in research. Ongoing support for this program will be critical both for continuing to build a diverse workforce in computing, as well as more broadly helping to bolster the pipeline of students choosing to study computing and information disciplines, which have seen dramatic declines in the

US in the first half of this decade. Amongst the REU projects funded by IIS is this notable effort:

- *REU: Research Experiences For Undergraduates in Virtual Reality, Robotics and Visualization* (IIS-0648211, Sharon Stansfield, Ithaca College) targets underrepresented minorities, introducing them to cutting-edge research topics in the IIS domain. It has been successful in this goal, reaching a 30% rate of minority participation.

In addition, a number of standard grants actively include undergraduates in their research programs. Such proposals include:

- *Fostering Creativity in Ubiquitous Social Computing* (IIS-0714158, Wassim Jabi, New Jersey Institute of Technology) teams students in computer science and in architecture, focusing on innovative efforts to encourage creativity and engagement in computing, such as studio-based learning for ubiquitous social computing.
- *Game2Learn* (IIS-0757521, Tiffany Barnes, University of North Carolina, Charlotte) builds new frameworks for building 3D learning games and a new game for teaching recursion.
- *Artistic Group Performance as a Model for Novel Collaborative Multimodal Human-Computer Interfaces* (IIS-0742968L, JoAnn Kuchera-Morin, University of California, Santa Barbara) develops teaching methods for incorporating artistic expression into computing design.
- *CAREER: Smarter Educational Software Through Sketch Recognition* (IIS-0546809, Christine Alvarado, Harvey Mudd College) enables improvements in learning through sketch recognition on tablets.
- *CAREER: Optimal Information Extraction in Intelligent systems* (IIS-0133996, Virginia de Sa, University of California San Diego) brings together undergraduates, graduate students, and post doctoral scholars for training in machine learning fundamentals and applications.
- *Collaborative Research: SEI (BIO)--Automated Methods for Generating High-Resolution GIS Databases from Remotely Sensed Data for Biodiversity Predictions* (IIS-0430779, Thomas Millette, Mount Holyoke College) created a culture of research at an all-women liberal arts college with a project that focuses on the automation and analysis of GIS data to support biology and geoscience research.
- *Mining Sequential and Structured Patterns: Scalability, Flexibility, Extensibility and Applicability* (IIS-0209199, Jiawei Han, University of Illinois at Urbana-Champaign) developed new data mining techniques for identifying novel relationships across the World Wide Web, and then created a textbook that compiled those data mining techniques to more broadly disseminate the research results.

We commend the efforts that IIS has made to support undergraduate education and research on multiple fronts. Nevertheless, we also note that IIS-wide, the number of undergraduate researchers supported by IIS programs has declined by roughly 20% from 2006 to 2008. This is a potentially worrisome trend since undergraduate students provide the pool from which future graduate students are recruited. Reasons for this trend might be the low funding rate of proposals, the lower level of funding compared to the requested level, or simply a downstream reflection of contraction in the pipeline of undergraduates studying computing disciplines. By contrast, the number of PhD students has increased over the reporting period.

Graduate Education: In addition to supporting PhD students through grants (noted previously), IIS has also funded a large number of doctoral consortia throughout the community. These are critical to the mentoring and preparation of PhD students as they become independent researchers.

We also identified interesting examples of ways in which IIS research is impacting graduate students even beyond the IIS boundaries, for instance, the project *Learning How to Think Like a Lawyer* (IIS-0412830, Kevin Ashley, University of Pittsburgh) develops an intelligent-tutoring system for use by law students.

Junior Faculty: CAREER grants continue to be a crucial mechanism for supporting young researchers; however, the funding rate for CAREERs appears to be flat after the decline reported by the previous COV. Moreover in 2008, CAREERs were funded at roughly 17% versus 22% for standard proposals. Furthermore, evidence also suggests that in general, PIs are taking a long time to win their first awards. We echo the sentiment of the previous COV in recommending that NSF take a careful look at the impact of the funding squeeze on the development of new researchers in the sciences.

Diversity of Research Evaluators and Contributors: As noted in earlier sections of this report, IIS participates in a number of programs that seek to broaden participation in computing and computing research; however, it is difficult to assess accurately overall progress in this regard. Firstly, there appears to be a lack of data about characteristics such as ethnicity and gender among PIs and proposal reviewers. Furthermore, NSF program directors and staff should also reflect the diversity that NSF is trying to achieve in the work that it promotes.

B.3 <u>OUTCOME GOAL for Research Infrastructure: "</u>*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools."*

Comments:

IIS has had significant impact on research infrastructure because many of the research projects funded are tied to application areas and specific scientific domains. The research funded by III builds on a strong research infrastructure created by the preceding Digital Library programs. That area is no longer funded as such, but integrated within the IIS area. Digital library concepts are now widely disseminated and specialized digital libraries have been established in many disciplines and industries, and the trend is ongoing. For example, several digital library program awards (e.g., IIS-0430906) established standards for harvesting and sharing scholarly documents across electronic repositories. We concur that the topic of digital libraries as such does not need focused funding, and found that innovative projects are still being submitted and awarded.

In fact, Digital Library resources now form a basis for discovery and learning. Two III projects—IIS-0634677: "Using the Cyberinfrastructure to build a Full Text Index on the Web" and IIS-0705774: "Using the Cornell Web Lab to study Social and Informational processes on the Web"—are excellent examples. William Y. Arms of Cornell University is extending the utility of resources such as the Internet Archive by making them searchable in far richer ways than originally conceived and making them available over the TeraGrid. In so doing, the project is advancing our understanding of issues in managing very large distributed data sets and providing infrastructure for social scientists to study the nature and evolution of the Web.

Project IIS-0430779: "Automated Methods for Generating High-Resolution GIS Databases from Remotely Sensed Data for Biodiversity Predictions" by T. Millette at Mount Holyoke College, created a set of tools for the analysis of GIS data to support biology and geoscience research.

It is commendable that IIS-RI is funding projects that contribute to research infrastructure by developing and releasing public domain software tools. An example from the area of Human Language Technology is the project by Dr. Dan Melamed, NYU (IIS-0238406), that developed a tool for aligning text in different languages. This tool is freely available to researchers.

Project IIS-0534094: “Modeling Uncertainty in Land Use and Transportation Policy Impacts: Statistical Methods, Computational Algorithms, and Stakeholder Interaction,” by A. Borning at the Univ. of Washington, has created an experimental tool, available as open source software UrbanSim, that enables urban planners to simulate/analyze their plans over extended time periods.

In addition to collaborative endeavors such as the Computing Research Infrastructure (CRI) and PetaApps programs, IIS has been instrumental in advancing the recognition and use of information as infrastructure.

Collaboration with Health Sciences and Health Care has taken on increasing importance. Research into the discovery of general principles of protein structure will advance the state of science in general as well as potentially lead to significant advances in human health. To this end, the importance of methods for data analysis as a piece of computing infrastructure should not be underestimated. Thus, projects such as award IIIS-0448502: “Accurate and Automated Protein Structure Prediction”—which seeks to develop and disseminate algorithms for protein structure prediction—contributes directly to the nation’s computing infrastructure in areas that can have far-reaching future impact. Such work in algorithmic infrastructure should continue to be supported by IIS, and should be seen as just as important to national computing infrastructure as physical instrumentation or facilities. It is also worth noting that the particular proposal here is part of the CAREER program, and thus serves to also help support the building of a national workforce in science.

Understanding how information is represented and processed by the brain remains one of the most important problems in science. New technologies, such as micro-machined electrode arrays and two-photon imaging, are enabling experimenters to record the simultaneous activity of neuronal populations yielding large and high-dimensional datasets. CRCNS funds several projects on data sharing (e.g., IIS-0745685: “Data sharing: Micro-machined electrode recordings from primary visual cortex” and IIS-0749056: “Data sharing: Neurophysiological studies of sensory coding”) that are designed to standardize formats for different data types and encourage researchers to release their data earlier than is the norm among NIH funded research.

PART C. OTHER TOPICS

C.1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

The COV was impressed with the portfolio of research being funded by IIS: it covers both traditionally important as well as emerging areas in the studies of the interrelationship between people, computers, and information. We did not observe any gaps within programs areas. In particular, it appears that the move from specific programs to clusters, combined with the creation of occasional emphasis areas, have been successful in managing possible gaps. Further, the COV is impressed with the way in which IIS is collaborating with other units such as OCI and SBE; such interdisciplinary connections are essential to the IIS mission. Although it is not within the period of our review, we find that IIS' partnership in the new SoCS program is another fine example of their focus on cutting-edge, interdisciplinary topics.

It is worth noting that a cluster model can create a different set of issues; namely, it is possible for proposals in certain areas to fall into panels that do not match the research area as well as more targeted panels. Earlier in this report (Section A.2.1), we suggested that mechanisms be explored to mitigate any problems arising for reviewing in such cases.

C.2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

No additional comments

C.3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

Staff Workload. We are concerned with the workload for IIS staff members. While workload has undoubtedly increased across all Directorates and Divisions, the centrality of IIS research to a broad range of research areas means that IIS staff in particular are asked to participate in a very large number of cross-cutting initiatives. In addition the explosion of research that addresses the relationship between humans, computers, and information means that the proposal load in IIS has grown very significantly under the period under review. This growth is occurring despite the fact that CISE as a whole has already put into effect limits on the number of proposals that a PI can submit each year. We stress that the IIS staff has done an excellent job in managing the review process, but going forward we believe it is essential for NSF to carefully evaluate workload, and to consider foundation-wide mechanisms to help balance load levels on Directorates and Divisions.

Permanent Staff. The COV observes that the IIS division has a larger percentage of IPA staff than other NSF divisions and that this has positively influenced its ability to provide effective and efficient leadership in rapidly-advancing research areas. We would encourage the NSF to consider ways in which permanent staff can renew themselves technically, much as academic faculty do through sabbaticals.

Better Technology. As noted earlier in this report, we believe that NSF staff should have access to better technology to manage the increasing volume and complexity of proposals and grants, and we note that much of this technology grew out of IIS research. Examples of these technologies/tools would be: tools for data mining to manage internal NSF data and tools for remote collaboration.

Broader Support. We noted that a large proportion of funding goes to faculty in major research universities. While this is appropriate, we believe it would be worthwhile to explore mechanisms to increase the involvement in research of faculty and students from other universities, for example by creating networks of faculty and students interested in similar research topics. The goal of such projects is to ensure that faculty outside the leading research universities have insight into the world of cutting-edge research, and that their students consider research careers; this is consistent with the NSF-wide outcome goals for learning stated in Section B.2.

C.4. Please provide comments on any other issues the COV feels are relevant.

As noted in the Introduction to this report, the IIS division deals with computing in its most strategic aspects. As the cost of computing has plummeted, a huge number of opportunities for using computing technology to improve the human condition have become possible, and it is precisely these advanced uses that are the purview of IIS. Many national priorities are deeply entwined with IIS subject matter, which bear a critical and ubiquitous relation to humans and human infrastructure. Funding organizations outside the U.S. recognize the importance of IIS subject matter and in many cases are providing substantial support. For example, Europe's 7th Framework Programme on Cognitive Systems, Interaction and Robotics, which provides $400M. In addition, the CCC Report "A Roadmap for US Robotics From Internet to Robotics," May 21, 2009 (Henrik Christensen, Chair) states that: "Led by Japan, Korea, and the European Union, the rest of the world has recognized the irrefutable need to advance robotics technology and have made research investment commitments totaling over $1 billion."

C.5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

Many of the suggestions from the previous COV are still relevant. While we appreciate the fact that the workload for the committee is limited to three days, the efficiency of the group could be increased by providing some additional material ahead of time, including:
(1) the previous COV report, (2) the COV meeting agenda and schedule, and (3) the current COV report template. Better IT tools for simultaneous collaborative editing are also needed.

During the COV, members made several requests for specific data that were not obviously available from the initial data that we were given. Often these data were crucial for understanding the context necessary to make informed decisions and some of these requests are listed below.

- Number of PhDs and undergraduate students supported on IIS grants, to assess trends in educational impact of IIS-funded research.
- Requested budget vs. awarded budget, and some indication of how scope might have changed in response to lower budget
- Total budget requested by all proposals vs total budget awarded to all funded projects in order to supplement data on funding rates
- List of panelists for each year
- Submission and funding rates for underrepresented PIs separating PIs and co-PIs
- Submission and funding rates for new awardees
- Time to first successful proposal for new awardees (some of this data can be inferred from time of PhD awarded to funding date; however, number of previously denied proposals not readily available)
- Percentage of submitted proposals that were recommended for funding by panels, but were not funded
- Percentage of proposals that were rated at least 'very good' but were not funded in order to understand whether there were high-quality proposals going unfunded

In addition to these specific requests, some COV members would like to make two observations. First, it would be helpful to have comparative data for the previous COV, and for CISE and NSF as a whole. Second, the COV understands that data that is self-reported (e.g., gender, ethnicity) is difficult to gather, however, we believe that NSF should encourage the community to provide such data.

Finally, we recommend that the report template should not be table-based because this makes it unstable across different versions of WORD and different platforms, which can create unnecessary formatting challenges.

We emphasize that the NSF staff were extraordinarily helpful and prompt in their responses to our questions and requests and that this list is not a criticism. We include these suggestions to: (1) help NSF identify the kind of data to track if it isn't already, (2) make the next COV aware of some of the issues they will need to address, and (3) help the organizers to plan for the next COV.

SIGNATURE BLOCK:

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Dr. Jennifer Preece
Chair, 2009 for the Information and Intelligent Systems Committee of Visitors