Social, Economic, and Workforce Implications of IT and IT Workforce Development

Definition of SEW PCA

The activities funded under the Social, Economic, and Workforce Implications of IT and IT Workforce Development (SEW) PCA focus on the nature and dynamics of IT impacts on technical and social systems as well as the interactions between people and IT devices and capabilities; the workforce development needs arising from the growing demand for workers who are highly skilled in information technology; and the role of innovative IT applications in education and training. SEW also supports efforts to transfer the results of IT R&D to the policymaking and IT user communities in government at all levels and the private sector. Amid today's rapid global transformations driven by IT, SEW research aims to provide new knowledge to help society anticipate, identify, understand, and address the diverse issues of the digital age.

Broad Areas of SEW Concern

- Economic, organizational, social, and educational transformations driven by new information technologies
- Participation in the digital society, including e-government
- Intellectual property and privacy rights
- Innovative applications of IT in education
- IT workforce development

Technical Goals

- Develop baseline empirical findings about the complex interactions between people and IT
- Support training to expand the skilled IT workforce
- Increase understanding of intellectual property and privacy issues in the digital society
- Promote linkages between the SEW research community and policymakers
- Demonstrate innovative IT applications for education

Illustrative Technical Thrusts

- Interactions and complex interdependencies of information systems and social systems
- Collaborative knowledge environments for science and engineering
- Management of knowledge-intensive dynamic systems
- Tools and technologies and tools for social-network analysis
- Application of information technology to law and regulation
- Technologies and tools to facilitate large-scale collaborative research through distributed systems
- Technologies in and theories of electronic business, supply chains, economics of IT, productivity, and related areas
- Innovation in computational modeling or simulation in research or education
- Advanced graduate training in the strategically important IT fields of bioinformatics and computational science

SEW Agencies

		Participating Agency
NSF	DOE/NNSA	GSA
NIH	DOE/SC	
NASA		

SEW PCA Budget Crosscut

FY 2004 Estimate	FY 2005 Request
$120.9 M	$130.9 M

- Efforts to eliminate barriers to IT workforce participation for women and minorities
- Experimentation with cutting-edge networked applications for engineering training and K-14 science and mathematics education

SEW PCA: Coordination and Activities

SEW Highlights

The SEW PCA has two related but distinct components: 1) education and workforce development activities and 2) activities involving the socioeconomic implications of IT. NSF is the sole NITRD agency pursuing research in the latter area, while the other SEW agencies' investments lie in the former. Because of the breadth of this portfolio, the SEW Coordinating Group (CG) has taken on a character somewhat different from those of the CGs devoted to IT research topics that engage multiple agencies. The SEW CG has developed a program of briefings on themes of interest to agencies beyond the IT R&D community. Subjects have included intellectual property issues in open source software, issues in creating a national health information infrastructure, and trends in IT workforce demographics and their implications for education and training.

Since FY 2002, the CG also has supported, through its Universal Accessibility Team, the development of a new program of workshops sponsored by GSA and the Federal CIO Council to foster collaboration among government and community implementers of IT and to demonstrate promising IT capabilities emerging from Federal research.

Each of these evolutionary directions has sought to position the SEW CG as a communications link between IT researchers and policymakers and implementers of IT applications. In FY 2004, the SEW CG's principal activity is an examination of how its role and structure have changed since the PCA's inception.

Universal Accessibility Team Activities

The monthly Collaboration Expedition Workshops, completing their third year in FY 2004, bring together a diverse group of IT researchers, developers, and implementers representing such fields as emergency preparedness and response, health care, environmental protection, and citizen services. Drawing between 60 and 100 participants each month, the workshops also assist Federal program managers in coordinating necessary steps to implement the Administration's Federal Enterprise Architecture Program in their agencies.

The workshops have developed into a crossroads for software and system developers, IT managers and implementers, and public services practitioners across all levels of government, in the private sector, and in local communities. Each monthly meeting includes demonstrations of emerging technologies and prototype applications for developing intergovernmental "citizen-centric" services, and discussions of barriers and opportunities in applying technologies to enhance citizen-government interactions. The goal is to accelerate multi-sector partnerships around IT capabilities that help government work better on behalf of all citizens. Sample meeting topics include:

- Taxonomies and the Semantic Web (XML and XML Schema, Resource Description Framework/Schema [RDF/S], DARPA Agent Markup Language [DAML]+Ontology Inference Layer [OIL] and the new Web Ontology Language OWL, derived from DAML+OIL)
- Extensible Federal Enterprise Architecture components that transcend "stove-piping" through open standards technologies
- Realistic citizen-service scenarios for benchmarking performance
- Audio e-book technology
- Multi-channel communication and information services, including dynamic knowledge repositories
- Web-based collaboration

SEW R&D Programs By Agency

Selected FY 2004 Activities and FY 2005 Plans

SEW **NSF** SEW

NSF's SEW research portfolio encompasses a broad range of efforts, from studies of the socioeconomic implications of the ongoing digital revolution, to explorations of how IT can enhance government-citizen interactions, to research on ways to expand and better prepare the Nation's IT workforce, to R&D on innovative applications of information technologies in education and training.

In FY 2004, elements of SEW research are supported under the following programs:

Information Technology Research (ITR) Program

This major foundation-wide interdisciplinary priority area in FY 2004 began its fifth and final year of grant awards with a new focus on Information Technology Research for National Priorities. SEW interests are highlighted in NSF's call for ITR proposals that integrate research and education activities or foster the development of a diverse IT workforce. In addition, the solicitation calls for SEW research related to the following national priorities:

- Advances in Science and Engineering (ASE), which could include research on technologies and tools to facilitate large-scale collaborative research through distributed systems
- Economic Prosperity and Vibrant Civil Society (ECS), which seeks projects that investigate the human and socio-technical aspects of current and future distributed information systems for economic prosperity and a vibrant civil society. Examples of topics include human and social aspects of distributed information systems for innovation, business, work, health, government, learning, and community, and their related policy implications.
- National and Homeland Security (NHS), which includes research on critical infrastructure protection and technologies and tools for understanding threats to national security

About 100 ITR grants awarded in prior fiscal years for SEW-related research are continuing in FY 2004. Under the overarching FY 2004 theme, new ITR proposals must address one or more of four specified technical focus areas. The following two of the four directly address SEW research interests:

- Interactions and complex interdependencies of information systems and social systems
- Innovation in computational modeling or simulation in research or education

Computer and Information Science and Engineering (CISE) Directorate Programs

In the FY 2004 divisional reorganization within the CISE Directorate, a substantial portion of SEW-related research is housed in the Systems in Context cluster of the Division of Information and Intelligent Systems (IIS). As part of the directorate's overarching FY 2004 emphasis on education and workforce issues, SEW-related research in educational technologies and IT workforce development is also supported under the Combined Research and Curriculum Development and Educational Innovation Program and the Information Technology Workforce Program. These two programs reside in the Education and Workforce Cluster of the Division of Computer and Network Systems (CNS).

CISE/IIS/Systems in Context

This IIS cluster includes three research thrust areas funding SEW-related work in FY 2004. They are:

Digital Government – supporting research that advances IT applications for governmental missions and/or research that enhances understanding of the impact of IT on structures, processes, and outcomes within government, both from the perspective of government agencies and from the viewpoint of the citizenry at large. Sample research topics:

- The capture of government decision-making processes
- The application of information technology to law and regulation
- Software engineering of large-scale government projects
- Online campaigning and e-voting
- New forms of IT-enabled civic engagement and interaction
- Failures and successes of governmental IT adoption

- Implications and impact of IT on democracy and forms of governance

Digital Society and Technologies – FY 2004 emphases in this thrust area are:

- Universal Participation in a Digital Society – research seeking to understand the underlying processes by which IT shapes and transforms society and society simultaneously shapes and transforms new IT, and how these transformations impact the goal of universal participation in our democratic society. Areas of study include e-commerce, digital science, the IT workforce, community networking, and digital governance.
- Collaborative Intelligence – includes theories, models, and technologies for distributed, intelligent, collective action among humans, agents, robots, and other embedded devices. Focus on:
  - The science of collaboration (design principles, mixed initiative and adjustable autonomy problems, and implicit and explicit, affective and instrumental human-machine interactions)
  - Distributed intelligence (knowledge representation, management and fusion, science of coordination, and division of labor)
  - Systems for managing trust, reputation, and other critical elements in heterogeneous, dynamic, distant relationships
- Management of Knowledge Intensive Enterprises – research to understand how structured, global collections of knowledge can be brought to bear on complex decision-making processes so that processes can rapidly reconfigure and reschedule resources while the enterprise remains stable enough to carry out routine processes and achieve high levels of performance. The focus is on:
  - Adaptive scheduling and control of product dynamics, rapid reconfiguration and rescheduling of human and machine resources
  - Learning hidden workflow rules to optimize workflow
  - Distributed decision-making and appropriate schemes for distributing decision authority throughout hierarchies, understanding how information is shared, partitioned, and flows to the right places
  - How we measure the productivity of dynamically, re-configuring business processes, local vs. global problems such as performance across levels of analysis
  - Collaborative knowledge representation, acquisition, retrieval, and inference
- Knowledge Environments for Science and Engineering – research focused on:
  - Identifying the requirements of distributed scientific practices, how scientific practices are changing (e.g., due to more complex data sets, more interdisciplinary teams) and to what consequence
  - Understanding barriers to adoption and use, building trust across geographic boundaries, and IT strategies for sharing resources
  - Understanding the governance issues related to distributed work practices, facilities, and shared resources
  - Understanding copyright restrictions, information privacy and open source software issues related to collecting and harvesting knowledge across geographic and social boundaries
- Transforming Enterprise – research investigates:
  - Technologies and theories of electronic business, supply chains, economics of IT, productivity, etc.
  - Technologies and theories of collaborative and distributed work, including the development and use of collective knowledge representations and open source software development of human and machine resources
  - Understanding the various legal, social, and cultural issues when information, software, and autonomous proxies flow across boundaries
  - Understanding how to value information and evaluate risks and reputations in transactions with distant strangers
  - Understanding and mitigating information balkanization

Universal Access – FY 2004 emphasis is on developing new knowledge about how IT can empower people with disabilities, young children, seniors, and members of other traditionally under-represented groups to participate fully in the digital society.

CISE/CNS/Education and Workforce

This CNS cluster supports projects that integrate research and education across CISE, study the causes of the current lack of diversity in the IT workforce, and lead to a broadening of participation by all under-represented groups. The cluster works closely with all CISE divisions to achieve these goals. It also coordinates CISE participation in a

portfolio of NSF-wide education and workforce programs. SEW-related work:

- Information Technology Workforce Program – projects to develop and implement promising strategies to reverse the underrepresentation of women and minorities in IT education and careers

CISE/Combined Research and Curriculum Development and Educational Innovation Program

FY 2004 efforts focus on the design, development, testing, and dissemination of innovative IT approaches for increasing the effectiveness of educational experiences, including integration of research results into courses and curricula

NSF's FY 2005 plans for SEW-related R&D include:

- *A series of workshops on open standards, grid computing and innovation diffusion, dynamic knowledge repositories and collaboration, and agile frameworks for broad economic prosperity*
- *Approximately 120 new group projects under the ITR for National Priorities program, which focuses on IT advances in science and engineering, IT for economic prosperity and vibrant civil society, and IT for national and homeland security*
- *Digital Society and Technologies Program will focus on research to understand the challenges facing enterprises in dynamic environments and the ways in which IT can allow for complex, distributed decision-making, rapid reconfiguration, and resource scheduling and reallocation while achieving high levels of performance*

SEW NIH SEW

NIH's National Library of Medicine (NLM) is the pioneer supporter of advanced training in the emerging field of bioinformatics, whose practitioners bring both high-end computer science and medical expertise to the health-care arena. The need for bioinformatics skills spans biomedical research applications, telemedicine, and large-scale health care systems. The NLM program of institutional support and individual fellowships is establishing an academic training infrastructure and expanding the ranks of bioinformatics professionals, who are still far too few in number to fill the growing nationwide demand for these practitioners.

Training efforts in FY 2004 include:

- Institutional Grants: NLM supports training grants in medical informatics at ten major universities. They are intended to train predoctoral and postdoctoral students for research in medical informatics. Some offer special track training in such informatics-intensive fields as radiation oncology and biotechnology.
- Individual Fellowships: Informatics Research Training. Post-doctoral health science workers who identify a mentor, institution, research project, and curriculum are eligible to compete for these fellowships. They complement the institutional programs (described above) by making it possible for students to enter informatics training at any institution with appropriate mentor and facilities.
- Applied Informatics: These fellowships support training for those who will design or manage large information systems, or adapt applications developed by research workers to actual use in a clinic setting, classroom, laboratory, library, or office. Although many applicants will have doctorates, nurses, librarians, and other health professionals without doctoral degrees are encouraged to apply.
- Integrated Academic Information Management Systems (IAIMS): Over the last decade, NLM has supported the development of IAIMS in selected major medical centers. The experience gained by those who, through on-the-job training, have developed and implemented complex integrated information systems will now be systematically exploited through designated training slots at IAIMS sites.
- Biotechnology: For recent doctoral graduates, the National Research Council Research Associateship Program provides an opportunity for concentrated research in association with selected members of the NCBI scientific staff.
- Medical Informatics: The Marine Biological Laboratory, Woods Hole, Massachusetts, conducts an annual NLM-sponsored one-week course in medical informatics. Thirty trainees are selected from applicants in health professions, research, and librarianship. They receive intensive hands-on experience with a variety of medical information systems, including medical informatics, expert systems, and molecular biology databases.

- HBCU Toxicology Information Outreach: NLM's Toxicology Information Program (TIP) supports projects designed to strengthen the capacity of historically black colleges and universities (HBCUs) to train medical and other health professionals in the use of toxicological, environmental, occupational, and hazardous wastes information resources developed at NLM. A number of HBCUs with schools of medicine, pharmacy, and nursing are participating in the program, which includes training and free access to NLM's databases.
- Medical Informatics Elective: The Computer Science Branch, Lister Hill National Center for Biomedical Communications (LHNCBC) at NLM, conducts an eight-week elective in Medical Informatics, as part of NIH's Clinical Electives Program. Each spring this elective combines an extensive seminar series by senior figures in the field with an independent research project under the preceptorship of an LHNCBC professional. Eight to fourteen fourth-year medical students are admitted each year.
- Medical Informatics Training Program: LHNCBC conducts a Medical Informatics Training Program to provide support for faculty members, postdoctoral scientists, graduate students, and undergraduate students for research participation at the Center through visits of a few months to several years.

SEW NASA SEW

Learning Technologies Project (LTP) – NASA's educational technology incubator. LTP funds activities and collaborates with endeavors that incorporate NASA content with revolutionary technologies or innovative use of entrenched technologies to enhance education at all levels in the areas of science, technology, engineering, and mathematics (STEM). LTP's mission is to efficiently develop world-class educational products that:

- Are poised for the widest possible market diffusion, that inspire and educate
- Use innovative methods or emerging technologies
- Address educational standards utilizing NASA data. These products account for diverse learning environments whenever applicable and wherever possible.

FY 2004 projects include:

- Animated Earth – developing IT capabilities to provide Internet-accessible animated visualizations of important Earth Science processes, events, and phenomena to students, educators and the public, using NASA remote sensing and model data; includes work to determine which standards and protocols will be adopted to convey these visualizations over the Internet.and to implement and document a public server-side infrastructure to deliver these visualizations using the chosen standards and protocols.

- Information Accessibility Lab – research aiming to provide software tools that enable development of assistive instructional software applications for sensorily impaired K-12 students; utilize a combination of graphing, sonification, and mathematical analysis software to represent mathematical and scientific information; and provide unique, NASA-technology teaching tools that enhance STEM education for sensorily impaired students.

- What's the Difference? – research to: develop a simple to use software component that uses richly visual and highly interactive comparisons to teach science and math concepts; design the component so that additional information and new information sets can be developed and easily added by curriculum developers; enable developers of educational software applications to utilize the visual comparison componentry and information in their applications; provide information sets and tool capabilities beyond those delivered for this project's phase 1 effort.

- Virtual Lab – the goal of this R&D effort is to: provide students and their educators with virtual but realistic software implementations of sophisticated scientific instruments commonly used by NASA scientists and engineers; design and implement the virtual instruments such that additional specimens can be added easily and additional instruments can be used to study the same specimens; build on the LTP Phase 1 Virtual Lab by expanding the set of specimens for the Virtual Scanning Electron Microscope; provide mechanisms to enable independent applications to invoke and contain the virtual instruments.

SEW DOE/SC & DOE/NNSA SEW

DOE Computational Science Graduate Fellowship (CSGF): Funded by the Office of Science and Office of Defense Programs, this program works to identify and provide support for some of the very best computational science graduate students in the nation. The fellowships have supported more than 120 students at approximately 50 universities. The program is administered by the Krell Institute in Ames, Iowa.

The CSGF program partnership of DOE/SC and DOE/NNSA to develop the next generation of leaders in computational science will continue in FY 2005.

SEW DOE/NNSA SEW

Academic Strategic Alliance Program (ASAP): Through partnerships with universities, this element of the Advanced Simulation and Computing (ASC) Program pursues advances in the development of computational science, computer systems, mathematical modeling, and numerical mathematics important to the ASC effort. By supporting student involvement in these research efforts, ASAP aims to strengthen education and research in areas critical to the long-term success of ASC and the Stockpile Stewardship Program (SSP).

The ASAP will continue in FY 2005.

Participating Agency

SEW GSA SEW

Collaboration Expedition Workshop Series – monthly open workshops for representatives of Federal, state, and local government, community organizations, and the private sector to explore how to create a citizen-centric governance infrastructure supported by new technologies. Sponsored by GSA's Office of Intergovernmental Solutions in conjunction with the Emerging Technology Subcommittee of the Federal CIO Council. Objectives are to:

- Accelerate mutual understanding of the Federal Enterprise Architecture (FEA) initiative and commitments toward intergovernmental collaboration practices needed to implement the E-government Act of 2002
- Accelerate maturation of candidate technologies
- Expand intergovernmental collaboration and facilitate development of communities of practice
- Provide a forum for discussion of and experimentation with new IT capabilities and "best practices" in IT applications and deployment

By bringing IT developers and researchers together with practitioners across a broad range of government and citizen service sectors, the Expedition Workshops are developing a collaborative "incubator" process to facilitate emergence of a lasting enterprise architecture by providing:

- Realistic citizen-service scenarios for benchmarking performance
- Innovation practitioners with multilateral organizing skills
- Faster maturation and transfer of validated capabilities among intergovernmental partners
- Extensible e-gov components that transcend "stove-piping" through open standards technologies (OMB Circular A-119)

Plans for FY 2005 include:

- *Continue to develop participant skills in managing an IT innovation life-cycle process that scans emerging technology and fosters collaborative prototyping*
- *Expand network of intergovernmental partners to include new state and local government actors, non-governmental organizations, and Federal leaders with e-government responsibilities*
- *Identify 1-3 emerging technologies with the greatest potential for affecting the lasting value of enterprise architecture and incorporate findings into information/service offerings of the sponsors*