



The American Competitiveness Initiative From the Eyes of an NSF Program Officer

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ACI in the NSF Context

- **NSF's budget is slated to double over ten years**
 - About 8% per year
- **So far, all of the directorates are experiencing growth, including:**
 - Social, Behavioral, and Economic Sciences
 - Education and Human Resources
 - Engineering
 - Computer & Information Sciences & Engineering



ACI in the SBE Context

- **“Wanted: Better Benchmarks”**
 - Science Magazine Editorial, May 2005
 - John Marburger III, Director of the OSTP
- “Globalization and changing modes of science that have blurred disciplinary distinctions have undermined the value of traditional science and engineering data and their conventional interpretations.”
- “The question is not whether R&D investments are important, but what investment strategies are most effective in the rapidly changing global environment for science.”



ACI in the SBE Context

- **Science of Science and Innovation Policy**
 - Prospectus link on the main SBE webpage
- “Develop the foundations of an evidence-based platform from which policymakers and researchers may assess the impacts of the nation's scientific and engineering enterprise, improve their understanding of its dynamics, and predict outcomes.”



Three SciSIP Areas

1. Measurement

- “Studies that better identify, characterize, measure, and evaluate the investments, processes, and social and economic returns of scientific and engineering research.”



Three SciSIP Thrusts

2. Understanding

- “The fundamentals of discovery and innovation will be examined from cognitive, organizational and national perspectives. These new models will incorporate the potential stages and feedback mechanisms that influence discovery, innovation processes and outcomes, as well as their relationships to individual, organizational, economic and social entities.”



Three SciSIP Thrusts

3. Community Development

- “The scientific underpinnings of education and training in science and engineering will be a component of the research and data collection. In addition, the broadening and deepening of the national STEM workforce capabilities is an important focus of this activity.”



SciSIP Activities

- Three workshops have been held
 - One on the cognitive and social bases of innovation and discovery in the contexts of scientific experimentation and engineering design

<http://www.lrdc.pitt.edu/schunn/innov2006/talks/schedule.htm>

- The other two on the sociological and econometrics dimensions of SciSIP



Innovation & Discovery Workshop

Speaker	Area	Talk Title
Steve Smith Texas A&M		<i>Alignment of Research on Creative Cognition Across Levels of Complexity and Ecological Validity</i>
Art Markman UT-Austin		<i>Tools for Moving Beyond Incremental Innovation</i>
Jeremy Gray Yale		<i>Cognitive Neuroscience of Discovery and Innovation: An Example Research Strategy into Cross-Domain Analogical Reasoning</i>
Gary Bradshaw Mississippi State	Cognitive	<i>Edison's Bright Idea: Mental Models, Heuristics, Strategies of Invention, and the Electric Light</i>
Ken Kotovsky Carnegie Mellon		<i>Sources of Insights in Engineering Design</i>
Ashok Goel Georgia Tech		<i>Exploring Design Innovation: The AI Method and Some Results</i>
Christian Schunn Pitt		<i>The Role of Artifacts on Analogy in Innovative Design</i>
Nancy Nersessian Georgia Tech		<i>Interdisciplinarity on the Benchtop: Model-Based Reasoning in Bio-Science and Engineering Research Laboratories</i>



Innovation & Discovery Workshop

Speaker	Area	Talk Title
Tory Higgins Columbia		<i>Creativity Differences in Promotion Versus Prevention Regulatory States</i>
John Levine Pitt		<i>Innovation in Task Groups: Newcomers as Change Agents</i>
Mihaly Csikszentmihalyi Claremont		<i>On the Phenomenology of Discovery</i>
Keith Sawyer WUSTL	Social	<i>Inside the Black Box of Collaborative Creativity</i>
Linda Argote Carnegie Mellon		<i>Transferring Innovations across Groups in Organizations: Evidence from the Field and the Laboratory</i>
Paul Paulus UT-Arlington		<i>Enhancing Group Creativity—The Effects of Training, Diversity, and Attitudes Toward Diversity</i>
Vincent Brown Hofstra		<i>Some Speculations on Facilitating Creative Idea Generation in Groups and Individuals: Cognitive Underpinnings</i>




Innovation & Discovery Workshop

Speaker	Area	Talk Title
Kris Wood UT-Austin		<i>Empirical Studies of Collaborative and Analogical Product Design: Implications on Innovation and Discovery</i>
Jon Cagan Carnegie Mellon		<i>Cognitively-Inspired Computational Design Methods</i>
Panos Papalambros U. of Michigan		<i>Observations on creativity and innovation in student design project teams</i>
Maria Yang USC	Engineering	<i>A Study of Prototypes, Design Activity, and Design Outcome: A Design Data Analysis Approach</i>
Dan Frey MIT		<i>The Role of Experimentation in Individual and Team Innovation and Discovery: Possible Forms of its Scientific Foundations</i>
Larry Leifer Stanford		<i>Surprise and Delight: design-thinking in practice and theory</i>
Jimi Shah ASU		<i>What We Have Learned from Empirical Studies of Design Ideation Methods</i>



SciSIP Solicitation

- In the works, stay tuned... 
- ...But any SBE program may give special attention to proposals relevant to SciSIP
- And any NSF program may give special attention to proposals relevant to ACI
 - Proposal must fit with the program's focus area
 - Contact the cognizant program officer



CreativeIT Workshop

- Sponsored in CISE, gathered a diverse group of engineers (including HF), designers and cognitive scientists
 - “Considering the synergy of creativity with research in design can have outcomes such as new models of creative cognitive and computational processes, new approaches to education for IT and non-IT students that encourage creativity, new modes of research that include creative professionals, and new tools to support human creativity.”
 - Contact Mary Lou Maher (mmaher@nsf.gov)



Relevant EHR Program

- Research and Evaluation on Education in Science and Engineering (REESE)
 - **Synthesis Research and Evaluation Project proposals** identify areas where the knowledge base in either evaluation or research is sufficiently robust to support strong scientific claims, identify areas of importance to education research and practice, and propose rigorous methods for synthesizing findings and drawing conclusions.
 - **Empirical Research and Evaluation Project proposals** identify areas that have the potential for advancing discovery and innovation at the frontiers of STEM learning. These proposals are expected to be based deeply in the STEM disciplines and be theoretically and methodologically strong with the potential of contributing to theory, methodology, and practice.



Science of Learning Centers

- Six currently funded SLCs, highlight one here:
- Spatial Intelligence and Learning Center
 - PI Nora Newcombe, Temple University
- “To understand spatial learning and to use this knowledge to develop programs and technologies that will transform educational practice and support the capability of all children and adolescents to develop the skills required to compete in a global economy. The core theme of SILC is that spatial cognition is malleable, and hence that spatial learning can be fostered by effective technology and education.”



Human Factors and the ACI

- Many HUGE and recently developed technologies are intimately linked with human behavior
 - Windows and the mouse
 - The World Wide Web
 - GPS
 - PDAs and the like
 - Google, Yahoo, Ebay, etc.
 - Wikipedia



Human Factors and the ACI

- Many more to come...
 - Virtual worlds and personae
 - Virtual laboratories and classrooms
 - New technologies for data visualization, exploration, and manipulation
 - New modes of transportation
 - ???



Human Factors and the ACI

- The interface of technology and human behavior seems to be increasingly important to the information industry
 - Is there evidence for this apparent trend?
 - Is it reflected in US hiring and education?
 - Is it reflected outside the US?



Human Factors and the ACI

- One could argue that technological advances will increasingly require interdisciplinary teams of engineers and behavioral scientists, especially human factors engineers
 - E.g., Xerox PARC
- From this perspective, the behavioral sciences have a key role to play in “rising above the gathering storm”