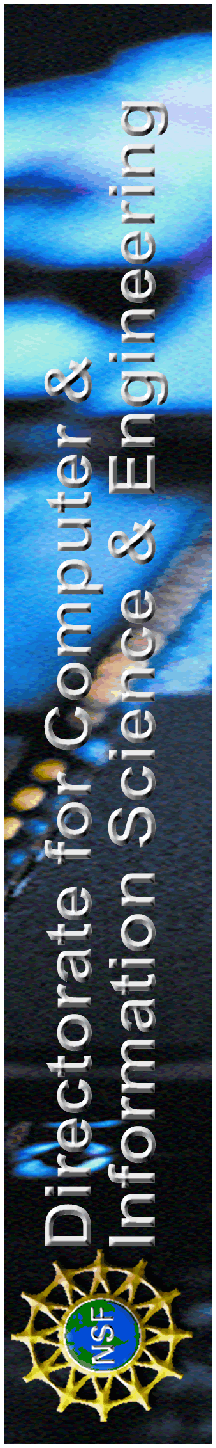
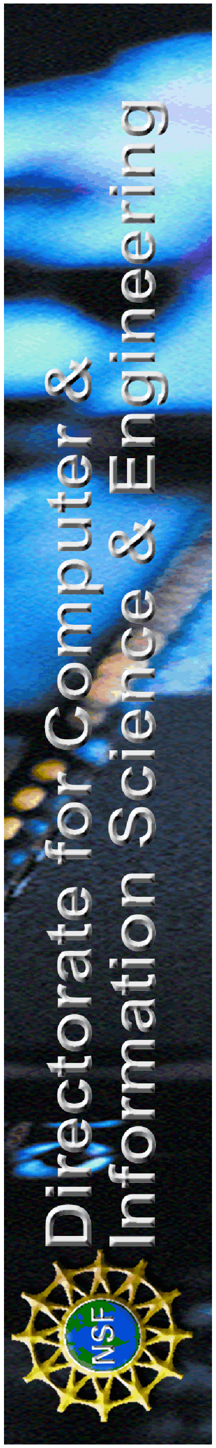


Funding Opportunities

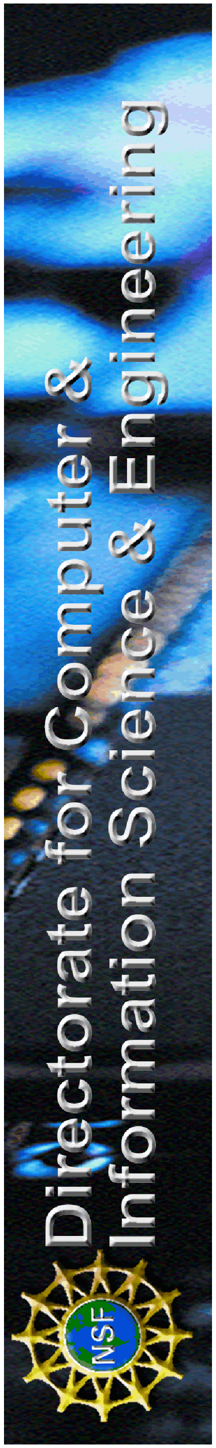
NSF/CISE Directorate

Almadena Chtchelkanova
Program Director
achtchel@nsf.gov



Currently Open and Future Solicitations

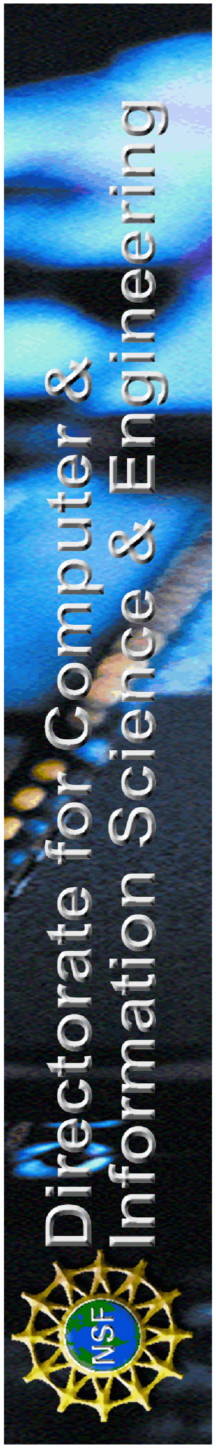
- Foundations of Computing Processes and Artifacts (CPA) Due December 07, 2007
- Expeditions in Computing Letters of Intent due Nov. 5, Pre-proposals Dec. 30, 2007
- Cyber-enabled Discovery and Innovation (CDI) will be published by September 30, 2007



Foundations of Computing Processes and Artifacts (CPA)

The CPA Cluster supports basic research and education projects aimed at advancing formalisms and methods pertaining to processes and artifacts for designing and building computing and communication systems

- Processes and artifacts range from formalisms, models, algorithms, theories, design principles and languages to hardware/software architectures, technology components, and a variety of physical manifestations and implementations
- The CPA cluster funds a diverse portfolio of high-quality, high-payoff *foundational* research to meet the needs of the scientific and engineering community as well as society at large

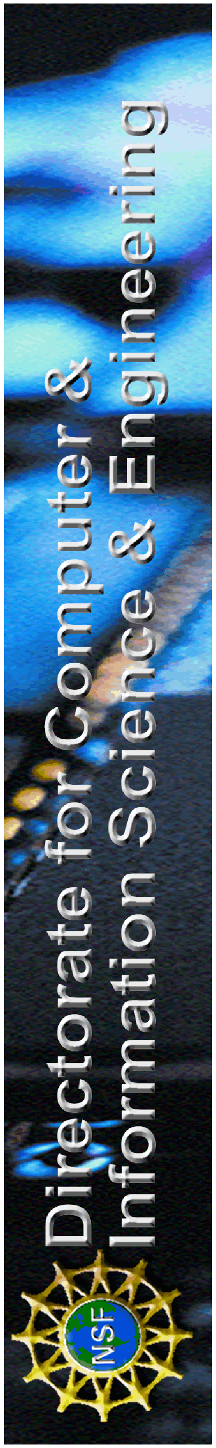


Foundations of Computing Processes and Artifacts (CPA)

- Current CPA focus areas and Program Directors

ACR	Advanced Computation Research (Algorithms, Storage, I/O, HPC)	Almadena Chtchelkanova (since 2005)
CHS	Compilers and High-performance Software	Almadena Chtchelkanova (since 2005)
CSA	Computer System Architecture	Timothy M. Pinkston (since 2006)
DA	Design Automation for Micro & Nano Systems (VLSI)	Sankar Basu (since 2003)
GV	Graphics & Visualization	Lawrence Rosenblum (since 2005)
SEL	Software Engineering & Languages	Sol Greenspan (since 2003) Joseph Urban (since 2006)

- Each focus area can have topics of specific interest, but *clustering* promotes cross-disciplinary research that may transcend programmatic/area boundaries



Advanced Computation Research (ACR)

Hardware/software research and enabling technologies for advancing the state-of-the-art in computational science and engineering, developing efficient HPC computational algorithms, high throughput input/output (I/O) capabilities, large data storage capacities, and tools for efficiently organizing, locating, and moving data produced by different applications in numerous locations and in various formats

Topics of interest include:

- Design of multi-level (hierarchical, layered) parallel algorithms and libraries
- Scalable and latency tolerant computational/numeric algorithms
- Performance modeling of scalable algorithms
- Management of large-scale distributed file systems and data
- Novel storage devices, architectures, and middleware for high-throughput I/O
- Software and hardware processes and artifacts for design, simulation, benchmarking, tracing, performance measurement, and tuning of I/O, file, and storage systems in high-performance computing environments

Directorate for Computer & Information Science & Engineering

Compilers & HP Software (CHS)

Foundations in compilers research and education for enabling automatic algorithm mapping, code and data transformation, translation to hardware description language (for reconfigurable architectures), advanced analysis to verify program correctness and improve programmer productivity, compiler support for automating the exploitation of parallelism (i.e., parallelizing compilers for single-threaded and multi-threaded programs for multicore & multiprocessor systems)

Topics of interest include:

- Parallelizing compilers and infrastructure for optimizing compilers for multiple platforms, including reconfigurable architectures
- Parallelization techniques for exploiting parallelism at multiple levels applicable to multiple programming models
- Software and compiler support for mapping and scheduling multiple threads on (possibly heterogeneous) multicore and multiprocessor systems
- Software and compiler techniques for managing on-chip communication, power consumption, temperature, and fault tolerance
- Compiler techniques to guarantee safety from potential deadlocks, memory leaks, race conditions, and other forms of correctness in parallel programs

Directorate for Computer & Information Science & Engineering

Computer System Architecture (CSA)

Foundations in computer system architecture research and education for facilitating and enabling scalable performance, power and thermal management, reliability (soft and hard error detection and recovery), dynamic adaptation, real-time computation, security, reduced design complexity, programmability, and other enhanced functionalities

Topics of interest include:

- Processor microarchitecture, memory, and interconnection networks: multithreaded, multicore, and multiprocessor architectures; distributed register and cache architectures; on-chip networks
- Novel architectures and hardware primitives that facilitate concurrency and exploit parallelism at multiple levels and in multiple forms: fine-grained, instruction, data, thread, stream, task, and coarse-grained
- Architectural techniques for managing on-chip communication, power consumption, temperature, operational variability, error/fault tolerance
- Application-to-hardware mapping: application-specific processors, programmable accelerators, and reconfigurable computing
- Design and analysis of computer systems: tools and methods for design space exploration; modeling, benchmarking, simulation, synthesis, and performance evaluation

Design Automation for Micro and Nano Systems (DA)

Foundations in VLSI design automation in both CMOS silicon technology and future computing media (i.e., MEMs, 3-D, optical, molecular, and nano-scale technologies) to meet the needs of deep submicron VLSI computing and communication chips

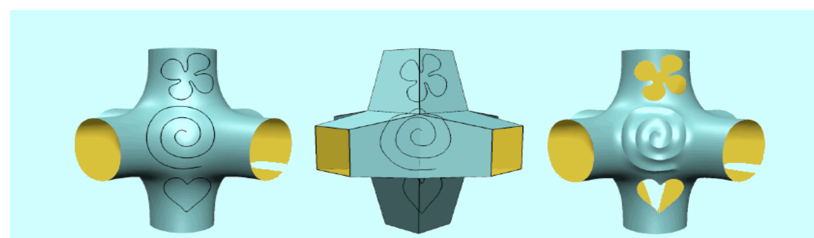
Topics of interest include:

- **Physical design: routing & layout, power optimization, logic synthesis, on-chip communication, modeling & device simulation**
- **System-level design: systems-on-a-chip, multicore, embedded, and application-specific processor design; hardware/software co-design**
- **Test and verification: analog and digital mixed-signal systems, built-in self-test, design for testability, formal proof of correctness**
- **Nano-scale design related to the circuits/architecture interface: novel approaches to parallelism suitable to nano-scale electronics, systems integration of nano-scale devices, design of reliable systems from unreliable components, defect/fault models, fundamental limits to such designs**

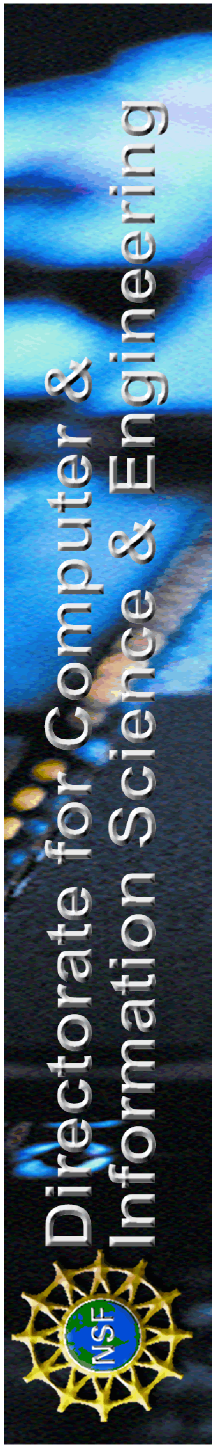
Graphics & Visualization (GV)

- **Integrated research and education projects to advance the scientific foundations and engineering practices/education that underlie the ability to perform visual information transfer, address models of physical events, develop mechanisms for image production, and utilize visualization to represent and explore information**
- **Focus is on the ability to model, render, and display data and to understand the forms of visualization that can best transfer particular types of information**
- **Seek *fundamental* advances that will enhance the numerous activities that utilize computer graphics and visualization, including science, engineering, medicine, entertainment, education, commerce, and homeland security**

Computer-generated lighting effects using flash photography [Durand, MIT]



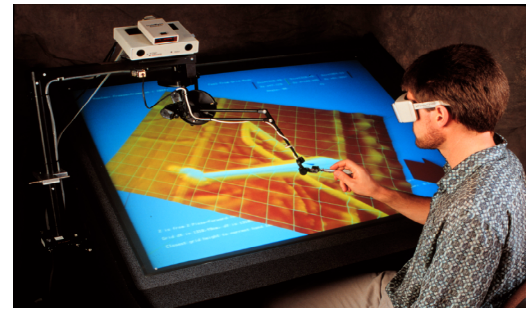
Multiresolution Subdivision Surfaces simplify the addition of sharp surface features onto surfaces [Zorin, NYU]



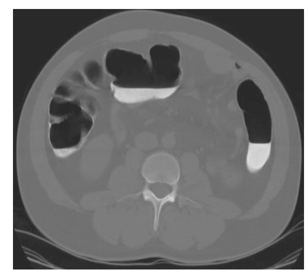
Graphics & Visualization (GV)

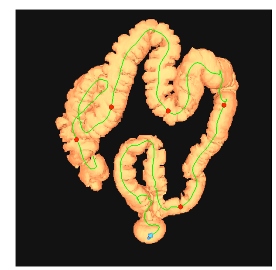
Topics of interest include:

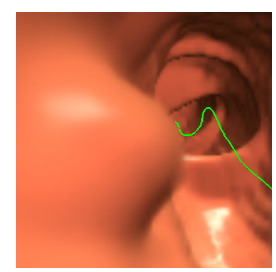
- Mathematical models for representing geometric and non-geometric data
- Algorithms for the photorealistic and non-photorealistic rendering of geometry, lighting, and materials
- Physical-based modeling and graphical simulation
- Animation techniques
- Multi-resolution algorithms for graphics modeling and applications
- Visibility algorithms
- Scientific visualization algorithms and systems
- Visualization aspects of visual analytics
- Visualization aspects of location-aware computing
- Virtual and augmented reality
- Novel hardware for graphics processing
- Graphics issues in computational photography and video
- Innovative multidisciplinary proposals that join visualization with other computer-science domains



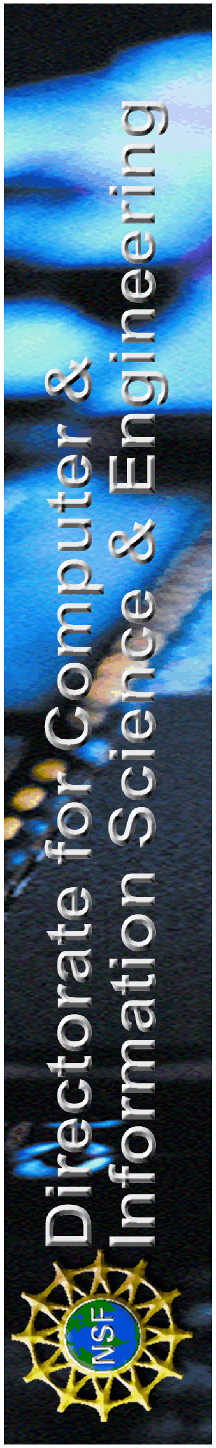
The **nanoManipulato**r system enables scientists to directly see and touch nanometer-scale objects [Taylor et al., UNC]







The steps of the **Virtual Colonoscopy**: CT scan of patient's abdomen; automatic segmentation and reconstruction; real-time volume rendering [Arie Kaufman, SUNYSB]



Software Engineering and Languages (SEL)

- Integrated research and education projects to advance the scientific foundations and engineering practices/education that contribute to new understanding of software and software development issues with an <u>objective of significantly increasing productivity of software development and attaining the highest quality software-based products and services</u>
- Relevant projects may concern any of the artifacts and processes involved in software engineering—including languages, theories, models, techniques, methods, tools and environments relating to requirements, specification, design, programming, verification, testing, maintenance, transformation, evolution and other activities of software development
- Proposals should emphasize lasting principles, robust theories, high-leverage tools and novel approaches with plans for validation through proofs of concept, empirical evaluation and/or other scientific methods

Directorate for Computer & Information Science & Engineering

Software Engineering and Languages (SEL)

Topics of interests include:

- **Programming language principles, design and implementation**
  - PL semantics to elucidate new features, e.g., aspects
  - Advancing type theory to full theorem proving
- **Software analysis and testing**
  - Test-case generation, fault localization
  - Static and dynamic checking, model checking
  - Monitoring and continuous testing of distributed systems
- **Formal methods for program development – components and composition**
  - Assembling components to meet a specification, trusted components, behavioral interfaces
- **Software development methodology**
  - Informal methods, integrated environments, processes,

Directorate for Computer &
Information Science & Engineering

Cyber-enabled Discovery and Innovation (CDI)

Dr. Sirin Tekinay,

Chair, CDI Implementation Team

National Science Foundation

FY 2008 Budget Request

2008
BUDGET
REQUEST

$6.43 billion

(Increase over FY 2007 Request: $409 million, 6.8%)

FY 2008 Budget Request by Appropriations Account (millions)

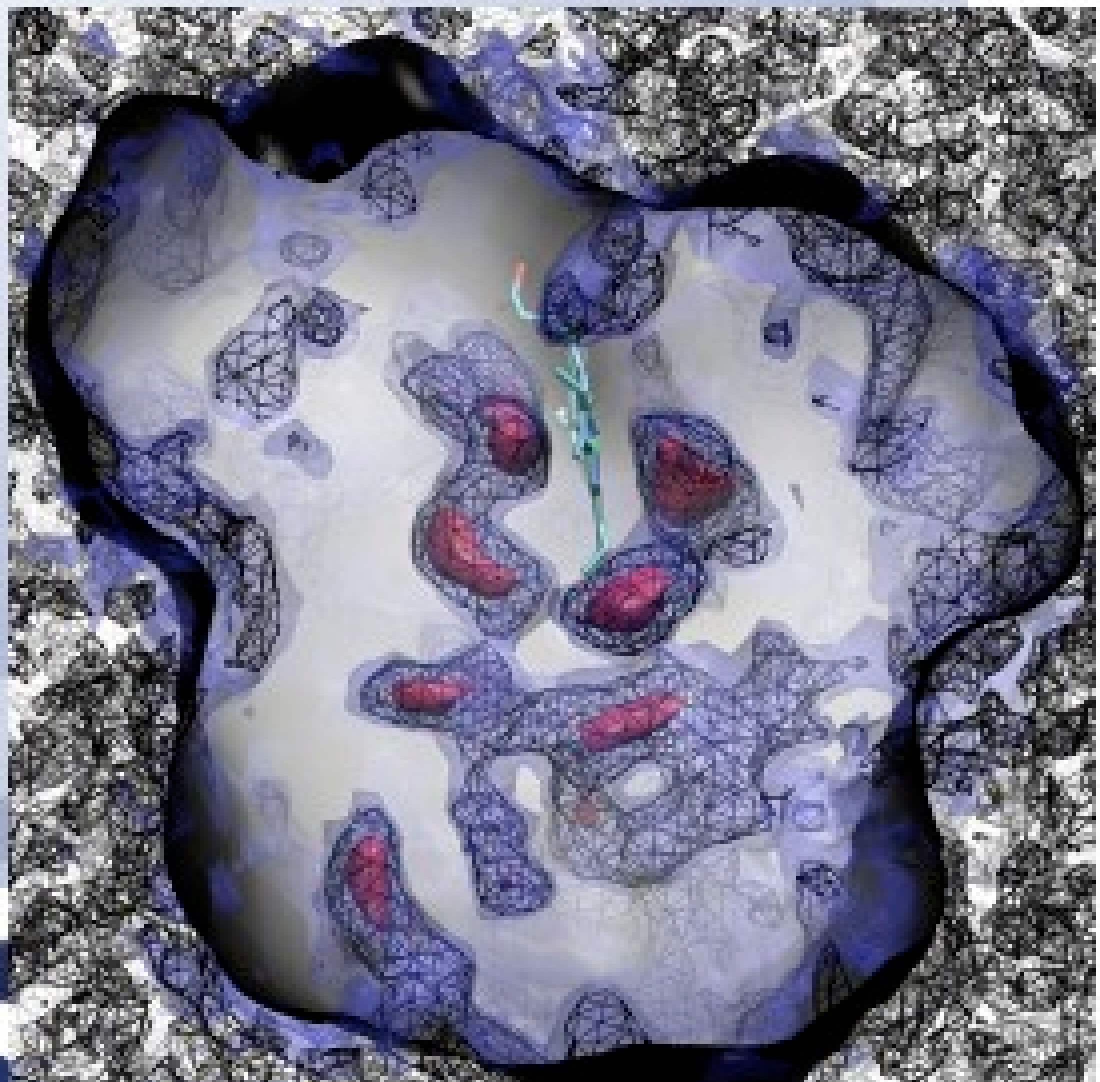
2008 BUDGET REQUEST

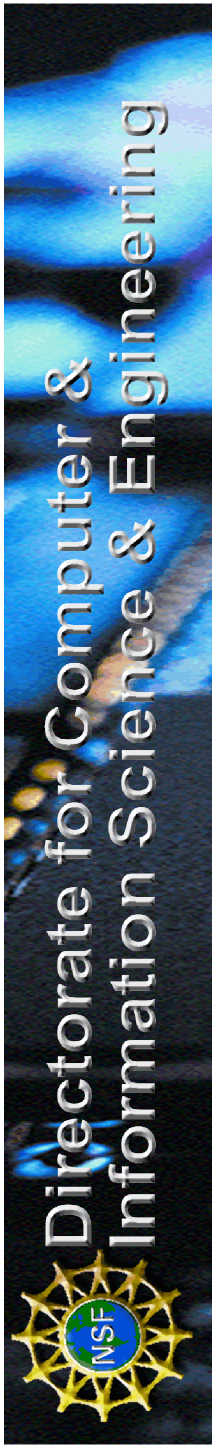
Appropriations Account	FY 2008 Request	Change from FY 2007 Request	
Research & Related Activities	$5,131.69	$365.74	(7.7%)
Education & Human Resources[1]	$750.60	$34.38	(4.8%)
Major Research Equipment & Facilities Construction	$244.74	$4.29	(1.8%)
Agency Operations & Award Management	$285.59	$3.77	(1.3%)
National Science Board	$4.03	$0.12	(3.1%)
Inspector General	$12.35	$0.49	(4.1%)
TOTAL, NSF	**$6,429.00**	**$408.79**	**(6.8%)**

Totals may not add due to rounding.
[1] Funding for EPSCoR is moved to R&RA in FY 2008.

Cyber-enabled Discovery for Innovation (CDI)

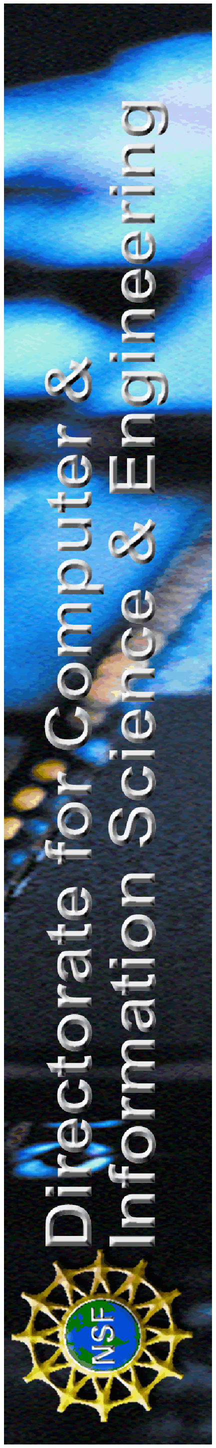
2008 BUDGET REQUEST





Cyber-enabled Discovery and Innovation

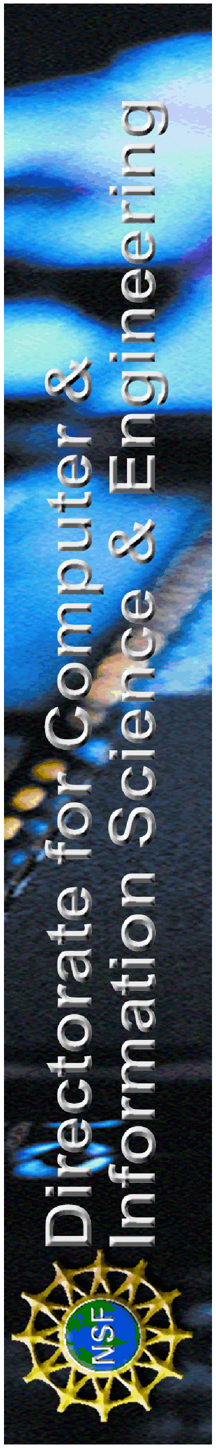
- Five thematic areas for multi-disciplinary research relying on, and promoting advances in, computational thinking
- Computational thinking refers to computational…
  - …Concepts
  - …Methods
  - …Models
  - …Algorithms
  - …Tools



Long-term Funding for Cyber-enabled Discovery and Innovation

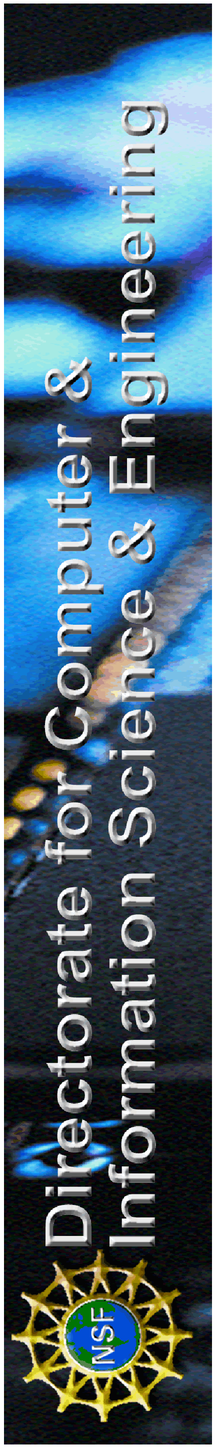
- **All NSF directorates are participating in this activity (*subject to budget approval*)**

Request FY 2008	**FY 2009**	**FY 2010**	**FY2011**	**FY 2012**
$52M	**$100M**	**$150M**	**$200M**	**$250M**



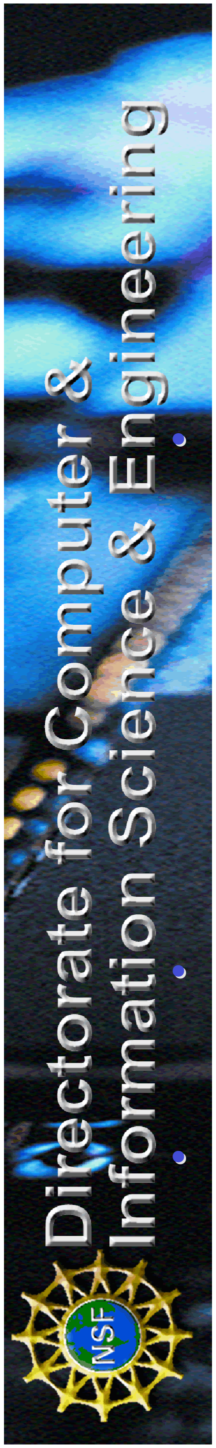
Cyber-enabled Discovery for Innovation (CDI): Five Themes

- Knowledge extraction.
- Interacting elements.
- Computational experimentation.
- Virtual environments.
- Educating researchers and students in computational discovery.



Knowledge extraction.

- **Knowledge extraction encompasses a variety of techniques – data mining, visualization, utilization of basic concepts from computation, geometry and topology – to help scientists and engineers find what is most important in the almost infinite amounts of data from sensors, telescopes, satellites, the media, the Internet, surveys, etc.**
- **Combining underlying conceptual ideas with heterogeneous data from multiple sources, high-bandwidth communications, and tera- to petascale computational power, scientists and engineers will be able to make sense of the massive volumes of data that bear on their grand challenges and address one of the most daunting challenges of the present century. This theme will improve across current techniques, which are insufficient for these challenges.**

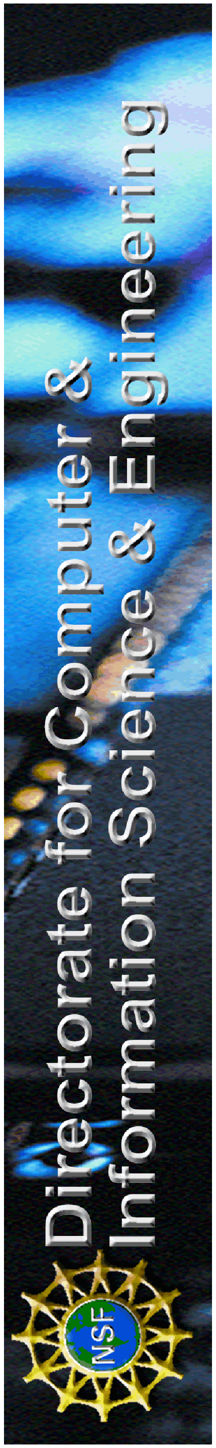


Complex interactions

- Analyzing the flow of electricity or information across the electric power grid or the Internet, describing protein folding and unfolding and finding superposition principles for scaling from the quantum- to the nano- to the macro-scales are examples of grand challenges that require scientists and engineers to understand interacting systems. Such systems, ranging from particles to galaxies and from computer networks to societies, are at the heart of many science and engineering grand challenges, and their understanding and control are major sources of innovation.
- Key factors in such systems are the large number of interacting elements, non-linearity of interactions, and aggregate or emergent phenomena observed at certain scales.
- This theme will improve both forward (predictive) and inverse (deductive) capabilities in order to better understand nature, and be able to design, control and make decisions about complex systems.

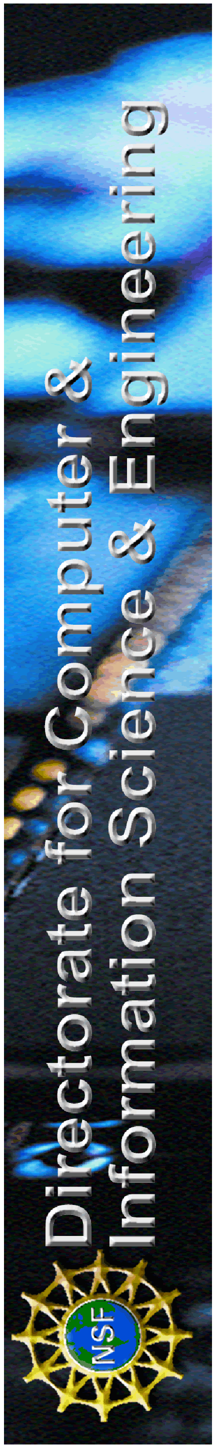
Computational experimentation.

- We cannot generate a hurricane to see how it develops and progresses; use routine brain surgery to experiment on neural synapses in the brain; or rerun the “Big Bang” to see how the physics of the universe develops.
- Computational experimentation allows insight into complex systems by enabling the creation of a virtual description (algorithmic or computational) that can interact with elements from the real world. Simulation and other dynamic modeling techniques allow us to experiment with complex systems in ways that would be unimaginable in the real world, and to constrain our understanding of the system characteristics or underlying physical phenomena. Furthermore, it allows us to guide real world operations and experimentation in cases that have potential for unforeseen or extreme events.
- Research in this area will provide needed new modeling techniques ranging from mathematical formulations to multi-scale simulation techniques.



Virtual environments.

- **Scheduling and operation of distributed facilities and sensor arrays, data extraction and analysis, international real time comparative analyses of global climate models, and injecting discovery and innovative environments in STEM learning and training - all require the use of virtual environments as important mechanisms to enhance discovery, learning, and innovation.**
- **Virtual environments enabled by cyberinfrastructure permit collaboration among diverse populations spread across geographic distances and time zones.**
- **This theme will develop new techniques for building and utilizing virtual environments, especially in the context of cyberinfrastructure.**

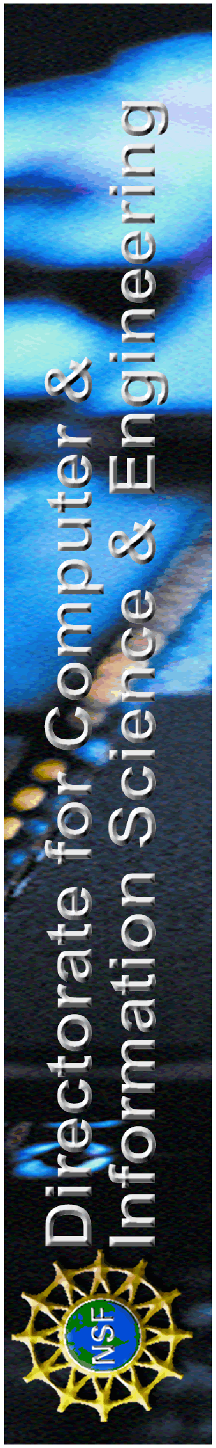


Educating researchers and students in computational discovery

- **Without explicit attention to this, the promise of new capability, as well as the translation of these capabilities into other segments of the economy, will not be realized.**
- **We will emphasize integrating computational discovery techniques into the basic education of all scientists and engineers as well as development of new techniques for use in all areas, not just science and engineering.**
- **Research on the role and impact of computational discovery in education, educational practice and learning in general is also important.**

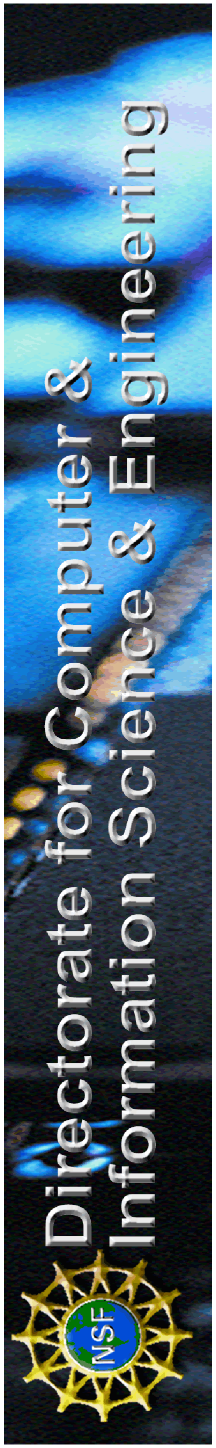
Cyber-enabled Discovery for Innovation

- **Sources of information:**
  - NSF website (www.nsf.gov): see FY 2008 Budget Request
  - News release: http://www.nsf.gov/news/news_summ.jsp?cntn_id=108366
  - Description: http://www.nsf.gov/about/budget/fy2008/pdf/39_fy2008.pdf



CDI FACTS

- CDI Implementation Team:
  - Representatives from seven research directorates and Office of Cyberinfrastructure
- Solicitation posting by September 30
- ≥ $26M committed to CDI program in 2008
  - Expected to evolve with collaborations in community and increasing NSF sponsorship
- First set of awards by July 2008



CDI Philosophy

- Contributions to more than one area of science or engineering including computer and information sciences, by developing and applying computational thinking
  - Multidisciplinary projects stimulating advances in concepts, methods, models, algorithms, tools
- "Business as usual" need not apply; no place for incremental research
- Untraditional approaches and collaborations welcome
- The five themes can be folded onto three areas of foci:
  - Deriving new knowledge from data
    - extraction, representation, integration
  - Understanding complexity
    - in social, built, and natural systems

Directorate for Computer & Information Science & Engineering

Food for Thought

- Science is under funded – would you agree?
- Research needs to be long term – would you agree?
- Yet, we publish highlights annually to justify next year's funding
- Therefore, we, the research community, come across as "cost (time, funding) effective"
- Let us show what can be done with additional resources put into research/

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