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Biocomplexity in the Environment (BE) for : Integrated Research and Education in Environmental Systems

- **Dynamics of Coupled Natural and Human Systems (CNH)**
- **Coupled Biogeochemical Cycles (CBC)**
- **Genome-Enabled Environmental Science & Engineering (GEN-EN)**
- **Instrumentation Development for Environmental Activities (IDEA)**
- **Materials Use: Science, Engineering, & Society (MUSES)**

Program Solicitation

NSF-02-010

DIRECTORATE FOR GEOSCIENCES
DIRECTORATE FOR BIOLOGICAL SCIENCES
DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING
DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES
DIRECTORATE FOR ENGINEERING
DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES
DIRECTORATE FOR SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES
OFFICE OF POLAR PROGRAMS

FULL PROPOSAL DEADLINE(S) :

January 24, 2002	**Deadline for CNH and IDEA**
February 20, 2002	**Deadline for CBC and GEN-EN**
March 14, 2002	**Deadline for MUSES**

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SUMMARY OF PROGRAM REQUIREMENTS

GENERAL INFORMATION

Program Title: Biocomplexity in the Environment (BE) for FY 2002: Integrated Research and Education in Environmental Systems

Synopsis of Program: This special competition promotes comprehensive, integrated investigations of environmental systems using advanced scientific and engineering methods. The concept of biocomplexity stresses the richness of biological systems and their capacity for adaptation and self-organizing behavior. By placing biocomplexity studies in an environmental context, this competition emphasizes research with the following characteristics: (a) a high degree of interdisciplinarity; (b) a focus on complex environmental systems that include interactions of non-human biota or humans; and (c) a focus on systems with high potential for exhibiting non-linear behavior. In this third year of a multi-year effort, five topical areas will be emphasized: 1. Dynamics of Coupled Natural and Human Systems (CNH); 2. Coupled Biogeochemical Cycles (CBC); 3. Genome-Enabled Environmental Science and Engineering (GEN-EN); 4. Instrumentation Development for Environmental Activities (IDEA); 5. Materials Use: Science, Engineering, & Society (MUSES).

In all areas, quantitative modeling, simulation, analysis, and visualization methods are emphasized, as well as integration of education and a global perspective. Consistent with the guidance provided in each of the five topical areas, individuals or small groups may submit proposals to conduct research projects or exploratory and planning activities. This comprehensive approach to research on biocomplexity in the environment is expected to improve science-based predictive capabilities for decision-making.

Cognizant Program Officer(s):

- For contacts in *Dynamics of Coupled Natural and Human Systems*, see www.geo.nsf.gov/be-02.htm#cnh.
- For contacts in *Coupled Biogeochemical Cycles*, see www.geo.nsf.gov/be-02.htm#cbc.
- For contacts in *Genome-Enabled Environmental Science & Engineering*, see www.geo.nsf.gov/be-02.htm#genen.
- For contacts in *Instrumentation Development for Environmental Activities*, see www.geo.nsf.gov/be-02.htm#idea.
- For contacts in *Materials Use: Science, Engineering, & Society*, see www.geo.nsf.gov/be-02.htm#muses.
- For contacts about the integrative element on *Education*, see www.geo.nsf.gov/be-02.htm#edu.
- For contacts about the integrative element on *Global Perspective*, see www.geo.nsf.gov/be-02.htm#gp.
- For contacts about the integrative element on *Quantitative Approaches*, see www.geo.nsf.gov/be-02.htm#qa.

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.074 --- Biological Sciences
- 47.070 --- Computer and Information Science and Engineering
- 47.076 --- Education and Human Resources
- 47.041 --- Engineering
- 47.050 --- Geosciences
- 47.049 --- Mathematical and Physical Sciences
- 47.078 --- Office of Polar Programs
- 47.075 --- Social, Behavioral and Economic Sciences

ELIGIBILITY INFORMATION

- **Organization Limit:** None
- **PI Eligibility Limit:** None
- **Limit on Number of Proposals:** None

AWARD INFORMATION

- **Anticipated Type of Award:** Standard Grant
- **Estimated Number of Awards:** 40-50 of which approximately 20-25 will be for research projects and 20-25 will be for exploratory, conference, or planning activities (total of five topical areas)
- **Anticipated Funding Amount:** Approximately $37.5 million (total of five topical areas), pending availability of funds.

PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

- **Full Proposals:** Deviations From Standard Preparation Guidelines
    - The program announcement/solicitation contains deviations from the standard Grant Proposal Guide (GPG) proposal preparation guidelines. Please see the full program announcement/solicitation for further information.

B. Budgetary Information

- **Cost Sharing Requirements:** Cost Sharing is not required.
- **Indirect Cost (F&A) Limitations:** Not Applicable.
- **Other Budgetary Limitations:** Other budgetary limitations apply. Please see the full program announcement/solicitation for further information.

C. Deadline/Target Dates

- **Letters of Intent (*optional*):** None
- **Preliminary Proposals (*optional*):** None
- **Full Proposal Deadline Date(s):**

January 24, 2002	**Deadline for CNH and IDEA**
February 20, 2002	**Deadline for CBC and GEN-EN**
March 14, 2002	**Deadline for MUSES**

D. FastLane Requirements

- **FastLane Submission:** Required
- **FastLane Contact(s):**
    - Brian Dawson, Computer Specialist, Directorate for Geosciences, Division of Earth Sciences, telephone: 703.292.4727, e-mail: bdawson@nsf.gov.
    - Florence Rabanal, Fastlane Project Coordinator, Directorate for Mathematical and Physical Sciences, telephone: 703.292.8808, e-mail: mpsoadfl@nsf.gov.
    - Philip Johnson, Computer Specialist, Directorate for Social, Behavioral, and Economic Science, Division of Behavioral and Cognitive Sciences, telephone: 703.292.8740, e-mail: pxjohnso@nsf.gov.

PROPOSAL REVIEW INFORMATION

- **Merit Review Criteria:** National Science Board approved criteria. Additional merit review considerations apply. Please see the full program announcement/solicitation for further information.

AWARD ADMINISTRATION INFORMATION

- **Award Conditions:** Additional award conditions apply. Please see the program announcement/solicitation for further information.
- **Reporting Requirements:** Standard NSF reporting requirements apply.

I. INTRODUCTION

Biocomplexity refers to the dynamic web of often surprising interrelationships that arise when components of the global ecosystem--biological, physical, chemical, and the human dimension--interact. Investigations of Biocomplexity in the Environment are intended to provide a more complete understanding of natural processes and cycles, of human behaviors and decisions in the natural world, and of ways to use new technology effectively to observe the environment and sustain the diversity of life on Earth. By placing biocomplexity studies in an environmental context, this competition emphasizes research with the following characteristics: (a) a high degree of interdisciplinarity; (b) a focus on complex environmental systems that includes interactions of non-human biota or humans; and (c) a focus on systems with high potential for exhibiting non-linear or highly coupled behavior with other systems.

Emphasis is also placed on developing the people and tools needed to advance biocomplexity studies. To establish and strengthen interdisciplinary areas of investigation, new communities of investigators need to be formed. This can be accomplished by bringing members of disparate disciplines into teams, by developing new methodologies and expertise, and by reaching beyond the borders of the United States for partners in inquiry. In the process, the next generation of researchers learns to work in diverse teams, cross disciplinary boundaries, and use advanced sensing and monitoring, communication and information technologies to work across many scales of time and space. Plans for the development of new instrumentation and novel modes of access to information are also included.

Five interdisciplinary areas will be emphasized and supported in this competition, pending availability of funds. These areas are:

- Dynamics of Coupled Natural and Human Systems (CNH), emphasizing quantitative understanding of the short- and long-term dynamics of natural capital and how humans value and influence ecosystem services and natural resources, including consideration of landscapes and land use and the influences of uncertainty, resilience and vulnerability in complex environmental systems on societal institutions.

- Coupled Biogeochemical Cycles (CBC), focusing on the interrelation of biological, geochemical, geological, and physical processes at all temporal and spatial scales, with particular emphasis on understanding linkages between chemical and physical cycles and the influence of human and other biotic factors on those cycles.

- Genome-Enabled Environmental Science and Engineering (GEN-EN), encouraging the integrated use of genomic and computational approaches to gain novel insights into environmental questions and problems.

- Instrumentation Development for Environmental Activities (IDEA), supporting the development of instrumentation and software that takes advantage of microelectronics, photonics, telemetry, robotics, chemical and physical sensing systems, modeling, data mining, and analysis techniques to bring recent laboratory instrumentation advances to bear on the full spectrum of environmental biocomplexity questions.

- Materials Use: Science, Engineering, and Society (MUSES), supporting projects that study reducing adverse human impact on the total, interactive system of resource use, the design and synthesis of new materials with environmentally benign impacts on biocomplex systems, as well as maximizing the efficient use of individual materials throughout their life cycles.

II. PROGRAM DESCRIPTION

Program Description Contents

A. Integrative Elements

1. Quantitative Approaches
2. Education
3. Global Perspective

B. Topical Areas

1. Dynamics of Coupled Natural and Human Systems (CNH)
2. Coupled Biogeochemical Cycles (CBC)
3. Genome-Enabled Environmental Science and Engineering (GEN-EN)
4. Instrumentation Development for Environmental Activities (IDEA)
5. Materials Use: Science, Engineering, and Society (MUSES)

A. INTEGRATIVE ELEMENTS

Quantitative approaches and education activities must be incorporated in all projects and international partnerships are strongly encouraged.

- An integrated, quantitative, systems-level method of inquiry is essential in biocomplexity studies.
- Education must be addressed and integrated effectively with all research plans. Educational activities should provide learning opportunities for students at appropriate levels (ranging from grades K-12 through graduate school), and the general public.
- A global perspective is expected in all proposals. Wherever appropriate and practical, specific international collaborations and networks for research and education are strongly encouraged.

1. Quantitative Approaches. In all topical areas described in Section II.B., competitive projects will be those that take a systems approach to questions central to biocomplexity in the environment. Such projects involve the study of non-linearities, feedback processes, or explicit and *a priori* integration across multiple components or scales of time and space, and use a conceptual, mathematical or computational model, computer simulation, or artificial intelligence technique to direct the research. Mathematical models must include estimates of uncertainty and experiments should be designed to attain a high level of precision. Proposals submitted by teams should identify which individual(s) will oversee the quantitative approaches and provide evidence of their demonstrated expertise in data collection, mathematical modeling, and/or data analysis.

2. Education. Competitive projects will be those that provide integrated research and education experiences for participants (including undergraduates, graduate students, teachers, and postdoctoral associates) and/or individuals beyond those directly involved in the project. Investigators are encouraged to include students as active participants on interdisciplinary teams. Proposals may address, for example, the development of materials for use in integrative, comprehensive curricula dealing with the diverse character of biocomplexity in the environment. Informal education channels, such as science centers, aquariums, and similar facilities, that are easily accessible and attractive to the public may be used to help enhance the public's ability to deal with complex environmental information and make informed decisions about the environment. Educational efforts at the K-12 level should promote the acquisition of scientific inquiry skills, take advantage of technology and use it appropriately, and be consistent with the National Science Education Standards. (For more information about these standards, see www.nap.edu/catalog/4962.html and www.nap.edu/catalog/5704.html).

Examples of specific education plans, as well as other activities that respond to the Broader Impacts Criterion, are provided in http://www.nsf.gov/od/opp/opp_advisory/oaccrit2.htm. Some specific examples of products that will benefit society include exhibits, databases, computer-based simulations, or kits that could be used by students or the public to collect and analyze data.

Reviewers will be asked to consider and evaluate the educational activities. Please refer to the section, “Integration of Research and Education” in Section VI.A of this solicitation.

Consistent with NSF’s emphasis on the integration of research and education in projects solicited and funded by the Foundation, grantees are encouraged to include a section that describes the educational implications of their research work in the papers they submit for publication.

3. Global Perspective. Because environmental processes transcend national boundaries, collaborations between U.S. investigators and foreign counterparts are encouraged wherever appropriate. Many research projects offer excellent opportunities for students at US and foreign institutions to gain experience in the conduct of research in other countries. NSF awards are normally limited to support of the U.S. portion of the collaboration. In the case of some developing countries, limited funds may be available to support the involvement of the foreign collaborator. Investigators may wish to consult with the cognizant program officers for Global Perspectives listed in the section on contact information. For information about NSF support for international collaborative programs, see NSF 00-138.

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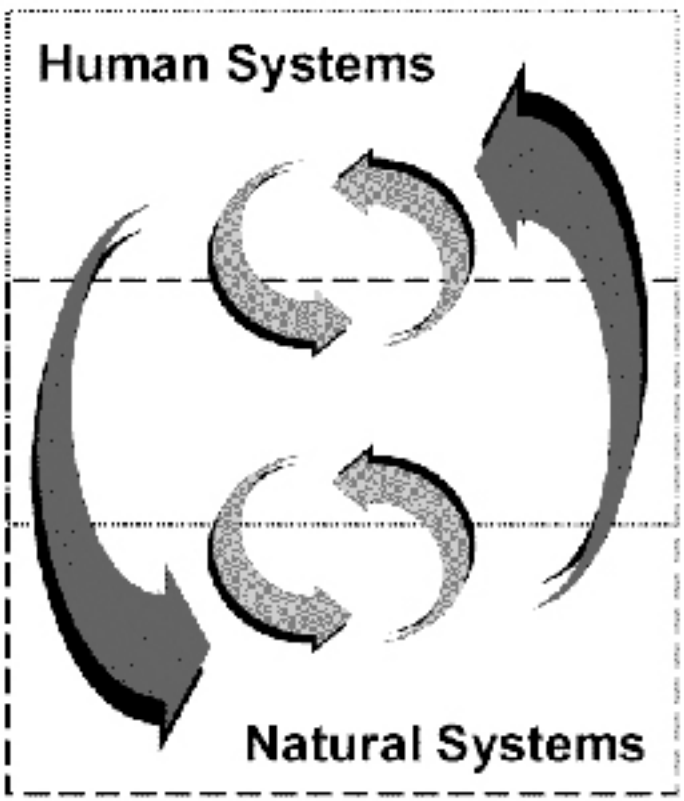
B. TOPICAL AREAS

Proposals must be focused on biocomplexity questions in one of the following five topical areas:

1. Dynamics of Coupled Natural and Human Systems (CNH)

This topical area focuses on the complex interactions among human and natural systems at diverse spatial, temporal, and organizational scales. To be competitive for support, teams of investigators drawn from relevant natural, social, and mathematical sciences, engineering, and education must examine the dynamics of appropriate natural and human systems as well as the interactions that link those human and natural systems. These relationships are symbolized by the arrows in the accompanying figure



Competitive projects in the CNH topical area will be those examining problems that draw on and show promise of enhancing theoretical insights about relevant human system processes, relevant natural system processes, and the interactions among human and natural systems. The interdisciplinary teams undertaking these projects must have appropriate expertise from scientific and engineering disciplines that study those human and natural system processes. They must also have appropriate expertise to undertake proposed quantitative analyses, educational projects, and fundable international collaborations (where appropriate).

Proposals may be submitted on any topic associated with the Dynamics of Coupled Natural and Human Systems, but projects focusing on natural capital; landscapes and land use; and uncertainty, resilience, and vulnerability are of particular interest. "Natural capital" refers to both tangible goods, such as food and fuel, and less tangible services, such as water purification and erosion control, that are provided by functioning ecosystems. Land-use changes often have consequences for biodiversity, regional climate, or hydrological patterns, so broadly interdisciplinary studies focused on the interplay of the built environment, natural resource use and conservation, and social, ecological, and geophysical factors are appropriate. Projects aimed at understanding the nature and dynamics of uncertainty, the resilience and vulnerability of social institutions to environmental change, and the resilience and vulnerability of biophysical systems to human-generated pressures are of interest, as are investigations of how institutions and policies for managing the natural resource base respond to change or to the potential for change.

Examples of research projects that might be funded through this competition include:

- Development of an integrated model that links economic models of urban development with models of land-cover change and ecosystem processes in order to assess relationships between urban development and species diversity.
- Cross-national research that explores spatial complexity, the value of natural capital in grazed ecosystems, the costs of complexity loss due to fragmentation, and the trade-offs between economic inputs and ecological complexity.
- Integration of circulation, population, habitat, and socioeconomic models to assess how biological reserves function in a coral reef ecosystem, how different stakeholder groups influence the operation of the reserves, and the efficacy of different reserve designs in promoting both local economic development and ecosystem preservation.
- The role that access (or lack of access) to scientific information plays in environmental justice, and the most effective methods for disseminating scientific information to traditionally disenfranchised groups.

Projects may be totally independent activities, or they may be conducted in association with existing projects or activities, including Long-Term Ecological Research sites, NSF-supported Human Dimensions of Global Change centers and teams, NSF Science and Technology Centers or NSF Engineering Research Centers, or similar venues. If the proposed activity is associated with other activities currently supported by NSF or other funders, the project description should make clear how the proposed work is different from lines of inquiry and activities for which support has already been acquired. A letter from the director of the ongoing activity or center agreeing to the proposed project should be included as Supplementary Documentation (Section I).

Most of the approximately $7.5 million expected to be available in this topical area will be used to support multi-investigator research and education projects and programs of three to five years duration. Support for any major award will not exceed a cumulative total of $2,000,000 for the duration of the award. A limited number of small awards (not to exceed $100,000) may be funded in response to proposals for developmental activities. Examples of the kinds of developmental activities that could be supported are the following:

- Workshops or symposia;
- Proof-of-concept studies and small-scale pilot studies;
- High-risk exploratory research;
- Cross-disciplinary personal development projects. For example, a researcher in the human sciences might spend a sabbatical working in the lab of a natural science team (or vice versa). These projects would be expected to enable individuals to become focal members of interdisciplinary teams that bridge the natural and human sciences.

In CNH, NSF anticipates making four to six major awards and four to six developmental awards.

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2. Coupled Biogeochemical Cycles (CBC)

One of the central challenges of environmental research is understanding how the physical, chemical, geological, hydrological, and biological processes that comprise the Earth's natural systems are functionally interrelated. Studies of coupled biogeochemical cycles across wide spatial and temporal scales will lead to the development of quantitative knowledge and integrative models for the cycling of water, carbon and other bioactive elements. These research efforts illuminate the complex web of material and energetic pathways connecting environmental processes to the dynamics of life on Earth. Such research will also provide the basis for understanding the co-evolution of Earth and its biosphere and the limits of environmental predictability.

The CBC topical area stresses interrelationships among earth system cycles. Proposals should address linkages between two or more biogeochemical cycles, the fundamental chemical reactions underlying biogeochemical cycles, or biotic influences on a biogeochemical cycle. Specific areas of interest include, but are not limited to:

- Relationships of cycling of carbon to the cycling of other biolimiting elements in terrestrial, atmospheric, polar, freshwater and marine environments, and the feedback relationships between carbon cycling and ecological dynamics, population genetics, ecosystem productivity, and the evolution of species; studies of biological, geochemical and physical mechanisms regulating carbon biogeochemistry may focus on the present or the geologic past.
- Patterns and mechanisms of cycling of life-supporting elements in terrestrial, freshwater, polar and marine ecosystems within regional gradients of chemical, hydrologic and climatic conditions, and feedbacks between elemental cycling and ecosystem structure and function.
- Intersections of the hydrologic and ecologic sciences, for example, climate alteration by terrestrial vegetation, ecosystem and hydrological functions of riparian zones, hydrological controls on aquatic ecosystems, and ecosystem vulnerability and resilience to extreme hydrological events.
- Extent and significance of deep biospheres and life in extreme environments, for example, investigation of biologically controlled or induced mineralization, the production of gas hydrates in polar and marine environments, molecular-scale geomicrobiology, and transport of microorganisms in the subsurface environment.
- Rhizosphere processes, such as greenhouse gas production and carbon sequestration, the effect of soil physical and chemical properties on rhizosphere functioning, alteration of the rhizosphere by changes in land use, and the responses of soil processes to elevated atmospheric carbon dioxide.

Proposals may be submitted by single investigators or by teams, but must be highly interdisciplinary. Proposals may be submitted for projects up to 5-year duration. No project will be supported for more than $400,000 per year. A limited number of small awards (not to exceed $100,000) may be funded in response to proposals for workshops or symposia, meetings to build international or interdisciplinary teams and proof of concept studies, small scale pilot studies, or high-risk exploratory research. Approximately $16 million is expected to be available in this topical area and a total of about 12 awards is expected.

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3. Genome-Enabled Environmental Sciences and Engineering (GEN-EN)

Individual organisms possess powerful but limited capacities to respond to changing environmental conditions. While we have some understanding about these responses at the molecular and cellular levels of organization, few studies have connected this knowledge to relevant genomic information in the individual. Fewer studies have attempted to use genomic information or approaches to understand an organism's impact on its environment or the feedback between an organism and the environment. Additionally, while populations of individuals and communities of species possess an even greater collective diversity of responses, applying genomic information and tools to understand processes occurring at population through ecosystem scales remains a major challenge. Exploiting genomic approaches to connect these scales of analyses offers the opportunity to gain novel insights into environmental issues and problem solving.

GEN-EN encourages studies, using scientific and/or engineering approaches, which develop and use genomic information and tools to further our understanding of how organisms interact with (adjust to and modify) their environment. Genomic approaches are necessary because traditional genetic analyses are not possible for the vast majority of living organisms. Competitive GEN-EN proposals should integrate biological research with research that develops and enhances appropriate computational, mathematical, statistical, simulation and/or visualization techniques. Teams should include appropriate expertise to pursue these methodological advances.

Nearly $7 million is expected to be available for support of 4-5 research proposals from interdisciplinary teams for projects up to 5 years duration, and total budgets up to $2.0 million.

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4. Instrumentation Development for Environmental Activities (IDEA)

This activity will support the development of robust instrumentation and associated software for observing, modeling and analyzing a wide range of complex environmental materials, life forms, and processes. The instrumentation should take advantage of recent advances in microelectronics, photonics, telemetry, robotics, and physical and chemical sensing systems to bring recent advances out of the controlled environment of the laboratory into the full spectrum of the Earth's environments. A unifying theme will be the development of *in situ* instrumentation or remote sensing technologies that minimize environmental impact while increasing real-time data-gathering opportunities. An important goal of research in this area is the development of useful instrumentation that can be widely disseminated and aid production of environmental data of high quality and comparability. Critical to the effective use of advanced instrumentation will be its integration into intelligent, adaptive systems with associated software for data collection, complex modeling, simulation, pattern recognition, management, and analysis. This activity supports the development of new instrumentation, not the deployment or testing of already developed instruments.

Activities in this area might include, but are not limited to:

- Development, use, and dissemination of robust diagnostic systems that can be used for observing and remote sensing of complex environmental systems and processes, including living components or geochemical cycles.

- Development, use, and dissemination of micro-mechanical and/or microelectronic systems (laboratories on a chip) that can be used *in situ* and can withstand the rigors of harsh natural environments.

- Adaptation of laboratory chemical or physical sensing techniques for use in remote *in situ* measurement.

- Development of sensors for microbial activity using recent advances in micro-fabrication that enable high-density arrays of biologically based detection elements, e.g., nucleic acid, enzymatic, or immunochemical.

- Coupling together of space-based observations of environmental phenomena with ground based *in situ* measurements of living systems and environments.

- Development of technology to enhance the acquisition, display and analysis of real-time *in situ* environmental measurements.

In order to encourage the interplay of skills from disciplines such as engineering, chemistry, physics, and computational science with areas such as biology, polar studies, and oceanography, proposals that support interdisciplinary teams or formation of such teams are solicited. Small interdisciplinary teams of typically 3-5 faculty researchers may request up to about $400,000 per year for up to five years. Approximately $5.5 million is expected to be available in this topical area to support 2-4 awards.

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5. Materials Use: Science, Engineering, & Society (MUSES)

Proposals for planning activities to develop interdisciplinary teams are solicited in this new topical area.

Physical and biological environmental systems are ultimate sources of the materials required for the great variety of manufactured goods produced by modern societies. Understanding the supply, treatment, use, and reuse of the resources provided by natural systems as well as the environmental effects of introducing alternative materials or new processes are complex problems that challenge many disciplines. Both technological issues, such as process and product redesign and manufacturing, as well as behavioral factors, such as economic and other social forces that affect consumption and adoption of new technologies and materials, must be addressed. Studies in the Materials Use: Science, Engineering, and Society (MUSES) topical area are aimed at reducing adverse human impact on the total, interactive system of resource use, as well as maximizing the efficient use of individual materials throughout their life cycles. MUSES includes fundamental research on: (a) global budgets and cycles of key materials; (b) means and methods for carefully assessing a material's impact at every stage of its entire life cycle; (c) design of alternative materials, processes, systems, and social structures that optimize the use of materials throughout their life cycles; and (d) modeling the effect of changes in a material's use on related materials and processes.

Research in this topical area must stress the fundamental understanding of comprehensive materials flows that extend from natural resource (physical and biota) materials extraction; through processing and manufacturing, assembly, and distribution and consumer use; and on through recycling, disposal, and reuse. In some cases, the synthesis and characterization of new classes of materials with desired properties may be involved. Models should include relationships among constructed, natural, and social systems and consider continuous materials use in addition to life cycle practice. Energy consumption during life cycle is relevant. Materials use at widely ranging scales is within the scope of MUSES, from niche specialty markets to major construction projects – highways, bridges, large buildings, etc. Also within the scope of MUSES is consideration of materials "escape" during transportation, processing or storage (leaks, accidents).

Illustrative examples of advanced materials that may be considered as part of this activity include, but are not limited to: the synthesis of new materials with value-added functional performance for applications such as biodegradable food containers, electronic materials for sensing in hazardous or extreme environments, disposable hospital products; materials modifications through processing that extend the life or ease the remanufacturability such as hybrid coatings that can be readily removed or upgraded through bioprocessing; and materials substitutions that lead to low emission and fuel efficient engines, or alloys and composites for lightweight aircraft and automobiles.

Specific areas of interest include, but are not limited to:

- Spatially and temporally explicit budgets for key materials, including ways in which human activities define, perturb, dominate or limit materials flow and supply.
- Acquisition, comprehension, and integration of data sets from environmental, economic, and social spheres, and the development of robust ways to utilize potential data intersections to predict materials flows.
- Patterns and driving forces of human consumption of resources, for example, the role of incentives in encouraging less wasteful materials use or the redesign of markets to provide more accurate signals of the societal costs associated with the use of materials.
- Metrics and assessment models for forecasting the results of substituting materials made from renewable resources for those made from non-renewable resources, including trade-offs such as land use and water consumption.
- Design and synthesis of desirable materials with predictable properties while evaluating environmental friendly impacts on biocomplex systems at each stage of their development as useful materials, viz., processing and fabrication, assembly and manufacture, and eventual recycling of spent materials.

Approximately $1.8 million is expected to be available to support workshops, planning, or exploratory activities that encourage development of interdisciplinary teams. These are one-time, one-year awards for up to $100,000 that are aimed at providing preliminary results that can lead to small group or Center proposals in the near future. Proposals for groups of various sizes are expected to be solicited in FY 2003.

Planning activities submitted in response to this solicitation must be aimed at forming interdisciplinary teams that include experts in fields ranging from earth sciences to materials chemistry to engineering to social science. Computational experts who can assist in the development of sophisticated models should be included. International partnerships could be particularly valuable to research and education in this topical area. MUSES activities, where appropriate, (a) include an economist or other social scientist on a team with scientists and/or engineers from physical, chemical, biological, and/or geological disciplines; (b) integrate economic and other social factors with extraction, materials design, and/or manufacturing considerations; and (c) use or develop computational models or simulations appropriate for the complexity, multi-disciplinary data sets, and global scale of these systems.
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III. ELIGIBILITY INFORMATION

The categories of proposers identified in the Grant Proposal Guide are eligible to submit proposals under this program announcement/solicitation.

IV. AWARD INFORMATION

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds. The estimated number of awards and anticipated funding amount for each topical area are provided in Section II, Program Description.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal:

Proposals submitted in response to this program announcement/solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF *Grant Proposal Guide* (GPG). The complete text of the GPG is available electronically on the NSF Web Site at: http://www.nsf.gov/cgi-bin/getpub?gpg. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (301) 947-2722 or by e-mail from pubs@nsf.gov.

Proposals submitted for this competition should clearly specify all relevant facets of the proposed project. With respect to the proposed research, the proposal should outline the theoretical foundations of the project as based in relevant literature. It should specify the research methods that will be used, the expertise that different researchers will bring to different facets of the project, and how and where results will be disseminated. With respect to education, the proposal should specify educational goals, what methods will be used to attain those goals, and the expertise of individuals who will participate in educational efforts. The proposal should also identify the proposed educational products, how those products will be disseminated, and how the educational activities will be evaluated.

Proposals Involving Three or More Senior Investigators:

The page limit guidance for group proposals in the GPG does not apply to proposals submitted in response to this solicitation. All project descriptions are limited to 15 pages in length. Teams should present a coherent view of their plans within these limits.

However, teams with more than 3 senior investigators are required to submit supplementary documentation, not to exceed two pages, that provides the following information: (1) a description of the management structure that will enable the team to work effectively; and (2) specification of the qualifications and contribution of each of the senior personnel to the activity. This information is in addition to the foreign collaborator's role that must be included in supplementary documentation concerning roles of team members. In addition, a compilation of conflicts of interest information should be emailed directly to first program officer listed for the BE topical area to which the proposal was submitted. This should include the proposal number and be sent within a week of the proposal submission deadline. Include in a single, alphabetized table, the full names of all people with conflicts of interest for all senior personnel (PI and Co-PIs) and any named personnel whose salary is requested in the project budget. Conflicts to be identified are: (1) PhD thesis advisors or advisees, (2) postdoctoral advisors or advisees, (3) collaborators or co-authors for the past 48 months, and (4) any other individuals or institutions with which the investigator has financial ties (please specify type)."

Proposals Involving Multiple Institutions:

In the case of proposals involving multiple institutions, a single institution should be identified as the lead institution and a single proposal describing the entire project should be submitted by that institution. Funds may be distributed among partner institutions via subawards from the lead institution. A budget on the standard NSF budget form should be submitted for each subawardee. Letters confirming collaborations can be scanned and submitted via FastLane as Supplementary Documentation (in Section I). If single projects are submitted in the form of multiple proposals (often called "collaboratives"), all proposals in the set shall be returned without review.

Proposals Involving Collaborators at Foreign Institutions:

Proposers are reminded they must provide biographical sketches of all senior project personnel, including those at foreign institutions. In addition, as supplementary documentation, proposals involving foreign collaborators must provide letters of endorsement from the foreign counterpart institutions.

Directing the Proposal to a BE Topical Area:

Once you have identified the Program Solicitation Number on the proposal Cover Sheet, the five relevant topical areas (i.e., CNH, CBC, GEN-EN, IDEA, MUSES) will be listed in the Program Box. Highlight the topical area that your proposal addresses and click on the "Select Program" button. Your proposal will automatically be assigned to the correct directorate and division on the Cover Sheet.

If you think that your proposal may be relevant to more than one topical area, make the selection you think is topically most appropriate and follow the guidance (monetary and otherwise) for that topical area. Do not submit duplicate or substantively similar proposals to more than one topical area. However, you may suggest possible joint review through an e-mail message sent to the program officers of relevant competitions. Be sure to include the proposal number in your e-mail message. After the proposal is received, NSF program officers from relevant topical areas will consult and determine the most appropriate course of action, which may involve joint review or transfer of the proposal from one topical area to another. In the case of a transfer from the topical area you selected, you will be informed. You may submit more than one proposal to the same or different topical areas only if they are substantively different from one another.

Proposers are reminded to identify the program solicitation number (NSF-02-010) in the program announcement/solicitation block on the proposal Cover Sheet (NSF Form 1207). Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

B. Budgetary Information

Cost sharing is not required in proposals submitted under this Program Solicitation.

Other Budgetary Limitations: Specific topical areas have award size limitations. Details are in Section II, Program Description.

Budgets should include travel funds for Principal Investigators to attend a workshop or meeting of those supported in this program every 2 or 3 years.

Specific amounts for research cruises, polar logistics, arctic logistics, or use of aircraft or other atmospheric sciences field facilities should not be included in the budget request. However, the PI should submit the UNOLS request, OPP logistics form, or ATM facilities form with the proposal.

C. Deadline/Target Dates

Proposals must be submitted by the following date(s):

Full Proposals *by 5:00 PM local time*:

January 24, 2002	**Deadline for CNH and IDEA**
February 20, 2002	**Deadline for CBC and GEN-EN**
March 14, 2002	**Deadline for MUSES**

D. FastLane Requirements

Proposers are required to prepare and submit all proposals for this Program Solicitation through the FastLane system. Detailed instructions for proposal preparation and submission via FastLane are available at: http://www.fastlane.nsf.gov/a1/newstan.htm. For FastLane user support, call 1-800-673-6188 or e-mail fastlane@nsf.gov.

Submission of Electronically Signed Cover Sheets. The Authorized Organizational Representative (AOR) must electronically sign the proposal Cover Sheet to submit the required proposal certifications (see Chapter II, Section C of the Grant Proposal Guide for a listing of the certifications). The AOR must provide the required certifications within five working days following the electronic submission of the proposal. Further instructions regarding this process are available on the FastLane website at: http://www.fastlane.nsf.gov.

VI. PROPOSAL REVIEW INFORMATION

A. NSF Proposal Review Process

Reviews of proposals submitted to NSF are solicited from peers with expertise in the substantive area of the proposed research or education project. These reviewers are selected by Program Officers charged with the oversight of the review process. NSF invites the proposer to suggest, at the time of submission, the names of appropriate or inappropriate reviewers. Care is taken to ensure that reviewers have no conflicts with the proposer. Special efforts are made to recruit reviewers from non-academic institutions, minority-serving institutions, or adjacent disciplines to that principally addressed in the proposal.

Proposals will be reviewed against the following general review criteria established by the National Science Board. Following each criterion are potential considerations that the reviewer may employ in the evaluation. These are suggestions and not all will apply to any given proposal. Proposers are reminded that both the intellectual merit and the broader impacts of the work to be accomplished should be addressed. While reviewers are expected to address both merit review criteria, each reviewer will be asked to address only considerations that are relevant to the proposal and for which he/she is qualified to make judgements.

What is the intellectual merit of the proposed activity?
How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of the prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?
How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

Principal Investigators should address the following elements in their proposal to provide reviewers with the information necessary to respond fully to both of the above-described NSF merit review criteria. NSF staff will give these elements careful consideration in making funding decisions.

Integration of Research and Education
One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

Integrating Diversity into NSF Programs, Projects, and Activities
Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports. **Additional Review Criteria**
Successful proposals in all topical areas of the competition must be highly interdisciplinary, address the inherent complexity and highly coupled nature of environmental systems, and involve systems that include interactions of biota or humans. The three integrative elements--quantitative approaches, education, and global perspectives--are also important. Research projects must include quantitative approaches or advanced conceptual models to study the systems chosen for investigation and specific plans for education. Proposals that promote the development of long-term international partnerships will be given special consideration.

In addition to NSF's standard review criteria, planning or exploratory activities will be evaluated on their interdisciplinarity and their potential to advance the study of biocomplexity in the environment.

In the evaluation of proposals submitted by teams of investigators, considerations in addition to standard NSF review criteria are:

- Strength of the collaborations planned and degree of interdisciplinarity
- Effectiveness of the group organization and management plan
- Value to education in these topical areas
- Strength of the dissemination plans

Extent, effectiveness, and long-term potential of collaborations with industries, national laboratories, and comparable research centers abroad, when appropriate.

Descriptions of educational activities should specify goals, methods to attain those goals, and the expertise of individuals to accomplish them. Thus, they will be evaluated based on:

- Potential interest to and appropriateness for the audience targeted
- Quality of planning and appropriateness of personnel
- Feasibility and potential for resulting in a disseminable product
- Integration and complementarity to the research efforts.

A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, are sent to the Principal Investigator/Project Director by the Program Director. In addition, the proposer will receive an explanation of the decision to award or decline funding.

B. Review Protocol and Associated Customer Service Standard

All proposals are carefully reviewed by at least three other persons outside NSF who are experts in the particular field represented by the proposal. This will be the case for proposals for all research projects requesting over $100,000 submitted in response to this announcement. More specifically, proposals in this category will be reviewed externally by mail review and/or panel review. Development or planning activities, exploratory, conference, or incubation proposals for $100,000 or less may be reviewed by a scientist, engineer, or educator serving as a NSF Program Officer and/or outside experts.

Reviewers will be asked to formulate a recommendation to either support or decline each proposal. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

NSF is striving to be able to tell applicants whether their proposals have been declined or recommended for funding within six months for 70 percent of proposals. The time interval begins on the date of receipt. The interval ends when the Division Director accepts the Program Officer's recommendation.

In all cases, after programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications and the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at its own risk.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program Division administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See section VI.A. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award letter, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award letter; (4) the applicable award conditions, such as Grant General Conditions (NSF-GC-1)* or Federal Demonstration Partnership (FDP) Terms and Conditions;* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award letter. Cooperative agreement awards also are administered in accordance with NSF Cooperative Agreement Terms and Conditions (CA-1). Electronic mail notification is the preferred way to transmit NSF awards to organizations that have electronic mail capabilities and have requested such notification from the Division of Grants and Agreements.

*These documents may be accessed electronically on NSF's Web site at http://www.nsf.gov/home/grants/grants_gac.htm. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (301) 947-2722 or by e-mail from pubs@nsf.gov.

More comprehensive information on NSF Award Conditions is contained in the NSF *Grant Policy Manual* (GPM) Chapter II, available electronically on the NSF Web site at http://www.nsf.gov/cgi-bin/getpub?gpm. The GPM is also for sale through the Superintendent of Documents, Government Printing Office (GPO), Washington, DC 20402. The telephone number at GPO for subscription information is (202) 512-1800. The GPM may be ordered through the GPO Web site at http://www.gpo.gov.

Special Award Conditions
Additional award conditions may be included addressing the pilot testing and evaluation of materials on pre-college students and the distribution or commercial publication of materials developed, a license for government use, and program income.

Meetings or workshops for Principal Investigators may be called by NSF approximately every two years. Investigators will be expected to make every reasonable effort to attend and to use grant funds to support their travel expenses.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the PI must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period.

Within 90 days after the expiration of an award, the PI also is required to submit a final project report. Approximately 30 days before expiration, NSF will send a notice to remind the PI of the requirement to file the final project report. Failure to provide final technical reports delays NSF review and processing of pending proposals for that PI. PIs should examine the formats of the required reports in advance to assure availability of required data.

NSF has implemented an electronic project reporting system, available through FastLane. This system permits electronic submission and updating of project reports, including information on project participants (individual and organizational), activities and findings, publications, and other specific products and contributions. PIs will not be required to re-enter information previously provided, either with a proposal or in earlier updates using the electronic system.

VIII. CONTACTS FOR ADDITIONAL INFORMATION

General inquiries regarding Biocomplexity in the Environment (BE) for FY 2002: Integrated Research and Education in Environmental Systems should be made to:

- For contacts in *Dynamics of Coupled Natural and Human Systems*, see www.geo.nsf.gov/be-02.htm#cnh.
- For contacts in *Coupled Biogeochemical Cycles*, see www.geo.nsf.gov/be-02.htm#cbc.
- For contacts in *Genome-Enabled Environmental Science & Engineering*, see www.geo.nsf.gov/be-02.htm#genen.

- For contacts in *Instrumentation Development for Environmental Activities*, see www.geo.nsf.gov/be-02.htm#idea.

- For contacts in *Materials Use: Science, Engineering, & Society*, see www.geo.nsf.gov/be-02.htm#muses.

- For contacts about the integrative element on *Education*, see www.geo.nsf.gov/be-02.htm#edu.

- For contacts about the integrative element on *Global Perspective*, see www.geo.nsf.gov/be-02.htm#gp.

- For contacts about the integrative element on *Quantitative Approaches*, see www.geo.nsf.gov/be-02.htm#qa.

For questions related to the use of FastLane, contact:

- Brian Dawson, Computer Specialist, Directorate for Geosciences, Division of Earth Sciences, telephone: 703.292.4727, e-mail: bdawson@nsf.gov.

- Florence Rabanal, Fastlane Project Coordinator, Directorate for Mathematical and Physical Sciences, telephone: 703.292.8808, e-mail: mpsoadfl@nsf.gov.

- Philip Johnson, Computer Specialist, Directorate for Social, Behavioral, and Economic Science, Division of Behavioral and Cognitive Sciences, telephone: 703.292.8740, e-mail: pxjohnso@nsf.gov.

IX. OTHER PROGRAMS OF INTEREST

The NSF *Guide to Programs* is a compilation of funding for research and education in science, mathematics, and engineering. The NSF *Guide to Programs* is available electronically at http://www.nsf.gov/cgi-bin/getpub?gp. General descriptions of NSF programs, research areas, and eligibility information for proposal submission are provided in each chapter.

Many NSF programs offer announcements or solicitations concerning specific proposal requirements. To obtain additional information about these requirements, contact the appropriate NSF program offices. Any changes in NSF's fiscal year programs occurring after press time for the *Guide to Programs* will be announced in the NSF E-Bulletin, which is updated daily on the NSF web site at http://www.nsf.gov/home/ebulletin, and in individual program announcements/solicitations. Subscribers can also sign up for NSF's Custom News Service (http://www.nsf.gov/home/cns/start.htm) to be notified of new funding opportunities that become available.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) funds research and education in most fields of science and engineering. Awardees are wholly responsible for conducting their project activities and preparing the results for publication. Thus, the Foundation does not assume responsibility for such findings or their interpretation.

NSF welcomes proposals from all qualified scientists, engineers and educators. The Foundation strongly encourages women, minorities and persons with disabilities to compete fully in its programs. In accordance with Federal statutes, regulations and NSF policies, no person on grounds of race, color, age, sex, national origin or disability shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving financial assistance from NSF (unless otherwise specified in the eligibility requirements for a particular program).

Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF-supported projects. See the program announcement/solicitation for further information.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090, FIRS at 1-800-877-8339.

The National Science Foundation is committed to making all of the information we publish easy to understand. If you have a suggestion about how to improve the clarity of this document or other NSF-published materials, please contact us at plainlanguage@nsf.gov.

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to applicant institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies needing information as part of the review process or in order to coordinate programs; and to another Federal agency, court or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records," 63 Federal Register 268 (January 5, 1998). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

Pursuant to 5 CFR 1320.5(b), an agency may not conduct or sponsor, and a person is not required to respond to an information collection unless it displays a valid OMB control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding this burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to: Suzanne Plimpton, Reports Clearance Officer, Information Dissemination Branch, Division of Administrative Services, National Science Foundation, Arlington, VA 22230, or to Office of Information and Regulatory Affairs of OMB, Attention: Desk Officer for National Science Foundation (3145-0058), 725 17th Street, N.W. Room 10235, Washington, D.C. 20503.

OMB control number: 3145-0058.