CHAPTER 3

Informing the World – Influencing STEM Knowledge

The NSF Strategic Plan includes investment priorities in learning which are intended to "Build strong foundations and foster innovation to improve K-12 teaching, learning ...in science and mathematics... Develop methods to effectively bridge critical junctures in STEM education pathways," and "Engage and inform the public in science and engineering through informal education."

– NSF Strategic Plan

Reaching out to the general public, working to help bridge critical junctures in STEM education, and improving K-12 learning in science and mathematics are all ways IGERTs work to influence STEM knowledge.

- Sixty-eight (68) of the reporting 114 IGERTs reported a total of 175 instances of involvement with K-12, and 20 IGERTs of the reporting 114 reported 44 instances of involvement with undergraduates, thereby addressing two sub-goals of learning: building stronger foundations and fostering innovation in K-12 teaching and learning and developing methods to effectively bridge critical junctures in STEM education pathways.
- One-hundred forty (140) grants (some grants were involved in all four outreach activities) report multiple outreach endeavors to nonprofit organizations, government agencies, international entities, and other universities.
- The 114 IGERTs reporting outreach activities in 2006-2007 reported a total of 688 opportunities to reach out to others to explain their research interests and to increase the public's awareness of STEM topics through museums, radio, television and media, lectures, and presentations.

Table 7 summarizes the outreach to K-12 and undergraduates as reported in 2006-2007 over all 136 IGERTs that reported, aligned by the interdisciplinary themes of the IGERT defined in Table 1.

The remainder of this chapter will detail information on outreach to K-12 students and their teachers, undergraduates, the general public, government agencies, industry, organizations and international entities.

NSF will inspire the next generation by promoting excellent science education, including timely access to exhilarating discoveries in classrooms, and by partnering with museums and other organizations that use informal science to bridge the gulf between scientific advances and public understanding.

NSF Strategic Plan

Table 7: Outreach to K-12 and Undergraduate Students by Interdisciplinary Research Themes[2]

TOPICS	# Instances IGERTs involved in K-12 education	# Instances IGERTs involved in undergraduate education
Sustainability: ecology and the environment	51	6
Computational science and engineering	60	18
Human and social dimensions of new knowledge and technology	52	11
Nanoscience: engineering and technology	43	15
Energy: alternate and renewable resources and conservation	5	0
Materials science and engineering	43	24
Bioinformatics	5	4
Civil infrastructure monitoring and improvement	1	0
Entrepreneurialism	15	2
Neuroscience: biology and psychology	19	0
Climate change: impacts and factors	5	1
Biological evolution and development	3	1
Diverse device development	28	8
Sensing, signals, imaging and signal processing	21	11

[2] The number of instances and IGERT grants involved in K-12 and undergraduate education are distributed across interdisciplinary research themes and, thus, will be counted more than once.

NSF Investment Priority: Build Strong Foundations and Foster Innovation to Improve K-12 Teaching, Learning, and Evaluation in Science and Mathematics

Sixty-eight (68) of the 114 IGERTs (59.6%) reporting outreach activities reported 175 such activities involving K-12 students and/or teachers. These educational opportunities run the gamut from laboratory or field experiences for students and teachers outside of the classroom, to lectures and talks, classes or courses taught to students and teachers, mentoring experiences, science fair mentoring and judging, and raising funds for improving K-12 education.

Examples of the educational opportunities of the 68 IGERTs that are involved with K-12 students and/or their teachers include:

☐ Working with teachers and students to develop gardens in the context of traditional Athabascan (native Alaskan) culture, IGERT trainees are educating students about the sustainability of a culture embedded in an ecosystem subject to rapid change. (0114423: Chapin, University of Alaska Fairbanks)

☐ Biological invasions are becoming increasingly common as the result of globalization, but the invasions are only recognizable if the native ecosystem is known. To familiarize students with the ecology of the area in which they live, IGERT trainees take tide pools to K-12 classrooms. (0114432: Strauss, University of California Davis)

☐ IGERT trainees who combine a strong interest in ecology and quantitative methods of modeling ecological resources are also concerned about quality science education for all students. Trainees developed a birding program and walk for students with special needs, thereby improving science education for the students. (0221595: Davis, Colorado State University)

☐ To improve K-12 students' understanding of nanotechnology and stimulate their interest in the study of STEM fields, a Micro/Nano summer Robotics Camp was organized by IGERT personnel. During the camp, students were introduced to the principles of micro- and nanotechnology using LEGOS,® thus engaging students in activities that were appealing and meaningful. (0221681: Bhansali, University of South Florida)

☐ Educating policy makers and the public is one goal of an IGERT researching the degradation and vulnerability of marine ecosystems. To help accomplish this task, trainees give talks to elementary, middle, and high school students about the biology and conservation of marine turtles, local marine organisms, and food webs and wetland conservation. The lectures are designed to help students relate to marine ecosystems and foster a desire to protect them. (0333444: Knowlton, University of California San Diego Scripps Institute)

☐ Increasing the interest of under-represented groups in STEM fields is a priority of NSF, and one IGERT has pursued this goal by presenting a two week summer program at Tuskegee University to introduce high school students from underrepresented groups to college education and scientific research. (0333380: Jeelani, Tuskegee University)

☐ The excitement of new discoveries in the field of plant genomics through the use of computational sciences led an IGERT to share their research with teachers and students in the form of lectures, laboratory experiences, and podcasts during the summer. Teachers and students learned about cutting edge science from the scientists performing the research, a powerful incentive for students. (0504304: Voytas, Iowa State University)

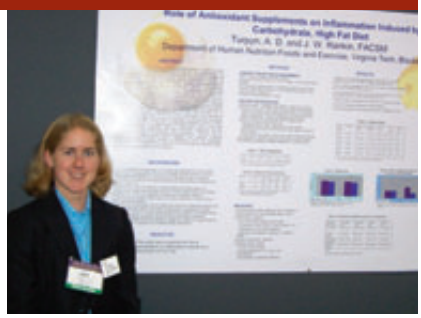
☐ The importance of awakening young children's sense of wonder about the natural world was evident to an IGERT whose research topic is the natural interface science application to environmental science and engineering. A workshop on herbs was presented to kindergarten students in a fun and exciting way to promote their interest in science. (0504196: Hochella, Virginia Polytechnic Institute & State University)

☐ The highly complex science of computational fluid dynamics was shared in the form of a workshop for high school students by one IGERT. The workshop introduced the students to high performance computing and computational fluid dynamics, acquainting students with topics not generally taught in high school science classes and demonstrating the excitement of real-world science. (0504507: Acharya, Louisiana State University & A&M College)

☐ The effect of biogeochemical microorganisms on Earth's environment is the focus of an IGERT that led to the development of a 15-hour class on climate change for tenth and twelfth grade students. Students investigated the science of global warming through basic modeling activities, data analysis, discussion and movies, providing a thorough grounding in a timely science topic. (9972759: Brantley, Pennsylvania State University)

NSF Investment Priority: Develop Methods to Effectively Bridge Critical Junctures in STEM Education Pathways: Undergraduate Scientific and Educational Interactions

Twenty (20) of the 114 grants (17.5%) reporting outreach activities reported 44 activities involving interactions with undergraduate students. IGERT trainees and faculty are working to effectively bridge the critical junctures of undergraduate to graduate training in the STEM pipeline. This is being accomplished by ensuring that a working knowledge of cutting-edge interdisciplinary science and the skills critical for graduate school success are reaching undergraduates.



Examples of IGERT efforts to bridge critical junctures in STEM undergraduate to graduate education include:

☐ A new course, "The Challenges of a Complex World," was developed for undergraduates as a result of an award from the University of Michigan Office of the Provost to promote interdisciplinary and team teaching. Students use mathematics, computation, and experimentation to address the biggest challenges of the modern world by learning the fundamental properties of complex adaptive systems as applied to global warming, sustainability, epidemics, terrorism, and the impacts of technology and globalization on the world. (0221611: Page, University of Michigan)

☐ In order to stimulate the interest of undergraduates in economics and provide opportunities to put what they learn into practice in the community, an IGERT trainee founded an undergraduate economics club called SWEET (Students Who Enjoy Economics Thinking). The club sponsors student activities and speakers in economics, as well as conducting community outreach programs to teach free enterprise. (0114423:Chapin, University of Alaska Fairbanks)

☐ Stimulating interest in physics was the purpose of a lecture to undergraduate physics majors in the Passion for Physics course. Undergraduates were also invited to an IGERT trainees' research posters session where they learned about the exciting possibilities of the transformation of future computing and communication systems and biomedical imaging through terahertz research in electronics, data transfer and networking systems, and spectroscopy and imaging. (0333314: Wang, Rensselaer Polytechnic Institute)

☐ Workshops on writing in the sciences were presented by a trainee to Research Experiences for Undergraduates (REU) students, thus promoting undergraduate students' interest in continuing their education in a STEM field. The course included a discussion of the anatomy of an article, timeline for developing a proposal, presentation techniques, and editing strategies. (0221713: Manjunath, University of California Santa Barbara)

☐ Undergraduate students are encouraged to continue their education in STEM fields when they participate in a summer research program introducing the interdisciplinary research at the interface of nano/micro-technology and life science. Undergraduates are given the opportunity to conduct research while learning about career development, graduate school, and presentation skills. (0549479: Li, University of California Irvine)

☐ Trainees not only excited undergraduate students about the research in marine biodiversity and the policies that affect it at the Society for the Advancement of Chicanos and Native Americans in Science conference, they also organized a panel to advise undergraduate students on graduate school, professional pathways, and the status of underrepresented minorities in the marine sciences. (0333444: Knowlton, University of California San Diego Scripps Institute)

☐ A trainee developed and implemented a college senior-level course in environmental engineering on decentralized and onsite wastewater management and reuse. In this class, students learned how to determine appropriate onsite and decentralized wastewater treatment and solutions based on the principles of engineering technologies, ecology, and policy and management. (0333408: Kalonji, University of Washington)

NSF Investment Priority: Prepare a Diverse, Globally Engaged STEM Workforce

One-hundred fourteen (114) of the 136 IGERTs reporting in 2006-2007 identified outreach to nonprofit organizations, government agencies, international entities, and universities, colleges, and 2-year colleges. Table 8 summarizes the variety of the interactions.

Table 8: IGERT Outreach Activities to Nonprofit Organizations, Government Agencies, International Entities and Universities

# Involving nonprofit organizations	# Involving government agencies	# Involving international entities	# Involving other universities, 4- and 2-year colleges
121 activities 41 grants (36.0%)	54 activities 20 grants (17.5%)	69 activities 22 grants (19.3%)	164 activities 57 grants (50.0%)

Examples of IGERT outreach to nonprofit organizations, government agencies, international entities, and other institutions of higher learning include:

Nonprofit organizations

☐ A trainee studying public policy and nuclear threats presented information about U.S. relations with Saudi Arabia and Egypt in a talk, "Rethinking Risks and Reassessing Rewards: U.S.-Saudi and U.S.-Egyptian Relations" to the RAND Corporation, a nonprofit think tank in Washington, D.C., that

conducts research on global and complex problems, thus influencing public knowledge about key political issues. (0221706: Shirk, University of California San Diego)

Government agencies

☐ Thirty-five (35) prisoners at the San Quentin State Penitentiary were able to earn college credit toward AA degrees by the efforts of an IGERT trainee who taught an introduction to American government course. The focus of this IGERT is involvement in social systems, evaluation of the effects, costs and benefits of policies, and implementing legislation consistent with original legislative intent. The trainee also presented results from her research on correctional officers and the perceptions of safety on the job to the correctional officers of the penitentiary. (0504642: Raphael, University of California Berkeley)

International entities

☐ Research conducted by an IGERT on the social and ecological impacts of climate change at high latitudes and the implications for ecological management and society was shared at the University of Northern British Columbia in the form of a seminar. (0114423: Chapin, University of Alaska Fairbanks)

☐ IGERT faculty and trainees have given invited lectures in China at Yunnan University, the Beijing Institute of Zoology, the Kunming Institute of Zoology, and the Southwest Forestry University at Yunnan, on topics including how to study the impact of peasant policy, ecology of digestion, the impact of plant phenolics on mammalian and avian herbivores and park and people relationships, promoting international education through IGERT interdisciplinary training. (0549369: Posner, University of Wisconsin Madison)

Other universities, 4- and 2-year colleges

☐ Educating undergraduates about the integration of mathematics and biology and enticing them into STEM fields in graduate school is the purpose of a series of lectures given at Bowdoin College, the Claremont Colleges, Ohio State University, Rockhurst University in Missouri, the University of Utah, Augsburg College, the University of Hawaii, and the University of Alberta by IGERT faculty and trainees. Topics ranged from a mathematician's look at blood clotting, the mathematics of heart attacks, the mathematical estimation of whole-forest uptake and release of carbon, and the opportunities for interdisciplinary research in mathematical biology. (0217424: Keener, University of Utah)

☐ A summit focusing on changes in the Columbia River Basin was organized and presented at the Columbia Gorge Community College for community college students and the public. The topics of natural processes and human influences on the Columbia river and its estuary, climate change, global warming and the Pacific Northwest and invasive species and native plant restoration are an outgrowth of the interdisciplinary IGERT's research on the Earth's subsurface biosphere and the links to Earth's physical and chemical environments and processes. (0114427: Myrold, Oregon State University)

NSF Investment Priority: Engage and Inform the Public in Science and Engineering Through Informal Education and Outreach

IGERTs reported 688 instances of outreach to groups summarized in Table 9. Activities ranged from radio and television interviews to websites, lectures, field trips, and museum presentations and exhibits. Trainees and faculty alike participated.

Table 9: IGERT Outreach Efforts Through Informal Education

Outreach Group	General public or community	Organizations	Government	International	Universities or colleges	Industry
Number of outreach instances	275	121	54	69	164	5
Number of IGERTs reporting the outreach	64	41	20	22	57	2

Examples of IGERT outreach efforts through informal education include:

☐ A two week trip to El Salvador by trainees for Engineers Without Borders resulted in a drinking water assessment of the area as part of an IGERT's research of the Earth's subsurface biosphere that could solve major environmental, agricultural, and industrial problems. Engineers Without Borders is a nonprofit humanitarian organization that partners with developing communities worldwide to improve quality of life through the implementation of environmentally and economically sustainable engineering projects, while developing internationally responsible engineering students. Using data provided by IGERT trainees, the organization is implementing a sustainable water delivery system in El Salvador. (0114427: Myrold, Oregon State University)

☐ The California Department of Fish and Game and U.S. Wildlife Service used the services of an IGERT trainee to inform their policies on the management and protection of amphibians and reptiles. (0114432: Strauss, University of California Davis)

☐ The Science Museum of Minnesota featured an IGERT trainee on its website that gave the public an opportunity to question a scientist about nanotechnology. The trainee is a mechanical engineering student and his description of his work, "he studies tiny, tiny dots," and explanation of how nanotechnology is being used in an attempt to detect cancer was of great interest to the public. http://dev.smm.org/buzz/museum/ask/arefe (0114372: Kortshagen, University of Minnesota Twin Cities)

☐ A film about the tree of life and the interrelatedness of all living things is being produced by the Peabody Museum of Yale University and will feature video interviews of IGERT researchers who are studying the interdisciplinary theme of computational phylogenetics and applications to biology. (0114387: Hillis, University of Texas Austin)

☐ "Why meat rots" is the topic of a story on *The Why Files*, a website designed to explain the science behind the news and make science accessible to all. The story is based on the research publications of IGERT trainees that explain how microbes use chemistry to compete with larger organisms. http://whyfiles.org/shorties/219bacterial_stink/

This research is also shared on *YubaNet*, a website that delivers daily news to the Sierra. http://www.yubanet.com/cgi-bin/artman/exec/view.cgi/21/44957 (0114400: Hay, Georgia Tech Research Corporation-GIT)

☐ In an IGERT program that seeks to effectively and ethically contribute to solving critical problems facing tropical working forests, an IGERT trainee led an ecological research methods workshop for biology and agroforestry undergraduate students at the Universidad de la Amazonia Pando in Bolivia. (0221599: Zarin, University of Florida)

☐ An IGERT trainee and Iraq veteran founded the *Open Prosthetics Project*, a nonprofit website that applies the ethical and intellectual property foundation of open source software to the task of building better artificial limbs in the search for a realistic and fully functional prosthetic. The IGERT research concerning biologically inspired materials is the foundation for this project. The story was featured in *Wired*, a magazine that reports how technology affects culture, the economy, and politics. http://www.wired.com/gadgets/mods/news/2006/09/71797. (0221632: Clark, Duke University)

Table 10: Alignment of Trainees With Research Themes

TOPICS	# Trainees
Sustainability: ecology and the environment	488
Computational science and engineering	476
Human and social dimensions of new knowledge and technology	488
Nanoscience: engineering and technology	287
Energy: alternate and renewable resources and conservation	44
Materials science and engineering	305
Bioinformatics	96
Civil infrastructure monitoring and improvement	12
Entrepreneurialism	224
Neuroscience: biology and psychology	71
Climate change: impacts and factors	76
Biological evolution and development	92
Diverse device development	292
Sensing, signals, imaging and signal processing	176

IGERT Trainees: Comparisons to National Data Sets

Accurate comparison of IGERT trainee data to national data requires defining a national data set that most closely resembles IGERT trainee demographics. Specifically, IGERT trainees are all declared doctoral students, as no master's students are currently supported, and must be U.S. citizens or permanent residents. Data for comparison selected to be as close as possible to these demographic requirements for IGERT are from the NSF compilation of 2005 doctorates awarded by sex, citizenship status, and major field of study of the recipients.[5] While not identical to the IGERT trainee data for 2006-2007 in that IGERT trainees are still in a graduate program, this is the only data set which allows for control of the variables of doctoral program, citizenship status, gender, and race/ethnicity – major variables for meaningful comparisons to IGERT trainees.

To enable more detailed comparison of IGERT data with national data, both overall statistics by gender, race, and ethnicity as well as a detailed breakdown analysis of IGERT trainees by major field of study using the fields described in the national data set have been compiled. To determine field of study for individual trainees, the department in which the trainee is currently enrolled was used as a proxy for the analysis.

[5] NSF SRS data Table 3: Doctorates awarded, by sex, citizenship status, and major field of study of recipients: 1996-2005.

Table 11 illustrates that for race/ethnicity IGERTs are ahead of national data in meeting the goal of the Solicitation in facilitating diversity in student participation and preparation, and to contribute to a world-class, broadly inclusive, and globally engaged science and engineering workforce. As the table shows, for gender, IGERTs are similar to national data overall.

Table 11: IGERT Trainees Compared with National NSF Data for Gender, Race and Ethnicity

	# IGERT Trainees	IGERT %	Science Resources Statistics (SRS) National Data %
Gender			
Female	635	41.8	44.5
Male	876	57.7	55.4
Not reported	8	.5	—
Race/Ethnicity[6]			
American Indian/Alaskan Native	18	1.2	0.4
Black or African American	82	5.4	4.4
Hispanic or Latino	91	5.9	5.0
Asian, Native Hawaiian & other Pacific Islanders	129	8.5	No comparable SRS data
White	1,101	72.5	76.6
Not reported	151	9.9	—

When analyzed by race and ethnicity, *IGERT trainee data exceeds or is equal to national data for 70% of all fields* (Table 12).[7] For females, when broken down by field, IGERT is *engaging more females into nontraditional fields for the gender. IGERTs exceeded national data for females in 80% of fields and were slightly lower in 20% of fields* (Table 13). Table 14 summarizes the alignment of male IGERT trainees by field with national data. Tables 13 and 14 also convey information about the concentration of fields for the 2006-2007 IGERT grants.

For IGERT trainees there was a 9.9% non-report rate for race/ethnicity and a 1.3% non-report rate for field of study. Among females there was a 1.1% non-report rate for field of study. Among males, the field non-report rate was 1.4%.

[6] Count will exceed the total of 1,519 trainees due to trainee double race/ethnicity.

[7] IGERT trainee data exceeds national data 50% of the time for all fields.

Table 12: IGERT Trainees' Race and Ethnicity by Field of Study Compared to National Data[8]

Field of Study	% American Indian, Alaskan Native IGERT*	% American Indian, Alaskan Native SRS	% Black or African American IGERT*	% Black or African American SRS	% Hispanic or Latino IGERT*	% Hispanic or Latino SRS	% White IGERT*	% White SRS	% Asian, Native Hawaiian & other Pacific Islanders IGERT***
Aeronautic & Astronautics Engineering	0.00	0.07	0.00	0.01	0.00	0.04	**7.00**	0.46	0.00
Astronomy	**0.00**	0.00	0.00	0.01	0.00	0.02	0.00	0.62	0.00
Biological Sciences	**0.46**	0.07	0.86	0.99	**1.51**	1.42	16.13	20.83	1.80
Chemical Engineering	**0.07**	0.00	**0.26**	0.09	**0.79**	0.13	**5.00**	1.48	0.60
Chemistry	**0.20**	0.01	**1.12**	0.26	**0.46**	0.34	**7.50**	5.97	0.70
Civil Engineering	**0.00**	0.00	0.00	0.06	**0.13**	0.07	**2.37**	1.19	0.13
Computer Sciences	0.00	0.006	0.00	0.09	**0.13**	0.07	**3.69**	2.04	0.80
Earth, Atmospheric and Ocean Science	**0.07**	0.02	**0.26**	0.04	**0.39**	0.11	**3.75**	2.396	0.20
Electrical Engineering	0.00	0.02	**0.20**	0.193	**0.13**	0.09	**2.76**	2.196	0.30
Industrial Engineering	**0.00**	0.00	**0.07**	0.05	0.00	0.01	**0.66**	0.31	0.13
Mathematics	**0.00**	0.00	0.07	0.14	**0.13**	0.10	2.30	2.58	0.06
Mechanical Engineering	**0.07**	0.02	**0.39**	0.07	**0.20**	0.08	**1.71**	1.48	0.40
Other Engineering**	**0.07**	0.006	**0.86**	0.12	**0.66**	0.069	**7.97**	1.97	1.60
Physics	0.00	0.01	**0.46**	0.07	**0.26**	0.099	**4.67**	2.78	0.50
Psychology	0.07	0.09	0.07	1.02	0.53	1.17	1.84	14.27	0.13
Social Sciences	**0.13**	0.12	0.79	1.05	0.66	0.93	11.45	12.08	1.10

* NOTE: In Tables 12, 13 and 14, bolded numbers indicate that IGERT trainee data exceeds or is equal to national data. The data for all IGERT columns are calculated using the following formula: (# IGERT Trainees with that field as their home department for their doctoral degree and associating themselves with the specific demographic group / Total # of IGERT trainees in 2006-2007 reporting period) X100. There are 1519 IGERT Trainees in this reporting period. The data for all SRS columns are calculated using the following formula: (# doctorates earned in that field by the demographic group indicated as reported for 2005 / Total # of doctorates earned in S&E) X100. (Footnote 8 below). This data set was selected for its closest alignment with IGERT trainees – all of whom must be US citizens or permanent residents and are pursuing doctoral degrees. The data show 16024 earned doctorates across all fields for 2005. We acknowledge the lack of perfect alignment of this data set and that of IGERT trainees.

** NOTE: The "other engineering" category is comprised primarily of biomedical engineering.

*** NOTE: There are no comparable SRS data for this category.

[8] NSF SRS data Table 5: Doctorates awarded to U.S. citizens or permanent residents, by race/ethnicity and major field of study or recipients: 1996-2005.

Table 13: Comparison by Field of Female Trainees With National Data

Field of Study	% of Females – IGERT*	% Females – National Data
Astronomy	**0.2**	0.2
Biological Sciences	11.7	13.5
Engineering:		
Chemical Engineering	**2.2**	0.5
Electrical Engineering	**0.8**	0.5
Civil Engineering	**1.4**	0.5
Industrial Engineering	**0.3**	0.1
Mechanical Engineering	**0.7**	0.3
Other Engineering	**4.7**	0.7
Chemistry	**5.2**	2.8
Computer Sciences	**1.0**	0.7
Earth, Atmospheric, Ocean	**2.9**	1.0
Mathematics	**1.0**	0.9
Physics	**1.3**	0.5
Psychology	1.1	12.4
Social Sciences	7.0	8.1

Table 14: Comparison by Field of Male Trainees With National Data

Field of Study	% of Males – IGERT*	% Males – National Data
Astronomy	0.0	0.5
Biological Sciences	9.7	13.9
Engineering:		
Aeronautic & Astronautics Engineering	0.3	0.5
Chemical Engineering	**4.2**	1.5
Electrical Engineering	**3.1**	3.0
Civil Engineering	**1.2**	1.1
Industrial Engineering	**0.6**	0.37
Mechanical Engineering	**2.5**	1.7
Other Engineering	**7.3**	2.1
Chemistry	**5.8**	4.8
Computer Sciences	**10.7**	2.3
Earth, Atmospheric, Ocean	**2.4**	1.7
Mathematics	1.7	2.4
Physics	**4.8**	3.0
Psychology	1.4	5.6
Social Sciences	**8.2**	7.8

* NOTE: In Tables 12, 13 and 14, bolded numbers indicate that IGERT trainee data exceeds or is equal to national data.

CHAPTER 5

IGERT Looking Ahead FY 2008-2009

To inspire and transform....

NSF advances scientific discovery by supporting transformational and distinctive new capabilities – those innovations in research and education that move discovery well beyond the boundaries of current knowledge.

– NSF Strategic Plan

The IGERT program looks forward to continuing at the vanguard of inspiring new and innovative models of transformative interdisciplinary graduate training. Now in its tenth year, the IGERT program continues to innovate not only through grants but also through the management of the program.

As a guidepost for the program, IGERT has adopted three strategies to ensure that the Solicitation and NSF goals that frame the program are addressed:

1. Synthesize and use the knowledge developed by the IGERT program as the basis for articulating and communicating the value of interdisciplinary education, research, and training to IGERT stakeholders, in general.
2. Facilitate and enable learning and communication among the IGERT community to both improve the IGERT program and each IGERT project.
3. Ensure alignment of NSF support, structure, roles, and responsibilities.

Beginning in 2006-2007 for FY 2008-2009 these strategies have led to the following initiatives:

- **Cyber-enabling collaboration and information exchange** among IGERTs and between IGERTs and the NSF and the general public.
  - An upgraded **Solicitation** for FY 2009 which addresses
    - **IGERT Resource Center**– a web-based community for IGERT
    - Information dissemination and sharing among IGERTs using tools such as webinars and Access Grid.
  - Determining the extent to which IGERTs are aligned with the goals of the new Cyber-enabled Discovery and Innovation initiative (CDI) and overall cyberinfrastructure (CI) initiative.[9]

IGERT Vision

Leading the nation in enabling transformative interdisciplinary graduate education through knowledge, ideas, practice, evaluation, and dissemination.

[9] Umesh Thakkar – IGERT Linkages to CDI and CI; DGE Internal Report, 2007.

- **Improvements in project monitoring and post award oversight**:
  - Enhanced methods of annual report collection which foster sharing accomplishments in research, education, and by trainees as well as sharing and disseminating learning and data from all IGERTs. This annual report is an example of the use of these data.
  - Upgraded final reporting and dissemination to the entire NSF.
- **Evaluation** of IGERT with respect to trainee achievements after graduation with a longitudinal study being undertaken in 2008.
- Proposing a series of **workshops to determine the impacts** of integrative interdisciplinary research and education training on institutions, faculty, graduate students, the economy and workforce, and scientific disciplines.
  - The first of these, an Institutional Workshop, is scheduled to be held after the IGERT PIs' meeting in May 2008.
- **Continually improving processes** for engagement of and involvement with NSF as a whole through interactions of the IGERT Coordinating Committee and other means, as appropriate.
  - Developing a compendium of IGERT **best practices** for sharing across NSF.

The remainder of this chapter gives illustrations of specific initiatives using the IGERT Resource Center and determining the alignment of IGERT with CDI and CI as examples. IGERT encourages readers to view our FY 2009 Solicitation at http://nsf.gov/publications/pub_summ.jsp?ods_key=nsf08540.

IGERT Linkages: Cyber-enabled Discovery and Innovation Initiative (CDI) and Overall Cyberinfrastructure (CI) Initiative

Since the start of the IGERT program, there have been 195 IGERT project awards. In response to the 2006 IGERT program solicitation,[10] 443 preliminary proposals were submitted. Of these, 100 preliminary proposals were invited to submit full proposals. IGERT received 98 full proposal submissions. After the full proposal panel reviews, there were 20 IGERT awards for FY 2007.

As part of the DGE programs' review, these recent IGERT awards and their connections to the emerging NSF Cyberinfrastructure vision were assessed.[11] Connections between these 20 IGERT awards for FY2007 and the new Cyber-enabled Discovery and Innovation research initiative[12] were also defined.

Utilizing Ucinet,[13] the social network analysis software,[14] various relationships among these projects and NSF directorates in addition to the possible connections to CI and CDI are illustrated.[15] Figure 1 shows how these projects connect to NSF directorates. Each numbered circle represents a unique IGERT project funded in 2007. The lines illustrate the connection among directorates and IGERT projects. For instance, 12 IGERT projects have possible connections to the Mathematical and Physical Sciences (MPS) Directorate (represented as a green node). Nine of these are new projects (represented as blue nodes), while 3 are renewal projects (represented as red nodes). In this cohort, every IGERT project has connections to at least 2 NSF directorates.

[10] http://www.nsf.gov/pubs/2006/nsf06525/nsf06525.htm

[11] http://www.nsf.gov/pubs/2007/nsf0728/index.jsp

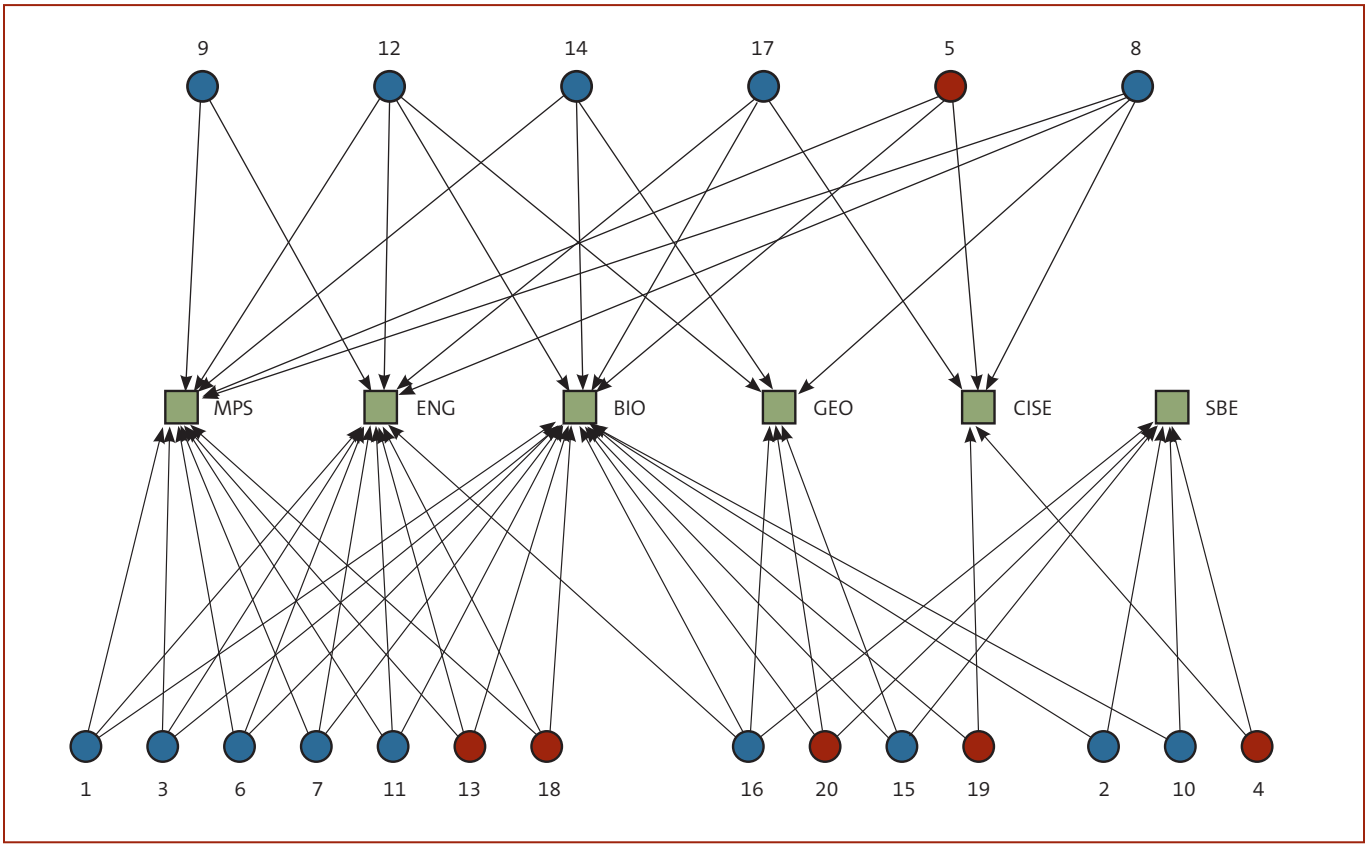
[12] http://www.nsf.gov/about/budget/fy2008/pdf/39_fy2008.pdf

[13] Borgatti, S.P., Everett, M.G., and Freeman, L.C. (2002). *Ucinet for Windows: Software for Social Network Analysis*. Harvard, MA: Analytic Technologies.

[14] http://www.analytictech.com/downloaduc6.htm

[15] In this document, the distances among nodes have no particular interpretation.

Figure 1: IGERT projects and NSF directorates



Eight projects have possible connections to cyberinfrastructure aspects (see Figure 2). For instance, one project (identified as # 8) has connections to 3 CI aspects. This project is also connected to 4 NSF directorates. For the remaining 12 projects, it was not clear at this time how these projects have connections to cyberinfrastructure. As indicated in Figure 3, all 20 projects have possible connections to the CDI. The project (identified as #8) has connections to 3 CDI themes.

Figure 2: IGERT projects and cyberinfrastructure aspects

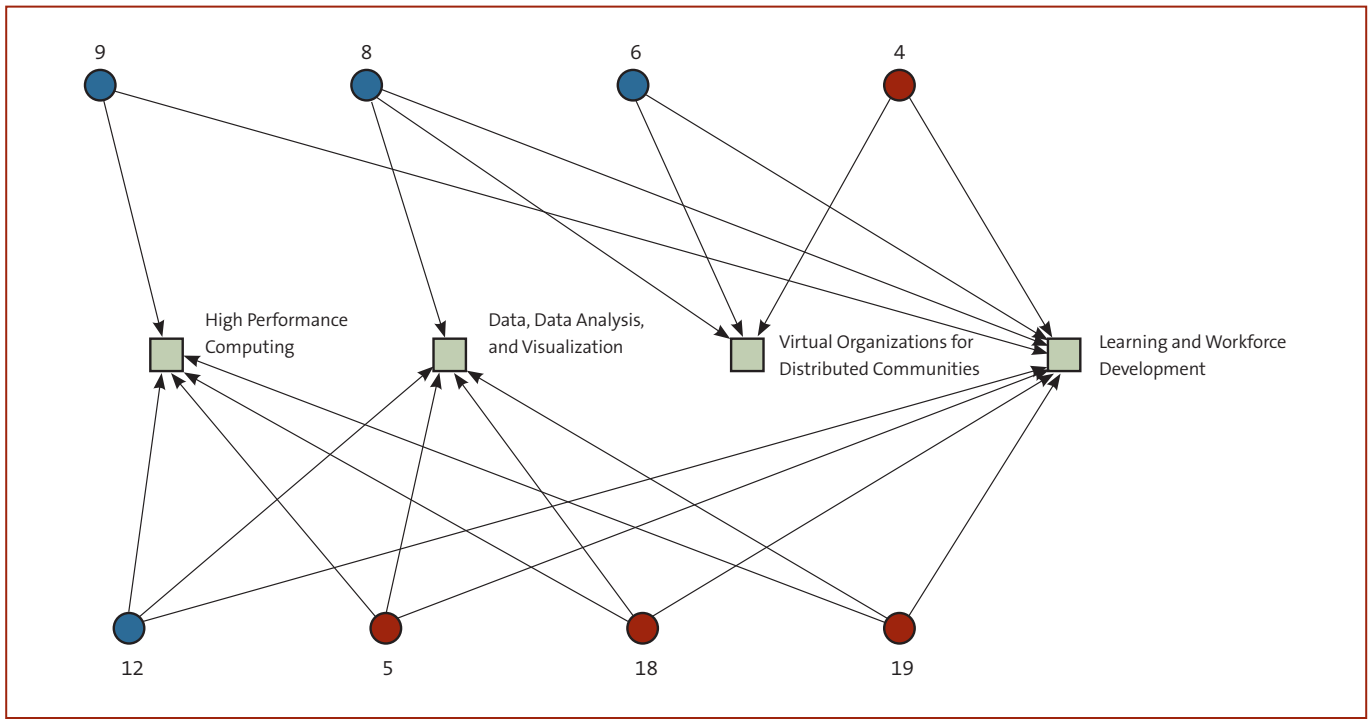
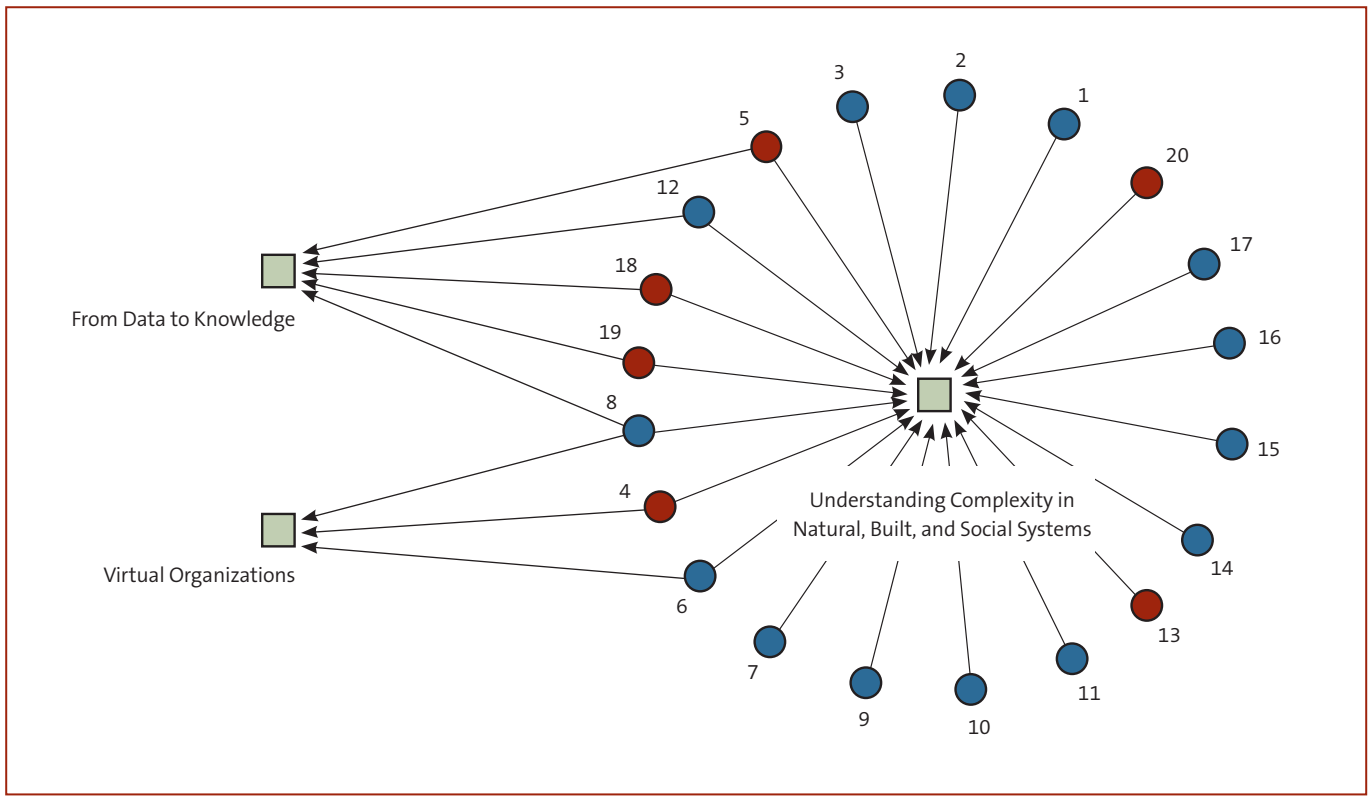


Figure 3: IGERT projects and cyber-enabled discovery and innovation themes



Resource Center

With the release of the FY 2009 grant solicitation, institutions being awarded IGERT grants will be committed to creating a supportive environment for cyber-enabled audio and video collaboration. The suggested tool to provide this form of communication is the Access Grid. Using an ensemble of open source videoconferencing resources developed by Argonne National Labs, Access Grid supports group-to-group (or individual) communication through high-speed networking over the web (Internet-2). It provides high quality audio and video interaction along with capabilities for sharing and interacting with files and applications. Utilizing Access Grid, program officers, faculty staff, IGERT trainees, and other members within the IGERT community will be able to participate in collaborative discussions with their colleagues from across the country in the comfort of their offices and home institutions. It is anticipated that NSF program officers will have the opportunity to conduct "virtual" site visits. Tremendous savings in both time and money will be realized once the IGERT Access Grid is utilized to its full capacity.

Another new project underway to further facilitate collaboration within the IGERT community is an IGERT Resource Center. It is envisioned that the resource center will provide information and tools through a web-based, electronic venue for sharing, interaction, communication, and information dissemination. Content items under consideration for incorporation include IGERT bibliographies, facilitated and ad hoc forums, curriculum repository, IGERT library, educational outreach portals, wikis, online virtual workshops, and workshop archives. The resource center is anticipated to be the hub of the IGERT cyber-community and a center for anyone seeking additional information related to the IGERT program.

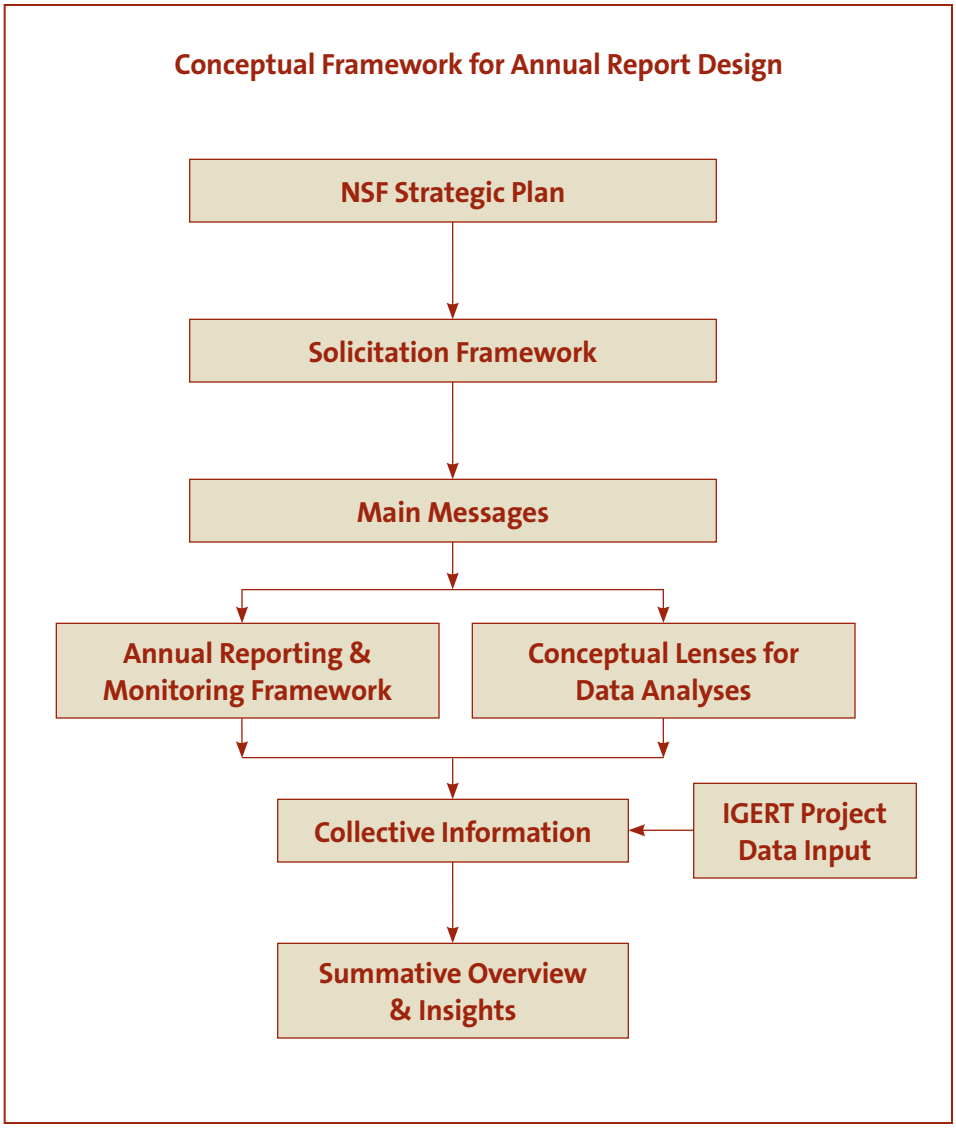
Appendix 1: Methodology and Conceptual Framework

The intent of the report is to give an overview snapshot of the IGERT program through the lens of the compiled annual reports of the individual IGERTs. Therefore, the methodology for the report is simple summation and reporting. No evaluation of the results or implications from these results have been drawn, as this is a descriptive report only.

The report summarizes the input of the 136 individual IGERT project annual reports submitted for the 2006-2007 collection period as submitted on the web-based reporting system for IGERT. Topics for summation were derived from the content of the reports which was itself developed using the IGERT Solicitation and NSF Strategic Plan as the guidelines. In 2008, the annual report for IGERT will again be upgraded allowing for a 2007-2008 report with greater richness.

The conceptual framework for this report illustrates the linkages among the NSF Strategic Plan, IGERT Solicitation, the IGERT annual project reports, and this descriptive report.

IGERT 2006-2007 Annual Report Concept: Demonstrate the value of the IGERT program by providing IGERT stakeholders with an annual summary and overview of the progress, achievements, practices, and statistics of active IGERT projects.



Appendix 2: Photo Credits

Front Cover (left to right): Reference stand 10 of the H.J. Andrews Long-term Ecological Research (LTER) site provides long-term monitoring of forest conditions, allowing researchers to reconstruct past disturbances and understand how these past events have shaped the character of today's forest. (0333257: Jones, Oregon State University)

Credit: Al Levno, USDA Forest Service, Pacific Northwest Research Station

Marin Conservation Corps Director Deborah Schoenbaum and youth volunteers assisted with an eradication effort coordinated by an IGERT trainee. (0114432: Strauss, University of California Davis)

Credit: Ann Dickinson

"Flower Bouquet," a 3-D nanostructure grown by controlled nucleation of silicon carbide nanowires on Gallium catalyst particles. As the growth proceeds, individual nanowires 'knit' together to form 3-D structures.

Credit: Ghim Wei Ho and Prof. Mark Welland, Nanostructure Center, University of Cambridge

Elephants in Chobe National Park, Botswana. (0504422, Brown, University of Florida)

Credit: MT Brown

Brian D. Iverson, a mechanical engineering doctoral student at Purdue University, holds up a disk containing several "micro-pump" cooling devices, which are small enough to fit on a computer chip. The tiny pumps circulate coolant through channels etched into the chip.

Credit: David Umberger, Purdue University News Service

Page 9: Pampas grass (*Cordateria jubata*), an invasive species that naturalizes throughout California and still is readily available in the retail trade. (0114432: Strauss, University of California Davis)

Credit: Mandy Tu

Page 10 (top): A student tests the biofeedback for rehabilitation system being developed by the experiential media IGERT at ASU. (0504647: Rikakis, Arizona State University)

Credit: Tim Trumble

Page 10 (bottom): IGERT trainees and associates developing and testing the SMALLab environment. (0504647: Rikakis, Arizona State University)

Credit: Ken Howie

Page 11: Professor Stephen Walsh with GPS device in the Galapagos Islands. (0333193: Entwisle, University of North Carolina Chapel Hill)

Credit: Amy McCleary

Page 12: Laser mediated heat shocks. Transgenic wing tissue from Bicyclus Anynana butterflies showing EGFP expressing cells due to a line heat shock. Higher magnification of EGFP expressing cells. Wildtype wing tissue after line heat shock. Complex grid pattern of EGFP expression. Complex butterfly pattern of EGFP expression as a result of laser heat shock. Scale bar = 100 µm in all panels. (0114330: Cartwright, State University of New York Buffalo)

Credit: D. M. Ramos, F. Kamal, E. A. Wimmer, A. N. Cartwright, and A. Monteiro, "Temporal and spatial control of transgene expression using laser induction of the hsp70 promoter," BMC Developmental Biology, vol. 6, Nov 2006

Page 14: Atmospheric science laboratory classroom with meteorological instruments and data acquisition systems for hands –on learning. (0221688: Mehta, Texas Tech University)

Credit: Courtesy of Wind Science and Engineering Research Center, Texas Tech University - Kishor C. Mehta

Page 15 (top right): Molecular Dynamics of Monoamine Oxidase B: A Monotopic Memberane Protein: Images generated by William Allen using VMD (unpublished). This image shows a close up of the tail sections under investigation. (0333378: Duncan, Virginia Polytechnic Institute and State University)

Credit: William Allen

Page 15 (middle left): Tailored Macromolecules for DNA Complexation and Cell Transfection. (0333378: Duncan, Virginia Polytechnic Institute and State University)

Credit: John Layman

Page 16: Elephants in Chobe National Park, Botswana. (0504422: Brown, University of Florida)

Credit: MT Brown

Page 18 (top): As part of the up-and-coming $1.4 Billion Spallation Neutron Source at Oak Ridge National Laboratory, Oak Ridge, Tennessee, the VULCAN engineering diffractometer is being developed. VULCAN's design allows for multiple detector-bank converage with in-situ tension and compression capabilities. This setup is currently unavailable among neutron engineering diffractometers in the world. (09987548: Liaw, University of Tennessee Knoxville)

Credit: Adapted from Materials Science and Engineering A, 437, 126-133, 2006

Page 18 (bottom): Electrode Array Smaller Than a Penny. (0549352: Touretzky, Carnegie Mellon University)

Credit: Ryan Kely, Matthew Smith, and Tai Sing Lee, Center for the Neural Basis of Cognition, Carnegie Mellon University

Page 19 (middle column): MAO-B dimer embedded into a lipid bilayer. (0333378: Duncan, Virginia Polytechnic Institute and State University)

Credit: William Allen

Page 20: Students and WISE personnel documenting damage caused by Hurricane Katrina. (0221688: Mehta, Texas Tech University)

Credit: Courtesy of Wind Science and Engineering Research Center, Texas Tech University' - Kishor C. Mehta

Page 21: Reference stand 10 of the H.J. Andrews Long-term Ecological Research (LTER) site provides long-term monitoring of forest conditions, allowing researchers to reconstruct past disturbances and understand how these past events have shaped the character of today's forest. (0333257: Jones, Oregon State University)

Credit: Al Levno, USDA Forest Service, Pacific Northwest Research Station

Page 22: Mini-Z THz spectrometer. (0333314: Wang, Rensselaer Polytechnic Institute)

Credit: Brian Schulkin

Page 23: Apparent slip velocity as a function of bulk shear rate (flow intensity) for a polydimethylsiloxane (PDMS) melt of molecular weight 970,000 in contact with a surface with tethered PDMS chains with a molecular weight of 96,000. The experimental data are by Durliat et al. [Europhys. Lett., 38, 383-388 (1997)]. (0221589: Denn, City University of New York City College)

Credit: The figure is from a paper "A stochastic chain simulation of wall slip in entangled polymer melts" by Fang Xu, Morton M. Denn, and Jay D. Schieber, to appear in the Journal of Rheology in May, 2006. NSF has permission to use the figure.

Page 26: TTUWindfluvana: Students and instructors visiting wind farm near Lubbock, Texas. (0221688: Mehta, Texas Tech University)

Credit: Courtesy of Wind Science and Engineering Research Center, Texas Tech University - Kishor C. Mehta

Page 29 (left column): University of Maine Sensor Science, Engineering and Informatics Project. (0504494: Beard-Tisdale, University of Maine)

Credit: UMaine SSEI E. Roy

Page 29 (right column): Marin Conservation Corps Director Deborah Schoenbaum and youth volunteers assisted with an eradication effort coordinated by an IGERT trainee. (0114432: Strauss, University of California Davis)

Credit: Ann Dickinson

Page 30: Cathy McNally and Mr. Doto Masamba, a Saadani Park Ranger, recording river edge habitat condition during an ecological reconnaissance of the Wami River in Tanzania. (0504103: August, University of Rhode Island)

Credit: Baraka Kalanghe

Page 30 (bottom left): IGERT SKINS trainee Andrea Wesser served as a student volunteer during the 2006 Micro/Nano Summer Rootics Camp at the University of South Florida. (0221681: Bhansali, University of South Florida)

Credit: Praveen Sekhar

Page 31: 2007-2008 MCTP Fellows, October 3, 2007. Top row (L-R) Matthew Allen, Jeffrey Wright, Li-Min (Raymond) Chen; 2nd row (L-R) Zachary O'Brien, Gregory Kuzmanich, Steven Jonas; 3rd row (L-R) Iris Rauda, Danny King; 4th row (L-R) Michael Kahn, Cortnie Vogelsberg, Dyanara Parra, Laura Saldarriaga-Lopez, Sabah Bux; 5th row (L-R) Emil Song, Wyatt Nelson. Not pictured are Augustin Hong, Alexander Tucker-Schwartz. (0114443: Garrell, University of California Los Angeles

Credit: UCLA Materials Creation Training Program

Page 35: The invasive Japanese mud snail, *Batillaria attramentaria*, may be small, but can have a tremendous impact on ecosystems of San Francisco Bay. (0114432: Strauss, University of California Davis)

Credit: Ann Dickinson

Page 36: MILES IGERT trainee, Abby Turpyn Peairs, presenting her research in the national conference. (Duncan: Virginia Polytechnic and State University)

Credit: Abby T. Peairs

Page 37: A student tests the biofeedback for rehabilitation system being developed by the experiential media IGERT at ASU. (0504647: Rikakis, Arizona State University)

Credit: Tim Trumble

Page 39: IGERT Trainee Scot Waye presented a 30-minute discussion of common indoor air pollutants and their sources to kick off a trainee organized public workshop on Indoor Air Quality. (Corsi: University of Texas Austin)

Credit: Ralph Barrera, Austin-American Statesman

Back Cover (left to right): Detecting Biological Samples Lab-on-a-chip being tested under fluorescence microscope for detection of biological samples.

Credit: Melvin Khoo, Sam Lu and Change Liu, University of Illinois at Urbana-Champaign

Shubha Chakravarty conducting fieldwork in Kenyya. (0333418: Stiglitz, Affiliation)

Credit: Shubha Chakravarty

Kristen Baker views some of her study subjects, tobacco hornworms

Credit: Rick Fatica; Image courtesy Perspectives Magazine