Innovative, Integrative, Interdisciplinary Graduate Education and Training: New Concepts for Assessment

Interim Report to IGERT Program Directors

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INTRODUCTION

This interim report is designed to give IGERT directors an overview of the national community of programs to which they belong and to provide an aggregate sense of the different local program structures and cultures that comprise it.

The report is divided into two sections: (1) Summary Statistics of the IGERT Population and (2) Preliminary Trend Line Data from IGERT PI Survey.

The tables and maps in the first section of this report provide a sense of the institutional contexts and geographic locations across which the population of IGERT programs is distributed. The quantitative and qualitative analyses of select items from the IGERT PI Survey in the second section outline some of the key patterns of convergence and divergence between these programs.

The IGERT PI Survey was administered between May and July 2005. If you have not responded to this survey but would like to, please email Dave Conz at conz@asu.edu and you will be provided a link to the survey immediately.

(1) SUMMARY STATISTICS OF THE IGERT POPULATION

Using publicly available data from multiple sources, we have calculated a number of summary statistics pertaining to the institutional context of IGERT programs. These include:

(a) IGERTs by geographic region, *U.S. census regions*
(b) IGERTs by institutional environment, *total no. IGERTs on campus*
(c) IGERTs by institutional environment, *public versus private*
(d) IGERTs by size, *host university STEM[1] graduate student population, '00*
(e) IGERTs by size, *host university federal research dollars, '02*
(f) IGERTs across domains and subdomains, *assigned by research team*
(g) IGERTs by year founded

Below, we provide corresponding data for each of these seven attributes. The findings represented in the tables, graphs, and maps are based on the universe of IGERT programs awarded between 1998 and 2004 (spring). Within this time frame, five IGERT programs were granted renewals. Because these renewals reflect essentially the same activity continued at the same institution, we count these programs only once so as not to over represent their characteristics in our analysis.

[1] STEM is the acronym for Science, Technology, Engineering and Mathematics.

(a) Distribution of IGERTs by geographic region, *U.S. census regions*

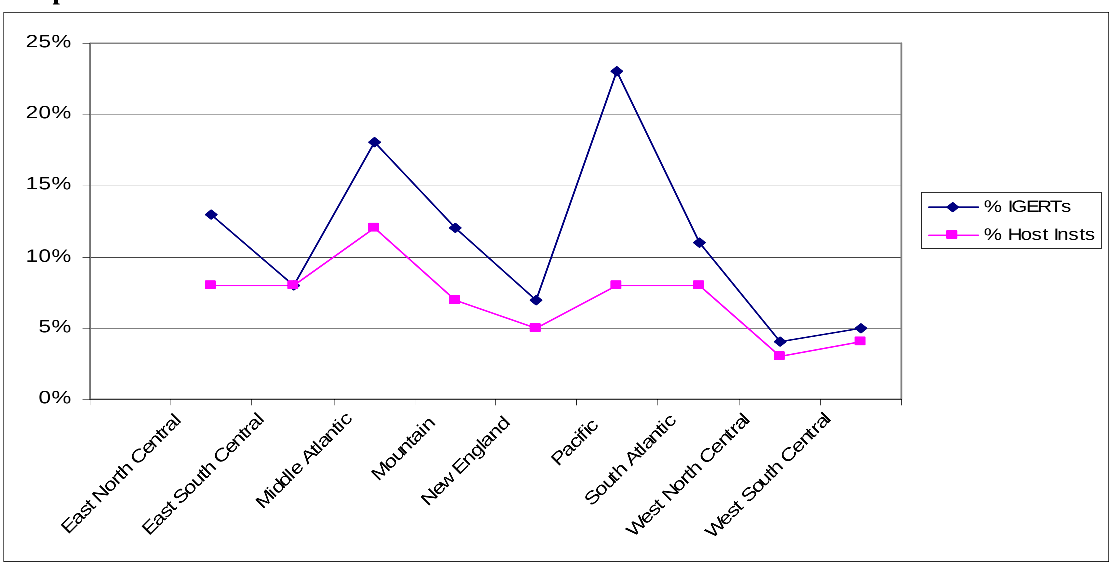
Table 1.1

Region	# IGERTs	% IGERTs	# Host Insts	% Host Insts
East North Central	16	13%	9	8%
East South Central	10	8%	10	8%
Middle Atlantic	21	18%	14	12%
Mountain	14	12%	8	7%
New England	8	7%	6	5%
Pacific	27	23%	10	8%
South Atlantic	13	11%	9	8%
West North Central	5	4%	4	3%
West South Central	6	5%	5	4%
TOTAL	**120**		**75**	

From the data presented in Table 1.1, one can see that the geographic distribution of the IGERT programs is characterized by a coastal distribution and, in fact, dominated, by a northeast cluster—57% are located at east coast institutions, 32% at west coast institutions, and 32% are in northeastern states. Only 15% are located in what one would consider mountain or central states.

Perhaps not surprising but still worth noting, is the fact that the IGERT programs located within the coastal regions—particularly in the Pacific and Middle Atlantic regions—tend to be grouped in relatively fewer institutions than the IGERTs found in most central and mountain states. In other words, there tend to be more universities on the east and west coasts with multiple IGERTs on campus than in the central and mountain states. This is more easily seen in Graph 1.1.

Graph 1.1



The distribution of IGERTs by number of programs per campus is also depicted in the geographic map entitled *Number of IGERTs per Institution* (See Appendix 1.)

(b) Distribution of IGERTs by institutional environment, *total no. IGERTs on campus*

Table 1.2

# IGERTs on Campus	# IGERTs	% IGERTs	# Host Insts	% Host Insts
1	46	37%	46	37%
2	34	27%	17	14%
3	24	19%	8	6%
4	16	13%	4	3%
TOTAL	**120**		**75**	

According to the data presented in Table 1.2, slightly more than half of the IGERTs awarded between 1998 and 2004 (spring) share a campus with another program. Said another way, approximately two-thirds of the 75 institutions hosting IGERT programs between 1998 and 2004 (spring) have multiple IGERTs on their campuses. As stated above, there does seem to be some correlation between an institution's geographic location and its likelihood to support multiple IGERTs.

At a minimum, this trend could suggest one of two things. First, these campuses may have an institutional environment which lends itself to different interdisciplinary research programs—because of organizational size, administrative structure, or epistemic culture—and where IGERTs are a natural ecological fit. Second, there may be some sort of signaling effect in place whereby "success" with one IGERT proposal suggests likelihood of success for a second or third program.

While more ongoing analysis is needed, based on preliminary survey and interview data, we are inclined to believe that the first explanation has more power than the second. In many instances, IGERT program directors have tended to know surprisingly little about other IGERTs on his/her campus. Moreover, as found in subsection (e) below, there does appear to be some significant correlation between university size as measured by total federal research monies. And, finally, as suggested in some of the responses to the PI Survey presented in Section 2, program directors report institutional context as a key defining characteristic of IGERT programs.

(c) Distribution of IGERTs by institutional environment, *public versus private*

Table 1.3

Private/Public	# IGERTs	% IGERTs	# Host Insts	% Host Insts
Private Institution	29	24%	21	28%
Public Institution	91	76%	54	72%
TOTAL	**120**		**75**	

Three quarters of the IGERT programs awarded between 1998 and spring (2004) are housed at public institutions. Moreover, whereas only 52% of the 21 private institutions housing IGERTs support more than one program, 70% of the 54 public institutions have more than one program on campus.

We contend this is true for two reasons. One, the financial arrangements of the IGERTs program are more attractive to public than private institutions. IGERT grants pay an education allowance (currently $10.5k) to cover tuition, health insurance, and fees, which is enough to cover such expenses at most public universities but falls far short of tuition at most private universities. Two, within the 75 institutions, the public research universities tend to have more “large” institutions represented than do the private universities.

Finally, as you will see from the map entitled *IGERTs by Type of Institution*, 76% of the private institutions that were awarded IGERTs between 1998 and 2004 (spring) are in northeastern states. (See Appendix 2.)

(d) Distribution of IGERTs by size, *host university STEM graduate student population, ’00*
(source*: IPEDS Institutional Characteristics Survey Data*)

Table 1.4

# STEM Grads	# IGERTs	% IGERTs	# Host Insts	% Host Insts
less than 4000	39	33%	28	37%
4000-6999	42	35%	26	35%
7000-9999	17	14%	11	15%
10000-12999	21	18%	9	12%
13000-15999	1	1%	1	1%
TOTAL	**120**		**75**	

(e) Distribution of IGERTs by size, *host university federal research dollars, ’02*
(source*: IPEDS Institutional Characteristics Survey Data*)

Table 1.5

Federal Research Funds (in thousands of $)	# IGERTs	% IGERTs	# Host Insts	% Host Insts
$1-99,999	28	23%	24	32%
$100,000-199,999	25	21%	15	20%
$200,000-299,999	23	19%	15	20%
$300,000-399,999	11	9%	6	8%
$400,000+	33	28%	15	20%
TOTAL	**120**		**75**	

Just over two thirds of the IGERT programs awarded within 1998-2004 (spring) period are located at institutions with a STEM graduate student population of at least 4000 students (2000) and with federal research funds totaling more than $200 million (2002). The percentages are 68% and 65%, respectively. Only one IGERT program is found at an institution with a less than $10 million in federal research dollars.

Moreover, by the Carnegie Classification (2000), 65 (87%) of the 75 institutions are considered Doctoral/Research Universities–Intensive, whereas nine (12%) are Doctoral/Research Universities–Extensive and only 1 is a Master's college and university I. This last school also happens to be the only Historically Black College and University awarded an IGERT in this time frame.

Finally, there is a significant correlation between the number of IGERTs on campus and the size of the institution as measured by the host universities total amount of federal research funds (.366, p = .01).

The geographic distribution of universities awarded IGERTs by size is also illustrated in the maps entitled *Number of STEM Graduate Students per IGERT Institution* and *Research Funds per IGERT Institution in Thousands*. (See Appendices 3 and 4.)

(f) Distribution of IGERTs by domain and subdomain

Table 1.6

Domain and *subdomain*	**# IGERTs**	**% IGERTs**
Biological Science	21	18%
biocomputation and informatics	*11*	*9%*
bioengineering/biotechnology	*7*	*6%*
evolution	*3*	*3%*
Cognitive and Neuroscience	13	11%
cognitive learning	*5*	*4%*
neurocomputation	*4*	*3%*
neuroengineering	*4*	*3%*
Computation and Complex Systems	7	6%
complex systems analysis	*4*	*3%*
computational science	*3*	*3%*
Environmental Systems	30	25%
earth systems	*10*	*8%*
ecosystems	*10*	*8%*
energy and environment: use and mgt.	*10*	*8%*
Materials Science	26	22%
lasers, optics, and photonics	*10*	*8%*
nanoscience/nanotechnology	*8*	*7%*
materials science	*3*	*3%*
polymers	*5*	*4%*
New Technology and Applications	12	10%
device optimization	*3*	*3%*
medical technology	*2*	*2%*
networking	*2*	*2%*
sensor devices	*3*	*3%*
visualization	*2*	*2%*
Social Science and Management	11	9%
innovation management	*4*	*3%*
social organization and policy	*7*	*6%*
TOTAL	**120**	

Many of the IGERTs defy easy methods of unique classification. However, in order to get at least a rough sense of how the programs are distributed across different areas of research, we have attempted to create a new schema of IGERT domain and subdomain categories. This schema was not pre-designed by us, but rather emerged from the data themselves.

Methodologically, developing the categories and assigning individual IGERTs to them involved the following. First, we examined individual IGERT program materials and NSF award abstracts, coding them by scientific area (e.g., environmental science, social science, materials science) and key research themes (e.g., environmental management and sustainability, poverty and policy, structural nanocomposites). Second, once this level of coding was complete, we compiled a full list of the areas and themes identified and looked for the primary patterns across them. Third, from these patterns, we collapsed some of the codes and aggregated others to form the schema above. Finally, we re-examined all individual IGERT program materials and NSF award abstracts a second time, re-coding them by the domains and subdomains of the new schema. At present, each IGERT has been assigned to a single domain and subdomain. This approach has worked better for some programs than others, and we are currently in the process of developing more elaborate schemata that will lend themselves more a complex modes of classification (For the full list and geographic maps of individual IGERT programs by domain and subdomain, see Appendices 5 through.12)

As evidenced by Table 1.6, at least by our methods of classification, approximately two thirds of the IGERT programs are found within three of the seven domains—Environmental Systems (25%), Materials Science (22%), and Biological Science (18%). Moreover, comparatively few programs can be classified with the social and behavioral science domains—Social Science and Management (9%) and Cognitive and Neuroscience (11%).

(g) Distribution of IGERTs by year founded

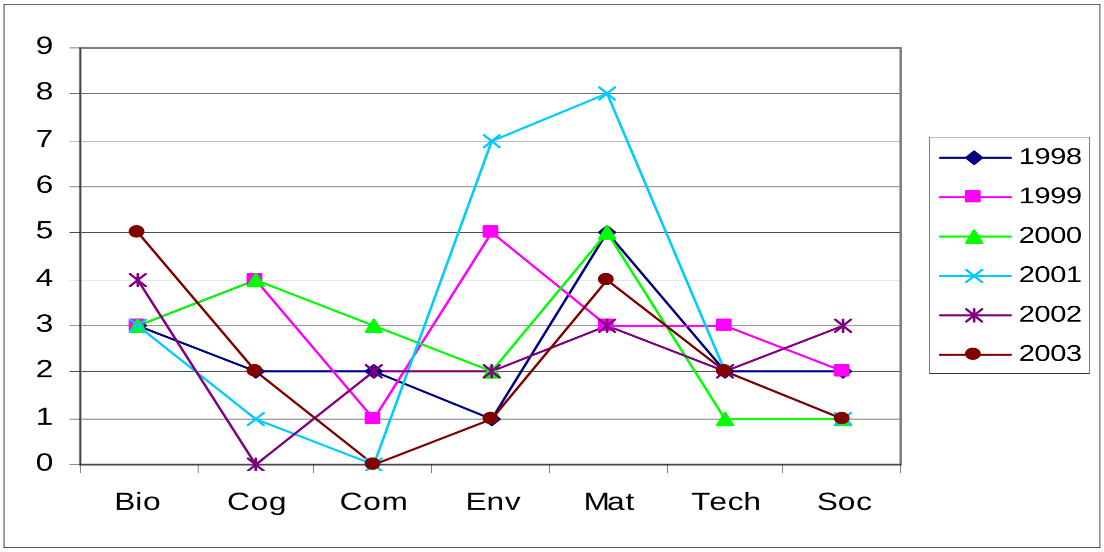
Table 1.7

Year Awarded	# IGERTs	% IGERTs
1998	17	14%
1999	21	17%
2000	19	15%
2001	22	18%
2002	16	13%
2003	21	17%
2004	4	3%
TOTAL	**120**	

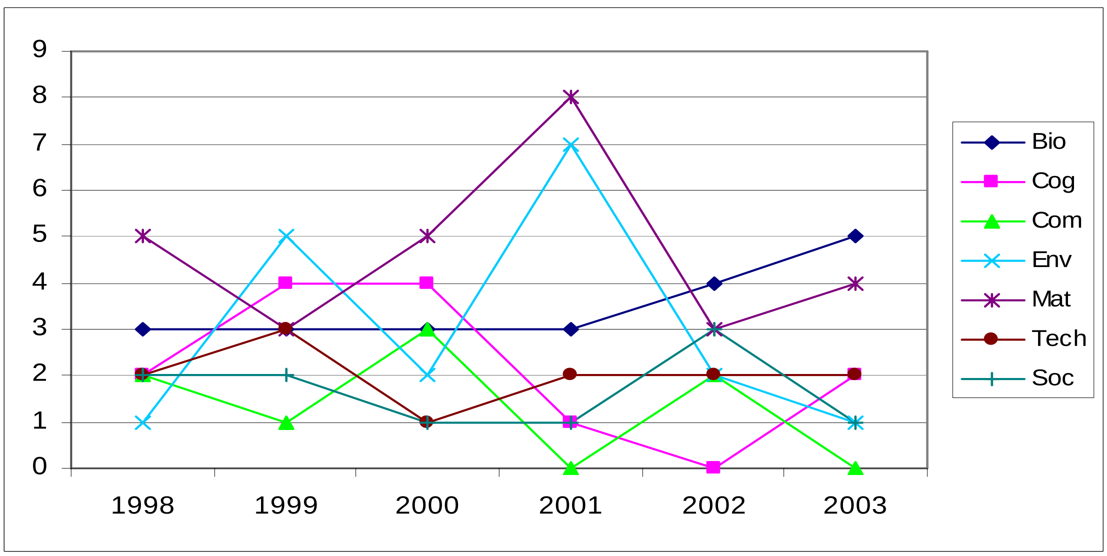
As Table 1.7 indicates, IGERTs have been awarded annually at a rather consistent rate, between 16 and 22 programs per year. The table reflects only four programs awarded in 2004 because of it only captures those IGERTs awarded by the spring of that year and the beginning of our analysis.

While not obvious from the data presented in Table 1.2, Graphs 1.2 and 1.3 reveal some interesting trends related to IGERT founding dates and research domains (1998-2003). For example, both graphs indicate a significant spike in the establishment of IGERT programs categorized in the domain of Materials Science in 2001. One might suspect this is due to increased attention to nanoscience/nanotechnology. However, in fact, most of the Material Science IGERTs awarded in 2001 are focused on the subdomain of lasers, optics, and photonics. Moreover, it appears that the number of IGERTs awarded within the Cognitive Science domain fell off between 2000 and 2002, while those within the Biological Science domain have increased steadily since 2001. This growth can be explained more specifically by an increase in awards to IGERTs concentrating on the subdomain of bioengineering/biotechnology (See Appendix 13 for map entitled. The geographic distribution of IGERTs by award year is represented in the map entitled *IGERTs by Year of NSF Award*. (See Appendix 13).

Graph 1.2



Graph 1.3



(2) PRELIMINARY TRENDLINE DATA FROM IGERT PI SURVEY

In the spring of 2005, electronic surveys were sent to administrators and principal investigators of 114 IGERT programs.[2] As of July 15, 2005, completed questionnaires were received from 63 administrators (55%) and 57 principal investigators (50%).

As seen from the data in Table 2.1, the IGERTs that responded were more or less evenly distributed across the seven founding years between 1998 and 2004, with the exception of 2003.

Table 2.1

Year Awarded	% IGERT Respondents
1998	14%
1999	11%
2000	15%
2001	12%
2002	13%
2003	22%
2004	13%
TOTAL	**114**

It is on this pool of data that the following quantitative and qualitative analyses of selected survey items are based. With regard to the quantitative analyses, the calculated percents are all based on the valid (nonmissing) sample for each item. Since there is a "choose not to respond" response available for virtually every item that is treated as valid data, the percents do not add always add to 100%.

Again, if you have not responded to this survey but would like to, please email Dave Conz at conz@asu.edu and you will be provided a link to the survey immediately.

This Section is divided into seven subsections:

(a) The Organization of IGERT Programs
(b) IGERT Program Activities
(c) PI Satisfaction with the IGERT Program
(d) Mechanisms of IGERT Program Interaction
(e) Distinctive IGERT Program Characteristics
(f) Greatest IGERT Program Successes
(g) Most Significant IGERT Program Shortcomings

Below, we provide corresponding data for each of these seven aspects of the IGERT program as reported by the program assistants or principal investigators (depending on the question) who responded.

[2] This is fewer than the IGERT population total for the period 1998-2004 (spring) because, as stated above, a few IGERTs have received a second round of funding, so essentially the same activity is continued at the same institution with a new award. In addition, this total is less than the recalculated total used in Section 1 because a few IGERTs awarded during this period indicated that they were no longer active and refused to participate in the study even before the survey was launched.

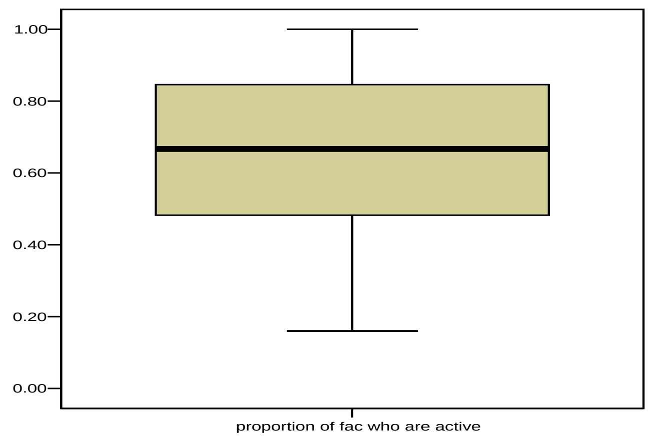
(a) The Organization of IGERT programs

First, thirty five percent of the 63 IGERT programs that responded involve more than one university; and 38% involve faculty from more than one university. Furthermore, within the host university, the number of departments typically involved in an IGERT program ranges from 1 (13%) to 8 (4%), with the median falling between 2 (26%) and 3 (22%).

Second, according to the program assistants who completed the survey thus far, programs have a range of between 7 and100 faculty listed as "official faculty affiliates" in their programs. However, by contrast, these same IGERTs report that the number of "active faculty participants" ranges from only four to 50.

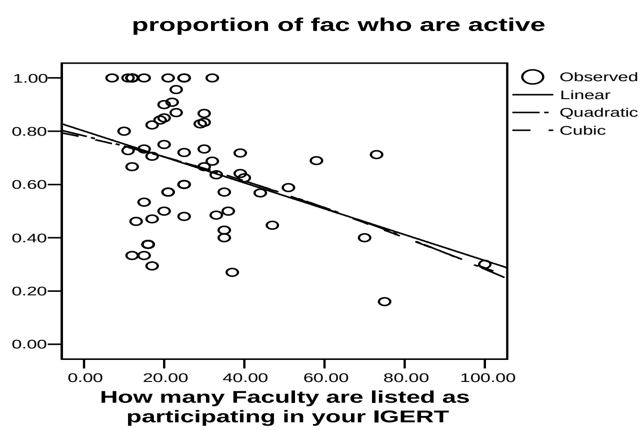
In fact, on average, only about two thirds of the faculty listed as official affiliates are considered active participants by the principal investigators who responded. Graph 2.1 below shows this distribution (the box represents the middle 50% of the distribution, which ranges from 45% to 85% participation). As we will see in subsections (c) and (g) below, faculty engagement was also identified by several principal investigators as a key shortcoming of their individual IGERT programs.

Graph 2.1



There is only a modest (-.37) linear correlation between the number of official faculty affiliates listed and the fraction who are active faculty participants. Thus, size alone does not account for nominal participants ("free riders"), but there is a marked ceiling effect when 40 or more faculty are listed. (See Graph 2.2).

Graph 2.2



Third, based on the data we have received from program assistants who completed the IGERT PI survey to date, IGERT programs appear to have a variety of different organizational "homes." As demonstrated in Table 2.2, programs may be housed within single departments, across multiple departments, or within other programs or centers/institutes. However, the majority are based in a single department.

Table 2.2

IGERT Home	% IGERT Respondents
1 Department	32%
2 Departments	5%
3+ Departments	27%
Interdisciplinary Programs	10%
Research Center/Institute	23%
Elsewhere	2%
TOTAL	**114**

Within these various program structures, 81% of the IGERTs report that students earn degrees from their home departments, whereas the remaining 20% earn degrees from the IGERT program itself or from an interdisciplinary degree-granting program that houses the IGERT program.

Importantly, given that most of IGERT programs involve multiple departments, a significant majority of PI's report that the various departments tend to work "very well" or "pretty well" together.

Table 2.3

Departmental Relations	% IGERT Respondents
Work very well together	39%
Work pretty well together	44%
Do not work very well together	15%
Work not at all well	3%
TOTAL	**114**

Yet, it is important to note that, as is shown below in subsection (c), PIs also report being least satisfied with departmental support of the IGERT program (as compared to NSF support and university support).

Finally, to compensate for their distribution across different disciplinary departments and what are often different institutional locales, most IGERTs provide joint physical spaces where IGERT students can come together either formally or informally. Some IGERT programs provide than one of these spaces.

Table 2.4

IGERT Space	% IGERT Respondents
Students have offices nearby	37%
Shared labs or workspace	43%
Student meeting rooms	32%
TOTAL	**114**

(b) IGERT Program Activities

First, as seen in Table 2.5, there is considerable variability in the amount of structure imposed by the IGERT program design on students, although most—62%—of the principal investigators who responded describe their IGERT as "somewhat tightly" or "somewhat loosely." It should also be noted, however, that because departmental mandates continue to have significant influence on what is required of a student, there can often be student-by-student differences with regard to how structured or not a single IGERT program may be in implementation.

Table 2.5

IGERT Structure	% IGERT Respondents
Very tightly structured	9%
Somewhat tightly structured	29%
Somewhat loosely structured	33%
Very loosely structured	3%
Depends on student's department	26%
TOTAL	**114**

Second, IGERT programs offer a range of different activities, most of which can be classified as: Interdisciplinary Activities, Collaborative Activities, Research Training Activities, Teaching Activities, or Career Development Activities.

Table 2.6 shows the percent of IGERT programs that have particular Interdisciplinary Activities. The "very important" and "very effective" columns show the percent who rated the importance or effectiveness of the activity in the highest category. For example, the first row of the table indicates that 14% of IGERTs do not offer joint courses, 17% do offer them, and a further 68% not only offer but require them. In other words, 85% of all IGERTs offer joint courses, with most (68% / 85% = 80%) requiring students to take them. Of those who offer joint courses, 58% consider them very important and 36% consider them very effective.

Table 2.6

Interdisciplinary Activity	No	Yes	Yes, and it is required	Very Important	Very Effective
Joint courses	14%	17%	68%	58%	36%
Joint research	12%	36%	53%	71%	53%
Joint advising	9%	29%	60%	61%	24%
Joint theses	5%	48%	40%	47%	24%
Joint PhD committees	10%	--	86%	76%	53%

In addition to selecting from the closed-ended list of interdisciplinary activities identified in Table 2.6, respondents were also given the opportunity to list separately any "other" Interdisciplinary Activities they might offer. Forty three percent identified other interdisciplinary activities, including immersive "boot camp" activities, retreats, and symposia among others.

Tables 2.7 through 2.10 reflect the percent of IGERTs that have each of the various types of the Collaborative Activities, Research Training Activities, Teaching Activities, and Professional Development Activities about which we asked. Respondents were not asked to rate the importance and effectiveness of these activities. They were asked to list any "other" activities offered by their program for each category.

Table 2.7

Collaborative Activity	No	Yes	Yes, and it is required
Teamwork training	66%	12%	21%
Collaborative fieldwork	28%	24%	45%
Multidisciplinary research projects	4%	42%	49%

In addition to the Collaborative Activities above, 19% of the responding IGERT programs report having "other" activities, such as internships and training in specific techniques, such as microscopy.

Table 2.8

Research Training Activity	No	Yes	Yes, and it is required
Quantitative analysis	38%	31%	31%
Data presentation	42%	23%	33%
Research ethics	14%	7%	76%
Proposal writing	53%	19%	24%
RA for IGERT faculty	9%	45%	39%
RA for other department faculty	16%	68%	7%
Supervise undergraduate RA	32%	64%	4%
Product design	93%	5%	2%

Sixteen percent of the IGERTs in our response group offer "other" Research Training, including: internships, fieldwork experiences, and technical writing workshops.

Table 2.9

Teaching Training Activity	No	Yes	Yes, and it is required
Teacher training	53%	33%	11%
Cross-disciplinary teaching	77%	14%	4%
Teaching workshop	30%	56%	9%
TA for IGERT faculty	14%	61%	9%
TA for other department faculty	42%	46%	4%
Develop IGERT course	46%	43%	7%
Teacher training	53%	33%	11%

Beyond the Teaching Training Activities above, 19% of the principal investigators who completed the survey indicated "other" teaching activities, including experience addressing a non-technical audience, dinner seminars, and mentoring of high school students.

Table 2.10

Professional Development Activity	No	Yes	Yes, and it is required
Job search & networking	65%	21%	14%
Nonacademic careers	37%	44%	18%
Teachers from industry	57%	27%	16%
Industry internships	30%	56%	12%
Government internships	37%	51%	9%
Nonprofit internships	47%	44%	7%

For the last category of program activity, 25% of the IGERTs for which we have data reported "other" Professional Development Activities, including Myer-Briggs assessments, participation in the Preparing Future Faculty program, travel support to attend meetings, internships in industry or outside the U.S., and training in scientific writing and publishing.

Third, IGERT PIs were asked to indicate the degree to which their program was founded on and oriented toward developing a tool, carrying out a vision, or solving a problem. A "Tool-based" IGERT might focus on developing the technology of microscopy at various scales and in various applications, whereas a "Vision-based" IGERT might concentrate on developing a particular synthesis of disciplines (such as biology and computation, or earth, life, and social sciences) which would be embodied in its graduates. And, a "Problem-based IGERT might develop approaches to understanding and solving a particular problem, such as social inequality, neural imaging, or environmental regulation and conservation.

Based on our preliminary analysis of these responses, it appears that IGERTs tend to focus on a problem with guidance from a vision and with tool development a distant third concern. Forty of the 56 IGERT PIs (72%) indicated that their IGERT is strongly guided by both a problem and a vision, and 12 of those 40 (30%) also indicated strong commitment to tool development.

Table 2.11

Program Orientation	Tool-based	Vision-based	Problem-based
Not at all	16	5	4
A little	47	13	9
Substantially	28	48	39
Very much	9	34	49
Mean	2.3	3.1	3.3

(c) PI Satisfaction with the IGERT Program

Table 2.12 reports PI's satisfaction with aspects of their IGERT programs. Satisfaction was reported on 7-point scales, with values 1-3 indicating dissatisfaction, 4 being neutral, and 5-7 indicating satisfaction. The table presents percent Dissatisfied (values 1-3), Satisfied (values 5-7), and Very Satisfied (value 7 only), as well as the mean value.

All in all, from the data we have to date, PIs report being quite satisfied with their programs, though they certainly left themselves room for improvement. Strikingly high satisfaction with the quality of students as well as their breadth and intensity of participation was also reported. Faculty breadth was rated highly, but the intensity of faculty participation lagged other dimensions of the programs.

Additionally, PIs were quite satisfied with the support given by NSF to the program, but somewhat less satisfied with university support and even less satisfied with departmental support. Connections between relatively low departmental support and faculty intensity are worth exploring, as is the possibility that IGERTs compete with other graduate programs for faculty commitment and for departmental resources and accommodations.

Table 2.12

Satisfied with …	Dissatisfied (1-3)	Satisfied (5-7)	Very Satisfied (7 only)	Mean
Faculty breadth	13%	85%	52%	5.9
Faculty intensity	24%	60%	7%	4.7
Student breadth	9%	89%	45%	5.9
Student intensity	4%	91%	38%	5.9
Dept support	22%	48%	11%	4.6
University support	17%	68%	26%	5.2
NSF support	11%	83%	48%	5.8
Student quality	7%	89%	44%	6.0
Accomplishments	6%	89%	27%	5.9
All in all	5%	95%	29%	6.0

N= 54

(d) Mechanisms of IGERT Program Interaction

Fifty respondents provided answers to the following question: *Would you please tell us what are the most important opportunities through which people (that is, students and faculty both) interact within your IGERT?* However, because respondents often identified multiple opportunities, there were 183 responses to this item in total.

At the highest level, these 183 responses were roughly categorized into five primary themes – Educational Offerings (41%), Research Training Opportunities (34%), Professional Development Options (17%), Social Occasions (4%), and Material Resources (4%). Each of these themes was then broken down further to reveal more detail in the patterns of response.

First, respondents seemed to distinguish between two main types of Educational Offerings – core educational activities (56%) and extra-curricular or optional educational activities (44%). Within the core educational activities category, responses were then clustered even further into three groupings: courses and curriculum, orientation/retreat, and summer program. And, within the extra-curricular or optional educational activities category, three basic groupings emerged: seminar/workshop series, discussion groups, and international experiences.

In order to provide a sense of the range of responses to this question related to Educational Offerings, Table 2.13 provides a sample.

Table 2.13 Sample of Responses – Educational Offerings Enable Interaction

Category	Subcategory	Response
core	courses/ curriculum	Through participation in the capstone IGERT course, Hybrid Neural Microsystems
core	courses/ curriculum	IGERT integrative courses have been very effective in creating an identity for the IGERT theme of biointerfaces … The courses have been trailblazers for breaking down barriers in research
core	courses/ curriculum	Science and society class where students and faculty discuss societal issues associated with nanotech
Core	Orientation	The two-week boot camp in the fall
Core	Orientation	IGERT Fellows' group orientation at beginning of academic year
Core	summer component	Summer course where IGERT students design and test interdisciplinary hypotheses in diverse teams of students
core	summer component	Participating in interdisciplinary summer program on nuclear policy
extra-/ optional	seminar/ workshop	Students get to meet leading researchers through the colloquium and seminar series
extra-/ optional	seminar/ workshop	Student organized interdisciplinary seminar with invited speakers
extra-/ optional	discussion groups	Seminars and journal clubs …
extra-/ optional	discussion groups	Students and faculty have regular time to meet and discuss education and research issues. Through [these] chances of interaction they develop a mutual understanding of each other's research and personality, both important factors for any successful collaboration
extra-/ optional	international experience	International exchange with Berlin and Oslo
extra-/ optional	international experience	International experience in which all fellows and associates travel together, take courses together and explore culture and industry in foreign country

Second, similar to Educational Offerings, the theme of Research Training Opportunities was subdivided into core research training activities (48%) and extra-curricular or optional research training activities (28%). However, unlike Educational Offerings, Research Training Opportunities also had a third category focused on research advising/mentoring activities (24%).

Within the core research training activities, responses included references to research-related mechanisms of interaction including joint research proposals and interdisciplinary research teams to research meetings and field/laboratory rotations. The extra-curricular or optional research training activities category included mention of various types of research-oriented seminars and workshops around which students and faculty come together to discuss different topics throughout the year as well as annual symposia/conferences via which IGERT students and faculty present and exchange research and research results at one final and more formal event.

Finally, the research advising/mentoring activities category includes responses focused strictly on elements of the research advising process, most frequently the use of co-mentoring techniques. Importantly, responses in this subcategory implied that co-mentoring is a key lever not only for student but also faculty interaction.

Table 2.14 offers a sample of responses to Question B1 related to Research Training Opportunities.

Table 2.14 Sample of Responses – Research Training Enables Interaction

Category	Subcategory	Response
Core	research projects/ proposals	Joint research projects and proposals by faculty of the two institutions
Core	research projects/ proposals	… Our IGERT provides students with an opportunity to learn how disciplines other than their own view and address biological invasions and to put their understanding into practice via a year-long, collaborative interdisciplinary project. Students design this project, with input from faculty and non-faculty partners, so that they have complete ownership …
Core	research teams	Integrative research teams of students and faculty
Core	research meetings	Student's monthly research meetings allowing them to discuss their research and see the work of others in the program
Core	research rotations	Collaborative research fostered by a grad student from one lab working in the lab of a mentor in another discipline
Core	research rotations	Field and laboratory interactions - obviously individual students interact with individual faculty in these, but most students have multiple opportunities to work with faculty in the participating departments
Extra-/ Optional	seminars/ workshops	Workshops on the fundamentals of disciplines related to atmosphere-biosphere studies
Extra-/ Optional	seminars/ workshops	Faculty and trainees can attend seminars and symposia focusing on computational neuroscience
Extra-/ Optional	annual symposia	The annual IGERT symposium showcases the talent of IGERT fellows and the breadth of the research landscape. All IGERT faculty (primary advisors and crossdisciplinary advisors) are invited to participate
Extra-/ Optional	annual symposia	The most important opportunity for ALL IGERT students and ALL IGERT faculty to participate together is the annual Symposium
Advising/ Mentoring	co-mentoring	Co-mentor of faculty from different disciplines in IGERT program. This interaction also provide the opportunity to develop collaboration research
Advising/ Mentoring	co-mentoring	Joint advising of Fellows by faculty from differing departments and research specialties
Advising/ Mentoring	co-mentoring	Each IGERT fellow is required to be advised by a primary faculty advisor (thesis advisor) and a second crossdisciplinary advisor -- the second advisor is typically from a different discipline

Third, within the Professional Development Options theme, five main but not necessarily mutually exclusive categories of opportunity for interaction emerged from the responses. These are: internships/ externships (30%), workshops/seminars (27%), committee-related roles and responsibilities (17%), research publications/presentations (13%), and teaching experience (13%). Responses have been classified into one of the five categories on the basis of what is emphasized most strongly in the commentary. These responses were not reducible further into subcategories.

Table 2.15 provides an introduction to these categories and some of the representative responses taken from the survey replies.

Table 2.15 Sample of Responses – Professional Development Enables Interaction

Category	Subcategory	Response
Prof Dev	internships/ externships	Policy internships in DC, national laboratories, and international organizations
Prof Dev	internships/ externships	Assistance and support for non-academic internships
Prof Dev	internships/ externships	Interaction with industry (i.e. weekly teleconferences, internships, etc.)

Prof Dev	seminars/ workshops	Washington DC workshop where students spend 2 weeks looking at science funding, science writing, etc.
Prof Dev	seminars/ workshops	Training in professional skills to communicate and work across disciplinary boundaries
Prof Dev	seminars/ workshops	We have developed a series of professional development seminars for IGERT trainees. Topics include grant proposal writing and intellectual property
Prof Dev	committee work	Selection of new IGERT Fellows
Prof Dev	committee work	Student-led monthly meetings (student government)
Prof Dev	committee work	Search committees for new IGERT faculty (whose hires were made possible by an additional $1.5 million award from the university)
Prof Dev	research products	Ability to verbally present work to a broad audience
Prof Dev	research products	Professional publications and presentations
Prof Dev	teaching experience	IGERT trainees and affiliated faculty act as mentors for NSF-REU and NSF-RET fellows
Prof Dev	teaching experience	Teaching and mentorship, including mentoring high school and undergraduate students

Fourth, within the Social Occasions theme, two main clusters emerged in the responses – social events (75%) and community building (25%).

See Table 2.16 for a sample of responses related to the Social Occasions Theme.

Table 2.16 Sample of Responses – Social Occasions Enable Interaction

Category	Subcategory	Response
Social	social events	Social events organized by students and by the program
Social	social events	Informal meetings/social events
Social	community building	Involvement in a dynamic, interdisciplinary community.
Social	community building	All students feel that they are part of a significant interdisciplinary group.

Finally, within the last theme of Material Resources, responses refer either to opportunities enabled by IGERT funding (50%) or space and equipment facilities provided through the IGERT program (50%).

Table 2.17 presents a sample of responses from each of these two categories within the Physical Resources theme.

Table 2.17 Sample of Responses – Physical Resources Enable Interaction

Category	Subcategory	Response
Material	IGERT funding	Auxiliary funding set aside for students to use for conference travel, training not available locally, jump-starting research projects, investigating potential field sites, etc.
Material	IGERT funding	funds for equipment, supplies and travel to national meetings
Material	space	Integrative laboratory equipment and space [for] students/post-docs
Material	space	Immersion aspect of residential program at [XXX]. Students and faculty have frequent discussions about interdisciplinary science questions and about conducting research

(e) Distinctive IGERT Program Characteristics

Fifty two respondents answered the following question: *What would you consider the most distinctive, defining characteristics of your IGERT?* As with mechanisms of interaction, respondents often reported more than one characteristic. Thus, there were in fact a total of 131 responses to this item. While many of the responses contain overlapping ideas, they can be approximately categorized into four basic programmatic dimensions – Content (58%), Participants (8%), Philosophy (8%), and Structure (26%).

Within the category labeled Content, responses refer collectively to the different program activities delivered by or their strategic dimensions. These responses can be specified into the following seven subgroups: program activities – core research training activities (19%), core educational activities (13%), extra-curricular or optional (9%), and professional development (5%); strategic dimensions – interdisciplinary breadth (36%), thematic foci (12%), and international exposure (4%).

Table 2.18 presents a sample of responses which cross-cut these different program activities and various strategic dimensions.

Table 2.18 Sample of Responses – Program Content as Defining Characteristic

Category	Subcategory	Response
Activity	core research	Hands-on research training in an area outside the student's regular research, or even their regular discipline, e.g., computer scientists learning to do neurophysiology, and vice versa
Activity	core research	Collaborative 9 month project within the IGERT students and faculty in their second year of graduate study
Activity	core educational	Core set of courses where students get training in the interactions of biology, chemistry, and hydrodynamics involved in chemical signaling that affects organismal behavior
Activity	core educational	A new course called "Problems in Genomics" in which a group of students identify a research problem, work on it as a group, and then publish a multi-authored paper together
Activity	extra-/optional	Regular symposia at the end of each semester, attended by people from across our campus, with invited speakers from different departments, and time for social interactions
Activity	extra-/optional	Our monthly dinner seminars are unusual, I think. Each month a different IGERT fellow presents their work to the faculty and students and we eat together first and socialize. It creates a nice atmosphere
Activity	professional development	The emphasis on practical experience through national and international internships
Activity	professional development	6-9 month Graduate Internships to help students develop their future careers
Dimension	interdisciplinary	Straddles natural sciences and social sciences
Dimension	interdisciplinary	Bring in students and faculty from disciplines seem so far apart and different: anthropology and Engineering
Dimension	international	International collaboration/opportunity for all Urban Ecology Fellows
Dimension	international	International perspective. Participating faculty and students do research in nations, and we have ongoing collaborations with hundreds of researchers around the globe
Dimension	theme/topic	Integration of the study of vision and learning in humans and machines -- this is an unusual combination of topics
Dimension	theme/topic	Emphasis on links between academic social science and social policy problems in the US and Europe

The second category, labeled Structure, encompasses responses which describe the organizational format and/or administrative character of the program as critical to the IGERT program's identity. Responses here all fall into the same category but are subcategorized according to which of the following four elements the comment emphasizes: inter-organizational structure (42%), cross-departmental structure (35%), institutional context (15%), and facilities (9%).

Importantly, as reflected in Table 2.19, the emphasis on the element is always positive.

Table 2.19 Sample of Responses – Program Structure as Defining Characteristic

Category	Subcategory	Response
Structure	inter-organizational	Involves students from 7 University of [XXX] campuses
Structure	inter-organizational	Not-for-profit research institutions paired with a university to provide unique research and educational opportunities
Structure	cross-departmental	Variety of departments involved. We currently fund students in 4 academic departments (Anthropology, Geosciences, Materials Science and Engineering, Chemistry) and would gladly fund students in Physics and Molecular Biology if we could get any to apply
Structure	cross-departmental	It involves students from at least six different departments on our campus -- computer science, electrical and computer engineering, cognitive science, psychology, neuroscience and philosophy
Structure	institutional context	The ease of interdisciplinary collaboration, which is a characteristic of the University of [XXX] at large, not just our IGERT. The University of [XXX] is a very unusual university in this respect, and is therefore a perfect site for IGERT programs
Structure	institutional context	High level of university financial support for this IGERT
Structure	facilities	Residential program builds strong cohorts and gives students exceptional access to faculty
Structure	facilities	Shared instructional/research facilities

The third category we have identified as Philosophy consists of responses which point to the belief sets or principles by which the other more tangible program elements are then selected and/or guided. Responses within this category cannot be broken down further.

Table 2.20 provides a brief selection of responses from this category.

Table 2.20 Sample of Responses – Program Philosophy as Defining Characteristic

Category	Subcategory	Response
Philosophy	philosophy	Breadth with coherence in graduate education
Philosophy	philosophy	Apprentice-artisan-craftsperson training ladder
Philosophy	philosophy	Small-scale, creativity/curiosity driven science
Philosophy	philosophy	Emphasis on small group interactions and constructive exchange.
Philosophy	philosophy	Flexibility, yet with commitment to developing a coherent program for each student that stays true to the goals of the program

The fourth and last category labeled Participants includes those responses focused on aspects of the individuals who attend the IGERT program and/or their role in or contribution to the uniqueness of the program. These responses are distributed evenly across references to the students (50%) and to the faculty (50%).

Table 2.21 offers a brief overview of some responses representative of this category.

Table 2.21 Sample of Responses – Program Participants as Defining Characteristic

Category	Subcategory	Response
Participants	faculty	Enthusiasm of faculty
Participants	faculty	Core faculty collaboration
Participants	faculty	Support from diverse faculty in promoting professional skills among trainees
Participants	students	The enthusiasm of the students involved
Participants	students	The quality of the students involved -- much higher quality than the typical domestic student
Participants	students	Students are policy oriented

(f) Greatest IGERT Program Successes

Forty two respondents provided information pertaining to the following: *Please tell us what you consider the greatest successes of your IGERT.* Of these, a total of 55 responses were yielded. These 55 responses were classified first at the level of program operation and influence – individual program (58%), institutional context (16%), and intellectual field (26%).

As is evident, the majority of respondents identified successes associated directly with the Individual Program itself, which was expressed by pointing to one of the following:, student participation and advancement (62%), faculty commitment and development (19%), or course/curriculum design and implementation (19%). Importantly, as the overview in Table 2.22 indicates, responses at this level refer to either the contribution of faculty, students, and courses/curriculum to the program or the impact of the program on them.

Table 2.22 Sample of Responses – Successes at Level of Individual Program

Category	Subcategory	Response
Program	student	We have produced some truly interdisciplinary scientists: people who have done publishable work in areas outside their home discipline. Examples include computer scientists who have done neurophysiology, and behavioral experimentalists who have learned to do brain imaging
Program	student	The greatest successes of the program have been in the spirit of the students involved. Many of the students would not have come to our graduate program if it were structured in a more traditional way
Program	student	Our students are active, interdisciplinary, problem solvers. Of the 5 students that have graduated or are about to graduate, all immediately got post-doc offers - most a year or so before they actually finished. … Our students thus seem to be perceived very positively by well established scientists and are viewed as bringing a strong and multidisciplinary skills set to these new labs
Program	faculty	Facilitating the development of new interdisciplinary research efforts between faculty members at [XXX]
Program	faculty	Multidisciplinary research programs of the IGERT fellows have brought together a number of faculty that have successfully generated increased grant funding, publications and patents
Program	faculty	Rediscovering the joy of teaching with four professors and eleven students.
Program	course/curriculum	Developing methods for providing a rigorous PhD in a multidisciplinary environment school. Also, developing new ways of educating environmental economists

Program	course/curriculum	The greatest success of our IGERT program has been the course we initiated on multidisciplinary teamwork, and the externship in local industry, clinical or national labs
Program	course/curriculum	Establishing a vigorous PhD program in computational biology.

At the next level of Institutional Context, respondents described either cultural (56%) or structural (44%) changes emanating from the IGERT program and rippling into the larger university community. These changes were reported to affect positively the practices of graduate training and the processes of collaboration and communication beyond the immediate participants and activities of the program itself.

Table 2.23 provides a brief but representative collection of responses from each these two subcategories.

Table 2.23 Sample of Responses – Successes at Level of Institutional Context

Category	Subcategory	Response
Context	cultural	Helping to facilitate this important cultural change in the way graduate students in the sciences are trained.
Context	cultural	The creation of a dynamic intellectual community in which the students feel empowered towards their education and which reaches across traditional departmental and disciplinary boundaries
Context	cultural	We are changing the graduate school culture to include more emphasis on helping students with the transition to graduate research from undergraduate studies, on external career options besides academia, and on experiencing future career options during internships so students make more informed decisions
Context	structural	Like most universities, our university is structured as essentially independent colleges, each containing a large number of departments. It is entirely possible for students and faculty to conduct entire careers without ever meeting someone outside of their own college, often with only little interaction outside their own department. We have created an organization that joins 5 faculty across departments in 5 colleges with a common research theme. Of course some of these faculty are highly involved, and others are much less so. But the result has been new scientific collaborations and new cooperation at the administrative level, and certainly a much better comprehension of fields outside of each narrow circle …
Context	structural	A preliminary success is that we provide a means for students in different departments to study together in IGERT courses and carry out research in areas of common interest, across disciplines. We feel that we have been successful in teaching students some basics in cross-disciplinary communication and international internships
Context	structural	Greatest success (after only one year of operation): Initial merging of XXX University MS and XXX University PhD programs

Finally, at the level of Intellectual Field, a full quarter of the respondents focused on successes which related to improving or advancing the state of scientific knowledge and practice within the IGERT's scientific area. Responses in this category were not reducible beyond this level.

A sample of these responses is provided in Table 2.24.

Table 2.24 Sample of Responses – Successes at Level of Intellectual Field

Category	Subcategory	Response
Field	scientific knowledge/practice	Discovering common interests and novel ways of looking at how ecosystems work. ... Defining the limits of existing approaches and developing or exploring new tools and new formulations that better express key problems or issues.
Field	scientific knowledge/practice	Developing [and rapidly progressing] the new field of biosphere-atmosphere studies (transdisciplinary) and significantly expanding the community of faculty and students conducting research at this interface
Field	scientific knowledge/practice	Students are working on interdisciplinary problems in an interdisciplinary environment that has faculty from 8 university departments plus two independent research institutions working together in teaching and on research questions they would not otherwise have done
Field	scientific knowledge/practice	The interaction and dialogue between trainees and faculty members from such diverse disciplines have opened their minds in different perspectives and approaches in solving scientific problems.

(g) Most Significant IGERT Program Shortcomings

The last item analyzed was the following: *Please tell us what have been the most significant shortcomings of your IGERT.* There was a total of 44 respondents and 44 responses for this item. As with question regarding IGERT program successes, the responses to this question were organized by level of program operation and influence – individual program (77%), institutional context (14%), and intellectual field (9%).

As with the IGERT successes reported in the previous question, the majority of responses to this question identified IGERT shortcomings at the level of the Individual Program. Within this category, however, reported shortcomings varied from issues related to difficulties with student recruitment (36%) and problems with faculty participation (32%) to complications with administration/communication and (32%).
Table 2.25 provides a sample of responses from across these different subcategories. It is worth emphasizing the contrast between the nature of the reported shortcomings having to do with students – which are related to identifying and recruiting students from a diverse set of disciplinary as well as demographic backgrounds to the program – and the nature of those having to do with problems associated with faculty – which focus on the limited involvement and engagement of faculty who are affiliated with the program.

Table 2.25 Sample of Responses – Shortcomings at Level of Individual Program

Program	students	The lack of substantial numbers of students participating from outside of electrical engineering, computer science, and computer engineering.
Program	student	Ability to attract enough U.S. students.
Program	student	Some of the students whom we recruited from other institutions were not as daring as we had hoped they would be, preferring to stick within their departmental home rather than fully embracing the interdisciplinary vision.
Program	administration	… the consistent involvement of industry representation in our activities through student internships, participation in the IGERT Advisory Board, and from College of Business. … the development of group cohesion and program identification by the first two IGERT cohorts

Program	administration	We have had to spend a lot of time breaking down administrative boundaries to develop new courses and get permission for faculty to teach them. Each department and college has its own mission to look out for ... our program represents one more mouth to feed. Despite our uniformly acknowledged success and the respect of every administrator involved, we still face an uphill battle in garnering resources [new faculty, new classes]
Program	administration	Inability to bring students and faculty from 7 campuses together more frequently during the academic year. … having to rely on video conferences which are a poor substitute. Hard to build a community of people who [except for summer] almost never get to see one another
Program	faculty	We always lacked incentives for broader-based faculty participation. Although one would be hard-pressed to find a more altruistic bunch, the incentives problem grows worse as the program declines
Program	faculty	Faculty treat it simply as a source of graduate and postdoc funding, and don't change their behavior
Program	faculty	No funding for faculty means no real inducement for them to take on significant new responsibilities. This translates to very few resources with which to create new courses and other offerings
Program	faculty	There has been less collaboration between faculty than we anticipated … more collaboration between IGERT students than we expected.

At the level of Institutional Context, all but one of the responses uniformly addressed obstacles to the IGERT program which are embedded in the departmental structure of the university. The one exception implicates the NSF's "failure to change."

A representative sample of responses related to the department structure as well as the one comment point to the NSF is provided in Table 2.26

Table 2.26 Sample of Responses – Shortcomings at Level of Institutional Context

Institution	department structure	We have not been able to change the department-based culture of graduate education. There is no incentive for departments to work together and change educational structures from other departments, and we have not been able to resolve issues such as teaching loads, TA funding, etc. for cross-departmental courses
Institution	department structure	… it turned out to be much harder to develop all of the courses that we had planned. Faculty in some departments have fairly full teaching loads, and courses they are required to teach, that make it difficult to create a whole new set of courses, as this is in addition to their regular load. Department chairs are not easily convinced that their faculty should get credit for team-taught courses
Institution	department structure	Allowing each home department to maintain its usual way of doing things makes it difficult to have one uniform set of standards and experiences that *all* IGERT Fellows are subject to
Institution	NSF	A big failure of IGERT generally is that it did not (yet) get NSF to change! For all the work they want us to shoulder getting the university to make changes, they were too gutless (or tradition-bound) to use their own very expensive review process to devise anything more imaginative than free-for-all competition for renewal, a Phase II IGERT leading into the Partnership for Innovation or other similar programs. As a result, well-functioning IGERTs are thrown to the wolves through a pre-proposal process, where the panelists cannot possibly know as much as the writers do about IGERT. NSF also did not lean into the universities and DEMAND REFORMS

And, finally, the responses related to Intellectual Field all touched upon difficulties associated with trying to build a new interdisciplinary field. Some pointed specifically to problems with trying to merge certain areas within the program's domain (50%) while others highlighted more general concerns associated with interdisciplinary training and development writ large (50%).

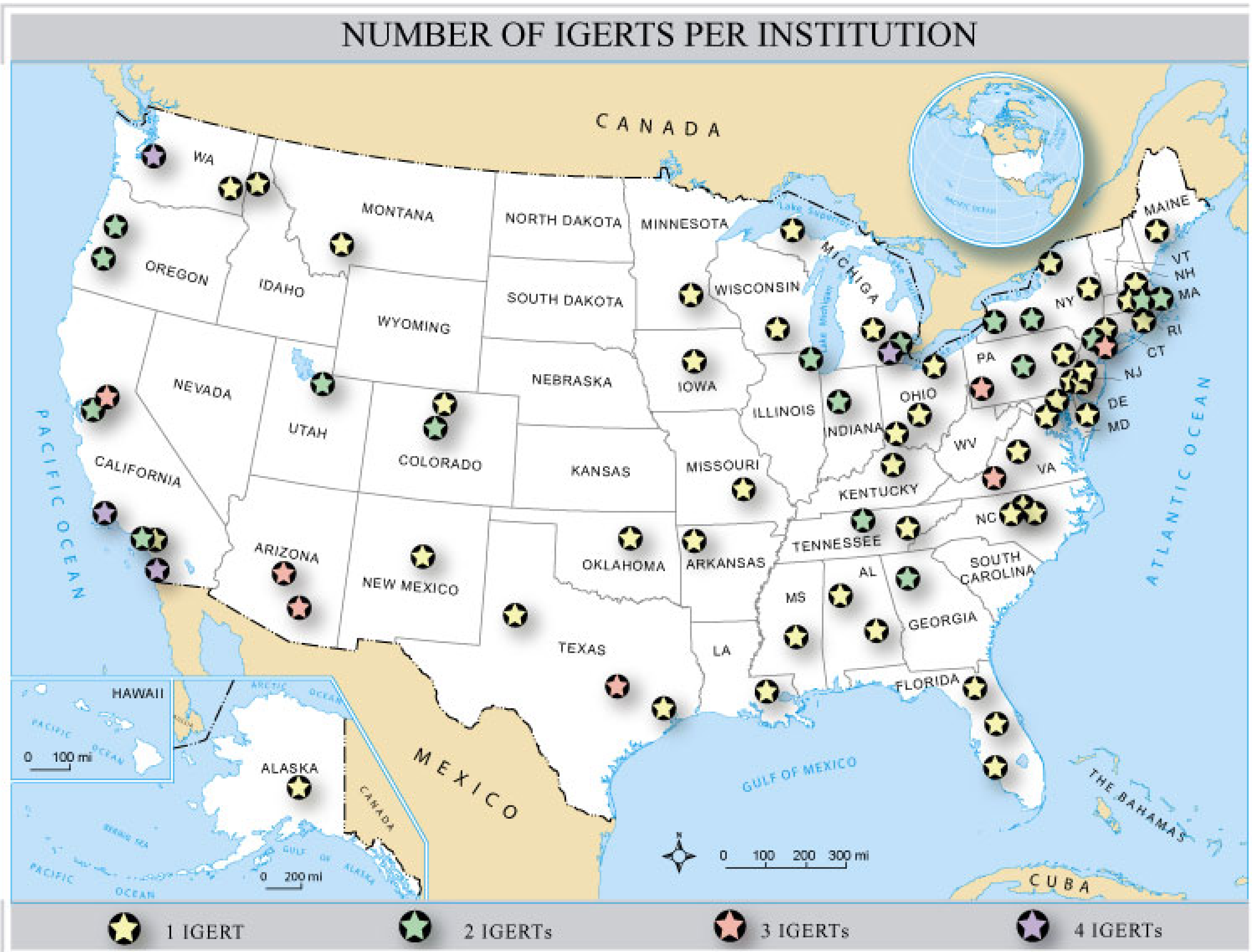
These responses are represented in Table 2.27.

Table 2.27 Sample of Responses – Shortcomings at Level of Intellectual Field

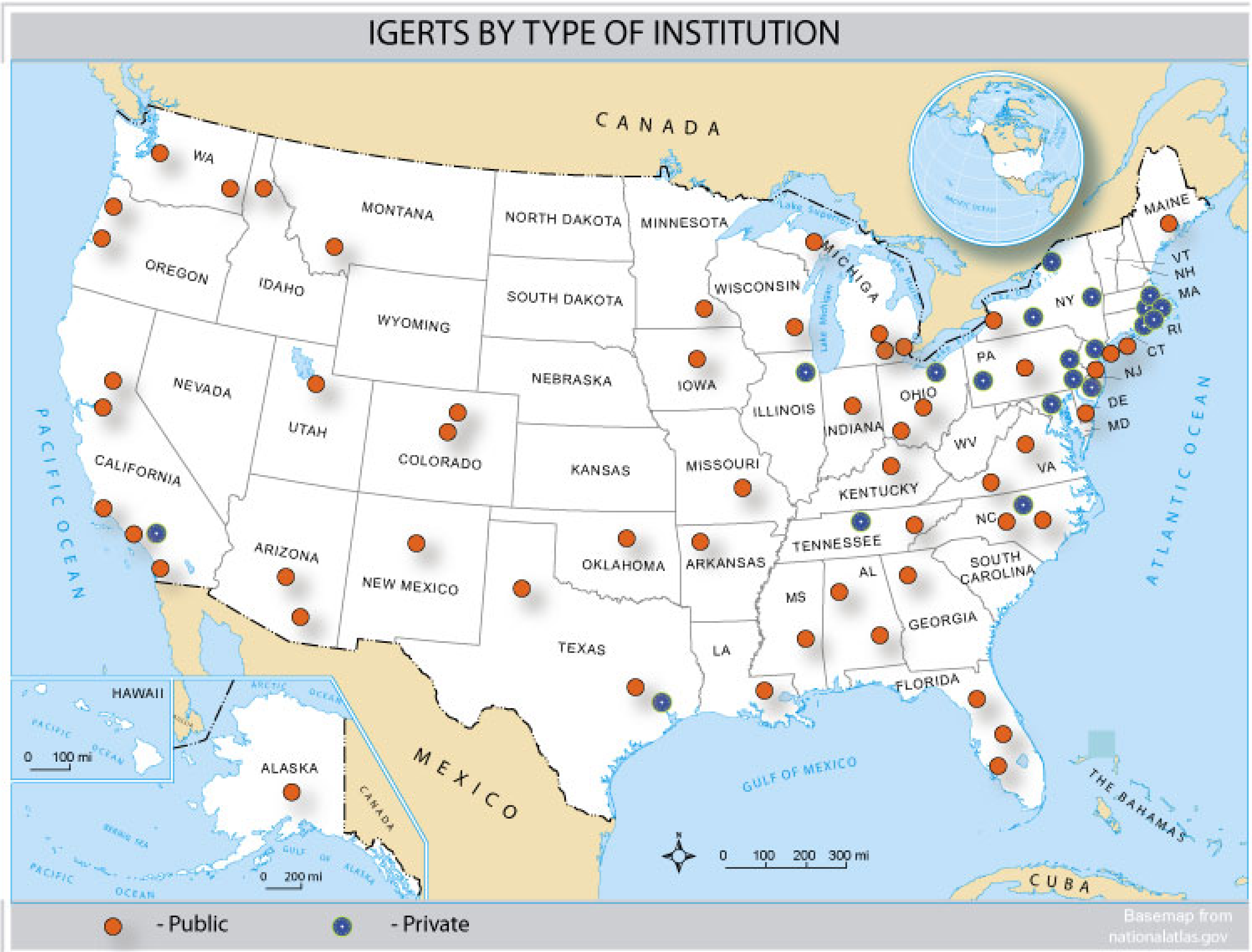
Field	interdisciplinarity between specific areas	We had originally expected more synergy among the polymer and ceramic aspects of the program. However, as individual research projects have taken form, in fact there is little overlap in these 2 fundamental technology areas
Field	interdisciplinarity between specific areas	Completely bridging natural science and social science remains an elusive goal
Field	interdisciplinarity in training in general	This is not a shortcoming of the IGERT program per se, but a challenge with getting the right balance between disciplinary training, so that students are credentialed and will find employment in a traditional department, all the while expecting them to work in interdisciplinary research areas for which employment is not assured
Field	interdisciplinarity in training in general	Spending the first few years engaged in formal education activities before we realized that you cannot teach interdisciplinarity. Instead, we found out that you have to provide the opportunity for interdisciplinarity, and then nurture it in a way that allows the trainees to maintain ownership

APPENDIX 1

The IGERT maps depict MAGNITUDE variables (number of IGERTs per institution, STEM size, and funding size) with color-coded stars and TYPE variables (disciplinary categories, public/private institution) with color-coded circles. While particular institutions can have multiple IGERT programs, maps depicting size or type of institution only indicate one symbol per location for the sake of legibility. For this reason, size and type maps contain less symbols (one per institution) than disciplinary maps (one per IGERT).



APPENDIX 2


IGERTS BY TYPE OF INSTITUTION
CANADA
WA
OREGON
IDAHO
MONTANA
WYOMING
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
CALIFORNIA
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TENNESSEE
KENTUCKY
TEXAS
LA
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AL
GEORGIA
FLORIDA
SOUTH CAROLINA
NC
VA
WV
PA
NY
MAINE
VT
NH
MA
RI
CT
NJ
DE
MD
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
HAWAII
ALASKA
THE BAHAMAS
CUBA
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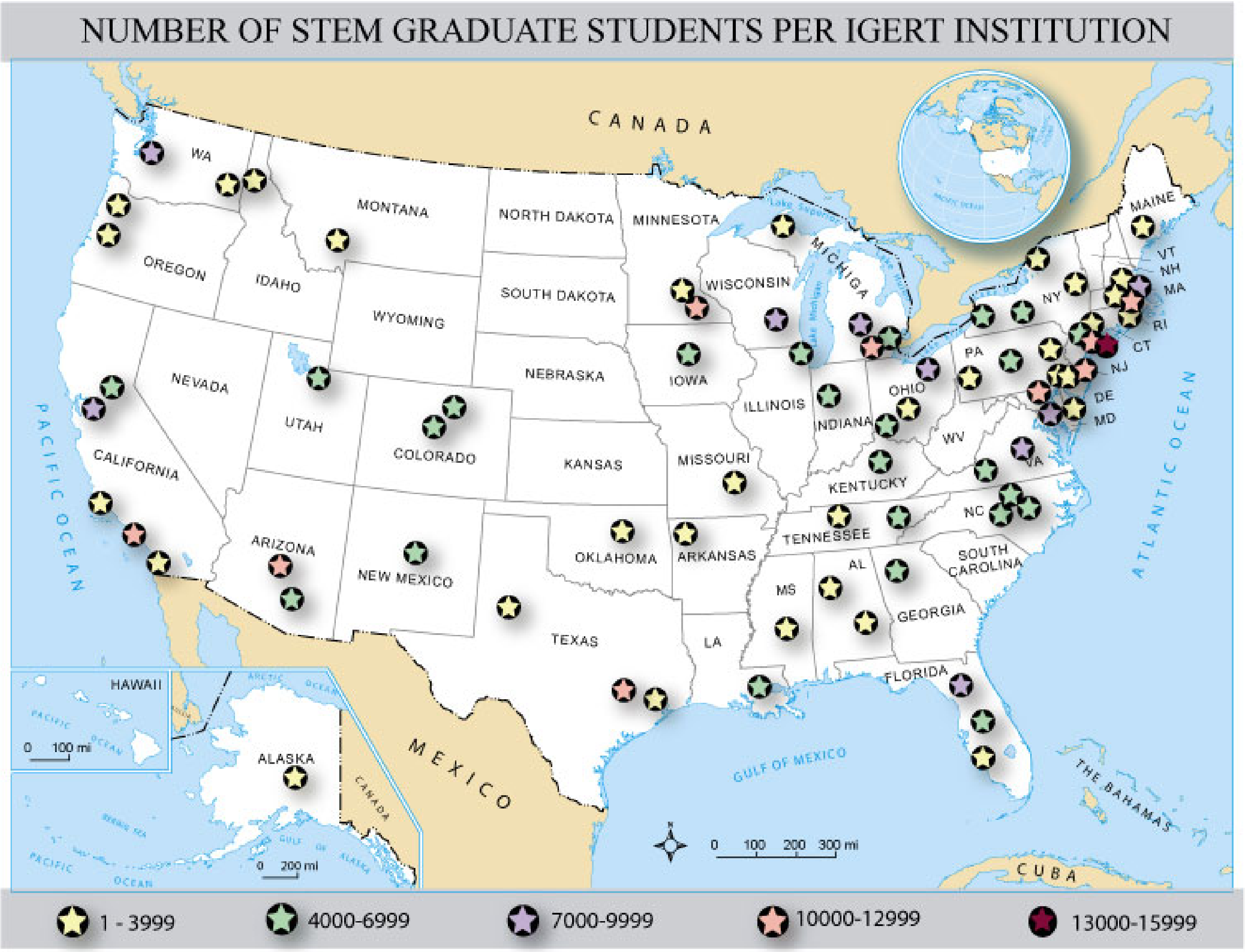
0 200 mi
- Public
- Private
Basemap from nationalatlas.gov

APPENDIX 3



NUMBER OF STEM GRADUATE STUDENTS PER IGERT INSTITUTION
CANADA
WA
MONTANA
NORTH DAKOTA
MINNESOTA
MAINE
OREGON
IDAHO
SOUTH DAKOTA
WISCONSIN
MICHIGAN
WYOMING
NY
VT
NH
MA
RI
CT
NEVADA
NEBRASKA
IOWA
PA
NJ
DE
MD
UTAH
ILLINOIS
INDIANA
OHIO
WV
VA
CALIFORNIA
COLORADO
KANSAS
MISSOURI
KENTUCKY
NC
TENNESSEE
SOUTH CAROLINA
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
AL
MS
GEORGIA
TEXAS
LA
FLORIDA
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
THE BAHAMAS
CUBA
HAWAII
ALASKA
0 100 mi
0 200 mi
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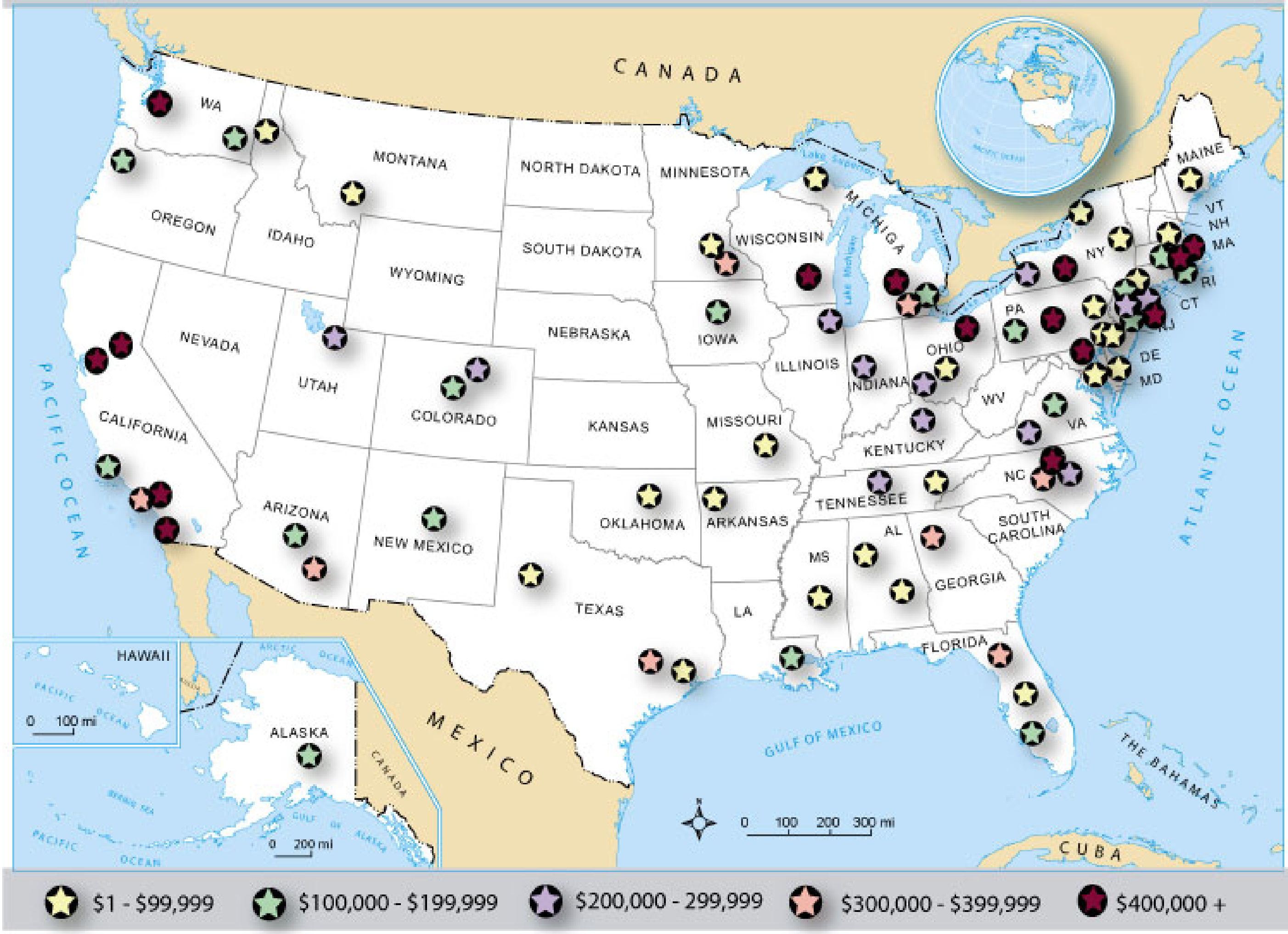
13000-15999

APPENDIX 4

RESEARCH FUNDS PER IGERT INSTITUTION IN THOUSANDS



APPENDIX 5

For the methodology behind this classification schema, please see page 5. As stated earlier, we are in the process of developing a more elaborate system of classification, which will allow individual IGERTs with multiple themes and areas to be cross-listed in different domains and subdomains. If you have suggestions either for how we could better characterize your program in the current schema or for how we might advance the new schemata, please send them to us at rhoten@ssrc.org.

Institution	IGERT Program	Domain	Subdomain
Arizona State University	Neural and Musculoskeletal Adaptation in Forms and Function	Cognitive science	neuroengineering
Arizona State University	Integrative Graduate Education and Research Training in Urban Ecology	Environmental systems	ecosystems
Arizona State University	Optical Biomolecular Devices: From Natural Paradigms to Practical Applications	Materials science	lasers, optics, and photonics
Boston University	Graduate Research Training in Bioinformatics	Biological sciences	biocomputation and informatics
Boston University	Multidisciplinary Approach to the Integration of High Performance Computing in Science Education	Computation and complex systems	computational science
Brandeis University	Quantitative Approaches to Neuroscience: From Molecules to Behavior	Cognitive science	neurocomputation
Brown University	Learning and Action in the Face of Uncertainty: Cognitive, Computational and Statistical Approaches	Cognitive science	cognitive
Carnegie Mellon University	Cross-Disciplinary Training in the Neural Basis of Cognition	Cognitive science	cognitive
Carnegie Mellon University	Interdisciplinary Research Training in Assistive Technology	New Technology and Applications	medical technology
Carnegie Mellon University	Multidisciplinary Training Program in Computational Analysis of Social and Organizational Systems	Social Science and Management	social organization and policy
Case Western Reserve University	Training Program in Neuro-mechanical Systems	Cognitive science	neuroengineering
City University of New York	Integrative Graduate Research and Training in Evolutionary Primatology - Reinvigoration and Reorientation of NYCEP	Biological sciences	evolution
City University of New York	Multiscale Phenomena in Soft Materials	Materials science	materials science
City University of New York	Nanostructural Materials and Devices	Materials science	nanoscience/nanotechnology
Clarkson University	Environmental Manufacturing Management	Environmental systems	energy and environment: use and mgt.
Colorado State University	Program for Interdisciplinary Mathematics, Ecology, and Statistics (PRIMES)	Environmental systems	ecosystems
Columbia University	A Joint Graduate Program in Applied Mathematics and the Earth and Environmental Sciences	Environmental systems	earth systems
Columbia University	Globalization and International Development	Social Science and Management	social organization and policy
Cornell University	Program in Nonlinear Systems	Computation and complex systems	complex systems analysis
Cornell University	Integrated Graduate Training and Research in Biogeochemistry and Environmental Biocomplexity	Environmental systems	earth systems
Drexel University	Nanoscale Engineering and Science: A New Educational Model Combining Two Universities	Materials science	nanoscience/nanotechnology
Duke University	Biologically Inspired Materials and Material System Training	Biological sciences	bioengineering/biotechnology
George Washington University	Integrative Human Evolutionary Biology	Biological sciences	evolution
Georgia Institute of Technology	Hybrid Neural Microsystems: Integrating Neural Tissue and Engineered Systems	Cognitive science	neuroengineering

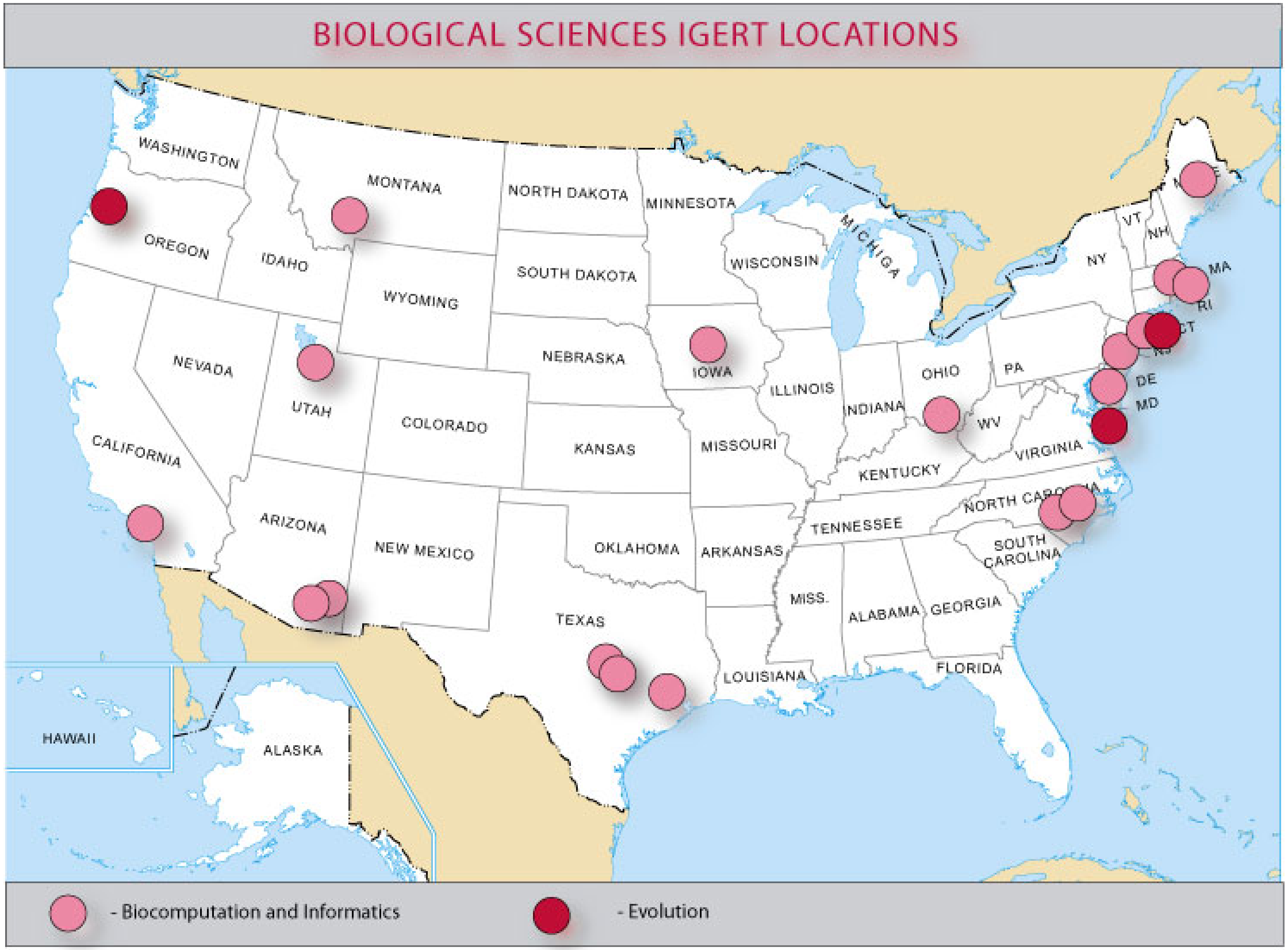
Institution	IGERT Program	Domain	Subdomain
Georgia Institute of Technology	Signals in the Sea	Environmental systems	earth systems
Georgia Institute of Technology	An Integrated Approach to Technological Innovation	Social Science and Management	innovation management
Harvard University	Integrated Training Program in Biomechanics	Biological sciences	bioengineering/biotechnology
Harvard University	Multidisciplinary Program in Inequality and Social Policy	Social Science and Management	social organization and policy
Iowa State University	Computational Molecular Biology Training Group	Biological sciences	biocomputation and informatics
Johns Hopkins University	Problem-centered Research Training: Integrating Formal and Empirical Methods in the Cognitive Science of Language	Cognitive science	cognitive
Lehigh University	Training Program in Manufacturing Logistics	Social Science and Management	innovation management
Louisiana State University	Teaching Craft for Macromolecular Creativity	Materials science	polymers
Massachusetts Institute of Technology	IGERT: Assessing the Implications of Emerging Technologies	Social Science and Management	social organization and policy
Michigan State University	A Unified Approach to Sequential Decision-Making in Cognitive Science	Cognitive science	cognitive
Michigan Technological University	IGERT: Achieving Environmental, Industrial, and Societal Sustainability via the Sustainable Futures Model	Environmental systems	energy and environment: use and mgt.
Montana State University	Education and Research Training in Structure and Function of Complex Biological Systems	Biological sciences	biocomputation and informatics
New York University	Program in Computational Biology (COB)	Biological sciences	biocomputation and informatics
North Carolina State University	Integrative Graduate Training in Bioinformatics and Functional Genomics	Biological sciences	biocomputation and informatics
Northwestern University	Dynamics of Complex Systems in Science and Engineering	Computation and complex systems	complex systems analysis
Northwestern University	Virtual Tribology System: Future Engineers and Future Powertrain Virtualization Technology	New Technology and Applications	device optimization
Ohio State University	Molecular Engineering of Microdevices (MEMD)	Materials science	polymers
Oklahoma State University	Advanced Graduate Training in Photonics Research	Materials science	lasers, optics, and photonics
Oregon State University	Earth's Subsurface Biosphere: Coupling of Microbial, Geophysical, and Geochemical Processes	Environmental systems	earth systems
Oregon State University	Ecosystem Informatics	Environmental systems	ecosystems
Pennsylvania State University	Consortium for Education in Many-Body Applications	Computation and complex systems	complex systems analysis
Pennsylvania State University	Biogeochemical Research Initiative for Education	Environmental systems	earth systems
Princeton University	PICCS: Program in Integrative Computer and Computational Sciences	Computation and complex systems	computational science
Purdue University	Training Program on Therapeutic and Diagnostic Devices	New Technology and Applications	medical technology
Purdue University	Innovation Realization Laboratory: Integrating Science and Engineering with Economics and Management	Social Science and Management	innovation management
Rensselaer Polytechnic Institute	Terahertz Science and Technology – A Studio-Based Approach	New Technology and Applications	visualization
Rice University	Program in Cellular Engineering	Biological sciences	bioengineering/biotechnology
Rutgers University	Integrative Education and Research on Biointerfacial Engineering	Biological sciences	bioengineering/biotechnology
SUNY-Buffalo	Biophotonics Materials and Applications	Materials science	lasers, optics, and photonics
SUNY-Buffalo	Integrated Graduate Education and Research Training in Geographic Information Science	Social Science and Management	social organization and policy

Institution	IGERT Program	Domain	Subdomain
Texas Technological University	Multidisciplinary Program in Wind Science and Engineering	Environmental systems	energy and environment: use and mgt.
Tuskegee University	Multidisciplinary Graduate Education and Research Training in Nanomaterials Science and Engineering	Materials science	nanoscience/nanotechnology
University of Alabama-Tuscaloosa	Freshwater Graduate Studies Integrating Ecology, Hydrology, and Geochemistry in Regions with Contrasting Climates	Environmental systems	earth systems
University of Alaska-Fairbanks	Interdisciplinary Graduate Research Training in Regional Resilience and Adaptation	Environmental systems	ecosystems
University of Arizona	Evolutionary, Computational, and Molecular Approaches to Genome Structure and Function	Biological sciences	biocomputation and informatics
University of Arizona	Archaeological Sciences: An Integrated Approach To Human Use of Ancient Landscapes	Environmental systems	energy and environment: use and mgt.
University of Arizona	Multidisciplinary Training at the Interface of Biology, Mathematics and Physics	Biological sciences	biocomputation and informatics
University of Arkansas	Electronic Education, High Performance Miniaturized Electronic Devices	New Technology and Applications	device optimization
University of California-Berkeley	Physical Biosciences: From Molecular Machines to Neural Imaging	Cognitive science	Neurocomputation
University of California-Berkley	Nanoscale Science and Engineering – From Building Blocks to Functional Systems	Materials science	nanoscience/nanotechnology
University of California-Davis	Nanophases in the Environment, Agriculture, and Technology	Environmental systems	earth systems
University of California-Davis	Biological Invasions: From Genes to Ecosystems, From Science to Society	Environmental systems	Ecosystems
University of California-Davis	Transportation Technology and Policy Program	Environmental systems	energy and environment: use and mgt.
University of California-Los Angeles	Training Program in Bioinformatics	Biological sciences	biocomputation and informatics
University of California-Los Angeles	NeuroEngineering Training Program	Cognitive science	Neuroengineering
University of California-Los Angeles	Multidisciplinary Graduate Materials Creation Training Program	Materials science	materials science
University of California-San Diego	Vision and Learning in Humans and Machines	Cognitive science	Cognitive
University of California-San Diego	Graduate Training Program in Computational Neurobiology	Cognitive science	Neurocomputation
University of California-San Diego	Marine Biodiversity and Conservation	Environmental systems	ecosystems
University of California-San Diego	Public Policy and Nuclear Threats: Training the Next Generation	Social Science and Management	social organization and policy
University of California-Santa Barbara	Computational Science and Engineering with Emphasis on Multiscale Problems in Fluids and Materials	Computation and complex systems	complex systems analysis
University of California-Santa Barbara	Integrated Training Program in Economics and Environmental Science	Environmental systems	energy and environment: use and mgt.
University of California-Santa Barbara	Advanced Optical Materials	Materials science	lasers, optics, and photonics
University of California-Santa Barbara	Digital Multimedia: Graduate Training Program in Interactive Digital Multimedia	New Technology and Applications	visualization
University of Central Florida	Optical Communications and Networking	Materials science	lasers, optics, and photonics
University of Cincinnati	Bio-Applications of Membrane Science and Technology	Biological sciences	bioengineering/biotechnology
University of Colorado-Boulder	Graduate Training in Carbon, Climate and Society	Environmental systems	earth systems
University of Colorado-Boulder	Graduate Training in Optical Science and Engineering	Materials science	lasers, optics, and photonics

Institution	IGERT Program	Domain	Subdomain
University of Delaware	Multidisciplinary Graduate Program in Biotechnology	Biological sciences	bioengineering/biotechnology
University of Florida	Working Forests in the Tropics	Environmental systems	ecosystems
University of Idaho	Ecosystem Management in Tropical and Temperate Regions: Integrating Education in Sustainable Production and Biodiversity Conservation	Environmental systems	ecosystems
University of Kentucky	Integrated Sensing Architectures	New Technology and Applications	sensor devices
University of Maine	Predoctoral Training in Functional Genomics of Model Organisms	Biological sciences	biocomputation and informatics
University of Michigan-Ann Arbor	Biosphere - Atmosphere Research and Training	Environmental systems	earth systems
University of Michigan-Ann Arbor	Molecularly Designed Electronic, Photonic, and Nanostructural Materials	Materials science	lasers, optics, and photonics
University of Michigan-Ann Arbor	Socio-technical Infrastructure for Electronic Transactions	New Technology and Applications	networking
University of Michigan-Ann Arbor	Structure, Adaptation, and Performance in Economic and Political Institutions	Social Science and Management	social organization and policy
University of Minnesota-Twin Cities	Integrative Graduate Training of Neuroscientists and Computational/Physical Scientists	Cognitive science	neurocomputation
University of Minnesota-Twin Cities	Nanoparticle Science and Engineering	Materials science	nanoscience/nanotechnology
University of Missouri-Rolla	Variable Speed Electromechanical Drive Systems	New Technology and Applications	device optimization
University of New Mexico	Cross-disciplinary Optics Research and Education	Materials science	lasers, optics, and photonics
University of North Carolina-Chapel Hill	Interdisciplinary Graduate Training in Population and Environment	Environmental systems	energy and environment: use and mgt.
University of Oregon	Integrated Training in the Evolution of Development	Biological sciences	evolution
University of Oregon	Doctoral Training at the Interface of Chemistry and Physics: New Materials for Electronics and Optics through Control of Nanoscale Structure	Materials science	lasers, optics, and photonics
University of South Florida	Sensory Knowledge-based Interface Science (SKINS)	New Technology and Applications	sensor devices
University of Southern California	Urban Environmental Sustainability: A Multidisciplinary Doctoral Education Program	Environmental systems	energy and environment: use and mgt.
University of Southern Mississippi	Entrepreneurship at the Interface of Polymer Science and Medicinal Chemistry	Materials science	polymers
University of Tennessee-Knoxville	Materials Lifetime Science and Engineering	Materials science	materials science
University of Texas-Austin	Computational Phylogenetics and Applications to Biology	Biological sciences	biocomputation and informatics
University of Texas-Austin	A New Pathway for Multi-Disciplinary Graduate Education in Optical Molecular Bio-Engineering	Biological sciences	bioengineering/biotechnology
University of Utah	Cross-Disciplinary Training in Mathematical Biology	Biological sciences	biocomputation and informatics
University of Utah	Extremely Small Scale Thermal-Fluid Systems	Materials science	nanoscience/nanotechnology
University of Virginia	Science and Engineering of Laser Interactions with Matter	Materials science	lasers, optics, and photonics
University of Washington	IGERT: Multinational Collaborations on Challenges to the Environment	Environmental systems	energy and environment: use and mgt.
University of Washington	Astrobiology: Life in and beyond Earth's Solar System	Environmental systems	earth systems
University of Washington	Integrative Graduate Education in Urban Ecology	Environmental systems	ecosystems
University of Washington	Nanotechnology	Materials science	nanoscience/nanotechnology
University of Wisconsin-Madison	Human Dimensions of Social and Aquatic System Interactions	Environmental systems	ecosystems

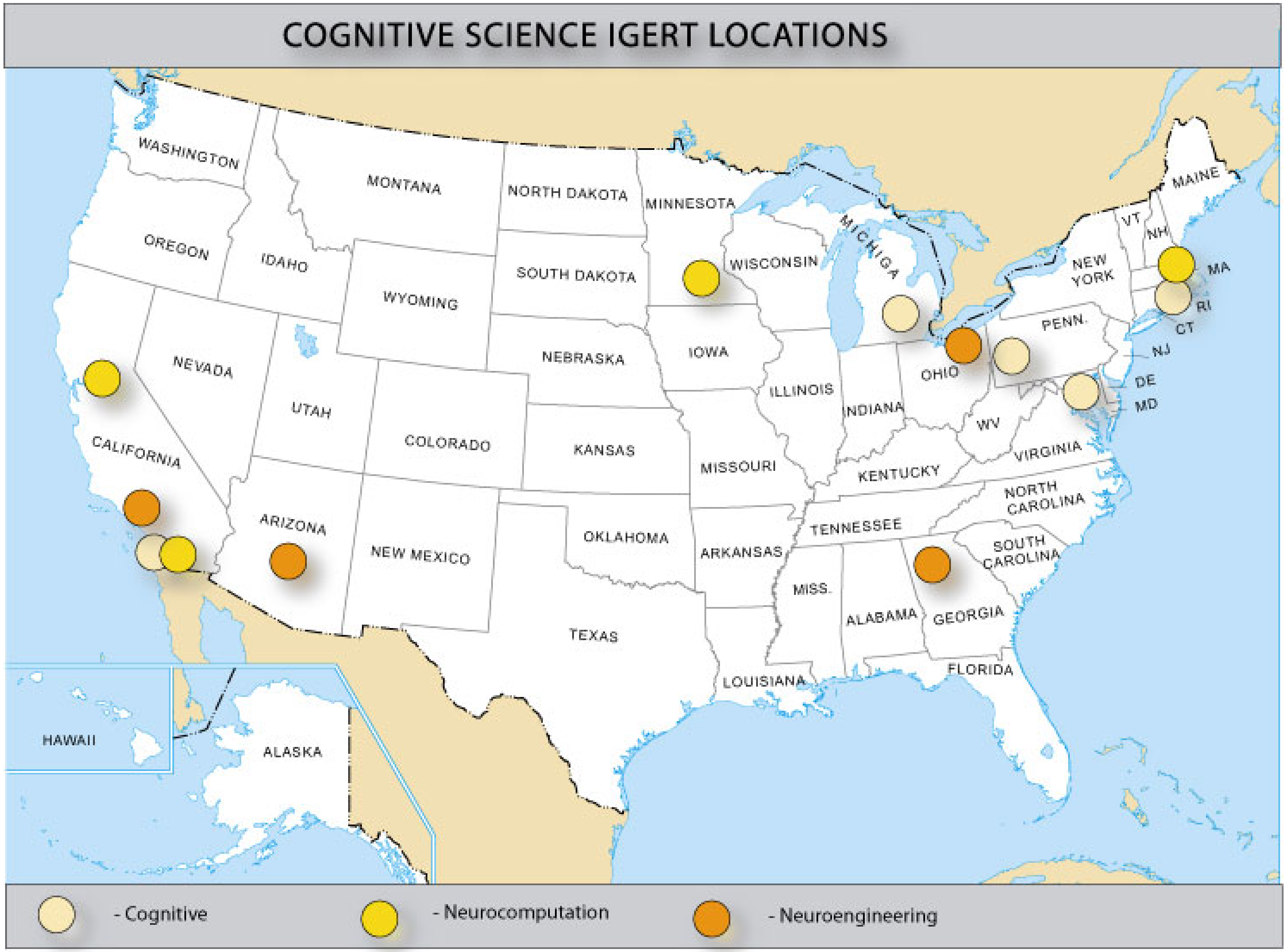
Institution	IGERT Program	Domain	Subdomain
Vanderbilt University	The Vanderbilt-Fisk Interdisciplinary Program for Research and Education in the Nanosciences (VaFIPREN)	Materials science	nanoscience/nanotechnology
Vanderbilt University	Multidisciplinary Training in Reliability and Risk Engineering, Analysis, and Management	Social Science and Management	innovation management
Virginia Polytechnic Institute and State University	Macromolecular Interfaces with Life Sciences: Oxidative Processes	Materials science	polymers
Virginia Polytechnic Institute and State University	Macromolecular Science and Infrastructure Engineering	Materials science	polymers
Virginia Polytechnic Institute and State University	Integrative Graduate Education and Research Training in Advanced Networking	New Technology and Applications	networking
Washington State University	Integrative Education of the Next Generation of Environmental Scientists and Engineers	Environmental systems	energy and environment: use and mgt.
Wayne State University	Interdisciplinary Traineeship in High Performance Computing Applications	Computation and complex systems	computational science
Wayne State University	Smart Sensors and Integrated Devices	New Technology and Applications	sensor devices

APPENDIX 6

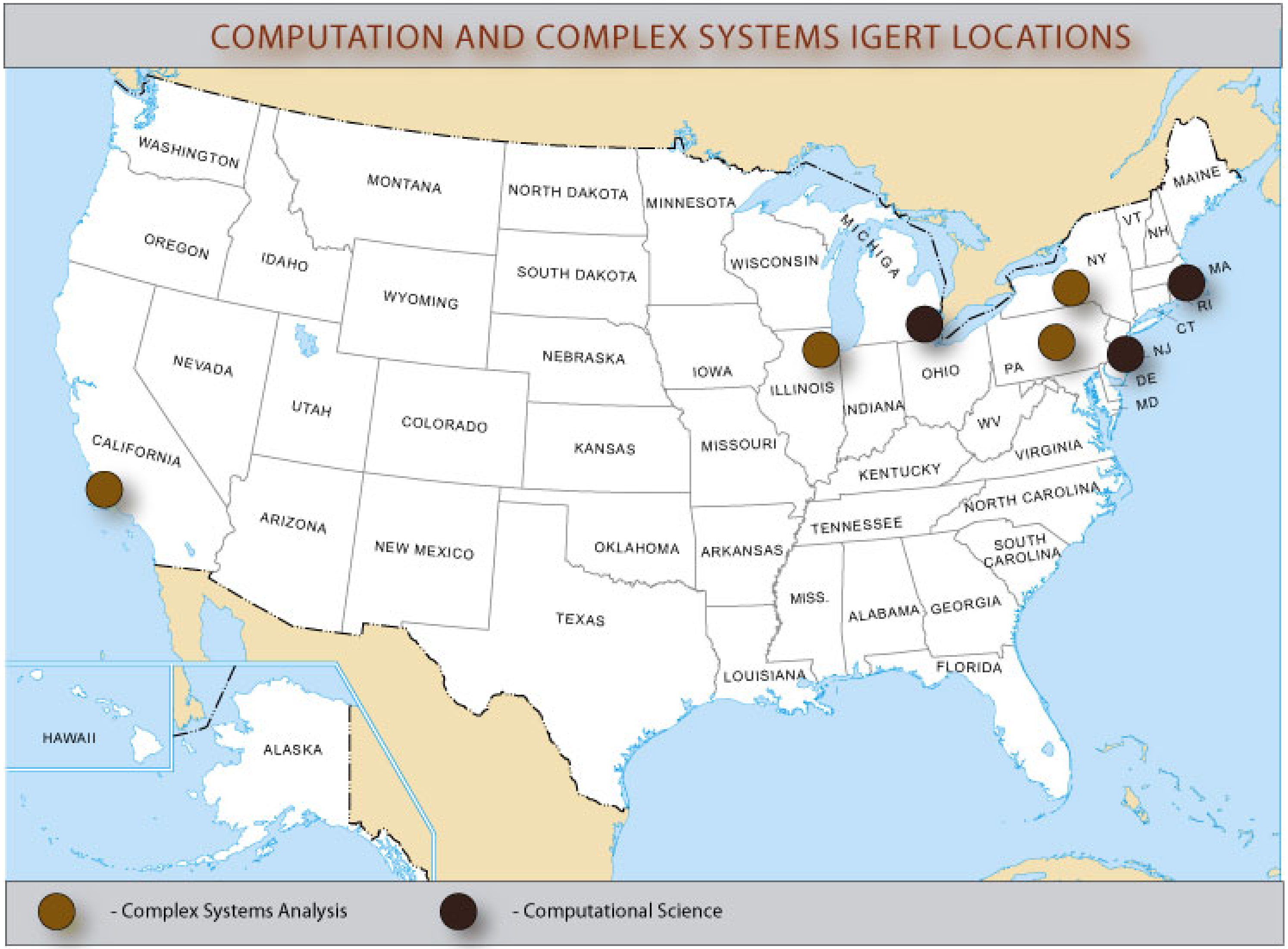


BIOLOGICAL SCIENCES IGERT LOCATIONS
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MISS.
MICHIGAN
INDIANA
KENTUCKY
TENNESSEE
ALABAMA
OHIO
GEORGIA
FLORIDA
WV
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
PA
NY
VT
NH
MA
RI
CT
NJ
DE
MD
HAWAII
ALASKA
- Biocomputation and Informatics
- Evolution

APPENDIX 7


COGNITIVE SCIENCE IGERT LOCATIONS
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGA
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISS.
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WV
PENN.
NEW YORK
VT
NH
MAINE
MA
RI
CT
NJ
DE
MD
HAWAII
ALASKA
- Cognitive
- Neurocomputation
- Neuroengineering

APPENDIX 8



COMPUTATION AND COMPLEX SYSTEMS IGERT LOCATIONS
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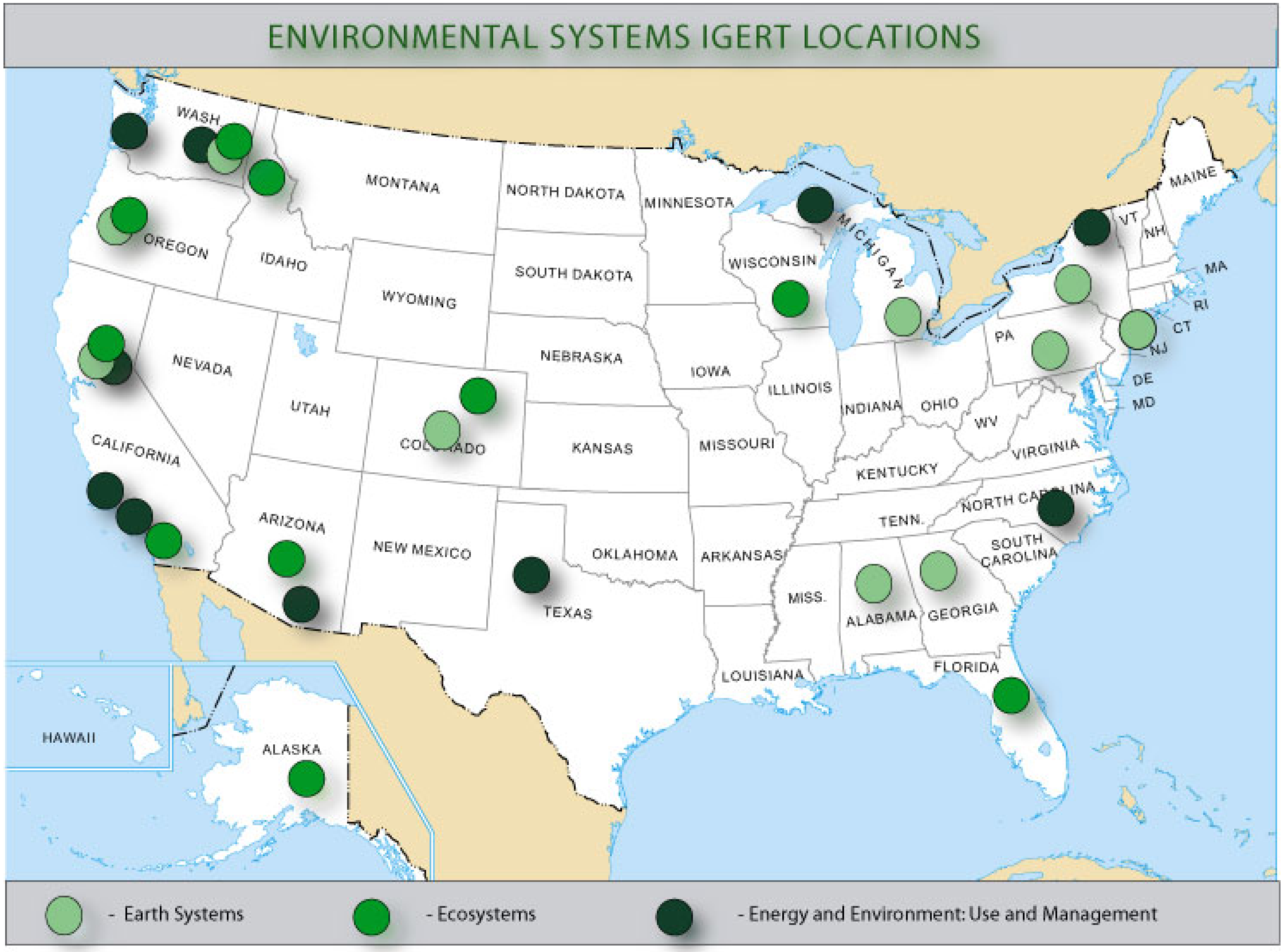
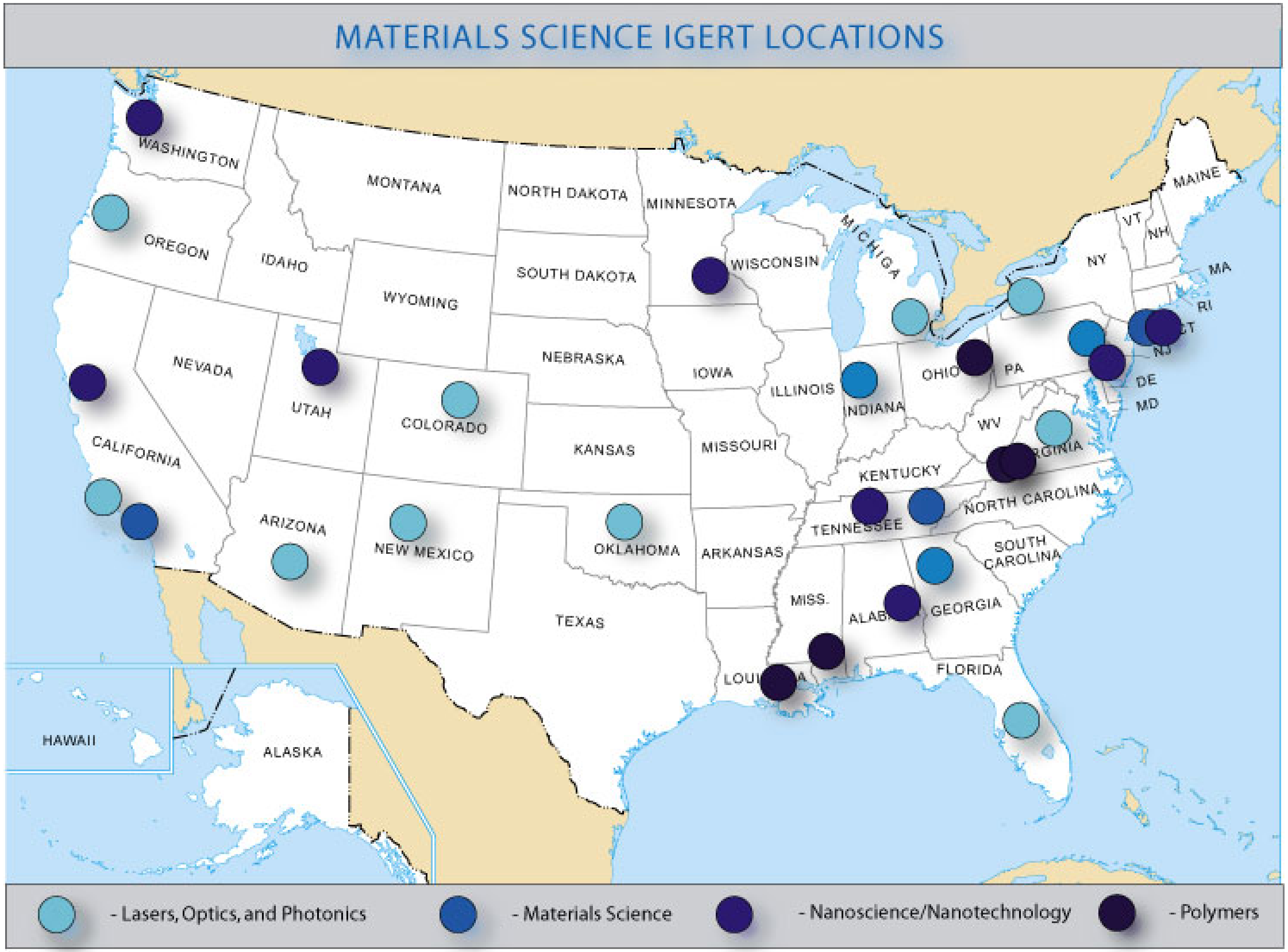
MONTANA
NORTH DAKOTA
MINNESOTA
MAINE
OREGON
IDAHO
SOUTH DAKOTA
WISCONSIN
MICHIGAN
VT
NH
NY
MA
RI
CT
WYOMING
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
PA
NJ
DE
MD
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
WV
VIRGINIA
KENTUCKY
CALIFORNIA
NORTH CAROLINA
TENNESSEE
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
SOUTH CAROLINA
MISS.
ALABAMA
GEORGIA
TEXAS
LOUISIANA
FLORIDA
HAWAII
ALASKA
- Complex Systems Analysis
- Computational Science

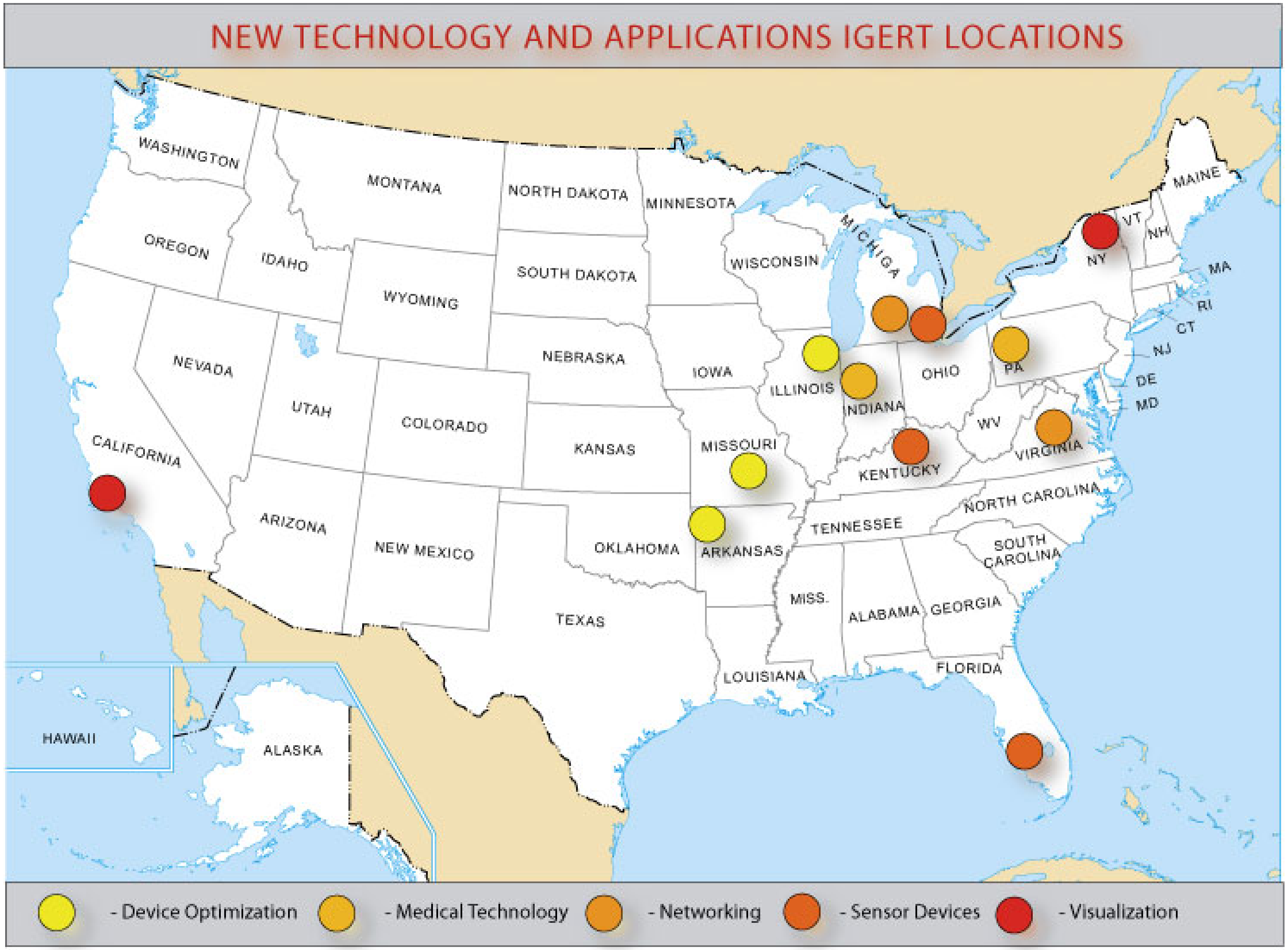
APPENDIX 9


ENVIRONMENTAL SYSTEMS IGERT LOCATIONS
WASH
MONTANA
NORTH DAKOTA
MINNESOTA
MICHIGAN
MAINE
VT
NH
MA
RI
CT
NJ
DE
MD
OREGON
IDAHO
WYOMING
SOUTH DAKOTA
WISCONSIN
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
PA
WV
VIRGINIA
NEVADA
UTAH
KANSAS
MISSOURI
KENTUCKY
CALIFORNIA
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TENN.
SOUTH CAROLINA
TEXAS
MISS.
ALABAMA
GEORGIA
LOUISIANA
FLORIDA
HAWAII
ALASKA
- Earth Systems
- Ecosystems
- Energy and Environment: Use and Management

APPENDIX 10


MATERIALS SCIENCE IGERT LOCATIONS
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
WISCONSIN
ILLINOIS
MICHIGA
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISS.
ALAB
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
WV
PA
NY
VT
NH
MAINE
MA
RI
CT
NJ
DE
MD
HAWAII
ALASKA
- Lasers, Optics, and Photonics
- Materials Science
- Nanoscience/Nanotechnology
- Polymers

APPENDIX 11



NEW TECHNOLOGY AND APPLICATIONS IGERT LOCATIONS
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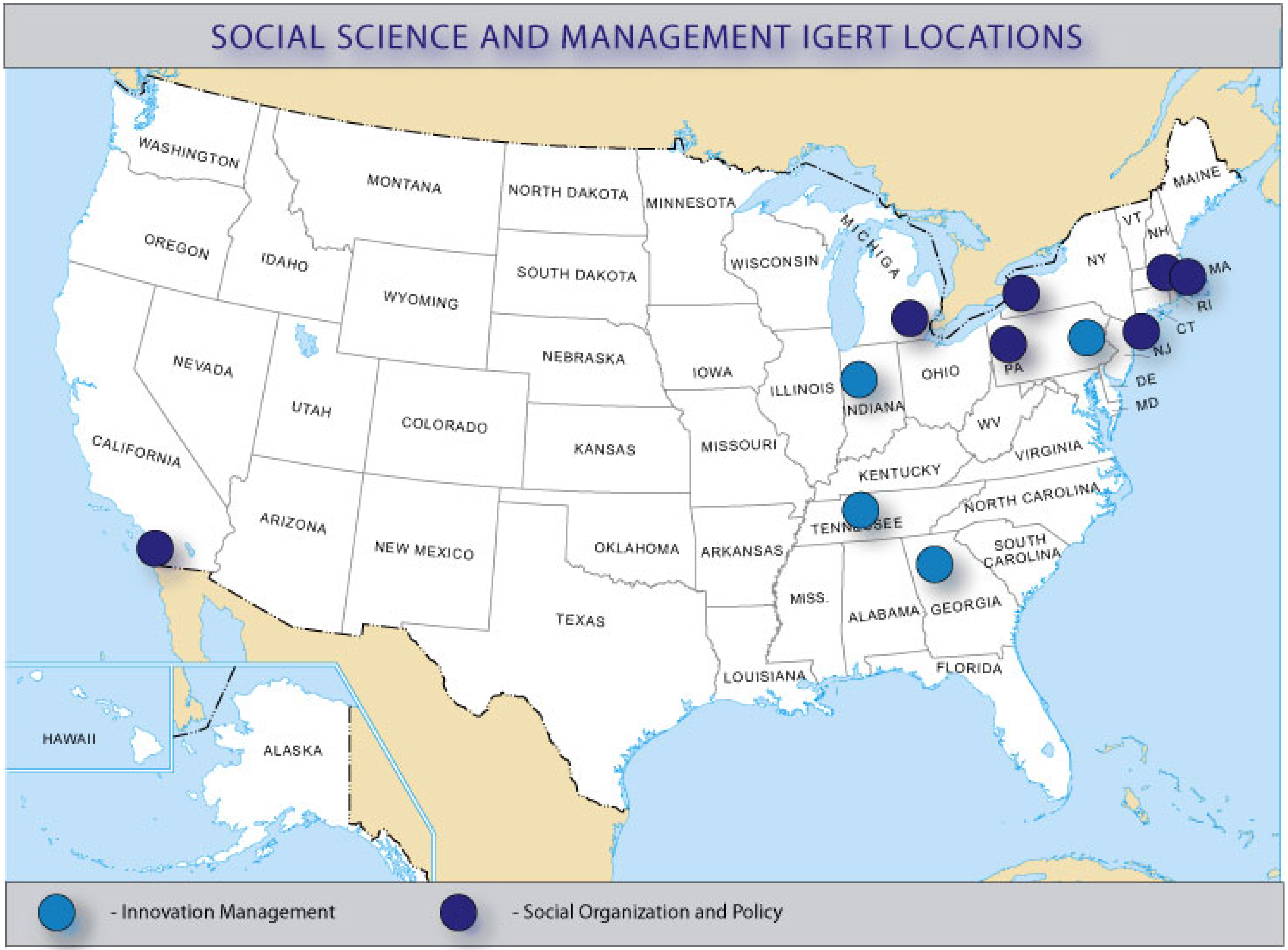
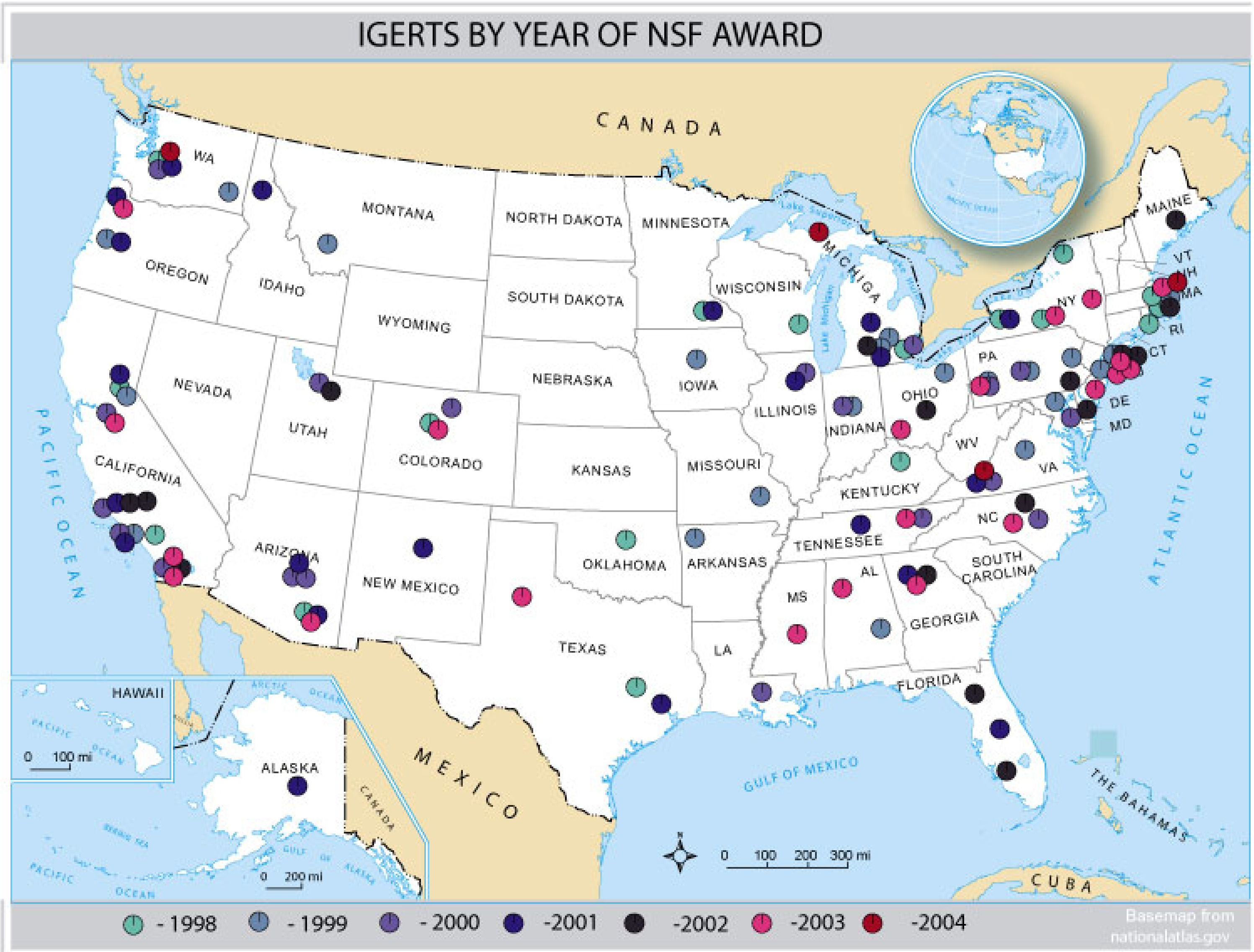
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
SOUTH DAKOTA
WISCONSIN
MICHIGAN
WYOMING
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
PA
NY
VT
NH
MAINE
MA
RI
CT
NJ
DE
MD
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
KENTUCKY
WV
VIRGINIA
CALIFORNIA
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
MISS.
ALABAMA
GEORGIA
TEXAS
LOUISIANA
FLORIDA
HAWAII
ALASKA
- Device Optimization
- Medical Technology
- Networking
- Sensor Devices
- Visualization

APPENDIX 12


SOCIAL SCIENCE AND MANAGEMENT IGERT LOCATIONS
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
MICHIGAN
MAINE
VT
NH
OREGON
IDAHO
WYOMING
SOUTH DAKOTA
WISCONSIN
NY
MA
RI
CT
NJ
NEVADA
NEBRASKA
IOWA
OHIO
PA
DE
MD
UTAH
COLORADO
ILLINOIS
INDIANA
WV
CALIFORNIA
KANSAS
MISSOURI
VIRGINIA
KENTUCKY
NORTH CAROLINA
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TENNESSEE
SOUTH CAROLINA
MISS.
ALABAMA
GEORGIA
TEXAS
LOUISIANA
FLORIDA
HAWAII
ALASKA
- Innovation Management
- Social Organization and Policy

APPENDIX 13


IGERTS BY YEAR OF NSF AWARD
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MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
WYOMING
SOUTH DAKOTA
WISCONSIN
MICHIGAN
NEVADA
UTAH
COLORADO
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
PA
NY
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KENTUCKY
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SOUTH CAROLINA
CALIFORNIA
KANSAS
MISSOURI
OKLAHOMA
ARKANSAS
ARIZONA
NEW MEXICO
TEXAS
MS
AL
GEORGIA
LA
FLORIDA
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
THE BAHAMAS
CUBA
HAWAII
0 100 mi
ALASKA
0 200 mi
CANADA
0 100 200 300 mi
- 1998
- 1999
- 2000
-2001
-2002
-2003
-2004
Basemap from nationalatlas.gov