IGERT OMB Submission (Revised)

March 20, 2011

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Supporting Statement for Paperwork Reduction Submission

A Descriptive Study of the National Science Foundation's Integrative Graduate Education and Research Traineeship Program

Section A

A.1. Circumstances Requiring the Collection of Data

Since 1998, the National Science Foundation (NSF) has supported interdisciplinary training of doctoral students across the nation through the Integrative Graduate Education and Research Traineeships (IGERT) Program. The IGERT program, now in its second decade of operation, represents a significant investment by the federal government in graduate education and in developing America's research workforce through support of students in science, technology, engineering, and mathematics (STEM) fields who participate in university-developed interdisciplinary graduate training experiences. NSF competitively awards five-year IGERT grants to institutions that plan to develop innovative, interdisciplinary doctoral training programs in STEM disciplines.

Each IGERT project is headed by one or more Principal Investigators (PIs) who are faculty members from various departments and/or disciplines both within and across institutions. The faculty members from each IGERT project develop a series of education and research activities in which students and faculty from multiple departments participate. These activities are organized to support an interdisciplinary theme, and include a combination of multidisciplinary research collaborations, cross-departmental lab rotations, interdisciplinary seminars, team-taught courses, and/or off-campus internships, among others. Students from multiple disciplines/departments related to the project's interdisciplinary theme are recruited by faculty members to participate in the program. Generally, IGERT trainees complete all the requirements of a specific department (or discipline within a department) as well as the requirements of the interdisciplinary IGERT project. Most IGERT trainees are enrolled in a single-discipline Ph.D. program and participate in IGERT activities in addition to their regular department activities; however some projects develop a new, interdisciplinary degree program for students. Trainees receive a graduate stipend of $30,000 and a cost of education allowance of $10,500 per year (12 months). On average, trainees participate in the program for two years. Since 1998, the IGERT program has made 260 awards to over 100 lead universities, providing funding for more than 5,800 graduate students.

The IGERT program has three strategic goals: (1) to educate Ph.D.-level scientists with the depth and breadth of knowledge and skills to become leaders in their fields; (2) to catalyze

changes in graduate education by establishing models for collaborative research across disciplinary boundaries; and (3) to promote diversity among participating students and the professional science and engineering workforce. These strategies are designed to provide STEM graduates the interdisciplinary tools needed to understand and address today's increasingly complex scientific problems.

The NSF has commissioned a number of external evaluations of various facets of the IGERT program since shortly after the program's inception in 1998. Monitoring initially focused on the characteristics of projects at individual universities, and consisted of analyses of data from the Distance Monitoring System (DMS) completed annually by the project Principal Investigators (PIs), funded trainees, and other students participating in the project. The Web-based survey database provides descriptive information about each IGERT project (e.g., who participates in the project, how many trainees are funded and for how long, what are the structural elements of the program). The DMS is operated by ICF Macro, a survey research and information technology company.

Beginning in 2002, NSF funded a cross-site analysis of the IGERT program, focusing on project implementation. The evaluation team, which included content area scientists, conducted monitoring site visits to projects in the first three cohorts (1998-2000). Each project was visited by a team that included both evaluation specialists and content experts in its third year of implementation; the team conducted in-person interviews with PIs, trainees, and key faculty, as well as relevant university administrators. The results led to a series of reports at the individual project and cohort level and across all sites, such as the *NSF Integrative Graduate Education and Research Traineeships Monitoring Report: Boston University, The Bioinfomatics Project* (Chase and Carney, 2001)*;* the *IGERT Annual Cross Site Report: 1998 Cohort* (Chase et al., 2002)*;* and the *Contractor Annual Report and Summary of the Cross-Site Monitoring of the NSF Integrative Graduate and Education Research Traineeship Program* (Martinez et al., 2006).

Subsequently, NSF commissioned an *Evaluation of the IGERT Program's Initial Impacts* for participating students, faculty, and institutions, employing a comparison group of non-IGERT participants (Carney et al., 2006). The *Impact Evaluation* examined differences between groups of individuals – for example, the interdisciplinary training of IGERT students compared with non-IGERT students. Most recently, NSF commissioned a another comparative study of the program, the "*Follow-up Study of IGERT Graduates*" (Carney et al., 2010), which focused on investigating the short-term professional outcomes of IGERT graduates to understand whether and how the IGERT program prepared its graduate student participants for successful STEM-related careers and how IGERT graduates fared in their early careers relative to their counterparts trained through more traditional programs.

Findings from both the annual DMS and the prior evaluation studies have informed program officers about the activities at each funded project, the numbers of participants (both faculty and trainees), selected early career outcomes, and observed changes at departmental and

institutional levels. However, the earlier data collections have not examined a central element of the program: how interdisciplinarity itself is defined and operationalized across IGERT projects. Understanding interdisciplinarity, particularly in terms of how to prepare scientists with the skills needed in an increasingly interdisciplinary research environment, is increasingly salient. The current study, therefore, is designed to describe how IGERT projects design, provide, and experience interdisciplinary graduate education.

As interdisciplinary science becomes more common, and the demand grows for scientists who have the skills to conduct interdisciplinary research, understanding how to prepare interdisciplinary researchers becomes increasingly salient. Prior research about interdisciplinary training is limited, however. Some researchers acknowledge the challenges associated with preparing interdisciplinary researchers within institutions and departments that are discipline-focused (Coppola, Banaszak Holl, & Karbstein, 2007; Feller, 2006); some researchers have examined context-specific interdisciplinary research models within specific laboratory or disciplinary settings (e.g., Lattuca and Knight, 2010; Nersessian, 2009), while others point to a dearth of empirical research about learning outcomes, methods, or benchmarks for interdisciplinary learning, especially in science and other technical fields (Aboelela et al., 2007; Boix Mansilla, 2006; Borrego & Newswander, 2010; Jacobs & Frickel, 2009; Schilling, 2001; Van Hartesfeldt & Giordan, 2008).

Two recent studies conceptualized likely outcomes of interdisciplinary education. Lattuca and Knight (2010) reviewed the engineering education and higher education literature, and from that review, developed a working definition of interdisciplinary competence. Such interdisciplinary competence is defined as one's ability to understand and utilize knowledge and modes of inquiry drawn from disciplines other than one's own, and that understanding and use of knowledge includes the following skills: a) an appreciation of various disciplinary perspectives; b) an ability to incorporate and evaluate multiple disciplinary approaches to problem-solving; c) an ability to recognize the strengths or weaknesses of one's own disciplinary perspective; and d) an ability to recognize the shared assumptions, skills, or knowledge among disciplines. Borrego and Newswander (2010) conducted an analysis of peer-reviewed literature from interdisciplinary studies in the humanities and social sciences fields and reviewed information from 129 funded IGERT proposals, and from that analysis, identified five similar categories of learning outcomes for interdisciplinary education, including: a) disciplinary grounding; b) integration; c) teamwork; d) communication; and e) critical awareness.

Building on the interdisciplinary skills and learning outcomes described above, as well as feedback from the study's Evaluation Advisory Committee, we identified the following knowledge, skills and abilities as important in preparing students to conduct interdisciplinary research:

- Depth of knowledge in one discipline or field of study

- Ability to recognize the strengths and weaknesses of multiple disciplines
- Ability to apply the approaches and tools from multiple disciplines to address a research problem
- Ability to work in a team with individuals trained in different disciplines
- Ability to communicate research based in one discipline or field of study to academic researchers trained in different disciplines
- Ability to communicate about interdisciplinary research to non-academic audiences (laypersons)

This study will examine whether and how IGERT participants (Principal Investigators and trainees) perceive the above knowledge, skills or abilities as important to conduct interdisciplinary research, and how IGERT projects develop trainees in these areas. In so doing, the current study focuses on the program's first broad goal: to prepare Ph.D. students to conduct interdisciplinary research.

A.2. Purposes and Uses of the Data

The primary purpose for collection of this information is to examine how interdisciplinary graduate education in the IGERT context is defined and operationalized, and how IGERT faculty assess trainees' interdisciplinary learning.

The study will answer the following questions:

1. Whether and in what ways do IGERT participants (PIs and trainees) perceive the knowledge, skills or abilities drawn from the literature as important to conducting interdisciplinary research?
2. What activities do projects implement to develop trainees' interdisciplinary research capacity, as characterized by these knowledge, skills or abilities? How do projects assess trainees' development as interdisciplinary scientists?
3. How helpful do trainees perceive their IGERT training to be in developing their capacity to conduct interdisciplinary research as characterized by these six areas?
4. How confident are IGERT trainees of their knowledge, skills, and abilities in these six areas?
5. What challenges do trainees encounter with the IGERT traineeship?

Exhibit 1 summarizes the study's research questions and data collection strategies.

Exhibit 1: Research Questions by Data Sources

Research Question/Topics	Data Sources		
	Primary Data Collection		Secondary (Extant) Data
	IGERT PIs (Interview)	IGERT Trainees (Survey)	Distance Monitoring Data
1. Whether and in what ways do IGERT participants (PIs and trainees) perceive the knowledge, skills or abilities drawn from the literature as important to conducting interdisciplinary research?			
IGERT trainees' perception of the importance of the knowledge, skills or abilities to conducting ***interdisciplinary research***		✓	
IGERT trainees' perception of the importance of the knowledge, skills or abilities to conducting research in ***one discipline or field of study***		✓	
IGERT trainees' perception of other areas that are important to conducting interdisciplinary research		✓	
IGERT PI's perception of the importance of the knowledge, skills or abilities to conducting interdisciplinary research	✓		
2. What activities do projects implement to develop trainees' interdisciplinary research capacity, as characterized by these knowledge, skills or abilities? How do projects assess trainees' development as interdisciplinary scientists?			
Role of the different IGERT training activities in developing trainees' capacity in the six areas	✓		✓
IGERT faculty's assessment of the development of trainees' interdisciplinary research capacity	✓		✓
3. How helpful do trainees perceive their IGERT training to be in developing their capacity to conduct interdisciplinary research as characterized by these six areas?			
Perceived helpfulness of IGERT training in developing IGERT trainees' capacity in the six areas		✓	
Other knowledge, skills or abilities trainees report that their IGERT training helps to develop		✓	
4. How confident are IGERT trainees of their knowledge, skills, and abilities in these six areas?			
IGERT trainees' perceptions of their confidence in these areas		✓	
5. What challenges do trainees encounter with the IGERT traineeship?			
Perceived challenges to participating in IGERT	✓	✓	✓

This data collection will provide the NSF program staff with an understanding of how projects provide training to develop trainees' knowledge, skills and abilities in areas identified in prior research as important for becoming an interdisciplinary scientist.

A.3. Use of Information Technology to Reduce Burden

The study will reduce survey respondent burden by using an internet-based survey to collect information from participants. The survey population for this study is doctoral students in science, engineering, and other technical fields who have routine access to web-based technologies. The use of web-based systems facilitates accuracy, completeness, and speed of data entry, and helps reduce respondent burden. Web-based surveys employ user-friendly features, such as automated tabulation, data entry with custom controls such as checkboxes, data verification with error messages for easy online correction, standard menus, and predefined charts and graphics. In addition, survey skip patterns automatically move the respondent to the next appropriate section, reducing time burden and simplifying the survey-taking experience. This also allows for easy identification of non-respondents and facilitates follow-up.

Because data entered by participants can be automatically uploaded into standard analysis software, an additional data entry step can be eliminated, thus increasing the efficiency of the researcher(s) conducting the study. Finally, email will be used to send respondents their invitations to complete the survey and to follow up with the non-respondents to encourage their participation.

Additionally, for the interview respondents, publically available information from project websites will be reviewed in advance so that interviewers are already familiar with individual projects' terminology, requirements, and activities. Further, the study will review prior years' DMS data to minimize burden on respondents and eliminate the need to ask questions about project operations about which PIs have already reported.

A.4. Efforts to Identify Duplication

This evaluation does not duplicate other NSF efforts. It is important to acknowledge that annual progress reports completed by IGERT PIs and trainees provide some information related to the proposed topics of interest. We plan to use any extant data that inform the study's research questions; however, extant data about the specific skills hypothesized as important in developing interdisciplinary research capacity are limited. IGERT PIs routinely provide information on some activities, but the structure of the DMS data emphasizes discrete components of IGERT training, and not the mechanisms or features of interdisciplinary training identified in the literature as salient to the development of interdisciplinary research skills.

A.5. Small Business

No small businesses will be involved in this study.

A.6. Consequences of Not Collecting the Information

The ultimate goal of the IGERT program is to provide students with the tools "to become in their own careers the leaders and creative agents for change," yet NSF's more immediate charge is for projects to prepare students to work in an interdisciplinary environment. The current study addresses this goal by describing IGERT training activities and ways in which IGERT projects are perceived to enhance IGERT trainees' preparedness to work in interdisciplinary environments. Consequences of not collecting this information include inability to answer a question of interest to program staff about how projects develop interdisciplinary scientists, and therefore limit guidance program staff can provide to current and future projects about translating interdisciplinary themes into specific activities and training elements.

A.7. Special Circumstances Justifying Inconsistencies with Guidelines in 5 CFR 1320.6

The project will fully comply with the guidelines of 5 CFR 1320.5. No special circumstances apply to this data collection.

A.8. Consultation Outside the Agency

Comments on this data collection effort were solicited in the Federal Register on September 10, 2010 (vol. 75, no. 175, p.55359). No outside comments were received.

Abt Associates Inc. was contracted by NSF to design and conduct the study of the IGERT program. Consultation on the study design was provided by NSF and an External Advisory Committee (EAC). The study design and instruments have been reviewed by an Evaluation Advisory Committee (EAC) comprised of experts in graduate STEM education, interdisciplinary research in science and engineering, and evaluation of higher education STEM programs. The EAC includes:

- Monica Cox – Director, Pedagogical Evaluation Laboratory and Associate Professor of Engineering Education, Purdue University
- Irwin Feller – Professor Emeritus of Economics, Pennsylvania State University
- Lisa Lattuca – Professor of Higher Education, University of Michigan
- Nancy Nersessian – Regents' Professor of Cognitive Science, Georgia Institute of Technology

Abt solicited feedback from the EAC to ensure that the overall study design is appropriate for the research questions, that the instruments have face and construct validity, and that data collection procedures are designed to enhance the reliability of study findings. Specifically, the EAC reviewed the overall design as well the draft instruments and individual items to ensure that individual items are designed to measure underlying constructs (construct validity) and that the items (and overall instruments) have adequate face validity for respondents who participate in IGERT projects. The EAC members also reviewed the study's data collection plan

and strategies to ensure high response rates. Taken together, the EAC comments have informed the study's overall design, instruments, data collection and analysis plans, and therefore serve to enhance the ultimate reliability of study findings. Additionally, both the PI interview and the survey have been and will continue to be pilot tested with respondents from the target populations who are not part of the study's sampling frame to ensure clarity of language and concepts, logical sequencing of questions and items, appropriate skip patterns, and ease of navigation (for online surveys). Respondents are being asked to comment on the clarity, content, and flow of items, as well as duration of data collection, to ensure that questions/items are clear, that directions are understood, that the sequence of items (and skip patterns where applicable) is logical, and to provide an accurate estimation of time burden. The draft instruments reflect feedback from the EAC and information obtained from pilot testing.

A.9. Payments or Gifts to Respondents

No payments or gifts will be provided to respondents.

A.10. Assurance of Confidentiality

Data collected will be available to the study contractors, contractors hired to manage data and data collection software, and at the aggregate level to NSF staff. Data will be processed in accordance to Federal and State privacy statutes. Detailed procedures for making information available to various categories of users are specified in the Education and Training System of Records (63 Fed, Reg. 264, 272 January 5, 1998). The system limits access to personally identifiable information to authorized users. Data submitted will be used in accordance with criteria established by NSF for monitoring research and education grants, and in response to Public Law 99-383 and 42 USC 1885c. The information requested may be disclosed to qualified contractors in order to coordinate programs and to a Federal agency, court or party in court, or Federal administrative proceeding, if the government is a party.

Individual respondents will be assured that the information they provide will not be released in any form that identifies them, and that their responses will be kept confidential to the extent provided by law. Data are being collected under the confidentiality statute 42 usc 1873 sec 14 (i)(1-3). The contractor will be expected to maintain the confidentiality, security, and integrity of the survey data. The web-based survey data and notes from the PI and trainee interviews will be maintained on a secure server with appropriate levels of password and other types of protection. Proposed procedures for protecting the data and privacy of respondents have been reviewed by the contractor's Institutional Review Board prior to data collection.

A.11. Questions of a Sensitive Nature

The proposed trainee survey and PI interview protocol do not ask any questions of a sensitive nature. All survey questions will be reviewed by the contractor's Institutional Review Board prior to fielding. Copies of the survey and interview protocol- can be found in Appendix A and B.

A.12 Estimates of Response Burden

The total number of respondents targeted for this study is estimated at **790**, which represents the following:

1. 750 IGERT Trainees
2. 40 IGERT PIs

We assume a target response rate of 80 percent for both the survey and interviews, reflecting standard social science practice about response rates; additionally, prior experience with similar populations indicates that an 80 percent response rate is reasonable. The total number of respondents is estimated to be **632**, resulting in an estimated response burden for the surveys of 340 hours over one year. Details on these calculations are provided in A.12.1 and A.12.2.

A.12.1. Number of Respondents, Frequency of Response, and Annual Hour Burden

Table A.12.1 below indicates the number of respondents, expected number of responses for each category of respondent type, and the time demand these instruments will place on individual respondents and on all respondents in aggregate.

Table A.12.1: Number of Respondents, Frequency of Response, and Annual Hour Burden

Respondent Type	Targeted group	Number of respondents	Instrument type	Time per response (hours)	Total time burden (hours)
IGERT Trainees	750	600	Survey	0.5	300
IGERT PIs	40	32	Interview	1.25	40
Total	**790**	**632**	**N/A**	**N/A**	**340**

[#] The above estimates for the number of responses for each type of respondent assume an 80 percent response rate, which is comparable to response rates obtained on other studies of a similar scope and with similar respondent types.

A.12.2. Hour Burden Estimates by Each Form and Aggregate Hour Burdens

As each respondent will complete the survey or interview once, the annual burden and the aggregate burden will be the same as shown in Table A.12.1.

A.12.3. Estimates of Annualized Cost to Respondents for the Hour Burdens

The overall annualized cost to respondents is **$12220**. The following chart shows the estimated total annual costs to each group of respondents over one year for the surveys.

Table A.12.3: Estimated Annual Costs to Each Group of Respondents

Respondent Type	Targeted Group	Number of Respondents[#]	Time Per Response (hours)	Total Time Burden (hours)	Hourly salary estimate	Estimated cost per respondent	Estimated overall cost
IGERT Trainees	750	600	0.5	300	$35	$17.50	$10500
IGERT PIs	40	32	1.25	40	$43	$21.50	$1720
Total	**790**	**632**	**N/A**	**340**	**N/A**	**N/A**	**$12220**

[#] Assumes an 80 percent response rate.

Figures are rounded to the nearest whole dollar. Based on an average salary estimates for Ph.D.s in Science and Engineering as reported in National Science Foundation's, Science and Engineering Indicators - 2006. National Science Foundation, Division of Science Resources Statistics. Arlington, VA (NSB 06-01) [February 2006], Figure 3-22.

Url: http://www.nsf.gov/statistics/seind06/figures.htm

(Used estimates for faculty with 5-9 years of experience @$70,000 and 15-19 years of experience @ $85,000)

A.13. Estimate of Total Capital and Startup Costs/Operation and Maintenance Costs to Respondents or Record Keepers

There is no overall annual cost burden regarding capital, operation, or maintenance costs to respondents that results from this study, other than the time spent responding to the survey.

A.14. Estimates of Costs to the Federal Government

The estimated cost to the Federal Government for the data collection activities included in this request for approval is $12,220. This cost estimate includes instrument development and pretesting; recruitment; data collection; and data processing.

A.15. Changes in Burden

This is a new collection of information.

A.16. Plans for Publication, Analysis, and Schedule

The contractor, Abt Associates, will prepare a set of research briefs (between 4-10 pages) on selected topics, as well as a more comprehensive report with appropriate detail describing the sampling, methodology, and analysis. The comprehensive report will also present short summaries of findings from each of the research questions backed by annotated data tables

that form the basis for the findings. Note that these findings will apply only to the projects included in the study. Possible topics for the research briefs include:

- Developing interdisciplinary capability among IGERT trainees
- How IGERT projects assess or monitor trainees' development as interdisciplinary researchers

The full study report will include an overview of the literature on the definition of interdisciplinarity as well as findings from analyses of survey data from trainees and interview data from PIs. Analyses of survey data will include a detailed summary that utilizes appropriate descriptive statistics. For survey items using continuous scales, the study will calculate means and standard deviations to describe both central tendency and variability. Frequency distributions and percentages will be used to summarize answers given on ordinal scales. In addition, if feasible, simple correlational models will be estimated to examine whether and how program and student characteristics are associated with trainees' perceptions of how helpful training activities have been. Together, these analyses will provide an overview of the activities the IGERT projects provide to develop trainees as interdisciplinary researchers, and trainees' perceptions of their confidence in the six areas hypothesized as central to conducting interdisciplinary research.

The project schedule is shown in Table A.16. Surveys are planned to begin in Fall 2011/Spring 2012.

Table A.16: Project Data Collection Schedule

Activity	Timeframe
Recruit survey respondents	Immediately after OMB clearance
Conduct PI interviews	1 month after OMB clearance
Conduct IGERT trainee survey	1 month after OMB clearance
Analyze data	3-6 months (interviews and survey) after OMB clearance
Report findings	8 months after OMB clearance

A.17. Approval to Not Display Expiration Date

The data collection instruments will display the OMB clearance number and expiration date.

A.18. Exceptions to Item 19 of OMB Form 83-I

No exceptions are sought.