

## **2006-2517: INTEGRATION OF INTERDISCIPLINARY GRADUATE RESEARCH AND EDUCATION THROUGH THE INSTITUTIONALIZATION OF DIVERSITY INITIATIVES**

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DR. PETER R. BETZER, Dean and Professor, College of Marine Science, joined the University of South Florida in 1971. He received a B.A. in geology from Lawrence College (1964) and a Ph.D. in chemical oceanography (1971) from the University of Rhode Island. His research interests are in the realm of aquatic geochemistry. He has authored over 60 publications in journals and books. Dr. Betzer has received local, national and international recognition for his research and leadership and has presented several invited lectures at various locations throughout the US, as well as in Soviet Union, Australia, England and China.

# **Integration of Interdisciplinary Graduate Research Education through the Institutionalization of Diversity Initiatives**

## Abstract

This paper presents the University of South Florida's novel and multi-faceted approach to integrating interdisciplinary graduate research and education with an institutional diversity initiative. Beginning with the NSF Integrative Graduate Education Research and Trainee (IGERT) program, USF has developed the infrastructure for interdisciplinary research-training, while focusing on minority graduate recruitment. IGERT provides students with significant financial support to explore interdisciplinary research areas. The program requires a team of advisors from distinct disciplines to co-advise and supervise graduate research. This approach has also been successfully applied with the minority-focused NSF Florida Georgia Louis Stokes Alliance for Minority Participation (FGLSAMP) Bridge to the Doctorate program. The successes have led to certification of mentors in all departments/disciplines at USF's Colleges of Engineering and Marine Science under the Alfred P. Sloan Foundations' minority PhD fellowship program.

## Introduction

It is becoming increasingly evident that the next generation of scientists will be required to work in a collaborative and interdisciplinary manner to make significant scientific breakthroughs and solve complex problems. It is also evident that the emerging workplace will not only be dominated by interdisciplinary challenges, but will also be culturally diverse. Given the decline in the enrollment of international students within U.S. science and engineering programs our universities will need to attract and integrate more minority students in our PhD programs, especially if they expect to maintain robust graduate programs.

Current statistics confirm a continuing steep decline in the enrollment of international students in U.S universities. The recent "Open Doors Report on International Educational Exchange"<sup>1</sup>, published by IIE shows a 6% decrease in overall international student population for AY 2004-2005 compared to 2.4% in 2003-2004. There is increasing realization among industries, educational institutions and scientific associations that the declining pool of qualified graduate students, can lead to yet another set of challenges in the long term competitiveness of the US economy.

Funding agencies have attempted to address the declining trend in higher education enrollments by launching programs that aim to make graduate education more exciting and rewarding. This effort is manifested in NSF's IGERT program which encourages research at the intersection of disciplines. Yet another NSF program, Bridge to the Doctorate, facilitates recruitment of students who would traditionally not pursue graduate studies. Critical to the success of these programs is the US academic institutions' ability to transform themselves and identify the pool of students in order to recruit them.

This paper presents the University of South Florida's novel and multi-faceted approach to integrating interdisciplinary graduate research and education with a set of bottom up,

administration supported diversity initiatives. After a brief summary of the ongoing initiatives, USF's approach to leveraging the initiatives, resulting in new multi-year fellowship opportunities, at a level of \$30,000 per year, for over 60 students, is presented.

Program Initiatives

A. IGERT- Sensory Knowledge Based Interface Science (SKINS)

The technical objective of the SKINS program is to understand the human skin as a smart interface and seamlessly couple multifunctional micromachined sensors to continuously collect data from it. As the surface of the skin terminates the sensory-motor loop in humans, developing such a system could provide a portal to the brain. This scientifically challenging approach requires the development of a seamless-bridge between the carbon based life forms and silicon based MEMS devices – both groups similar in architecture, but with varying physical, chemical and mechanical properties..

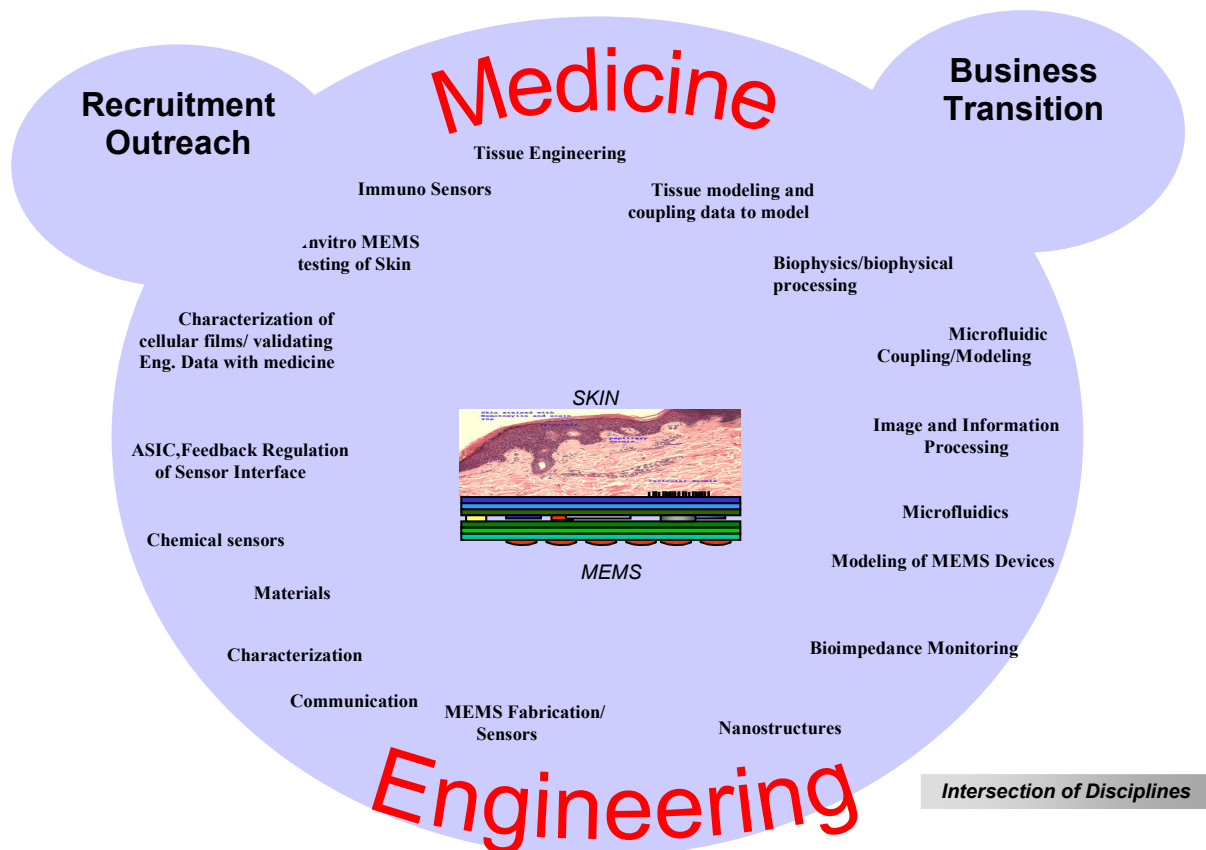


Figure 1 Functional Tasks of the IGERT- SKINS Program

This long term interdisciplinary problem required a non-disciplinary approach to the solution. Figure 1 schematically illustrates the diverse disciplines that are needed to contribute to this challenge. At the outset there was recognition that a challenge of this magnitude and complexity required a global approach. Fifty researchers from 5 continents (9 institutions) were excited about the idea and agreed to become student mentors in this research. All students recruited by the program were required to have advisors across disciplines.

As the program developed, the need for changing the fellows' mindset became increasingly clear. It became obvious that the students needed to be trained in the language and basics of other disciplines. This led to the development of four interdisciplinary core courses: a) Chemical Biological Sensors and Microfabrication b) Biology of Human Skin c) Sensor Characterization Laboratory and d) Sensor Information Processing. Additionally, they were also required to share office space and attend seminars.

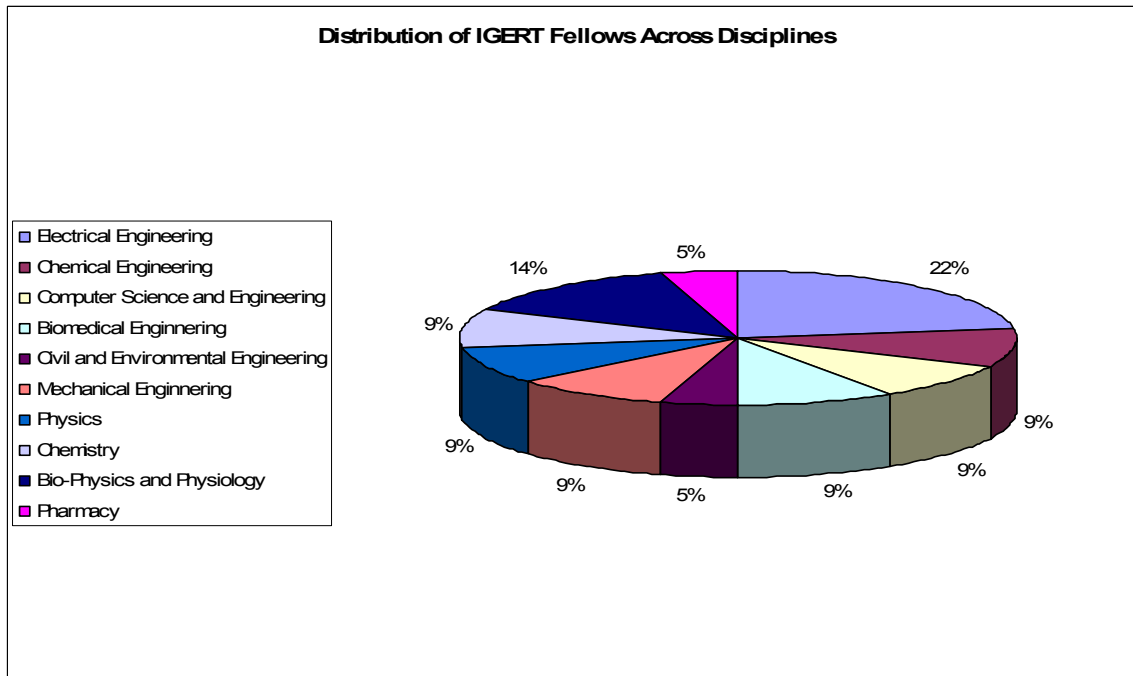


Figure 2 Distribution of IGERT Fellows among Various Disciplines

The IGERT program has so far recruited 22 research fellows (9 women, 7 underrepresented minorities) who are pursuing degrees in diverse disciplines (Figure 2). Each of these students has a unique research experience as they progress to be the next generation of technology leaders, who possess: a) multidisciplinary research proficiency b) an international research perspective c) an industry/business perspective and d) technical communication and leadership skills.

## B. Florida-Georgia Louis Stokes Alliance for Minority Participation -Bridge to Doctorate Project (FGLSAMP-BD)

The “Bridge to Doctorate” (BD) program started as an extension of the Florida Georgia Louis Stokes Alliance for Minority Participation (LSAMP) undergraduate program. The goal of the LSAMP undergraduate program was to increase the diversity of the students graduating in the science, technology, engineering and mathematics (STEM) disciplines. The BD program provided additional resources to facilitate the progression of undergraduate LSAMP scholars to a PhD degree. The BD program was developed as an intercollegiate program and incorporated the elements of the IGERT program. The BD program was focused on training students at the intersection of marine science, physical sciences and engineering to explore cutting-edge design and development of marine, environmental, biological, chemical and biomedical sensor technologies. Figure 3 highlights the distribution of BD fellows across various disciplines.

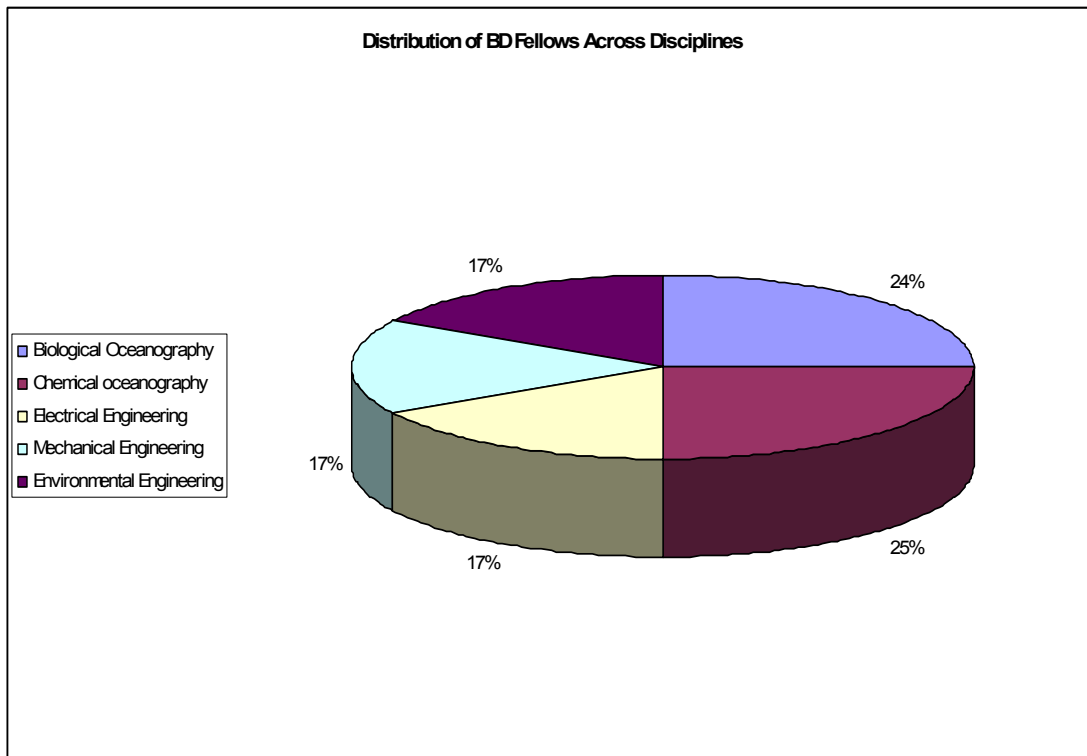


Figure 3 Distribution of BD Fellows among Various Disciplines

The envisioned goals of the BD program are being achieved through a process that began with formulation of scientific objectives by the interdisciplinary group of faculty in collaboration with the students. Prototype devices are being designed and constructed by students, in laboratories and centers, teaming with other students, staff and engineers of the centers. Subsequently, under the direction of faculty, prototype devices will be laboratory-tested by students. After

satisfactory performance has been demonstrated in the laboratory, sensors will be tested in-situ. Subsequent to a number of testing and re-engineering cycles, sensors will be used for scientific investigations in the field. This effort is fostering cross-disciplinary expertise and new research endeavors between faculty and students in that area.

A significant feature of this program is to retain all BD Fellows through the completion of their M.S. degrees (at the minimum) and upon completion of M.S. degrees immediately transition them into doctoral degree programs. Additionally, REU program for minority students was launched by this project utilizing non-LSAMP BD supplement funds. It is anticipated that the research education for undergraduates (REU) program will enhance the pool of qualified undergraduates with practical research experience that can be recruited for the FGLSAMP and/or other LSAMP alliance's BD projects next academic year.

The BD program, seemingly more conservative than the IGERT program in the research scope, presented its unique sets of challenges. The critical mass of students in each college was large enough to allow students to stay within his/her comfort zone. Additionally the Engineering and Marine Science Campuses were physically separated by 50 miles, making interaction difficult.

To ensure team-building and interdisciplinary training, two new courses were developed: The first course, Biogeochemical Sensors – Development & Applications concentrates on the application, design and adaptation of sensor technology for use in marine, environmental, biological and biomedical research applications, the Science Engineering Instruction . The second course , Science and Engineering Instruction & Professional Development introduces effective pedagogical and classroom management techniques for college-level science and engineering instruction; with development of professional and “soft-skills” including technical writing (research manuscripts and proposals), conference presentation preparation (oral and poster), professional etiquette, time management, strategic career planning and interviewing skills. The courses were cross listed in both Colleges of Engineering and Marine Science.

These courses were designed as half-day biweekly sessions that started with a working lunch. This enabled the students to interact and share their concerns, challenges, successes and failures with the group. The courses were offered separately in Fall and Spring, ensuring student interaction for two semesters.

### C. Alfred P. Sloan Foundation's Minority PhD Program

The success of the two programs (IGERT and FGLSAMP) combined with the strength of several other federally supported and privately endowed graduate student training and commitment towards diversity-related activities resulted in the Colleges of Engineering and Marine Science becoming a certified site for fellows of the Alfred P. Sloan Foundation Minority PhD program to pursue their PhD. Nationally, USF has the distinction of being the only university that is able to offer Sloan scholarships for all its engineering granting programs and is also one of only institutions where Sloan scholars can pursue their doctorate programs in Marine Science. The mentors span across all thrust areas within the college. In this capacity they are responsible for advising and mentoring Sloan fellows who work directly with them or they co-advise and mentor those within their thrust area.

It is recognized that no single fellowship award (like most research awards) does not last the duration of the student's tenure. Hence it becomes imperative that a plan be developed to ensure that the students are supported throughout their tenure through a combination of support.

At USF, the students are mentored in proposal writing and evaluation in the two courses – the course on Chemical and Biological Sensors & Microfabrication and the course on Science and Engineering Professional Development . The students write a 15 page proposal that is reviewed in an NSF format by other students in the class. The review process follows the NSF format (written reviews, panel discussion and panel summary) with a clear grading policy. Students know that only 15% of the proposals can be placed in the highly recommended category and only highly recommended proposals get 100%. This effort has had a direct positive impact on fellowships with dramatic successes.

Once the student receives the fellowship, the programs work with the student and the fellowship granting institution to stagger/defer fellowships such that the student is covered for five years at a level close to NSF fellowships. A significant effort in the institutionalization of the programs is currently underway under the leadership of the Deans of the Colleges of Engineering and Marine Science. Both colleges have decided to make student endowment of support a priority, with the College of Marine Science already having endowed 13 student fellowships while the College of Engineering has already endowed 7.

### Outcomes

The programs described above are structured to provide students with experiences that will enrich them. A critical component of the programs has been enabling students to undertake national and international internships and field experiences. The students were provided with new forums to present their interdisciplinary research during the university's first-ever interdisciplinary research symposium. All student participants who have been with the program for a year have published/presented at least one paper.

The programs' mentoring is available to all students. This has enabled them to apply for different fellowships (Ford, NSF, NASA, McKnight, DoD DHS) and over the past year they have won 5 McKnight Fellowships (25 awarded), 2 DHS Fellowships (79 awarded) and one NSF Graduate Research Supplement (10 awarded) amongst others.

In less than three years, NSF IGERT and FGLSAMP-BD programs and their leveraging has resulted in over 65 new fellowship recipients of which 45 recipients are minorities who are enriching diversity and helping to build a stronger graduate community spanning the entire university.

### Conclusions

USF has a strong commitment to the integration of interdisciplinary research and education, with the goal of providing students with academic-experiential programs that promote intellectual development and success through a diverse, student-centered environment. Colleges and

departments combine resources and services to empower undergraduate and graduate students to succeed and establish outstanding careers. Aggressive minority recruitment strategies with attractive scholarships and continued guidance towards graduation have definitely resulted in participation of a wider community. This initiative of integrating interdisciplinary graduate research education through institutionalization of diverse community has a positive impact nationwide, thus striking a balance with the declining international enrollment.

#### References

1. <http://opendoors.iienetwork.org/?p=36523>