ASEE Annual Conference and Exposition, Conference Proceedings, 2007

Graduate Certificates in Entrepreneurism – A Survey of Existing Programs as a Guide to Creating New Graduate Certificate Programs

Abstract:

Graduate Certificate programs are emerging as a way for traditional graduate students to add a narrow academic concentration outside their primary degree area, and for the general citizenry easy access to graduate level instruction. In this paper, two universities that have been active in internal entrepreneurial engineering activities at both the undergraduate and graduate level will report on a cooperative survey of existing entrepreneurship and project management-focused Graduate Certificate programs made in preparation to creating their own programs.

These Graduate Certificate programs were examined for program ownership, number of hours required, internal or external student focus, classes required or offered as electives, time limits on degree completion, as well as several other program attributes of interest to the academic community. While the authors found a wide divergence of graduate certificate programs available in the U.S. and other countries, there were commonalities in structure and content that would be of interest to other universities considering creating such a graduate certificate in their own institution.

In this paper, the authors will present the results of their survey and will also discuss the process by which each institution is implementing their own graduate certificate. In addition to the published paper, the detailed data gathered during the survey will be made available to other educational institutions that are interested in considering this as a method to increase graduate level entrepreneurial activities in the internal and external communities that they serve.

Background:

Interest in collegiate-level engineering or technology entrepreneurship has been increasing at a rapid rate over the past 10 years. Examples of this interest are easily found:

- The Entrepreneurship (ENT) Division within ASEE in 2000 and ENT Division membership now has over 550 members, indicating a strong interest from individual faculty members and their institutions.
- A supportive national organization for these entrepreneurial efforts (the National Collegiate Inventors and Innovators Alliance - NCIIA[1]) was formed in 1995 under financial support of the Lemelson Foundation[2], with the number of NCIIA member institutions now standing at 339. The NCIIA provides encouragement of technology entrepreneurship education through training and developmental grants to support technology entrepreneurship courses, programs and E-teams.
- ASME is establishing the Center for Engineering Entrepreneurship and Innovation (CEEI) which will initially provide collegiate-level entrepreneurship support. This effort

Creating an Industrial Work Group Atmosphere in Technology Graduate Programs: An Unexpected Impact on Minority Success in Graduate School

Abstract

The interdisciplinary graduate program in Microelectronics-Photonics (microEP) was created at the University of Arkansas in the fall of 1998 to merge traditional graduate research and educational excellence with specific training in operational effectiveness methods, intra and entrepreneurial skills, and teaming and group dynamics practice. The stated goal of this approach was to create a graduate program that emulates the industrial work group environment, with the group objective being that every graduate student achieves the highest academic training of which he or she is capable.

In the seven years since the microEP grad program was started, this educational experiment in creating a graduate program centered in a natural work group culture has proven beneficial to its students – and has even been largely adopted by the UA Physics graduate program[1]. What was not expected is that this natural work group approach also created a graduate community that has acted to bridge minority students from the heavily supportive MSI atmosphere to the generally impersonal atmosphere found in white majority research intensive grad programs.

Including the fall 2005 entering microEP Cohort 8 students, one hundred and three students are currently enrolled or graduated. This includes seventeen minority students, a percentage half again as high as the national average of graduating minority PhD students[2] and much higher than the current enrollment in the traditional UA science and engineering graduate programs. Two African-American men have completed their PhD microEP degrees, with one joining Virginia Commonwealth University as a tenure track faculty member, and the second currently enrolled in the University of Alabama Birmingham Medical School.

In this paper the authors will first discuss methods that have been used to locate students in communities underrepresented in science and engineering that would be well served by the microEP research and educational training. The authors will then discuss their observations on how the natural work group approach to graduate education has unintentionally addressed some of the factors affecting minority student retention[3].

Philosophy of microEP Graduate Program

The microEP graduate program at the University of Arkansas was started in 1998 with the intent of creating an educational environment for its students that was as much like an industrial professional technologist work group as possible. The technical focus of this work group would be in the areas of advanced micro/nanoscale materials and devices in the broad area of electronics and photonics. The method was to be the agency that would allow merging of already existing academic efforts in this field with operational methods and training in common usage in industry.

Embedding Theory and Practice of Technology Group Management in an Interdisciplinary Science/Engineering Graduate Program

Background

In 1998 there was a positive atmosphere in support of interdisciplinary graduate programs at the University of Arkansas by the central administration, with leadership being provided by the new Chancellor, Dr. John White. One interdisciplinary graduate program had already been created in Environmental Dynamics, although that program only spanned departments within the Fulbright College of Arts and Scientists.

Faculty in multiple science and engineering departments were working in many research areas in micro technology, and there were strong developmental areas in several fields of nanotechnology. The primary research thrusts in these areas, along with the associated educational coursework, were in electronically and photonically active materials, the devices that could be made from these materials and the high performance subsystems that could be made through a combination of these materials and devices.

This research was by its very nature interdisciplinary, with the separation between science and engineering blurring at the micro scale and disappearing at the nanoscale. This created natural partnerships across departmental boundaries between individual faculty members and small research groups. What was lacking to the faculty working in these turbulent boundaries between traditional departmental emphases was a method by which their students could optimize their curriculum in support of their career preparation. Their students had no method to take career-based coursework from different departments – and still be granted a degree at the end of their educational path as a graduate student.

In 1998 a position was created using a combination of National Science Foundation (NSF) and University funds to hire a technical manager from industry to establish and promote an interdisciplinary graduate program in support of the research faculty in this area. Ken Vickers was hired into this position after twenty years at Texas Instruments in integrated circuit process and equipment engineering. The charge was to incorporate industrial management methods into both the program's internal management, and into the student curriculum using both formal and informal methods.

The stated goal of this experimental approach to graduate education was to create a MS/PhD program that emulated an industrial work group environment in a traditional academic setting. The approach was to define to the student participants that they now not only had individual achievement goals, but also had a group goal to assure that every graduate student achieved the highest level of career preparation of which he or she was capable.

The interdisciplinary science/engineering graduate program in Microelectronics-Photonics (microEP) was created at the University of Arkansas in the fall of 1998 under Vickers' guidance to merge traditional graduate research and educational excellence with specific training in operational effectiveness methods, intra and entrepreneurial skills, and teaming and group

Microelectronics-Photonics Interdisciplinary Science/Engineering Graduate Program Startup – Lessons Learned at the Five Year Point

Ken Vickers, Ron Foster, Greg Salamo
University of Arkansas

Background:

The University of Arkansas defined in 1998 an experimental interdisciplinary technology graduate program in Microelectronics-Photonics (microEP). While the microEP Graduate Program is an interdisciplinary degree-granting entity reporting directly to the Graduate School, its academic program elements are reviewed and approved through the normal academic processes of both the Fulbright College of Arts and Sciences and the College of Engineering. Faculty and students enter the program primarily with Physics, Chemistry, and Electrical, Chemical, and Mechanical Engineering backgrounds, but may enter from any rigorous science or engineering degree program. The first students entered the program in the fall 1998 semester, with the MS and PhD microEP degrees fully approved in July 1999 and July 2000 respectively.

The traditional research and educational focus of this program is electronically and photonically active materials, the devices that can be made from those materials, and the high performance solid systems that can be made from the combination of materials and devices. The non-traditional educational focus is in the management of the systems and human resources that move these technologies from the laboratory into full commercialization for the benefit of society. Specifically, the microEP graduate program strives to emulate an industrial work group in an academic environment, an environment that is based in assessing performance through evaluation of individual projects and knowledge rather than in meeting group objectives.

The microEP program also stresses the concepts of civic responsibility through the concept of the "citizen technologist". All microEP students are trained in their responsibilities to lead their communities after graduation to repay the large investment that society has placed into their graduate education. Inherent in this is the need to support the K-16 educational pipeline that will produce the next generation of their professional colleagues. It is important to lead through example, so the microEP faculty and administration have pursued resources to actively participate in all of these activities. The microEP program has received NSF IGERT, REU, RET, GK-12, and MRSEC awards; and a Department of Education FIPSE award to implement the microEP educational concepts in the traditional Physics Graduate Program.

The history of the microEP program formation, along with the details of its approach to graduate education, have been fully described in a paper presented by the authors at the 2002 ASEE Annual Convention[1]. The program has now produced over twenty-five MS graduates and three

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Early Progress Indicators: an Innovation Incubator

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Abstract:

The goals of a novel Innovation Incubator (I^2) are to simultaneously enhance on-campus education and research as technology commercialization activities are deployed. The Incubator is beginning a third year of operations, and it is appropriate to look for early indicators of progress related to the effort. It is generally accepted that real evaluation of early and seed-stage investments cannot be completed for several years. However, qualitative assessments can be made on the impact of the Incubator.

One specific requirement of an I^2 client is a commitment to enter a Small Business Innovative Research (SBIR) proposal during the course of the one-year of support. The baseline level of SBIR activity in Arkansas has been consistently poor in comparison to other states. The number of proposals made by Arkansas small businesses within the past two years have roughly tripled, resulting in a record number of Phase I successes. It is expected that these successes will be translated to increased level of Phase II successes. These accomplishments can be related to I^2.

A specific concern for Incubator personnel at the beginning of the program was the amount of deal flow. Within the past two years, seven spin-off companies have been formed, based around University IP – an increase from a base of virtually zero spin-off companies formed over the past 20 years. Increased activity is seen as a key early indication of progress relating to policy changes in the management of intellectual property by the University's Sponsored Research office.

The incubator makes the case that progress has been made in a manner that is entirely complementary to ongoing education and research. The Incubator is fundamentally designed to have high student involvement. Research in many areas has increased in relevance as entrepreneurial faculty and students increasingly relate their research to application needs. The I^2 applicant screening process is fundamentally linked with education goals, since graduate students participate at every stage. In addition, the majority of financial assistance that the Incubator provides to a small company is in the form of employment of graduate and undergraduate students to work on development of prototypes to meet the company's needs.

In addition to other early indicators of success, two companies formed around graduate students that had completed a management course in Intra/Entrepreneurship of Technology have had recent success in obtaining SBIR and follow-on funding.

This paper is a continuation of the paper delivered at ASEE 2002 conference entitled "Launching an Innovation Incubator in a University Setting" by Vickers, Salamo, Loewer and Ahlen. In the 2004 conference, we will discuss early progress indicators and recommendations for broadening implementation.

Session 1654 (2002-2251)

Launching an Innovation Incubator in a University Setting

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Abstract:

A novel Innovation Incubator has been launched with the goal of enhancing both education and commercialization of technology. The Incubator supports area clients that have new ideas, but lack the resources to advance towards proof-of-concept. Graduates students are involved with the Incubator in screening clients, and working with clients to improve intellectual property position and develop initial business plans. Once a client is accepted for full Incubator support, a graduate student is assigned to the client for up to one year in order to perform on-campus research targeted at developing proof-of-concept for the client's idea. A voucher is included in order to provide for access to University facilities and equipment. Graduate students gain experience in real-world commercialization situations, and simultaneously provide benefit to the area economy.

This paper is a continuation of the paper delivered at ASEE 2001 conference entitled "University of Arkansas Innovation Incubator: Flaming the Sparks of Creativity" by Vickers, Salamo, Loewer and Ahlen[1]. In the 2002 conference, we will discuss early implementation details of the Innovation Incubator and considerations on clients in active consideration. In addition, we will discuss strategies for managing communications, successes and failures.

A number of policies and procedures have been developed in support of the launch of the Innovation Incubator. The "rules of engagement" have been developed, including the limitation on scope of activity both geographically and technologically. The applicant screening process is fundamentally linked with education goals, since graduate students participate at every stage. In addition, faculty members are involved in the critical decision-making processes. An objective scoring method has been created in order to insure that bias is minimized, and a committee drawing from a broad knowledge and experience base has been created. Clients are rated on five factors that intend to be predictive of success in commercialization.

A major activity of the Incubator is the matching of talents, desires and skills of graduate students with a client opportunity. Ideally, the work that the graduate student completes with a client will lead naturally to a Masters-level thesis.

Session 3142

Graduate Student Practice of Technology Management: The Cohort Approach to Structuring Graduate Programs

Ken Vickers, Greg Salamo, Ronna Turner
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Background

Many conferences have been held to discuss the skills needed by engineering and technology program graduates to be successful in technology based careers. These conferences strive to understand the full spectrum of job requirements by typically including representatives of academe, government, and industry. A common result of these conferences [1,2,3,4,5] has been lists of desired characteristics in newly hired technologists, including first and foremost the academic competency demanded by the technology job position. But they follow this need for technical competency with a need for proficiency in operational and interpersonal skills, skills that allows technologists to apply their academic training in an efficient manner in today's high tech work environments.

In the field of technical decision-making, it was felt that technical proficiency will not be sufficient to assure that future scientists and engineers make proper decisions, or to even assure that they are successful in their personal careers. They must also be able to work effectively in areas outside of their technical expertise, as they are no longer allowed to exist in an isolated technical environment. The fact is that many products require a high level of technical sophistication to even evaluate if it is the proper product for an application. As a result, today there must be more interaction between the developers of a new technology product and the customer. The scientist or engineer is therefore forced into active participation in such areas as customer negotiations, marketing and business planning, and manufacturing support. While their need for technical competence is not being reduced to support their primary task, their need for other non-technical knowledge is being increased by the many secondary roles that they are being asked to play.

From the large industry perspective, the need for a broadened knowledge base in their scientists and engineers lies in the broad financial impact of the decisions they will make. In a survey of manufacturing engineering jobs, Mason[4] reports, "The results...also emphasize the importance of a broad education. Engineers need to be technically proficient at their job and at the same time understand the economic and engineering implications of their decisions." The Boeing Company CEO Philip Condit has stated, "...it is important that engineering education also have breadth. Students need to know about business economics: What does it cost to build a project? What's involved in integration?"[6]

Land Grant Research University Partnerships with HBCUs for Enhanced Undergraduate Research Opportunities

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Background

The University of Arkansas (UA) is a Land Grant University with the stated mission of being "a nationally competitive, student-centered research university serving Arkansas and the world". Because of this mission, it is imperative that the University provides a nurturing environment for students from all portions of our society. Only then will we gain the benefit from the talents that exist throughout our population, including talents hidden in population segments that have not traditionally enrolled at this University (or sometimes in any post-secondary institution).

In the United States there is a tradition of strong Historically Black Colleges and Universities (HBCUs) that provide both a nurturing culture and strong academic preparation to students of color in our society. But many of these institutions do not support a graduate research program, instead developing relationships with graduate research institutions for post-graduate opportunities for their students.

As a research institution, the University of Arkansas has the need for strong graduate students to support its research initiatives. However, most graduate programs have not devoted the same level of attention, energy, time or resources to the recruitment of graduate students that athletic programs or enrollment services have devoted to the recruitment of undergraduate students. The result is that the student side of the search for graduate program/student matches has driven the graduate "recruitment" system.

Potential graduate students today have an advantage in finding good graduate matches because of the extensive search capability and knowledge contained in the World Wide Web. At the same time, these undergraduates also seek guidance from individuals in their home institutions concerning the general reputation of a university, college or department. Without recruitment efforts by graduate programs, undergraduate faculty lack knowledge of graduate programs at other institutions, which can limit prospective students' confidence in accepting academic opportunities that would well support their academic and career goals.

Even with the difficulties involved, HBCU students have found and enrolled in UA graduate programs. Upon arrival on campus, they found that there existed a lower level of interaction between research faculty and students at the UA as compared to the students' undergraduate HBCU. This change of academic operational culture, coupled with the change in workload at the graduate versus undergraduate level and the change in social factors from a black majority

ASEE Annual Conference Proceedings, p 5279-5298, 2001 Session 1380

Graduate Physics Education – Industrial Style

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University of Arkansas

Abstract

The education and training of the workforce needed to assure global competitiveness of American industry in high technology areas, along with the proper role of various disciplines in that educational process, is currently being re-examined. Several academic areas in science and engineering have reported results from such studies that revealed several broad themes of educational need that span and cross the boundaries of science and engineering[1-5]. They included greater attention to and the development of team-building skills, personal or interactive skills, creative ability, and a business or entrepreneurial where-with-all.

While many engineering programs around the country have embraced some of these needs with unique programs, physics has lagged far behind and has tended to maintain its traditional basic science education. Rather than these needs being a goal of a traditional physics graduate program, we tend to instead produce students trained in the conventional sense. Students strong in basic understanding but with little or no interpersonal skills. Students ignorant of business related issues, yet with problem solving skills needed by business. And, above all, students very comfortable in an academic environment, but unsure of how to effectively use their academic expertise in a non-academic arena.

The University of Arkansas in the fall of 2000 received a Department of Education Fund for Improvement of Post Secondary Education (FIPSE) grant to implement changes in its graduate physics program to address these issues. The proposal goal is to produce next-generation physics graduate students that are trained to evaluate and overcome complex technical problems by their participation in courses emphasizing the commercialization of technology research. To produce next-generation physics graduates who have learned to work with their student colleagues for their mutual success in an industrial-like group setting. And finally, to produce graduates who can lead interdisciplinary groups in solving complex problems in their career field.

In this paper we will present the evidence that led to the specific strategic plans that were proposed to the department of education, strategic plans that will be used to achieve the goal of physics graduates from the University of Arkansas with enhanced technology implementation skills. The early implementation status through March 2001 will also be discussed, along with specific near

ASEE Annual Conference Proceedings, p 10905-10915, 2001 Session 2554

University of Arkansas Innovation Incubator: Flaming the Sparks of Creativity

Ken Vickers, Greg Salamo, Otto Loewer, and John Ahlen
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Abstract

One significant area for small business development is in science and technology. In this area, research universities have played a significant role through the students and faculty in establishing start-up companies. For example, many universities have developed small business incubators designed to provide operating space and secretarial support at minimum costs for start-up companies. Many of these small business incubators bring the universities' intellectual resources to arms length of start-ups. What they do not do is nurture ideas. They do not bring together talent to explore, to inquire, to innovate.

The University of Arkansas, in partnership with the Arkansas Science and Technology Authority, has created a new partnership to fill this innovation gap. A partnership that will nurture new ideas by providing the resources needed to move Arkansas into the high technology of today's economies and reaping the benefits of its intellectual capital. And in doing so, this partnership will result in opportunities for University of Arkansas researchers to work with Arkansas businesses, in an increased number of technology business start-ups, in the establishment of an "innovation" culture with students and faculty, in identification of many valuable problems suitable for student research theses, and in demonstrations of the difference the university enterprise can have on the economic well being of the state.

This partnership, known as the Innovation Incubator (I^2), has won funding through the NSF Partnership for Innovation program in fall 2000. While I^2 will focus initially on the expanding field of nano to micro electronics-photonics, it will rapidly grow to encompass all areas of the University. This paper will describe the methods by which this partnership will identify and manage applied on-campus research for small industrial companies, research intended to provide the proof of concept necessary to secure larger developmental funding or private capitalization. Finally, the paper will discuss the early implementation current status of program elements through March 2001.

I. Introduction

The National Science Foundation in fall 2000 funded the University of Arkansas under the

Session 2793

Research to Commercialization: Entre/Intrapreneurship of High Technology University Research for Creation of Local Start-up Companies

Ken Vickers, John Todd
University of Arkansas

Abstract

A three-course technology commercialization sequence has been initiated at the University of Arkansas under the financial support of the National Collegiate Inventors and Innovators Alliance (http://www.nciia.org). These courses combine Masters students from business, science, engineering, and law schools into teams in the classroom. The objective of the first class in the sequence (during the spring semester) is to introduce the elements of the evaluation process that is used to decide if a research area is a suitable candidate for commercialization (in either an entrepreneurial or intrapreneurial environment). The students then apply this evaluation process to current on-campus research results, select a suitable commercialization candidate, and work with the technology transfer office and research professor to commercialize the research during the following summer and fall semesters.

The first course in the sequence was initiated in the Spring 2000 semester with mixed results. This paper will introduce the detailed class plan and course materials, an analysis of class concept performance after its first year of operation, and a discussion of changes incorporated into the class for the spring 2001 semester. The reader may examine the on-line course materials at the web site http://cavern.uark.edu:8900/ by entering as a guest user and then selecting course MGMT 5383.

I. Introduction

Widely divergent engineering and science societies across the country have convened working groups from industry, government, and academe to examine the education received by technology degree students in our colleges and universities. These groups were convened not because the US educational system was broken, but rather to identify characteristics that would move it to the next performance level for the good of our students, businesses, and communities.

Examination of the sections of the reports of these groups dealing with technology businesses showed many items that were common across many of the studies:

- The need for interdisciplinary studies (www.nsf.gov/igert)
- The need for business training of technologists

ASEE Annual Conference Proceedings, p 6133-6140, 2000

Session 2586

The Role of a Middle/High School Engineering Design Contest in Student Preparation for Higher Education and Careers

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Abstract

BEST (Boosting Engineering, Science, and Technology) is a non-profit, community-based volunteer organization started in 1993 by a group of technologists in Sherman, Texas to systematically address the lack of public peer acclaim for academically successful K-12 students. BEST provides public recognition of these students' academic, technological, and problem solving skills by offering students a chance to compete in a sports-like engineering design contest, one that deliberately mimics a product design-to-market cycle. This paper will document the growth of the BEST local hub network from its inception in 1993 to its 1999 status of 14 local hubs in five states. Variations in local hub organizations will be discussed to illustrate the many ways that communities can implement a BEST contest. A detailed roadmap by which a new local hub can implement a BEST contest in its community will be presented, along with a description of the evolving nature of the BEST Robotics Inc. parent organization. The BEST program's positive effect on individual students, schools, and communities will be discussed, with examples of some significant changes directly attributed to BEST implementation in their locales.

I. Introduction

The performance of American school children in science and mathematics is low compared to that of many other industrialized nations. Several theories have been proposed to account for this low performance, from ineffective schooling to lack of parental encouragement to over-selling of non-academic careers such as professional sports. But regardless of cause, it can be observed in almost all school systems that academically successful students in our schools receive much less peer recognition and acclaim than do athletically successful students.

In 1993 a group of concerned industrial technologists in the Texas Instruments facility in Sherman, Texas decided to combat this problem by creating an opportunity for academically successful students to receive the same type of public acclaim as the school's athletic teams. Modeling their new effort after a Massachusetts Institute of Technology freshman design class,

ASEE Annual Conference Proceedings, p 3803-3812, 2000

Session 1351

Introducing Industrial Organizational Training into an Interdisciplinary Engineering/Science Graduate Program

Ken Vickers, Greg Salamo
University of Arkansas

Abstract

This paper describes a new interdisciplinary graduate program between science and engineering implemented at the University of Arkansas in the fall semester of 1998. This graduate program in Microelectronics-Photonics (microEP) supplements the traditional education elements of coursework and research with non-traditional training and within-program implementation of industrial operational practices. The non-traditional training is based in the methodology that microEP students operate in an industry-like dual-reporting scheme, being supervised by both their major research professor and the microEP program director. Under the program director, the students are grouped by entry year into cohorts that manage their joint education as if it were the expected output of an industrial factory. This paper will provide an overview of the major goals of the program, the specific activities that have been implemented to meet these goals, and an evaluation of the program's effectiveness after three semesters of operation.

I. Introduction

The education and training of the workforce necessary for global competitiveness of American industry in high technology areas, along with the proper role of academe, government, and industry in that educational process, is being examined in widely divergent industrial segments. Academic areas such as manufacturing engineering, aerospace engineering, and electrical engineering have all reported results from such studies [1-5]. These reports reveal several broad themes of educational need developing across these industrial segments:

a) Integrating technical and non-technical broad knowledge areas.
b) Integrating multidisciplinary technical skills into a comprehensive knowledge base.
c) Integrating global perspectives into local decision making.
d) Integrating soft skill set development with traditional technical education.

It is our intent to address these broad themes at the University of Arkansas through an innovative combination of traditional coursework with an industry-like work environment, which is then overlaid on state-of-the-art research in high performance microelectronic-photonic materials,