

Florida Board of Governors

Request to Offer a New Degree Program: Doctor of Philosophy in Materials Science and Engineering at Florida State University

Florida State University
University Submitting Proposal

Fall 2011
Proposed Implementation Date

Graduate School
Name of College or School

None
Department(s)

Materials Science and Engineering
Academic Specialty or Field

Doctor of Philosophy in Materials Science & Engineering (40.1001)
Complete Name of Degree (Include CIP code)

The submission of this proposal constitutes a commitment by the university that, if the proposal is approved, the necessary financial resources and the criteria for establishing new programs have been met prior to the initiation of the program.

Date Approved by the University Board of Trustees

President Date

Signature of Chair, Board of Trustees

Vice President for Academic Affairs Date

Provide headcount (HC) and full-time equivalent (FTE) student estimates for Yrs 1 through 5. HC and FTE estimates should be identical to those in Table 1. Indicate program costs for Years 1 and 5 of implementation as shown in the appropriate columns in Table 2. Calculate an Educational and General (E&G) cost per FTE for Yrs 1 & 5 (Total E&G divided by FTE).

Implementation
Timeframe

Projected Student
Enrollment (From Table 1)

Projected Program Costs
(From Table 2)

	Projected Student Enrollment (From Table 1)		Projected Program Costs (From Table 2)		
	HC	FTE	Total E&G Funding	Contract & Grants Funding	E&G Cost per FTE
Year 1	6	5.4	\$390,375	\$69,810	\$72,292
Year 2	14	12.6			
Year 3	23	20.7			
Year 4	33	29.7			
Year 5	43	38.7	\$1,078,807	\$1,706,608	\$27,876

Rationale and Executive Summary

This is a proposal to create an interdisciplinary Doctor of Philosophy in Materials Science and Engineering (MS&E) program at the Florida State University that will be administered by the Graduate School. The MS&E program will begin with faculty members whose tenure homes span nine departments currently spread across two colleges. This Ph.D. program builds on the recently created interdisciplinary Master of Science in Materials Science program that started in 2008.

Materials science and engineering is a broad-reaching and interdisciplinary field, where gigabyte memory sticks, human joint replacements, lightweight and smart prostheses, touch screen cell phones, and the advanced composites (more than 50% by weight) in the new generation of commercial jet airliners are all or in part the results of MS&E. Materials science involves the relationships between the processing, structure, properties, and performance of materials. MS&E graduates develop or synthesize new materials and create new products or systems using existing materials. Fundamental to MS&E is the design and simulation of the properties of new and existing materials through advanced computational methods. There is an inter-weaving of basic and applied experiences that creates a unique skill set that allows graduates to successfully pursue the frontiers of MS&E research.

This program advances the State and Federal calls to increase competence in science, technology, engineering, and math (STEM) in upcoming generations, and to promote interdisciplinary approaches to solving fundamental problems in a global environment. FSU is situated in the “Northwest Region” in the I-10 transportation corridor, one of the 10 regions that comprise the Enterprise Florida Roadmap demographics¹. In this region, there are urgent needs and a strong push to create high-tech companies and jobs. MS&E can play a critical role in these. In addition, there are a number of federal research laboratories in the region including Eglin and Tyndall AFBs, the Naval Surface Warfare Center, and the Naval Air Station Pensacola that need new and well trained doctoral graduates to replace the retiring employees in the MS&E field. The program, through the many faculty, departments, centers, and facilities that will comprise its core, addresses many of the Roadmap priorities. Specifically, students will be exposed to or can contribute to university start-ups, advanced manufacturing, aviation and aerospace, energy, multidisciplinary research, STEM pipelines, alignment with industry, expansion of academic R&D, World Class Scholars, Centers of Excellence, development of universities as Best-in Class, Federal facilities, and the culture of commercialization.

FSU has made significant investments to create a materials-oriented environment that is ready to fully support an interdisciplinary MS&E Ph.D. program. These investments include state-of-the-art atomic resolution transmission electron microscopy (TEM) instruments and laboratories, high performance computing capabilities for modeling and

¹ *Enterprise Florida's Roadmap To Florida's Future, 2010-2015 Strategic Plan for Economic Development*, eflorida.com/roadmap

simulation, and establishing two materials-related Faculty Cluster Hires in (1) Growth, Processing and Characterization of Advanced Materials and in (2) the Integrative NanoSciences Institute. To date, these Clusters have recruited 8 new faculty members (4 in the Engineering and 4 in Arts and Sciences) with tenure homes in 5 different Departments. An additional 4 to 6 hires are planned in the future. Moreover, in the past few years, four new major institutes and centers have been created in one newly-renovated and three new buildings that were purpose made for these entities. These institutes and centers, all of which are connected with materials research, are: the Center for Applied Power Systems, the Applied Superconductivity Center, the High-Performance Materials Institute, and the Florida Center for Advanced Aero-Propulsion. The Department of Scientific Computing has materials science faculty who bridge theory with the real world through advanced computational techniques.

The core faculty members named in this proposal do materials research and actively participate in the new Master of Science program. They have successful, on-going research programs investigating materials, having brought in more than \$31M in materials-related contracts and grants since 2005.

Three universities in Florida offer Ph.D. degrees in MS&E: the University of Florida, the University of Central Florida, and Florida International University. As shown in the body of the proposal, the main research interests of the FSU MS&E faculty members are unique to FSU, and complementary to research areas in the three existing programs. Support letters for the program from these three schools, plus a support letter from FAMU, which is interested in programs that may potentially impact its engineering faculty members, are included as appendices.

Three important reasons to create this program are to be able to recruit students whose primary interest is to earn a Ph.D. in materials science and engineering, to educate these students in a broad, interdisciplinary environment, and to better leverage educational and research resources in multiple units across campus. At present, there is no Ph.D. degree *per se* in MS&E at FSU, and in particular, no departmental curriculum that provides a route to a core competence in MS&E. Although some departments have expanded their doctoral curricula to address materials related areas, there is a need to provide a broader educational experience for MS&E students at the inter-college level.

This interdisciplinary program, which will be administered by the Graduate School, is designed to avoid departmentalizing the program (Fig. 1). It will begin with faculty members with tenure homes in 9 departments across two colleges but is designed to easily incorporate faculty members from other departments and colleges. The initial faculty members come from Biological Science, Chemistry and Biochemistry, Physics, and Scientific Computing in the College of Arts and Sciences, plus Chemical and Biomedical Engineering, Civil and Environmental Engineering, Electrical and Computer Engineering, Industrial and Manufacturing Engineering, and Mechanical Engineering in the College of Engineering.

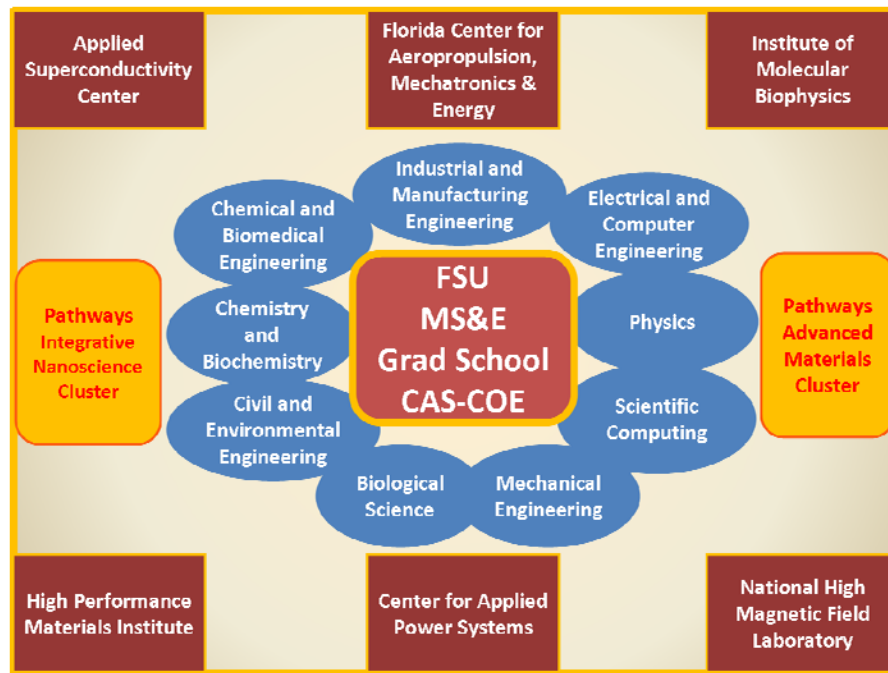


Fig. 1. Overview of the institutional structure of MS&E. The center crimson rectangle shows the Graduate School that will administer the program. The blue ovals are the academic departments in which MS&E faculty members have their tenure homes. The crimson rectangles along the edges are the centers, laboratories, and institutes. The gold rectangles are the Pathways Clusters.

In their first year, students will gain a firm basis in the fundamentals of MS&E through a series of complementary core courses taught by faculty members from different departments and through the weekly Interdisciplinary Seminar Series (ISS). In the ISS students will gain exposure to both FSU and external researchers working in the area of MS&E, they will learn presentation skills and present their own research in ISS, and outside speakers will be brought in to talk on business related topics such as entrepreneurship and how to bring research ideas to market. The ISS will also serve as a forum for MS&E faculty members who wish to recruit MS&E students.

Creating the MS&E Ph.D. program has many benefits. It will produce more engineers for the State; it will significantly contribute to research, economic development and job creation in the Panhandle area – in Feb. 2011 Bing Energy announced it will move from California to Tallahassee where it will manufacture commercial fuel cells using advanced technology developed and patented by faculty members in the MS&E Ph.D. program; it will help FSU gain ground on the AAU frontier; and it will better position FSU in the area of materials science and engineering in terms of federal research grants, particularly large-scale, interdisciplinary grants. It builds on the sizable investments FSU has already made in MS&E, it is composed of faculty members who are currently at FSU, it augments the existing M.S. program in materials science allowing students to pursue a Ph.D. in MS&E, it provides a means for FSU faculty members to recruit students who are primarily interested in studying MS&E, it provides a way to educate and train these students in a broad, interdisciplinary manner, it is relatively inexpensive to implement, and its graduates will benefit the State and the Nation.

TABLE OF CONTENTS

INTRODUCTION 8

I. Program Description and Relationship to System-Level Goals..... 8

A. Briefly describe within a few paragraphs the degree program under consideration, 8

B. Describe how the proposed program is consistent with the current State University System (SUS) Strategic Planning Goals. Identify which goals the program will directly support and which goals the program will indirectly support. 9

INSTITUTIONAL AND STATE LEVEL ACCOUNTABILITY 10

II. Need and Demand 10

A. Need: Describe national, state, and/or local data that support the need for more people to be prepared in this program at this level. 10

B. Demand: Describe data that support the assumption that students will enroll in the proposed program. 13

C. If similar programs (either private or public) exist in the state, identify the institution(s) and geographic location(s). 13

D. Use Table 1 (A for undergraduate and B for graduate) to categorize projected student headcount (HC) and Full Time Equivalents (FTE) according to primary sources. 20

E. Indicate what steps will be taken to achieve a diverse student body in this program, and identify any minority groups that will be favorably or unfavorably impacted. 22

III. Budget..... 23

A. Use Table 2 to display projected costs and associated funding sources for Year 1 and Year 5 of program operation. Use Table 3 to show how existing E&G funds will be shifted to support the new program in Year 1. 23

B. If other programs will be impacted by a reallocation of resources for the proposed program, identify the program and provide a justification for reallocating resources. 26

C. Describe other potential impacts on related programs or departments (e.g., increased need for general education or common prerequisite courses, or increased need for required or elective courses outside the proposed major). . 27

D. Describe what steps have been taken to obtain information regarding resources (financial and in-kind) available outside the institution (businesses, industrial organizations, governmental entities, etc.). 28

IV. Projected Benefit of the Program to the University, Local Community, and State 28

Use information from Table 1, Table 2, and the supporting narrative for “Need and Demand” to prepare a concise statement that describes the projected benefit to the university, local community, and the state if the program is implemented. 28

V. Access and Articulation – Bachelor’s Degrees Only.....	31
INSTITUTIONAL READINESS	31
VI. Related Institutional Mission and Strength	31
A. Describe how the goals of the proposed program relate to the institutional mission statement as contained in the SUS Strategic Plan and the University Strategic Plan.	31
B. Describe how the proposed program specifically relates to existing institutional strengths, such as programs of emphasis, other academic programs, and/or institutes and centers.	32
C. Provide a narrative of the planning process leading up to submission of this proposal.	35
VII. Program Quality Indicators - Reviews and Accreditation.....	37
Identify program reviews, accreditation visits, or internal reviews for any university degree programs related to the proposed program, especially any within the same academic unit.....	37
VIII. Curriculum.....	37
A. Describe the specific expected student learning outcomes associated with the proposed program.	37
B. Describe the admission standards and graduation requirements for the program.	38
C. Describe the curricular framework for the proposed program, including number of credit hours and composition of required core courses, restricted electives, unrestricted electives, thesis requirements, and dissertation requirements.....	40
D. Provide a sequenced course of study for all majors, concentrations, or areas of emphasis within the proposed program.	44
E. Provide a one- or two-sentence description of each required or elective course.	44
F. For degree programs in the science and technology disciplines, discuss how industry-driven competencies were identified and incorporated into the curriculum and identify if any industry advisory council exists to provide input for curriculum development and student assessment.....	47
G. For all programs, list the specialized accreditation agencies and learned societies that would be concerned with the proposed program.....	48
H. For doctoral programs, list the accreditation agencies and learned societies that would be concerned with corresponding bachelor’s or master’s programs associated with the proposed program.	48
I. Briefly describe the anticipated delivery system for the proposed program (e.g., traditional delivery on main campus; traditional delivery at branch campuses or centers; or nontraditional delivery such as distance or distributed learning, self-paced instruction, or external degree programs).	48
IX. Faculty Participation.....	48
A. Use Table 4 to identify existing and anticipated ranked (not visiting or adjunct) faculty who will participate in the proposed program through Yr 5.	48

B.	Use Table 2 to display the costs and associated funding resources for existing and anticipated ranked faculty (as identified in Table 4).	52
C.	Provide the number of master's theses and/or doctoral dissertations directed, and the number and type of professional publications for each existing faculty member (do not include information for visiting or adjunct faculty).	52
D.	Provide evidence that the academic unit(s) associated with this new degree have been productive in teaching, research, and service.	57
X.	Non-Faculty Resources	57
A.	Describe library resources currently available to implement and/or sustain the proposed program through Year 5.	57
B.	Describe additional library resources that are needed to implement and/or sustain the program through Year 5.	59
C.	Describe classroom, teaching laboratory, research laboratory, office, and other types of space that are necessary and currently available to implement the proposed program through Year 5.	59
D.	Describe additional classroom, teaching laboratory, research laboratory, office, and other space needed to implement and/or maintain the proposed program through Year 5.	59
E.	Describe specialized equipment that is currently available to implement the proposed program through Year 5. Focus primarily on instructional and research requirements.	60
F.	Describe additional specialized equipment that will be needed to implement and/or sustain the proposed program through Year 5.	60
G.	Describe any additional special categories of resources needed to implement the program through Year 5.	60
H.	Describe fellowships, scholarships, and graduate assistantships to be allocated to the proposed program through Year 5.	61
I.	Describe currently available sites for internship and practicum experiences, if appropriate to the program.	61
J.	If a new capital expenditure for instructional or research space is required, indicate where this item appears on the university's fixed capital outlay priority list.	61
	Appendix A –Abbreviations used in the body of the proposal	62
	Appendix B - Partial list of equipment available for materials science research	63
	Appendix C – Support letters	65
	Appendix D – External review of the proposal by John Wiley	69

Proposal for a Doctor of Philosophy in Materials Science and Engineering at Florida State University

INTRODUCTION

Note: Appendix A is a list of abbreviations we use in the proposal.

I. Program Description and Relationship to System-Level Goals

- A. Briefly describe within a few paragraphs the degree program under consideration, including (a) level; (b) emphases, including concentrations, tracks, or specializations; (c) total number of credit hours; and (d) overall purpose, including examples of employment or education opportunities that may be available to program graduates.**

We propose an interdisciplinary Doctor of Philosophy in Materials Science and Engineering (MS&E). The proposed Ph.D. program goals are to educate students in the broad field of materials science and engineering through an interdisciplinary approach where they are taught by faculty members with a variety of backgrounds from different departments and colleges. It will train students to conduct world-class research on materials and provide the students the opportunity to acquire professional written and oral communication skills.

The interdisciplinary MS&E program will be administered by the Graduate School to provide balanced access to, and investment in, the program throughout various colleges and departments. MS&E will begin with faculty members with tenure homes in nine departments (Biological Science, Chemical and Biomedical Engineering, Chemistry and Biochemistry, Civil and Environmental Engineering, Electrical and Computer Engineering, Industrial and Manufacturing Engineering, Mechanical Engineering, Physics, and Scientific Computing) spanning two colleges (Arts and Sciences, and Engineering). In the future MS&E can expand to include faculty members who do materials related research in other departments and colleges.

The MS&E Ph.D. program will require a minimum of 54 credit hours beyond the bachelor's degree.

The program will emphasize research in materials science and engineering. Materials science and engineering has an enormous impact on modern society. Discoveries and advances in materials are helping shape modern life. For instance, materials scientists at Intel convert silicon wafers into the integrated circuits that are the heart of all new consumer electronic devices; Boeing and Airbus's newest planes are lighter and more fuel efficient because they have replaced aluminum components that were designed by materials scientists decades ago, with new, lighter and stronger carbon-fiber composites; and the superconducting magnets that are crucial for MRI scanners were developed by materials scientists. Our MS&E graduates will be employed doing research and

development in the manufacturing industry, research in industrial and federal/national research laboratories, and teaching and research in academia. Some well-known companies in which materials scientists play key roles include 3M, Alcoa, Boeing, Cummins, DuPont, Exxon Mobil, General Dynamics, GE, General Motors, HP, IBM, Intel, Lockheed Martin, Motorola, and Xerox.

The Program Directorship will rotate on a regular basis. The Director, chosen from the participating faculty members in the MS&E program, approved by the deans of participating colleges, and appointed by the Dean of the Graduate School, will oversee the program with input from an executive committee. This committee, called the Governing Executive Committee, will be formed with representation from all participating colleges/departments in which MS&E faculty members have tenure homes. Any faculty member at FSU who does research in materials science can apply to be an MS&E faculty member and advise MS&E Ph.D. students. FAMU faculty members with an appointment in the FAMU-FSU College of Engineering and who do materials research will be eligible to be a member of MS&E and co-advise MS&E Ph.D. students.

B. Describe how the proposed program is consistent with the current State University System (SUS) Strategic Planning Goals. Identify which goals the program will directly support and which goals the program will indirectly support.

(See the SUS Strategic Plan at <http://www.flbog.org/StrategicResources/>)

MS&E directly addresses several of the SUS Strategic Planning Goals, including:

- I.A.4 Access to and production of degrees – emerging technologies doctoral degrees;
- I.B.3.a Meeting statewide professional and workforce needs – Economic development;
- I.C. Building world-class academic programs and research capacity;
- I.D. Meeting community needs and fulfilling unique institutional responsibilities.

As the Board of Governors notes in its *“New Florida” Initiative* in January 2010, Florida’s future depends on developing a knowledge and innovation economy that is built on high-technology, high-wage jobs in the fields of science, technology, engineering and mathematics (or “STEM”). Building this new economy requires new talent, so we need to increase the percentage of Floridians who have advanced degrees in these critical fields. In the *2010-2015 Roadmap* developed by Enterprise Florida¹, it is stressed that the key to Florida’s future economic growth is to expand and transform foundational industry clusters (e.g., Advanced Manufacturing, Marine and Space), expand existing industry clusters (e.g., Aviation and Aerospace, Clean Energy and Life Science) and develop new clusters (e.g., Nanotechnology). MS&E plays a key role, as it is related to almost all of these fields critical to Florida’s economic growth. A new Ph.D. program in MS&E will help the State achieve its goals by producing more, high-skilled workforce in these critical fields.

FSU has made considerable recent investments hiring first-rate faculty members, acquiring research equipment, supporting research infrastructure, and building laboratories and new buildings to support research in materials science. With these resources, the new Ph.D. program will directly address SUS Goals by attracting students who will be educated in the STEM field of materials science and engineering and carry out world-class research in an interdisciplinary environment.

The new MS&E Ph.D. program will also directly address the FSU mission and goals defined in the University's mission statement (2005) for promoting excellence in graduate education and research and encouraging the dissemination and transfer of knowledge by providing broad access to institutional resources and services to the community and to the State. It will provide new opportunities for graduate education and research in the area of MS&E and offer technology transfer opportunities to industry in the State.

INSTITUTIONAL AND STATE LEVEL ACCOUNTABILITY

II. Need and Demand

- A. Need: Describe national, state, and/or local data that support the need for more people to be prepared in this program at this level. Reference national, state, and/or local plans or reports that support the need for this program and requests for the proposed program which have emanated from a perceived need by agencies or industries in your service area. Cite any specific need for research and service that the program would fulfill.**

The first materials science and engineering programs were created in the early 1960s, but the discipline is much older than that, having deep, broad roots in metallurgy and ceramics. Materials science and engineering has been a multi-disciplinary field since its inception, having merged metallurgy and ceramics, and included parts of other disciplines such as solid-state physics and polymers, and has incubated new fields such as nanotechnology. It bridges condensed matter physics, chemistry, the engineering disciplines, and most recently biology, and nanoscience and nanotechnology. Materials science experimental, computational, and theoretical research forms an important vehicle to create new materials and improve existing materials that underpin the development of new technologies in medicine, energy, transportation, electronics, communications, information, building, construction, homeland security and national defense. All major federal funding agencies, including the National Science Foundation, Department of Energy, Department of Defense, and National Institutes of Health, support large research programs in materials science and engineering. In the 2010 *U.S. News and World Report* rankings of America's Best Graduate Schools², 7 of the top 10 graduate programs in materials science and engineering are at state universities like FSU. Materials research and engineering are strong components at many AAU member universities.

² <http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-engineering-schools/material-engineering>

There is an increasing demand for materials scientists by high-technology industries including manufacturing, automotive, aerospace, catalysis, electronics, construction, medical science, and metal and mineral extraction. The Bureau of Labor Statistics states that "...the employment of materials scientists is projected to grow by 12 percent as manufacturers seek to improve the quality of their products by using new materials and manufacturing processes"³. Growth is expected to be particularly strong for materials scientists and engineers working on nanomaterials and biomaterials. Also, according to the Aerospace Industries Association, there will be a need for more people in the aerospace industries, including materials scientists, as baby boomers retire and the industry creates more advanced designs with greater capabilities and higher efficiencies.

Several faculty members in our recently created (Fall 2008) interdisciplinary Master of Science in Materials Science work closely with colleagues at the military research laboratories in the Panhandle. These faculty members have recently learned that these defense labs have been directed to increase the number of Ph.D. level researchers in the labs, including materials scientists.

Florida has strong national presence in key economic sectors such as aerospace, defense, marine and space. Lockheed Martin, Boeing, Raytheon, Northrop Grumman, and General Dynamics – top aerospace/defense companies in the U.S. – all have substantial operations in Florida, and all employ materials scientists. New materials are key to advances in these industries, such as the carbon-fiber composites being used in military aircraft and the latest commercial Boeing and Air Bus planes.

Other large companies in Florida, such as Siemens Westinghouse Power Corp., employ materials scientists who improve the efficiency of power systems by incorporating new, higher-performance materials in advanced systems designs.

Enterprise Florida cites data from the Food and Drug Administration that "Florida has one of the country's largest medical device sectors, ranking 2nd in the U.S. for the number of FDA-registered medical device establishments." There are over 20,000 people in Florida who work in this sector. Advanced materials are critical to this industry sector⁴.

There are also many small companies in Florida that depend on advanced materials and employ Ph.D. materials scientists, including Quantachrome, Applicote, Semiconductor Diagnostics, Inc., nScript, Inc., and Fractal Systems, Inc.

In Feb. 2011 Bing Energy, a high-tech company that manufactures commercial fuel cells to generate electricity, announced it will move from California to Tallahassee. A key component of their fuel cells competitive advantage comes from a new electrode material that was developed and patented by FSU faculty members in the MS&E program. Bing

³ Bureau of Labor Statistics - Occupational Outlook Handbook, 2010-11 Edition

⁴ eFlorida - http://www.eflorida.com/Life_Sciences.aspx?id=220

Energy cited being close to the faculty members where the technology was developed as one of the reasons they decided to move their operations to Tallahassee.

The federal science and engineering (S&E) workforce is shrinking. For example, the Department of Defense S&E workforce declined from 45,000 to 28,000 in the decade between 1990 and 2000 and more will soon retire, many of them in areas related to materials science and engineering⁵. This is evidenced by the recent increasing recruitment effort for FSU doctoral graduates from some federal research laboratories. A unique feature of the proposed MS&E doctoral degree program is to address this critical issue by complementing existing work and needs of the federal research labs in the Florida panhandle (Tyndall and Eglin AFBs, the Naval Air Station Pensacola, and the Naval Surface Warfare Center) and beyond. Emphasis will be placed on DoD areas of current and future needs including advanced structural materials, nanomaterials, energy materials, multifunctional materials, and multiscale materials. Our goal is to enhance our nation's global leadership position in MS&E by training current and future federal employees (uniformed and civilian) to be world class leaders in areas of critical national needs, matching the core competencies available within the MS&E program at FSU. The students working at the federal labs will work on innovative research funded through the labs as their dissertation work. The new MS&E program will provide the flexibility in core course delivery to accommodate the targeted students' rigorous work environments.

On the national level, well-known companies in which materials scientists and engineers play key roles include 3M, Alcoa, Boeing, Cummins, DuPont, Exxon Mobil, General Dynamics, GE, General Motors, HP, IBM, Intel, Lockheed Martin, Motorola, and Xerox. The graduates from MS&E can also work in research and development in academia, national labs and industrial labs.

The increasing budget and scales of federal agencies' SBIR/STTR programs in MS&E fields have created and will continue to generate higher demand for the doctoral graduates in these fields. Recently, more and more doctoral graduates work for high-tech small businesses, with many of them taking leadership roles in those companies working on SBIR/STTR projects. The new Ph.D. program will help enhance the graduates' capabilities of running SBIR/STTR programs with the proposed interdisciplinary training programs, research experience with federal funded projects, and entrepreneurship/commercialization education/practice.

Recent placements of our own students indicate that the job-market for graduates in MS&E will be strong. Over the past few years, graduating Ph.D. students who worked with MS&E faculty members have been employed at Air Force Research Laboratory, Boeing, Lexar, GE, Fermi National Accelerator Lab, Intel, and Sandia National Laboratory to name a few. These examples show that advanced materials play a central role in many advanced, new technologies, and MS&E graduates will be readily employed.

⁵ "Envisioning A 21st Century Science and Engineering Workforce for the United States: Tasks for University, Industry, and Government," *The National Academies Press*, 2003

Creating the MS&E program will also enhance FSU's ability to increase federal research funding, graduate student recruitment, and Ph.D. production. Over the past decade, federal research awards to interdisciplinary teams in materials areas have increased substantially. This is seen for example in the DoD MURI program, the NSF Division of Materials Research Centers programs, including the MRSECs, NSECs, CEMRIs and most recently MIRTs. The interdisciplinary MS&E Ph.D. program at FSU will help build strong bridges between MS&E faculty across campus and it will help make FSU more competitive for these interdisciplinary grants.

B. Demand: Describe data that support the assumption that students will enroll in the proposed program. Include descriptions of surveys or other communications with prospective students.

According to a recent NSF Graduate Enrollment Survey⁶, from 2001 to 2007, the growth of graduate student enrollment in the materials engineering field grew 13.6%. This indicates materials science and engineering is a steadily growing field so we can confidently expect students to apply to MS&E. In addition, several students who inquired about the new FSU Master of Science in Materials Science program were interested in whether FSU had a Ph.D. program. Those interested in earning a Ph.D. in materials science and engineering applied to other schools. One student who was admitted to the Master of Science in Materials Science program chose chemical and biomedical engineering over the masters program in materials science because she could earn a Ph.D. in chemical engineering but not in materials science. A growing number of the current students in our new Master of Science in Materials Science Program have told their advisors they plan to continue on for a Ph.D. and would like to be able to earn their Ph.D. in MS&E at FSU. This adds an important imperative to the timing of this proposal.

Faculty members at FSU who do materials science research regularly receive inquiries from students asking about pursuing a Ph.D. in materials science and engineering under their guidance. In recent years, many students have either not applied to or have left FSU due to the lack of MS&E related programs that satisfy their interests and professional aspirations.

C. If similar programs (either private or public) exist in the state, identify the institution(s) and geographic location(s). Summarize the outcome(s) of any communication with such programs with regard to the potential impact on their enrollment and opportunities for possible collaboration (instruction and research). Provide data that support the need for an additional program.

There are three materials science and engineering Ph.D. programs in Florida: at Florida International University (FIU), the University of Central Florida (UCF), and the University of Florida (UF). UF and FIU are single-department programs in which all of

⁶ National Science Foundation: Graduate Students and Post doctorates in Science and Engineering: Fall 2007 <http://www.nsf.gov/statistics/nsf10307/pdf/nsf10307.pdf>

the faculty members in the Ph.D. program come from a single department, the students take their courses within that department but may take elective courses outside the department, and the students are mainly taught by faculty from that department. UCF is centered in a single department but has faculty members associated with it from other departments. These models work well for the existing programs. The research areas in these three programs are multi-disciplinary covering a wide range of topics in MS&E.

The proposed FSU program follows a different model. It will initially be made up of faculty members with tenure homes in nine different departments across two colleges and is administered by the Graduate School, but can expand in the future to include faculty members in other FSU departments and colleges. It could also include faculty members from another university, such as FAMU, if they establish a Ph.D. degree in MS&E. Collaborative arrangements could be made for efficient use of resources if FAMU were to initiate such a degree. Students will have their academic home in the Graduate School; they will take a set of required core courses and elective specialization courses to give them both breadth and depth in MS&E. These courses will be taught by faculty members from multiple departments in Arts and Sciences and in Engineering; they will meet weekly for their entire time as graduate students in a new Interdisciplinary Seminar Series; and they will meet regularly with their research committee, composed of faculty members from across campus. The rationale for this model at FSU is to build a strong, new Ph.D. program using the components that already exist at FSU. These components are: faculty members who are already doing materials research and participating in the interdisciplinary Master of Science in Materials Science program (created in fall 2008); diverse, strong scientific and educational expertise from faculty members in nine different departments who will instruct and train MS&E students; extensive investment FSU has already made hiring new faculty, purchasing research equipment, creating research laboratories, and building new buildings for materials research. In short, all the components for the MS&E Ph.D. program already exist at FSU. This proposal brings them together in an effective, cost efficient new program.

The new Ph.D. program in Materials Science and Engineering at FSU will have minimal research overlap with the three existing MS&E Ph.D. programs at UF, UCF and FIU. We have surveyed the research areas in each of these three programs from their websites and talked with each of the three programs. We had a retreat at UF between FSU and UF MS&E faculty members in December 2010 where we presented this proposal to UF faculty members, discussed research areas in the two programs, and sought areas for collaboration. The UF faculty members had a positive reaction to this proposed MS&E program at FSU. The faculty members determined that there are unique, strong research programs at FSU that do not overlap or compete with UF's research programs; rather, the two programs are complementary. With the MS&E program at FSU, UF and FSU can write joint proposals to federal funding agencies for major, multi-university grants.

Appendix C contains support letters from FIU, UCF, and UF for this MS&E Ph.D. program. Support for the FSU program was discussed internally up to the provost level at each of these schools. We also have a support letter from FAMU. We asked FAMU to review the program, even though it does not have a Ph.D. program in MS&E, because we

wanted the FAMU administration to be able to have the opportunity to review the program and evaluate potential impact on engineering faculty members with FAMU lines in the joint FAMU-FSU College of Engineering.

The UF Ph.D. program is in the Department of Materials Science and Engineering. It is the largest and highest nationally-ranked program in Florida. It is broad in scope having faculty members who do processing and characterization of materials and as well as advanced computational studies to understand, model, and predict properties of materials. Table II.C.1 lists the research areas in MS&E at UF and FSU. Although it is natural that there is some overlap in research areas between two large MS&E programs, the top portion of the table shows those areas where FSU has developed strong research thrusts that are not major research areas at UF. Likewise, the UF MS&E program is particularly strong in biomaterials, which is an area FSU has chosen not to emphasize over the past few years so as not to duplicate the UF program.

TABLE II.C.1

Summary of MS&E research activities at FSU and UF. This table is not meant to be a full and comprehensive comparison.

Research Areas	Description of FSU MS&E activities	Related UF MS&E activities
----- Research areas at FSU with little overlap at UF -----		
Fundamental theory: bulk and low dimensional materials	Fundamental understanding of interactions in materials, including effects of disorder, dimensionality, temperature, and magnetic field.; Dobrosaljevic, Rikvold, Vafek	No apparent program
Superconducting devices, quantum computing elements	Superconducting devices, and quantum computing elements; Chiorescu	No apparent program
Fundamental magnetism	Molecular magnetism, magnetic and hybrid materials; Chiorescu, Latturner, Shatruk	No apparent program
Nanocomposites	Carbon nanotube based functional materials, fundamental research, processing and testing of nanocomposite materials.: Alamo, Liang, Liu, Wang, Zhang	Durability of epoxies for infrastructure applications; nanoparticle-metal matrix composites; E. Douglas, M. Manuel
Applied Superconductivity	Fundamental and applied research on technologically important and emerging superconducting materials. Materials for next generation high-field magnets; Hellstrom, Larbalestier	High Temperature Superconducting Thin Films and Devices; D. Norton (now Assoc. Dean for Res. and Grad. Prog.)
Chemical Vapor Deposition for Nanostructured Materials	Unique methods to use CVD to produce carbon nanotube forests and directed synthesis of nanowires on microelectromechanical (MEMS)-type platforms; O. Englander, M. Zhang	CVD on VII-V - Nitrides; C. Abernathy (now Dean of UF COE)
Thin film structures	Oxide thin films produced by molecular beam epitaxy (MBE) and pulsed laser deposition (PLD) for sensors, devices, and low dimensional novel materials properties; Chiorescu, Warusawithana, Zheng	Oxide and semiconductor films growth ; C. Abernathy, D. Norton (both are now UF COE administrators), S. Pearton
Materials characterization under novel and extreme conditions	Broad spectrum of characterization techniques for materials characterization and testing; Brooks, Chiorescu, Hellstrom, Larbalestier, Liang, Siegrist	Advanced diffraction tools for electroactive ceramics; J. Jones, K. Jones
----- Research areas at both FSU and UF -----		
Polymer Science and Engineering	Experimental and computational aspects of polymers including: rheology, crystallization, morphology, structure-properties relations, and polymer-nanostructure composites; Alamo, Collier, Shanbhag, Liu	General efforts in polymer science, biopolymers, etc.; C. Batich, A. Brennan, E. Douglas, K. Powers
Materials chemistry and energy related-materials.	Materials synthesis for energy harvesting, storage, and fuel cell applications. Various growth techniques for new materials.; Latturner, Shatruk, Siegrist, Strouse	Complex alloys, thin film photonics, electroactive ceramics, ferroelectrics. F. Ebrahimi, P. Holloway, K. Jones, J. Jones, J. Nino, S. Pearton, R. Singh
Modeling, Simulation, Computation of materials.	Modeling and simulation of macro and nanoscale structures, semiconductor devices, magnetic materials, and biomaterials.; Andrei, El-Azab, Liang, Oates, Rikvold, Sobanjo	Molecular dynamics studies; S. Sinnott, S. Phillpot
----- Research areas at UF with little overlap at FSU -----		
Biomaterials	Bio-lithographic and self organized bio-structures, functional applications of cellulose, electronic properties of natural and functionalized silks; Brooks, Lenhert	Major departmental effort in biomaterials, biomimetics, and biomedical areas by 11 UF-MS&E Faculty
Ceramics, metals, minerals	Small research effort at FSU	Major departmental effort involving 6 faculty members

TABLE II.C.2

Summary of MS&E research activities at FSU and UCF. This table is not meant to be a full and comprehensive comparison.

Research Areas	Description of Unique FSU MS&E activities	Related UCF MS&E activities
----- Research areas at FSU with little overlap at UCF -----		
Applied Superconductivity	Fundamental and applied research on technologically important and emerging superconducting materials. Materials for next generation high-field magnets; Hellstrom, Larbalestier	No research effort
Superconducting devices, quantum computing elements	Superconducting devices, and quantum computing elements; Chiorescu	No research effort
Chemical Vapor Deposition for Nanostructured Materials	Unique methods to use CVD to produce carbon nanotube forests and directed synthesis of nanowires on microelectromechanical (MEMS) platforms; Englander, Zhang	No research effort
Fundamental magnetism	Molecular magnetism, magnetic and hybrid materials; Chiorescu, Lattner, Shatruk	No research effort
----- Research areas at both FSU and UCF -----		
Nanocomposites	Carbon nanotube based functional materials, fundamental research, processing and testing of nanocomposite materials.: Alamo, Liang, Liu, Wang, Zhang	Carbon nanotube-based functional materials, e.g., conductive polymer/nanotube composites & 2-D circuits; fundamental research, processing & testing nanocomposite materials; An, Guo, Zhai
Fundamental theory: bulk and low dimensional materials	Fundamental understanding of interactions in materials, including effects of disorder, dimensionality, temperature, and magnetic field.; Dobrosaljevic, Rikvold, Vafek	Mesoscale models of thermal transport; atomic & electronic structure at solid/liquid interfaces; Schelling
Materials characterization under novel and extreme conditions	Broad spectrum of characterization techniques for materials characterization and testing; Brooks, Chiorescu, Hellstrom, Larbalestier, Liang, Siegrist	Broad spectrum of materials characterization and testing techniques, including neutron and x-ray studies at load and temperature; coatings for extreme environments; Sohn, Vaidyanathan
Thin film structures	Oxide thin films produced by molecular beam epitaxy (MBE) and pulsed laser deposition (PLD) for sensors, devices, and low dimensional novel materials properties; Chiorescu, Warusawithana, Zheng	Thin film solar cells and magnetic materials; IR bolometers; MEMS; Heinrich, Dhere, Coffey, Chow
Polymer Science and Engineering	Experimental and computational aspects of polymers including: rheology, crystallization, morphology, structure-properties relations, and polymer-nanostructure composites; Alamo, Collier, Shanbhag, Liu	Polymer research for functionalization of microfluidic system; soft lithography; liquid crystal imaging; soft materials; Zhai, Fang, Hun, Hickman
Materials chemistry and energy related-materials.	Materials synthesis for energy harvesting, storage, and fuel cell applications. Various growth techniques for new materials.; Lattner, Shatruk, Siegrist, Strouse	Solar cells; renewable energy; PEM & solid oxide fuel cells; batteries; Dhere, Heinrich, Fenton, Orlovskaya, Coffey
Modeling, Simulation, Computation of materials.	Modeling and simulation of macro and nanoscale structures, semiconductor devices, magnetic materials, and biomaterials.; Andrei, El-Azab, Liang, Oates, Rikvold, Sobanjo	Multiscale modeling; molecular dynamics; Schelling, Chen, Gou, Vaidyanathan
Biomaterials	Bio-lithographic and self organized bio-structures, functional applications of cellulose, electronic properties of natural and functionalized silks; Brooks, Lenhart	BioMEMS; microfluidic devices; biomaterials for drug screening; Cho, Hickman, Fang, Chen, Seal
----- Research areas at UCF with little overlap at FSU -----		
Optics and optical materials	Small program at FSU	Major program effort in optics and electro-optics; 5 faculty members
Nanoparticle and nanostructured materials	Small program at FSU	Synthesis and property studies of nanocomposite and nanostructured materials; 5 faculty members
Ceramic materials	Small program at FSU	Fabrication and characterization of ceramics; An, Orlovskaya
Diffusion, interactions, and reactions	Small program at FSU	Diffusion in bulk and grain boundaries; 4 faculty members
Nonequilibrium materials	Small program at FSU	Mechanical alloying; non-equilibrium materials; Suryanarayana, Heinrich

Table II.C.2 analyzes research at UCF and FSU. Again the table shows there is some research overlap between these two programs. The top of the table indicates the FSU research areas that are particularly strong at FSU and the bottom of the table shows the strong research areas at UCF. Faculty members in the UCF program have strong ties with the Center for Research and Education in Optics and Lasers (CREOL), the Florida Solar Energy Center (FSEC), and the NanoScience Technology Center (NSTC).

The FIU Ph.D. program, which is relatively new, is smaller (6 faculty members at present) than the other two existing Ph.D. programs and the proposed FSU program (26 faculty members). The research specializations of the individual FIU faculty members are in ceramics, memory alloys, fuel cells, thermodynamics, MEMS, high-density information storage, carbon nanotube-based devices and technology, nano electromechanical systems (NEMS), nanoparticle synthesis and characterization, bio/nanomaterials for drug delivery, modeling, and characterization.

Referring back to Tables II.C.1 and II.C.2 we see that the strong FSU research areas in the top of section of each table are not duplicated in the UF or UCF MS&E research programs. The unique research areas at FSU, which are complementary to research areas at UF and UCF are: nanocomposites; fundamental theory of bulk and low-dimensional materials, applied superconductivity, superconducting devices and quantum computing elements; chemical vapor deposition for nanostructured materials; and materials characterization under novel and extreme conditions.

Supporting the FSU research areas described in the Table in Section II.C are several strong research centers at FSU with which MS&E faculty members are associated. These include the National High Magnetic Field Laboratory (NHMFL), the Applied Superconductivity Center (ASC), the recently formed Analysis and Fabrication Facility in Physics under the direction of Condensed Matter and Materials Physics (CMMP), the Center for Advanced Power Systems (CAPS), the High-Performance Materials Institute (HPMI), the Florida Center for Aeropropulsion, Mechatronics and Energy (AME), and the Institute of Molecular Biophysics (IMB). These Centers and Institutes, which are all unique to FSU, actively support materials research at FSU. In addition to the facilities provided by these Centers and Institutes, several recent academic and organizational changes have defined the central role of materials at FSU and have provided a natural slate of classroom courses to educate Ph.D. students. For example, the Department of Chemistry and Biochemistry has recently established a degree in Materials Chemistry. The Department of Physics recently formed the Condensed Matter and Materials Physics group. The recently-formed Department of Computational Sciences offers a degree track in Computational Materials Science.

Over half (14) of the MS&E faculty members listed in the proposal are associated with FSU's National High Magnetic Field Laboratory (NHMFL). They do basic and applied research on magnetic materials or on materials that require the very high magnetic fields or specialized magnetic characterization capabilities available at NHMFL. The NSF-funded NHMFL is the only high-magnetic field laboratory in the US and is only one of a handful in the world. The NHMFL has branch laboratories at UF and Los Alamos

National Laboratory (LANL). The facilities at UF are the Microkelvin Laboratory in the Physics Dept. and the outside users program in the Advanced Magnetic Resonance Imaging and Spectroscopy within the McKnight Brain Institute. FSU does not have capabilities that duplicate these UF facilities. LANL has the Pulsed Field Laboratory, which is not duplicated at FSU.

The Applied Superconductivity Center is a world leader studying superconducting materials that are used to generate very high magnetic fields, to produce and transmit electricity, and to build high-power electric motors. Before moving to FSU from the University of Wisconsin-Madison in 2006, Larbalestier and Lee had developed the materials processing used to make the Nb(Ti) superconductors at the heart of commercial, medical MRI systems.

Several of the faculty members are associated with the High-Performance Materials Institute (HPMI). It is an international leader in composite materials, particularly nanocomposites made with carbon nanotubes. The research is to understand, develop, and commercialize new multifunctional materials technologies using carbon nanotubes. HPMI works closely with industrial and DOD research laboratories.

One may be wondering why FSU wants to offer a Ph.D. in materials science and engineering if its faculty members are already doing research in materials science. The answer is simple – students. Potential Ph.D. students interested in materials science recognize that to get a well-rounded education in materials science and engineering requires an educational infrastructure in materials science and engineering, such as this MS&E program. At present, without an MS&E Ph.D. program, we cannot effectively recruit, train, and certify students whose primary interest is in materials science and engineering. Currently FSU students doing Ph.D. research on materials cannot follow a Ph.D. curriculum that emphasizes materials science and engineering. Instead they have to follow the Ph.D. curriculum of their home department. These students do not, and cannot, get the broad educational background in materials science and engineering within the curricular confines of these traditional departments needed to develop a steady stream of high-quality, MS&E Ph.D. graduates from FSU. As discussed below, more than half of the students in the current Master of Science in Materials Science program have expressed strong interest in continuing with Ph.D. studies in MS&E at FSU if the new program can be created soon. Without the MS&E Ph.D. program, these students plan to go elsewhere to pursue their Ph.D. studies.

D. Use Table 1 (A for undergraduate and B for graduate) to categorize projected student headcount (HC) and Full Time Equivalents (FTE) according to primary sources.

Generally undergraduate FTE will be calculated as 40 credit hours per year and graduate FTE will be calculated as 32 credit hours per year. Describe the rationale underlying enrollment projections. If, initially, students within the institution are expected to change majors to enroll in the proposed program, describe the shifts from disciplines that will likely occur.

The enrollment estimates in Table 1B are based on the enrollment history and past experience from the participating departments, as well as national statistics for MS&E compiled by the National Science Foundation⁷. As soon as the MS&E Ph.D. program is implemented, we expect students will continue on from the Master of Science in Materials Science program and a few will transfer from other graduate programs at FSU. Undergraduates presently in science or engineering departments at FSU can pursue an interdisciplinary Ph.D. program in MS&E at FSU.

⁷ http://www.nsf.gov/statistics/nsf10309/content.cfm?pub_id=3996&id=8

**TABLE 1B
PROJECTED HEAD COUNT FROM POTENTIAL SOURCES
(Graduate Degree Program)**

Source of Students (Non-duplicated headcount in any given year)*	Year 1		Year 2		Year 3		Year 4		Year 5	
	HC	FTE	HC	FTE	HC	FTE	HC	FTE	HC	FTE
Individuals drawn from agencies/industries in your service area (e.g., older returning students)	0	0	0	0	0	0	0	0	0	0
Students who transfer from other graduate programs within the university**	1	0.9	2	1.8	2	1.8	2	1.8	2	1.8
Individuals who have recently graduated from preceding degree programs at this university	2	1.8	4	3.6	6	5.4	8	7.2	10	9
Individuals who graduated from preceding degree programs at other Florida public universities	0	0	1	0.9	3	2.7	5	4.5	7	6.3
Individuals who graduated from preceding degree programs at non-public Florida institutions	0	0	0	0	0	0	0	0	0	0
Additional in-state residents***	0	0	0	0	0	0	0	0	0	0
Additional out-of-state residents***	0	0	0	0	1	0.9	2	1.8	3	2.7
Additional foreign residents***	3	2.7	7	6.3	11	9.9	16	14.4	21	18.9
Other (Explain)***	0	0	0	0	0	0	0	0	0	0
Totals	6	5.4	14	12.6	23	20.7	33	29.7	43	38.7

* List projected yearly cumulative ENROLLMENTS instead of admissions

** If numbers appear in this category, they should go DOWN in later years.

*** Do not include individuals counted in any PRIOR category in a given COLUMN.

E. Indicate what steps will be taken to achieve a diverse student body in this program, and identify any minority groups that will be favorably or unfavorably impacted.

The university's Equal Opportunity Officer should read this section and then sign and date in the area below.

The MS&E faculty members will strive for diversity within MS&E by actively recruiting students from the historically-black Florida A&M University (FAMU) with undergraduate degrees in chemistry, physics, and mathematics, plus FAMU engineering students in the FAMU-FSU College of Engineering. In addition, MS&E faculty members will be encouraged to have minority students in the REU summer program work in their laboratory to get first-hand research experience on materials. REU is the Research Experience for Undergraduates program funded by the National Science Foundation and is run through the National High Magnetic Field Laboratory (NHMFL) at FSU. Admission to this program is coordinated with the NHMFL offices of the Center for Integrated Research and Diversity to select a diverse cross section of REU students following NSF Diversity Guidelines. This hands-on summer research experience is an excellent tool for recruiting minority students for graduate school.

In the FAMU-FSU College of Engineering, about 24% of the undergraduates are from FAMU, an HBCU, and over 35% of the FSU students are minority or women students. MS&E includes faculty members in all departments in the College of Engineering. These faculty members can use their class-room interaction with FAMU and FSU students to recruit minority students into MS&E.

The NHMFL has a diversity program that targets minority students for research assistant positions in the lab. Since many of the MS&E faculty members are associated with the NHMFL, MS&E will encourage its faculty members to work with the NHMFL to recruit minority students.

In addition, the association of FSU with FAMU through the joint College of Engineering provides opportunities for collaborative research between FSU and FAMU faculty members. Further, FAMU students will be able to take materials classes at FSU.

Equal Opportunity Officer

Date

III. Budget

- A. Use Table 2 to display projected costs and associated funding sources for Year 1 and Year 5 of program operation. Use Table 3 to show how existing Education & General funds will be shifted to support the new program in Year 1.**

In narrative form, summarize the contents of both tables, identifying the source of both current and new resources to be devoted to the proposed program. (Data for Year 1 and Year 5 reflect snapshots in time rather than cumulative costs.)

**TABLE 2
PROJECTED COSTS AND FUNDING SOURCES**

Instruction & Research Costs (non-cumulative)	Year 1						Year 5				
	Funding Source					Subtotal E&G and C&G	Funding Source				Subtotal E&G and C&G
	Reallocated Base* (E&G)	Enrollment Growth (E&G)	Other New Recurring (E&G)	New Non-Recurring (E&G)	Contracts & Grants (C&G)		Continuing Base** (E&G)	New Enrollment Growth (E&G)	Other*** (E&G)	Contracts & Grants (C&G)	
Faculty Salaries and Benefits	103,555	0	0	0	0	\$103,555	334,985	0	0	0	\$334,985
A & P Salaries and Benefits	0	0	0	0	0	\$0	0	0	0	0	\$0
USPS Salaries and Benefits	19,200	0	0	0	0	\$19,200	19,776	0	0	0	\$19,776
Other Personnel Services	0	0	0	0	0	\$0	0	0	0	0	\$0
Assistantships & Fellowships	250,370	0	0	0	69,810	\$320,180	706,278	0	0	1,706,608	\$2,412,886
Library	0	0	0	0	0	\$0	0	0	0	0	\$0
Expenses	17,250	0	0	0	0	\$17,250	17,768	0	0	0	\$17,768
Operating Capital Outlay	0	0	0	0	0	\$0	0	0	0	0	\$0
Special Categories	0	0	0	0	0	\$0	0	0	0	0	\$0
Total Costs	\$390,375	\$0	\$0	\$0	\$69,810	\$460,185	\$1,078,807	\$0	\$0	\$1,706,608	\$2,785,415

*Identify reallocation sources in Table 3.

**Includes recurring E&G funded costs ("reallocated base," "enrollment growth," and "other new recurring") from Years 1-4 that continue into Year 5.

***Identify if non-recurring.

Faculty and Staff Summary

Total Positions (person-years)	Year 1	Year 5
Faculty	0.578	1.967
A & P	0.000	0.000
USPS	0.500	0.500

Calculated Cost per Student FTE

	Year 1	Year 5
Total E&G Funding	\$390,375	\$1,078,807
Annual Student FTE	5.4	38.7
E&G Cost per FTE	\$72,292	\$27,876

**TABLE 3
ANTICIPATED REALLOCATION OF EDUCATION & GENERAL FUNDS**

Program and/or E&G account from which current funds will be reallocated during Year 1	Base before reallocation	Amount to be reallocated	Base after reallocation
058000-110 - Provost Instruction and Research	11,602,554	-295,497	11,307,057
113000-110 - Dean of Graduate School	790,320	295,497	1,085,817
Academic year faculty member salaries & fringe benefits given below - faculty will continue to be paid from their existing department			
074000-110 - Biological Science	6,214,495	-4,186	6,210,309
075000-110 - Chemistry & Biochemistry	5,117,185	-8,342	5,108,843
084000-110 - Physics	4,687,587	-14,285	4,673,302
137000-110 - Scientific Computing	1,934,985	-7,141	1,927,844
212000-110 - College of Engineering	5,285,258	-60,924	5,224,334
Totals	\$35,632,384	-\$94,878	\$35,537,506

Tables 2 and 3 present information on the projected costs and existing funds, respectively. It is important to note that reallocation of faculty salaries and benefits does not change the budgets for the College of Arts and Sciences or the College of Engineering, or any departments in these colleges, since the faculty members will remain entirely in their home department and be paid by their home department.

Six full fellowships per year will be provided for first-year students through the Graduate School. These fellowships will include in-state tuition waivers for all six fellowships and out-of-state tuition waivers for 3 of the fellowships. Out-of-state tuition waivers for 2 additional first-year students will be available each year. Beginning the summer after their first academic year, the students will be supported on research grants that will pay the stipend and in-state tuition waiver. Out-of-state tuition waivers for up to 50% of the students in MS&E through graduation will be offered.

A half time office staff assistant will be provided for MS&E, as well as funds for supplies for the MS&E office, funds to recruit students, and for travel for four outside speakers per year for the Interdisciplinary Seminar Series, which is described below in Section VIII.C. The Director of MS&E will be provided with a half month of summer salary.

No new faculty members will be hired for the MS&E program. All faculty members associated with MS&E have a tenure home in a specific department, so their costs are reallocations of existing funds within their home department. The expenses associated with the faculty members are for teaching courses, being the major advisor for MS&E students in their research groups, and for committee work in MS&E.

Most of the courses that form the basis of this program already exist and have the capacity to accommodate the MS&E students. The courses are typically open to any FSU student as well as FAMU student. The exercise of sharing the distribution of students by program amply documents this with no real impact on the availability of courses.

By the end of the summer of their first academic year, each incoming student who has received fellowship support will find a research advisor who will support the student on C&G funds from that point through graduation. Students who enter without a fellowship will be supported on faculty members' C&G funds from the time they enter MS&E.

B. If other programs will be impacted by a reallocation of resources for the proposed program, identify the program and provide a justification for reallocating resources.

Specifically address the potential negative impacts that implementation of the proposed program will have on related undergraduate programs (i.e., shift in faculty effort, reallocation of instructional resources, reduced enrollment rates, greater use of adjunct faculty and teaching assistants). Explain what steps will be taken to mitigate any such impacts. Also, discuss the potential positive impacts that the proposed program might have on related undergraduate programs (i.e., increased undergraduate research

opportunities, improved quality of instruction associated with cutting-edge research, improved labs and library resources).

Overall, we expect there will be little negative impact on existing programs by creating MS&E. The curriculum, save for the new Interdisciplinary Seminar Series, is built around existing courses across campus. Several of the core courses that will be used for the MS&E Ph.D. program were developed for the recently created Master of Science in Materials Science program. The new Interdisciplinary Seminar Series will be cross-listed in all the departments with participating MS&E faculty members. It will be team taught by MS&E faculty as part of their teaching assignment.

A strong positive impact from the MS&E Ph.D. program is providing a mechanism for faculty members doing materials research to recruit students who want to earn a Ph.D. in the field of materials science and engineering. Currently there are untenured MS&E faculty members who are building research programs and need graduate students that have a keen, primary interest in MS&E. There are also newly-hired senior faculty members who also need students interested in MS&E. Because there is no materials science Ph.D. program, these faculty members currently can only recruit Ph.D. students through their home departments. Students who want to pursue MS&E are not inclined to enroll in these traditional departments, where many of them earned their BS degree.

In addition the existence of the MS&E program will provide a richer experience for FAMU students who are enrolled in engineering or disciplines related to the MS&E degree by having more students to interact with and by their being able to enroll in the MS&E Interdisciplinary Seminar Series (see Section VIII). The MS&E program will also provide new opportunities for potential collaborations between FSU and FAMU faculty members that may benefit FAMU students.

C. Describe other potential impacts on related programs or departments (e.g., increased need for general education or common prerequisite courses, or increased need for required or elective courses outside of the proposed major).

We expect MS&E will have minimal impact on related programs and departments. MS&E students will attend existing courses. The curriculum is built almost entirely around existing courses, with about 43% of the courses being in Arts and Sciences. We anticipate a steady-state matriculation of about 10 students per academic year. These students will all take the required fundamental core courses (see Section VIII for a list of all courses) together, which will add roughly 10 students per core course per year. There is currently room for the 10 additional MS&E students in all of these core courses. Each of the MS&E students will also take an elective core course plus elective specialization courses chosen from the roughly 30 courses that are offered. Thus there will be just a few MS&E students in the elective courses each year. There is room for the MS&E students in these courses. The MS&E courses that MS&E students will take make up a small fraction of the total number of courses that are taught in each department and college. Students will need to meet all prerequisite requirements for the classes they take.

D. Describe what steps have been taken to obtain information regarding resources (financial and in-kind) available outside the institution (businesses, industrial organizations, governmental entities, etc.). Describe the external resources that appear to be available to support the proposed program.

External support for the Program will come in two forms. First is fellowship support for graduate students. In addition to the availability of the six university fellowships provided through the Graduate School for first-year students, the MS&E faculty members will write proposals for grants to support graduate students to the Department of Education Graduate Assistance in Areas of National Need (GAANN), Florida-Georgia Alliance for Minority Participation (FGAMP) Graduate Fellowships, NASA Graduate Student Researchers Program (GSRP), and NSF Integrative Graduate Education and Research Traineeship (IGERT). We will also work with individual students to apply for fellowships from organizations such as the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM), NSF - Graduate Student Fellowships, the Ford Foundation Diversity Fellowships, Sloan Foundation Graduate Fellowships, and the Bill and Melinda Gates Foundation.

The second type of support is for Research Assistantships paid from faculty member's research grants. MS&E faculty members are very successful in obtaining outside research grants (more than \$31M since 2005, see the table in Section IX.C) to federal and private agencies such as the National Science Foundation, Department of Defense agencies, NASA, National Institutes of Health, Department of Energy, Petroleum Institute. These winning proposals are for top-quality, cutting-edge research as identified by the scientific community in the peer review process used to evaluate proposals.

IV. Projected Benefit of the Program to the University, Local Community, and State

Use information from Table 1, Table 2, and the supporting narrative for “Need and Demand” to prepare a concise statement that describes the projected benefit to the university, local community, and the state if the program is implemented. The projected benefits can be both quantitative and qualitative in nature, but there needs to be a clear distinction made between the two in the narrative.

In this section, we first provide the Benefits of the Program, and then the Benchmarks we will use to gauge its success.

Benefits of the Program

Students, the University, the local community, the State, and the Nation will benefit from the program:

- It will provide a means to recruit students interested in studying MS&E and create a way to educate and train these students in a broad, interdisciplinary manner.

- It will augment the existing M.S. program in materials science allowing students to pursue a Ph.D. in MS&E.
- It will build on the sizable investments in faculty members and research infrastructure FSU has already made in MS&E.
- It will be relatively inexpensive to implement.
- It will help FSU as a whole in gaining ground on the AAU frontier.
- It will better position FSU in the area of materials science and engineering in terms of federal research grants, particularly large-scale, interdisciplinary grants.
- It will address one of the three areas of critical education need for the State: producing more engineers.
- It will significantly contribute to research, economic development and job creation in the Panhandle area.
- It will add to the Nation's technical capability by the additional research it will attract and enable, and the highly trained researchers who will graduate from the program.

Specifically the MS&E program is right on target with promoting Florida's future. Quoting from the Enterprise Florida's Roadmap to Florida's Future¹, "The Florida High Tech Corridor Council is a state best practice model with potential applicability for other regions and state transportation corridors." Florida State University is situated in the "Northwest Region" as one of the 10 Regions that comprise the Enterprise Florida Roadmap Demographics. FSU must step to the plate to provide leadership in this Region to fulfill many of the action items recommended in the Enterprise Florida Roadmap. A strong Ph.D. program in MS&E is an essential component in FSU's role in Florida's future. Priority areas listed in the Roadmap to which MS&E will respond include:

- Advanced Manufacturing – through MS&E faculty members and students being associated with High-Performance Materials Institute and Industrial and Manufacturing Engineering.
- Aviation and Aerospace – through MS&E faculty members and students being part of the Florida Center for Advanced Aeronautics and Propulsion.
- Clean Energy - by MS&E faculty members and students being exposed to seminars given by the Institute for Energy Systems, Economics and Sustainability.
- Multi-disciplinary research – by MS&E faculty members participating in interdisciplinary research efforts as seen in the existing Master of Science in Materials Science program and this new proposed Ph.D. program, and by FSU having initiated cluster hires that span several departments.
- Development of universities as "Best-in Class" – by MS&E faculty helping guide ongoing investments in research for FSU to achieve its goal of being best in class.
- Alignment with industry clusters for economic growth – by MS&E faculty members and students being associated with the High-Performance Materials Institute.
- STEM pipeline – by creating a new Ph.D. program that will graduate MS&E students with backgrounds in science and engineering. MS&E is particularly

important because the development of new materials underlies many advances in technology. It will actively recruit diversity students and women who are FSU and FAMU undergrads and mentor them through graduation.

- Expansion of academic R&D – by MS&E faculty members pursuing major research centers from NSF, DOE, DoD, and NIH in the area of materials science.
- World Class Scholars – by FSU having hired Larbalestier and Hellstrom from the University of Wisconsin-Madison.
- Centers of Excellence – by MS&E faculty members having won competitions creating the Center of Excellence in Advanced Materials within Industrial and Manufacturing Engineering and the High-Performance Materials Institute.
- Federal Facilities – by MS&E faculty members and students associating with the National High Magnetic Field Laboratory and guiding its renewal process.
- Culture of commercialization – by having students exposed to business ideas and concepts, through the Interdisciplinary Seminar Series that all of the MS&E students will take each semester. Students will be able to take Technology Entrepreneurship, and Commercialization as an elective specialization course to broaden their understanding of how to commercialize their ideas. Also, students can participate in existing and planned entrepreneurship programs at FSU such as ChemPreneur program offered by the Department of Chemistry and Biochemistry and the College of Business. With the unique entrepreneurship/commercialization training, this new Ph.D. program should generate significant impact on economic development and create jobs in Florida.
- Regional Innovation Networks – by MS&E faculty members working with the Tallahassee Economic Development Council to bring new businesses to the Florida Panhandle region.
- Retention of talent – one of the biggest problems faced in the Panhandle is the loss of recently trained graduates to other major centers of industry, academics, and technology, most of which are outside Florida, and in some cases, even outside the US. In coordination with the FSU Office of Technology Transfer, the College of Business, programs such as SBIR and STTR, existing University-Industry connections, and emerging entrepreneurial efforts sponsored by the FSU Office of Research, the new Ph.D. program will provide an effective mechanism to encourage our brightest talent to consider growing their businesses and careers locally after graduation.

Benchmarks

Specific targets and benchmarks for MS&E within the first 5 years are the following:

- Enroll 10 new students per year by year 5.
- Improve the quality of the students entering the program as shown by increasing the average GRE score of admitted students over 5 years by 50 points (based on the current 1600 point scale and using the first year enrollees as the baseline)
- Have active participation from all MS&E faculty members as shown by faculty members (1) supporting MS&E students from their research grants, (2)

- participating in MS&E functions such as attending faculty meetings, serving on supervisory committees, and participating in the qualifier exam, (3) teaching and speaking at the Interdisciplinary Seminar Series, (4) teaching core and elective specialization courses, and (5) helping recruit new students.
- MS&E faculty members obtaining multi-investigator center funding from federal agencies for funding in materials science.
 - MS&E faculty members obtaining block grants to support and train graduate students, such as the NSF-IGERT and the Dept. of Education GAANN. An IGERT will be submitted in year 2 of the program.
 - Implement graduate training programs with major Department of Energy labs such as the “shared graduate student training concept” now under discussion between Oak Ridge National Laboratory and Florida State University.
 - Attract students who work with faculty members across campus in rough proportion to faculty member participation in each college by the end of year 4.

FSU Review of the program

In the seventh year after MS&E is implemented and every 7 years thereafter, MS&E will be reviewed as part of the Quality Enhancement Review, as well as by a committee made up of members of the FSU Graduate Policy Committee. Continuation of MS&E will be contingent on recommendations stemming from these reviews and provided to the office of Academic Affairs.

V. Access and Articulation – Bachelor’s Degrees Only

Not applicable.

INSTITUTIONAL READINESS

VI. Related Institutional Mission and Strength

A. Describe how the goals of the proposed program relate to the institutional mission statement as contained in the SUS Strategic Plan and the University Strategic Plan.

The goals of MS&E address the State of Florida’s needs and embody the Mission of Florida State University to “...preserve, expand, and disseminate knowledge in the sciences, technology...”⁸.

Within the SUS Strategic Plan, FSU’s distinctive institutional mission⁹ is as a “...graduate research university that puts research into action for the benefit of our students and society.” It recognizes that the “...notable research faculty provide a range of

8 http://president.fsu.edu/plan/strategicPlan_Nov2009.pdf

9 http://www.flbog.org/about/_doc/strategicplan/StrategicPlan_05-13.pdf

interdisciplinary offers that transcend the traditional disciplines, including ... Materials Science...”. And it notes that FSU “...provides world class opportunities for graduate ... students to: ...work with faculty to forge new relationships among professions, including ... the physical sciences and engineering...”.

Florida has a strong national presence in key economic sectors including aerospace, defense, marine and space, and a growing presence in the medical device industry. These industries are dependent on materials science and engineering. Florida’s current leadership in some of these economic sectors is slipping. Companies in Florida as well as other states are facing unprecedented challenges and are aggressively developing their own capabilities. In addition, Florida is behind many states in some key emerging economic sectors such as nanotechnologies. Florida has recognized the need to foster engineering education and research. Recently, Florida identified engineering as one of the areas where critical education needs exist (education and nursing are the other two areas). To bolster the economy, Florida needs an increasing number of well-trained engineers in emerging fields, including materials science and engineering. The MS&E Ph.D. program will produce the graduates in this emerging field to meet the demand.

In keeping with its mission of excellent graduate education and its role as a comprehensive graduate-research university, FSU inaugurated the Pathway of Excellence Initiative in 2006, which leverages the University's unique strengths with significant new investments in research and graduate education through academic clusters, new facilities and new graduate programs. Recognizing the importance of materials education and research, FSU funded two cluster hiring initiatives in Advanced Materials and in Integrative NanoSciences. Establishing the MS&E Ph.D. program is a major component in this cluster program.

B. Describe how the proposed program specifically relates to existing institutional strengths, such as programs of emphasis, other academic programs, and/or institutes and centers.

MS&E is an essential element to a number of existing and growing institutional strengths in materials research at FSU. Over the past 5 years, FSU and the State of Florida have made significant investments in materials research and education; the MS&E Ph.D. program is an integral component of the success of these initiatives. New and existing programs include:

- Applied Superconductivity Center (ASC). FSU invested ~\$4M to recruit and relocate ASC from the University of Wisconsin-Madison to FSU. This included two tenured faculty members (Larbalestier, a member of the National Academy of Engineering, and Hellstrom) and a number of senior Scholar/Scientist researchers. Both of the faculty members were in the Department of Materials Science and Engineering and in the interdisciplinary Materials Science Program at the University of Wisconsin-Madison and thus bring important experience and insight to develop and run MS&E. They also bring with them a longstanding track record in graduate education in materials science and engineering.

The State of Florida selected Larbalestier and Hellstrom as 21st Century Scholars representing a significant investment in materials research and education at FSU. Only 16 faculty members were selected as 21st Century Scholars.

- Cluster Hiring Initiative in Growth, Processing and Characterization of Advanced Materials. This FSU initiative includes six new faculty lines over several years and represents a \$5.7M FSU commitment to materials research and education. The promise of establishing an MS&E Ph.D. program was an element to recruit world-class faculty to fill these new positions and is needed to recruit graduate students to work with them. The Cluster faculty will play a significant role in MS&E. The Cluster has hired four of the six faculty members:). Englander (ME), T. Siegrist (CBE), M. Warusawithana (Physics), and M. Zhang (IME). All of these new faculty members will benefit from having access to MS&E students.
- Cluster Hiring Initiative in the Integrative NanoScience Institute (INSI), which is building a program in the emerging area of bio-nanoscience. The program is at the interface of materials science, device engineering, synthetic chemistry, and molecular biology, blending “hard” (metals and semiconductors) and “soft” (organic and biological) materials: the science, engineering and art of tailoring and harnessing biomolecular function in nano-fabricated settings. Research is on fundamental nanoscale phenomena and processes that will be required for successful integration of hard and soft materials, and for putting such hybrid materials to practical use. Representing a broad area of bio-related devices and materials, hires to date include J. Guan (Chemical and Biomedical Engineering), Sourav Saha (Chemistry and Biochemistry) H. Mattoussi (Chemistry and Biochemistry). INSI hired S. Lenhert (Biological Science) who will benefit from having access to MS&E students due to the diverse needs of the bio-materials program he is developing.
- Related Clusters. Pathways Clusters that can provide potential synergistic relationships to the MS&E program include Clusters in Neuroscience, Biological Sciences, and Psychology.
- High-Performance Materials Institute. HPMI is a NSF Industry/University Cooperative Research Center, in partnership with the Ohio State University and the University of Wisconsin-Madison. HPMI is recognized nationally and internationally as a leader in developing cost-effective, high-performance composite materials and systems. The HPMI has a close working relationship with researchers and practitioners in local and national industries and laboratories. Currently, HPMI is focused on investigating high-performance and multifunctional nanotube-based nanocomposites. HPMI recently moved into a new Materials Research Building (2009) that was purpose built for their research on advanced composite materials.

- National High Magnetic Field Laboratory (NHMFL). The NHMFL grant is one of the biggest contracts from the NSF Division of Materials Research to a university. 14 of the faculty members involved with MS&E are associated with the NHMFL and have their graduate students work within the NHMFL using its unique magnetic capabilities to synthesize and characterize materials, carrying out theoretical and computational studies on materials, and developing new materials for high-field magnets. After MS&E is implemented, many of the graduate students who work on these projects will be in MS&E where they can get a stronger education in materials science and engineering.
- Chemistry and Biochemistry. Most of the instrumentation area in the new 168,000 sq ft chemistry building is dedicated to materials characterization, including: NMR, X-ray, XRF, mass spec, laser spectroscopy, atomic force microscopy, EPR, optical spectroscopy. The Department of Chemistry and Biochemistry has recently created a specialization area in Materials Chemistry, which offers courses and research work for students related to various aspects of the chemistry of materials. Faculty members in the materials chemistry specialization area will participate in MS&E.
- College of Engineering. All five departments in the College of Engineering are actively involved in materials research. Civil and Environmental Engineering has research in composite materials reinforced with natural fibers; an energy materials group is emerging in Electrical and Computer Engineering; Industrial and Manufacturing Engineering's High Performance Materials Institute (HPMI) is a world leader in carbon nanotube composites; and Mechanical Engineering has more materials-focused faculty and activities than any other department.
- Physics. The Department of Physics has a long history of excellent research in the areas of materials. Five faculty members are associated with MS&E. They actively pursue research projects in magnetic materials, semi-conducting materials, and nanoscience/nanotechnology.
- Scientific Computing. Scientific computing is a new department, having been established in 2008. It has a Ph.D. program with a specialization in Computational Materials Science. Being able to recruit students with a background in materials science and engineering will benefit scientific computing faculty members who do computational studies on materials.
- The Institute of Molecular Biophysics (IMB) is associated with *the Graduate Program in Molecular Biophysics* (MOB). This interdisciplinary research institute brings together biologists, chemists, mathematicians, physicists, and engineers. The structural biology and computational biophysics faculty are a sub group of MOB faculty members who reside in IMB.

- The Interdisciplinary Program in Neuroscience promotes interdisciplinary research into neural processes. It includes faculty members from biological sciences, biomedical sciences, mathematics, and psychology. Neurosciences is included because in discussions with its director, the breadth of neuroscience research includes interesting problems that MS&E students and faculty might be interested in such as biomaterials or bioengineering methods to study implanted electrode arrays.

C. Provide a narrative of the planning process leading up to submission of this proposal.

Include a chronology (table) of activities, listing both university personnel directly involved and external individuals who participated in planning. Provide a timetable of events necessary for the implementation of the proposed program. Planning Process

The idea for an interdisciplinary MS&E Ph.D. program originated in the discussions to create an interdisciplinary program in Materials Science. These discussions were begun in 2006 and culminated in the creation of the interdisciplinary Master of Science in Materials Science program. This was approved in 2008: the first student matriculated in 2008 and the first student graduated in 2010. The plan was to establish the M.S. degree first then follow it with the Ph.D. program. Informal planning for the Ph.D. degree started as soon as the Master of Science degree was created and the materials science faculty members began to meet about the M.S. program. The first formal discussions with the FSU administration about the Ph.D. program occurred in late 2009. The Proposal to Explore was written and approved in spring 2010. The Proposal to Implement has been written over the summer and fall of 2010.

Date	Participants	Planning Activity
Nov. 19, 09	Kirby Kemper, Nancy Marcus, Jennifer Buchanan, Ben Wang, Chuck Zhang, Jim Brooks, and Eric Hellstrom	Discussed strategy and for creating interdisciplinary Ph.D. program in MS&E based on the newly created interdisciplinary Master of Science in Materials Science.
Jan. 7, 10	Larry Abele, Kirby Kemper, Nancy Marcus, Joe Travis, Marty Chen, Chuck Zhang, Jim Brooks, and Eric Hellstrom	Discussed plans to create Ph.D. program with FSU upper administration.
Jan. 20, 10	Faculty from participating departments	Discuss plans to create Ph.D. program based on the M.S. Program in Materials Science
Jan. and Feb. 10	Jim Brooks, Eric Hellstrom, and Chuck Zhang	Drafted Proposal to Explore and got approval from 9 dept. chairs and two deans
Feb. 22, 10	Marty Chen, Bruce Locke, Eric Hellstrom plus FSU Graduate Planning Committee	Presented Proposal to Explore to GPC. It was approved.
Mar. 15, 10	Nancy Marcus and Eric Hellstrom	Discussed broad issues about funding the program and how to make sure the Ph.D. program was truly interdisciplinary
Apr. 23, 10	Faculty from participating departments	Discussed curriculum issues.
July 9, 10	Nancy Marcus and Eric Hellstrom	Discussed specific issues for funding graduate students in year 1 and beyond
July and Aug. 10	Nancy Marcus and several department chairs	Discuss issues that individual departments have with funding graduate students.
June – Sept. 10	Jim Brooks, Eric Hellstrom, Chuck Zhang	Draft the Proposal to Implement
Sept. 13, 10	Nancy Marcus and MS&E faculty	Discuss the interdisciplinary nature of MS&E and funding options
Sept. 21, 10	MS&E faculty	Discuss core curriculum
Oct. 20, 10	Nancy Marcus, Kirby Kemper, Jim Brooks, Eric Hellstrom, Chuck Zhang	Discuss administrative structure of MS&E
Dec. 14, 10	6 FSU faculty members met with 10 UF faculty members	Retreat at UF to discuss this proposal, review research areas, and look for possible areas to collaborate
Dec. 2011 and Jan. 2010	Hellstrom, UCF and FIU MS&E directors	Discussed research strengths and unique programs at UF and FSU, and potential collaborations
Jan. 3, 11	Deans, Dept. Chairs, Jim Brooks, and Eric Hellstrom	Discuss important issues for the proposal to satisfy wide range of academic stakeholders
Jan. 24. 2011	FSU Graduate Planning Committee	Proposal approved by FSU Graduate Planning Committee
Mar. 4, 2011	FSU Board of Trustees	Approved by FSU Board of Trustees

Events Leading to Implementation

Date	Implementation Activity
June 2011	Draft MOU between participating departments, colleges, and the Grad School. This will be based on the MOU for MS Program in Materials Science.
Aug. 2011	Approve MOU by participating departments, colleges, and the Grad School
Aug. 2011	Create administrative codes for the program within FSU. These codes already exist for the MS Program in Materials Science, so the protocol for doing this is known.
Fall 2011	Start MS&E Ph.D. program with students who have earned an MS degree in FSU's Master of Science in Materials Science. Already have students from the MS Program in Materials Science who will be on hold waiting for the Ph.D. program to start.

VII. Program Quality Indicators - Reviews and Accreditation

Identify program reviews, accreditation visits, or internal reviews for any university degree programs related to the proposed program, especially any within the same academic unit.

List all recommendations and summarize the institution's progress in implementing the recommendations.

N/A

VIII. Curriculum

A. Describe the specific expected student learning outcomes associated with the proposed program.

If a bachelor's degree program, include a web link to the Academic Learning Compact or include the document itself as an appendix.

The specific learning outcomes are:

(1) Ability to demonstrate a thorough knowledge of materials science and engineering:
Students graduating with a Ph.D. in materials science and engineering must demonstrate an understanding of a range of topics in materials science and engineering and must also demonstrate the ability to carry out meaningful, independent research.

Assessment Plan: This learning outcome will be assessed by the student performance in the core courses with a written exam, an oral presentation of the research topic with an oral examination (prospectus) of the elective specialization courses and the final oral defense of the dissertation. The evaluation will be based on the following measurements: (1) at least 75% of all students in MS&E will pass the written qualifying exam covering the core courses; (2) at least 80% of the students who pass the qualifying exam will pass their oral

prospectus; and (3) at least 80% of the students who pass their prospectus will pass their dissertation defense.

(2) Ability to Communicate in a Professional Setting: Students graduating with a Ph.D. in MS&E will be able to demonstrate technical communication skills at an appropriate level.

Assessment Plan: This learning outcome will be assessed by the student performance by participation in the ISS (Interdisciplinary Seminar Series), in the dissertation defense, publications, and oral presentations. The evaluation will be based on the following measurements: (1) at least 80% of the students in the program will pass their prospectus exam; (2) at least 80% of the students who pass their prospectus exam will pass their dissertation defense; (3) at least 80% of the students who pass their prospectus exam will complete a paper and submit it to a journal or a technical conference before graduating; and (4) at least 80% of the students will have given an oral presentation of their research in a public forum other than their dissertation defense.

B. Describe the admission standards and graduation requirements for the program.

MS&E will follow FSU's admission standards and adds some additional requirements. These are:

FSU requirements

- An earned bachelor's degree from a regionally accredited U.S. institution, or a comparable degree from an international institution, with a minimum 3.0 (on a 4.0 scale) grade point average (GPA) in all work attempted while registered as an upper-division undergraduate student working towards a bachelor's degree; or
- A graduate degree from a regionally accredited U.S. institution, or a comparable degree from an international institution;
- Test scores from a nationally standardized graduate admission test which is acceptable for the program to which the applicant is applying.
- International students whose first language is not English are required to take the TOEFL exam and to have a minimum score of 80 on the Internet-based examination.
- Three (3) letters of recommendation

MS&E specific requirements

- Undergraduate or graduate degree in a STEM field.
- Have a minimum combined score of 1100 on the verbal and quantitative GRE exam.
- A statement of professional goals
- The student's application materials will be reviewed by an MS&E admissions committee composed of faculty members from participating departments.

Admissions process

Students will apply to the MS&E program through the FSU Graduate School Admissions Portal. Each applicant will be evaluated by the admissions committee, which will be made up of MS&E faculty members with tenure homes covering all the departments across campus. This committee will decide whether to admit each student and will also evaluate each student for one of the first-year fellowships.

Graduation Criteria for the Ph.D. in MS&E

All students must pass all of the required coursework (27 credit hours of graded course work) with a minimum 3.0 GPA. In addition to meeting the university requirement to maintain an overall GPA of 3.0 or above, MS&E students need to achieve a grade of "B" or better in each core course. Students not achieving a "B" must either retake the course or take another core course in a different topic area that will be selected by MS&E in consultation with the instructor of the core course in which the student did not achieve at least a "B."

All MS&E students must take a written qualifying exam. This will be based on the required core courses.

All MS&E student must write, present, and defend a prospectus on their proposed research. As part of the oral prospectus presentation and defense, the research committee will evaluate the student's mastery of the breadth of materials science based on oral questions covering the topics in the student's elective specialization courses.

A dissertation is required, which must be an original work and will serve in part to demonstrate the student's ability to carry out research. On completion, the dissertation will be defended orally in front of the dissertation committee.

Dissertation Advisor and Supervisory Committee

The student will choose a major professor (dissertation advisor) from the MS&E faculty by the end of his/her second semester. The Ph.D. supervisory committee consists of a minimum of five faculty members with Ph.D. directive status. The major professor is the chair of the supervisory committee and must be an MS&E faculty member. The student and the major professor will select the supervisory committee. A maximum of 2 members of the supervisory committee can be from the advisor's department, a maximum of 3 can be from the advisor's college, and the committee must have members from at least 3 different departments. In addition at least 4 of the 5 committee members must be from MS&E. Additional members may be appointed to the committee if deemed desirable by the major professor. The supervisory committee must be selected by the end of the semester in which the student passes the Ph.D. qualifying exam covering the core courses.

FSU faculty members who participate in the MS&E Ph.D. program must be approved for graduate faculty status in MS&E. The university representative on the committee will be a faculty member who does not have graduate faculty status in MS&E.

After passing the qualifying exam, and following existing Graduate School policy, the student will submit a summary of his/her research results and plans for ongoing research in August of each year and will discuss this in a meeting with all of his/her supervisory committee in September of each year. The committee will write a short evaluation of the student's progress. This evaluation procedure is done yearly until the student graduates.

Ph.D. Qualifying Examination

The Ph.D. qualifying exam will be a written examination based on the content of the four core courses completed by the candidate. It will be taken after the first year. Students have two chances to pass the qualifying exam.

Preliminary Examination and Prospectus

After passing the Ph.D. qualifying exam and finishing all the elective specialization courses, the student will prepare a prospectus. This is a written document that includes preliminary research results and a plan and timeline to complete the research. The student will submit the written prospectus to his/her supervisory committee and will also present the prospectus orally. During the oral prospectus presentation, the student will have oral questions from the supervisory committee based on the student's elective specialization courses to gauge the student's understanding of the breadth and depth of materials science. This oral examination and presentation of the prospectus will constitute the preliminary examination.

Ph.D. Dissertation Defense

Upon satisfactorily completing the preliminary examination and prospectus, the student will finish his/her research and then prepare a written document for his/her dissertation and defend the dissertation orally.

- C. Describe the curricular framework for the proposed program, including number of credit hours and composition of required core courses, restricted electives, unrestricted electives, thesis requirements, and dissertation requirements.**

Identify the total numbers of semester credit hours for the degree.

Students entering the program with a B.S. degree (or equivalent) will be required to take a minimum of 54 credits including at least 27 credits of letter-graded courses and at least 24 credits of dissertation research. Students will also take the Interdisciplinary Seminar Series (0 credits) the entire time they are in MS&E. The letter-graded credits are described below.

27 credits (minimum) of letter-graded courses

- 4 core courses (minimum 12 credits).
 - Fundamental Core Courses: - Three required
 - Elective Core Courses: - One required
- 5 elective, specialization courses (minimum 15 credits)

24 credits (minimum) of dissertation research

Fundamental Core Courses – All three courses are required.

Survey of materials. – This topic includes an introduction to advanced materials, biomaterials, nanomaterials, and/or topics in materials chemistry, and is covered in several existing courses in mechanical engineering in chemistry and biochemistry, and in biological science. Incoming MS&E students will have a wide variety of backgrounds. The survey course provides fundamental understanding about materials these students need for the other MS&E courses. This topic area can be taught by faculty members in Chemical Engineering, Chemistry, and Mechanical Engineering.

- *Topics in Materials Chemistry I:* Introduction to materials chemistry, focusing on the structure, properties, and functions of metals and alloys, glasses and ceramics, semiconductors and nanomaterials. This course is intended for graduate students involved in materials research (CHM 5715)

Thermodynamics and kinetics. – This topic concerns the fundamental properties of thermodynamics, and the kinetics of the transformation of materials. Existing courses in chemical and biomedical engineering cover these topics. This topic area can be taught by faculty members in Chemical Engineering, Chemistry, Industrial Engineering, Mechanical Engineering, and Physics.

- *Materials Thermodynamics and Kinetics:* The course offers students the foundation of thermodynamics and kinetics applied to materials research (ECH 5934)
-

Solid state science for materials scientists/engineers. - This topic covers the essential areas of structural, thermal, electronic, and magnetic properties of materials, including superconducting, magnetic, semiconducting, and ferroelectric materials of strong current technological interest. The essential theoretical background for materials properties will be provided in the course. This topic area can be taught by faculty members in Chemical Engineering, Electrical Engineering, and Physics.

- Presently, this course is entitled *Materials and Measurement*. It was created by Physics and is being taught as one of the MS core courses. For the Ph.D. program, the emphasis of the syllabus will be more focused on the underlying physics of materials. Measurements will be treated in a separate course in the Characterization of Materials elective. (PHY 6937)

Elective Core courses - Students select one course from the following list

Survey of synthesis and processing. - This topic address the synthesis of materials in bulk, thin film, amorphous, single crystals; morphologies and their transformation into structures for measurement; applications in technology and commercialization. Existing courses in industrial engineering and chemical engineering cover these topics, and new courses in physics and mechanical engineering will be considered as the program develops. This topic area can be taught by faculty members in Chemical Engineering, Chemistry, Industrial Engineering, Mechanical Engineering, and Physics.

- *Synthesis and Processing of Advanced Materials:* This course provides a basic understanding and up-to-date knowledge on the material structures and design, synthesis methods, and processing technologies of various advanced materials. A broad range of materials from inorganic ceramics and metal oxides to organic soft matters is covered with emphasis on processing/structure/property/function relationship of a number of advanced materials mainly for structural, electrical and electronic, and optical applications. (EIN 5930)

Computational methods for materials. - This topic is central to the theory, modeling, computation, and understanding of materials formation and materials properties. This topic area can be taught by faculty members in Chemical Engineering, Mechanical Engineering, Physics, and Scientific Computing.

- *Molecular Dynamics: Algorithms and Applications:* This course provides a comprehensive introduction to molecular dynamics simulation algorithms and their corresponding applications in molecular science.(ISC 5225)
- *Multiscale Modeling of Materials:* This course covers mathematical and algorithmic basis for atomic scale, mesoscale and continuum scale modeling approaches in material sciences. Emphasis is on the atomic-to-continuum connection, statistical approaches and homogenization problems in continuum modeling of heterogeneous materials. (ISC 5229)

Characterization of materials. - This topic covers materials measurement, including optical, physical, electronic, magnetic, resonant, and scattering methods, and microstructural probes. This topic area can be taught by faculty members in Chemical Engineering, Chemistry, Mechanical Engineering, and Physics.

- *Characterization of Materials I:* Characterization of solid state materials by optical and electron microscopy, X-ray, electron, and neutron diffraction methods, and transport and magnetic measurements. The course covers fundamental principles and practical aspects of measurements used in materials research. (CHM 5716)
- *Characterization of Materials II:* Polymer and small molecule characterization using NMR and other physical and spectroscopic techniques. The class is

comprised of lectures and a practical component performed at an instrument germane to the specific section of the course. (CHM 5717)

Interdisciplinary Seminar Series - taken every semester the student is in MS&E (0 credits)

- This seminar-type course will be offered by MS&E faculty to provide students with an opportunity to obtain information on advances in materials research through presentations from visiting scientists and from MS&E faculty. Students will learn and practice presentation skills in this seminar. In addition to technical topics, this seminar series will also have talks on business related topics to help prepare the students to take leadership roles as they move from the university setting to industry and society. The ISS will serve as a forum for MS&E faculty members who wish to recruit MS&E students, and hence some seminar periods will be set aside to allow multiple faculty members to make short presentations advertising their research programs. This new, interdisciplinary course will be cross-listed by all departments with MS&E faculty members.

This core curriculum is built on existing courses at FSU, which are available to FAMU students. Topic areas and course content will be regularly reviewed. Changes in the selection of courses that meet the core-course requirements will be made when necessary to insure the MS&E program is responsive to the changing needs of the students, the particular talents and interests of the faculty members, and changes in the field.

D. Provide a sequenced course of study for all majors, concentrations, or areas of emphasis within the proposed program.

Suggested course sequence a student entering MS&E will take. The sequence also shows when other actions, such as selecting an advisor and taking required exams need to be done.

Semester - 1	Semester – 2
2 Required Core courses 1 Elective Specialization course ISS graduate seminar	1 Required Core course 1 Elective Core course 1 Elective Specialization course ISS graduate seminar <i>Choose research advisor by end of semester</i>
Semester - 3	Semester – 4
2 Elective Specialization courses ISS graduate seminar Research <i>Take Ph.D. preliminary exam during semester</i>	1 Elective Specialization course Research ISS graduate seminar
Semester – 5	Semester – 6
ISS graduate seminar Research <i>Prepare and defend prospectus</i>	ISS graduate seminar Research
Semester – 7	Semester – 8
ISS graduate seminar Research	ISS graduate seminar Research
Semester – 9	Semester – 10
ISS graduate seminar Research	ISS graduate seminar Research <i>Defend Ph.D. dissertation</i>

E. Provide a one- or two-sentence description of each required or elective course.

The required and elective core courses plus the Interdisciplinary Seminar Series were described above in Section VIII.C. The elective specialization courses are briefly described below. Elective courses may be added or removed by the Curriculum Committee.

- *Technology Entrepreneurship and Commercialization.* This course provides students with a hands-on educational experience proposing and analyzing technology-based ideas for development as a product and introducing the product into the market. (Currently offered as a directed independent study (DIS) course through each student’s home department.)
- *Composite Materials Engineering.* This course offers students fundamental knowledge of constitutional materials, interface, fabrication and basic mechanical behaviors of composite materials. (EMA 5182)

- *Advanced Composite Engineering Topics*. A survey course on advanced composite topics, including fabrication process modeling and simulation, high temperature resins and composites, fiber preform and liquid composite molding (LCM), electrical and EMI shielding properties of composite materials. (EIN 5930)
- *Introduction to Micro- and Nanoscale Science and Engineering*. Introduction to nanoscale materials processing and properties, quantum mechanics of nanoscale materials, statistical mechanics and thermodynamics of finite systems, self-assembly and morphological growth in nanoscale systems, pattern formation at the nanoscale, and nanoscale mechanics. (EML 5930).
- *Experimental Methods in Nanoscale Science and Engineering*. Introduction experimental methods used to fabricate nanoscale materials. Course includes lab section fabricating nanoscale systems. (EML 5930).
- *Introduction to Advanced Materials*: The course provides the fundamentals of the science and practical uses of materials. (EML 5930)
- *Topics in Materials Chemistry II*: Introduction to materials chemistry, focusing on the structure, properties, and functions of polymers, organic and soft materials, and bio-inspired materials. This course is intended for graduate students involved in materials research. (CHM 5718)
- *Survey of Physical Chemistry*. An intense survey of physical chemistry covering the areas of thermodynamics, statistical mechanics, quantum mechanics, and chemical kinetics. The course emphasizes the application of mathematical methods in treating physical quantities. (CHM 5530).
- *Physical Methods*. This course offers description and applications of physical methods of molecular characterization. (CHM 5681).
- *Physical and Chemical Kinetics*. Comprehensive reaction kinetics and dynamics, phenomenological rate laws, mechanisms, diffusion-control and activation-controlled reactions and experimental and numerical techniques for kinetic studies. (CHM 5440).
- *Polymer Science and Engineering*. The course offers graduates fundamental concepts and structure-property relationships of polymeric materials. (ECH 5828)
- *Biomaterials and Biopolymers*. The course offers graduates an introduction to naturally occurring and synthetic biomaterials and biopolymers. Their structure, synthetic paths, properties and uses will be covered. (BME 5105)
- *Colloidal Engineering*. This course offers graduates thorough understanding of the primary forces acting between particles, colloidal stability, methods of characterizing particles and suspension mechanics. (ECH 5934)
- *Polymer Processing*. This course offers graduates a basic understanding of the major techniques used for processing thermoplastics, thermosets and polymeric solutions. (ECH 5937)
- *Polymer Characterization I & II*. This course describes synthesis and chemical mechanisms of polymerization reactions (Part I) and the theoretical basis of major methods of characterization of polymers in solution and the solid state (Part II).

Included are spectroscopic methods, molecular mass determination, surface studies and mechanical properties. (CHM 5454).

- *Chemical and Physical Characterization of Biopolymers*. Course covers biopolymer types and conformations; solution properties of biopolymers; macromolecular equilibria; hydrodynamic behavior; determination of size and shape; biopolymer separations; introduction to biological spectroscopy. (BCH 5745).
- *Polymeric Materials Manufacturing and Processing*. Introduction to fundamentals of polymeric materials processing including polymerization and rheology, and manufacturing processes including extrusion, injection molding and liquid composite molding. (EIN 5930)
- *Applied Superconductivity*. This course offers students an introduction to superconductivity, superconducting materials, and the technology challenges related to their processing and application. (EML 5072)
- *Electronic Materials and Devices*. A survey course on advanced conductive and semiconductor materials. (ECE 5930)
- *Materials for Energy Systems*. Introduction to several classes of Materials that are used in systems that produce, store or transfer energy. It concentrates on three main areas in which energy is transformed to useful sources: solar to chemical energy by photocatalysis, nuclear to electric energy by controlled nuclear reactions, and chemical to electrical energy in solid oxide fuel cells. (EML 5930)
- *Condensed Matter Physics I*. Crystal structure phonons, electron in metals, semiconductors, magnetism, ferroelectrics, and liquid crystals. (PHZ 5491)
- *Condensed Matter Physics II*. Elementary excitations in solids, the many-body problem, quantum fluids and superconductivity, magnetism, dielectrics, collective effects in fluids. (PHZ 5492)
- *Techniques in Experimental Physics*. The course is designed for students to become acquainted with modern techniques in experimental physics, learn lab skills, and understand the limiting factors of an experiment and how the results can be improved by using an optimal design. Modern trends in nanoscience and quantum experimental physics will be emphasized in this course. (PHY 5846C)
- *Electrochemistry*. Instrumentation and techniques in electrochemistry, including such topics as electrode processes, potentiometry, voltammetry, and coulometry. (CHM 5153).
- *Electrochemical Engineering*. This course offers graduates basic principles of electrochemical properties of materials and major and specialty applications. (ECH 5937)
- *Multiscale Modeling of Materials*. Prerequisites: basic knowledge of atomic structure of materials, mechanics, and graduate level knowledge in engineering mathematics and/or mathematical physics. This course emphasizes the use of mathematical and computational techniques to solve problems of materials structure and properties. The computational algorithms used in each of these areas will also be emphasized. Concrete examples will be used to explain the basic ideas, and the students will pursue projects in which they apply the concepts discussed in the lectures. (ISC 5935)

- *Applied Computational Science I*. This course provides students with high-performance computational tools necessary to investigate problems arising in science and engineering, with an emphasis on combining them to accomplish more complex tasks. A combination of course work and lab work provides the proper blend of theory and practice with problems culled from the applied sciences. Topics include numerical solutions to ODEs and PDEs, data handling, interpolation and approximation, and visualization. (ISC 5315)
- *Applied Computational Science II*. This course provides students with high-performance computational tools necessary to investigate problems arising in science and engineering, with an emphasis on combining them to accomplish more complex tasks. A combination of course work and lab work provides the proper blend of theory and practice with problems culled from the applied sciences. Topics include mesh generation, stochastic methods, basic parallel algorithms and programming, numerical optimization, and nonlinear solvers. (ISC 5316)
- *Theory of Elasticity*. The course offers upper division undergraduate and entry-level graduate foundation of advanced mechanics of materials. (EGM 5653)
- *Continuum Mechanics*. This course offers student fundamentals of continuum mechanics. (EML 5611)
- *Engineering Data Analysis*. Analysis of experimental and observational data from engineering systems. Focus on empirical model building using observational data for characterization, estimation, inference and prediction. (ESI 5417)
- *Applied Optimization*. The course offers student fundamental of Heuristic Optimization and its applications in engineering design, production and materials research. (ESI 5408)
- *Mechanical Metallurgy*. This course offers students fundamentals of metallurgy. (EMA 5226)
- *Physical and Chemical Kinetics*. Comprehensive reaction kinetics and dynamics, phenomenological rate laws, mechanisms, diffusion-control and activation-controlled reactions and experimental and numerical techniques for kinetic studies. (CHM 5440)

F. For degree programs in the science and technology disciplines, discuss how industry-driven competencies were identified and incorporated into the curriculum and identify if any industry advisory council exists to provide input for curriculum development and student assessment.

The Ph.D. in MS&E is a research-oriented degree. The graduate students will be supported on faculty members' research grants, which are typically funded by a federal agency or industry. The federal grants are won in competitive grant procedure where the MS&E faculty member writes a winning proposal that addresses a significant research question in a cutting edge research area. Industry funds significant, cutting-edge research in areas that are important to the industry. Thus the MS&E students will do research on topics the scientific and technical community believes are important, relevant, and timely.

- G. For all programs, list the specialized accreditation agencies and learned societies that would be concerned with the proposed program. Will the university seek accreditation for the program if it is available? If not, why? Provide a brief timeline for seeking accreditation, if appropriate.**

N/A

- H. For doctoral programs, list the accreditation agencies and learned societies that would be concerned with corresponding bachelor's or master's programs associated with the proposed program. Are the programs accredited? If not, why?**

Materials Science and Engineering is accredited at the undergraduate level by ABET (Accreditation Board for Engineering and Technology). There is no agency or society that accredits the M.S. degree in Materials Science and Engineering.

- I. Briefly describe the anticipated delivery system for the proposed program (e.g., traditional delivery on main campus; traditional delivery at branch campuses or centers; or nontraditional delivery such as distance or distributed learning, self-paced instruction, or external degree programs). If the proposed delivery system will require specialized services or greater than normal financial support, include projected costs in Table 2. Provide a narrative describing the feasibility of delivering the proposed program through collaboration with other universities, both public and private. Cite specific queries made of other institutions with respect to shared courses, distance/distributed learning technologies, and joint-use facilities for research or internships.**

The MS&E courses will be delivered on campus using traditional delivery methods.

IX. Faculty Participation

- A. Use Table 4 to identify existing and anticipated ranked (not visiting or adjunct) faculty who will participate in the proposed program through Year 5. Include (a) faculty code associated with the source of funding for the position; (b) name; (c) highest degree held; (d) academic discipline or specialization; (e) contract status (tenure, tenure-earning, or multi-year annual [MYA]); (f) contract length in months; and (g) percent of annual effort that will be directed toward the proposed program (instruction, advising, supervising internships and practica, and supervising thesis or dissertation hours).**

TABLE 4 (page 1 of 3)
ANTICIPATED FACULTY PARTICIPATION

Faculty Code	Person and department	Rank	Contract Status	Initial Date for Participation in Program	Mos. Contract Year 1	FTE Year 1	% Effort for Prg. Year 1	PY Year 1	Mos. Contract Year 5	FTE Year 5	% Effort for Prg. Year 5	PY Year 5
A	Alamo, Rufina; PhD Chemical and Biomedical Eng.	Professor	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Andrei, Petru; PhD Electrical and Computer Eng.	Assoc. Prof.	Tenure	Fall 2011	9	0.75	4.50%	0.034	9	0.75	11.00%	0.083
A	Brooks, James; PhD Physics	Professor	Tenure	Fall 2011	9	0.75	4.50%	0.034	9	0.75	11.00%	0.083
A	Chiorescu, Irinel; PhD Physics	Asst. Prof.	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Collier, John; PhD Chemical and Biomedical Eng.	Professor	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	El-Azab, Anter; PhD Scientific Computing	Professor	Tenure	Fall 2011	9	0.75	4.50%	0.034	9	0.75	11.00%	0.083
A	Englander, Ongi; PhD Mechanical Engineering	Asst. Prof.	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Hellstrom, Eric; PhD Mechanical Engineering	Professor	Tenure	Fall 2011	9	0.75	9.00%	0.068	9	0.75	15.00%	0.113
A	Larbalestier, David PhD Mechanical Engineering	Professor	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Lattuner, Susan; PhD Chemistry and Biochemistry	Assoc. Prof.	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Lenhart, Steve; PhD Biological Sciences	Asst. Prof.	Tenure	Fall 2011	9	0.75	4.50%	0.034	9	0.75	11.00%	0.083
A	Liang, Richard PhD Industrial and Manufact. Eng.	Professor	Tenure	Fall 2011	9	0.75	4.50%	0.034	9	0.75	11.00%	0.083

TABLE 4 (page 2 of 3)
ANTICIPATED FACULTY PARTICIPATION

Faculty Code	Person and department	Rank	Contract Status	Initial Date for Participation in Program	Mos. Contract Year 1	FTE Year 1	% Effort for Prg. Year 1	PY Year 1	Mos. Contract Year 5	FTE Year 5	% Effort for Prg. Year 5	PY Year 5
A	Liu, Tao (Ted); PhD Industrial and Manufact. Eng.	Asst. Prof.	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Oates, William; PhD Mechanical Engineering	Asst. Prof.	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Rikvold, Per Arne; PhD Physics	Professor	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Shanbhag, Sachin; PhD Scientific Computing	Asst. Prof.	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Shatruck, Mykhailo; PhD Chemistry and Biochemistry	Asst. Prof.	Tenure	Fall 2011	9	0.75	4.50%	0.034	9	0.75	11.00%	0.083
A	Siegrist, Theo; PhD Chemical and Biomed. Eng.	Professor	Tenure	Fall 2011	9	0.75	4.50%	0.034	9	0.75	11.00%	0.083
A	Sobanjo, John; PhD Civil and Environmental Eng.	Assoc. Prof.	Tenure	Fall 2011	9	0.75	4.50%	0.034	9	0.75	11.00%	0.083
A	Strouse, Geoffrey; PhD Chemistry and Biological	Professor	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Vafek, Oskar; PhD Physics	Asst. Prof.	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Wang, Hsu-Pin (Ben); PhD Industrial and Manufact. Eng.	Professor	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Warusawithana, Maitri; PhD Physics	Asst. Prof.	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Zhang, Chun (Chuck); PhD Industrial and Manufact. Eng.	Professor	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Zhang, Mei; PhD Industrial and Manufact. Eng.	Assoc. Prof.	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070
A	Zheng, Jianping (Jim); PhD Electrical and Computer Eng.	Professor	Tenure	Fall 2011	9	0.75	1.91%	0.014	9	0.75	9.28%	0.070

**TABLE 4 (page 3 of 3)
ANTICIPATED FACULTY PARTICIPATION**

Faculty Code		Source of Funding	PY Workload by Budget Classification		
			Year 1		Year 5
A	Existing faculty on a regular line	Current Education & General Revenue	0.578		1.967
B	New faculty to be hired on a vacant line	Current Education & General Revenue	0.000		0.000
C	New faculty to be hired on a new line	New Education & General Revenue	0.000		0.000
D	Existing faculty hired on contracts/grants	Contracts/Grants	0.000		0.000
E	New faculty to be hired on contracts/grants	Contracts/Grants	0.000		0.000
Overall Totals for			Year 1		Year 5
			0.578		1.967

- B. Use Table 2 to display the costs and associated funding resources for existing and anticipated ranked faculty (as identified in Table 4). Costs for visiting and adjunct faculty should be included in the category of Other Personnel Services (OPS). Provide a narrative summarizing projected costs and funding sources.**

In Year 1, the total reallocated E&G funds for faculty salaries and benefits will be \$103,555 with \$94,878 being reallocated within department accounts in Arts and Sciences and within department accounts in the College of Engineering and \$8677 from the Provost Instruction and Research Account. It will increase to \$334,985 in Year 5 due mainly to faculty members having more MS&E students in their research groups. There will be no change in any department budget or the budgets of the College of Arts and Science or College of Engineering's due to these reallocations.

In Year 1 there are also \$286,820 in reallocated E&G funds from the Provost Instruction and Research account for a half time OPS position, first year fellowships, student tuition waivers, and expenses.

No new faculty members will be hired explicitly for MS&E. MS&E faculty members will teach courses with MS&E students, will participate in running the interdisciplinary program, and will pay for and supervise MS&E students' research.

- C. Provide the number of master's theses and/or doctoral dissertations directed, and the number and type of professional publications for each existing faculty member (do not include information for visiting or adjunct faculty).**

The following table summarizes the graduate degree and research productivity for the faculty members who will participate in MS&E. It also contains research information used in Section IX.D.

TABLE IX.C. - M.S. and Ph.D. students, publications, and external research funding (page 1 of 4)

This table shows the number of M.S. and Ph.D. students directed and the publication record of MS&E faculty members (career totals). The information on research activities from 2005 through 2010 is used in Section IX.D. Note: contracts and grants awarded after June 2010 are not included in the table. The footnotes at the end of the table describe how the data in the column “Total \$ From Grants” were determined.

Faculty Member (Dept.)	M.S. Theses	Ph.D. Dissertations	Professional Publications (in referred journals) ¹				Externally-funded research activities – 2005 through 2010 ^{1,2}		
			Referred Journal Arts.	Proceedings	Book Chpts.	Books	No. of research contracts and grants Total (PI, CoPI)	Total \$ from grants	Entities that funded the research
Rufina Alamo (CBE)	8	4	165	155	15		6 (3,3)	\$1,150,000	NSF, Exxon Chemical Co, Engelhard Corp.
Petru Andrei (ECE)	0	2	25	24	4		4 (2,2)	\$371,208	NSF
James Brooks (Phy)	0	6	53	18	2	1	4 (4,0)	\$488,417	NSF
Irinel Chiorescu (Phy)	0	2	24	5	0	0	3 (3,0)	\$526,000	Arrived in 2005: NSF, Univ. of New Orleans, Sloan Foundation
John Collier (CBE)	59	18	64	52	18	0	9 (7,2)	\$1,485,968	NSF, U.S. Army Res. Off, SunGrant, Bush Brothers, EPA, Brown-Forman, USDA, DOE
Anter El-Azab (SC)	3	1	50	30	1	1	16 (16,0)	\$977,038	U.S. Dept. of Energy, Univ. of Florida, Battelle Energy Alliance, LLC, Universal Technology Corporation, U.S. Army Research Office, Oak Ridge Associated Universities, Lawrence Livermore Nat'l Security, LLC, UT-Battelle, LLC
Ongi Englander (ME)			5	6			2 (1,1)	\$39,975	Arrived in 2007: NSF, Proctor & Gamble
Eric Hellstrom (ME)	6	8	120	20	3		4 (1,3)	\$573,119	Moved to FSU in 2007: Fermi National Lab., U. S. Department of Energy, NSF

TABLE IX.C. - M.S. and Ph.D. students, publications, and external research funding (page 2 of 4)

Faculty Member (Dept.)	M.S. Theses	Ph.D. Dissertations	Professional Publications (in referred journals) ¹				Externally-funded research activities – 2005 through 2010 ^{1,2}		
			Referred Journal Arts.	Proceedings	Book Chpts.	Books	No. of research contracts and grants Total (PI, CoPI)	Total \$ from grants	Entities that funded the research
David Larbalestier (ME)	15	33	350	~75	2	0	21 (11,10)	\$4,006,685	Moved to FSU in 2006: NSF, U.S. Department of Energy, Air Force Research Lab., Alameda Applied Sciences Corporation, Fermi National Accelerator Lab., Consiglio Nazionale Delle Ricerche (CNR-, Superpower, Inc., University of Wisconsin, New Energy and Industrial Development, American Superconductor, ITER (Int'l Fusion Energy Org), Univ. of Florida, UT-Battelle, LLC
Susan Lattuner (Chem)	0	5	15	0	0	0	4 (4,0)	\$470,082	NSF, American Chemical Society, Oak Ridge National Lab.
Steve Lenhart (BS)	1	0	20	7	2	0	2 (1,1)	\$1,315,000	Arrived in 2009: Funding was at KIT in Germany before he came to FSU
Richard Liang (IME)	21	9	40	42	3		20 (11,9)	\$3,640,924	Lockheed Martin, Northrop Grumman Corporation, Transformational Technologies, Inc., National Composite Center, Spirit Aerosystems, Inc., General Dynamics Corporation, Universal Technology Corporation, U.S. Department of the Army, Air Force Office of Scientific Research, ATK Launch Systems, Inc., HX5, LLC, U.S. Army Research Lab., Georgia Aerospace Systems
Tao Liu (IME)			21	9			3 (3,0)	\$316,016	Arrived in 2007: NEI Corporation (NASA), Universal Technology Corporation (Air Force Research Lab), Georgia Institute of Technology (DARPA)
Billy Oates (ME)	1	1	11	10	8		6 (3,3)	\$625,000	Arrived in 2006: Space and Naval Warfare Systems Center, Proctor & Gamble, U.S. Army Research Office, Spectral Energies, LLC

TABLE IX.C. - M.S. and Ph.D. students, publications, and external research funding (page 3 of 4)

Faculty Member (Dept.)	M.S. Theses	Ph.D. Dissertations	Professional Publications (in referred journals) ¹				Externally-funded research activities – 2005 through 2010 ^{1,2}		
			Referred Journal Arts.	Proceedings	Book Chpts.	Books	No. of research contracts and grants Total (PI, CoPI)	Total \$ from grants	Entities that funded the research
Per Arne Rikvold (Phy)	0	3	37	13	2	0	5 (3,2)	\$517,000	NSF, IESES
Sachin Shanbhag (SC)	0	0	29	1			4 (2,2)	\$218,000	Arrived in 2006: NSF, Dept. of Energy, Petroleum Research Fund
Mike Shatruck (Chem)	0	0	26	26	1	0	2 (2,0)	\$304,667	Arrived in 2007: NSF
Theo Siegrist (CBE)	0	0	197	26	1				Arrived in 2009
John Sobanjo (CEE)	6	1	7	3	0	0	4 (4,0)	\$705,000	Federal Highway Administration, Florida Dept. of Transportation
Geoff Strouse (Chem)	4	17	126	20	1	0	8 (6,2)	\$1,076,259	Northern Nanotech, National Institute of Biomedical Imaging, Univ. of California Santa Barbara, National Center for Research Resources, National Institute of General, NSF, ONR
Oskar Vafek (Phy)	0	0	23	0	0	0	1 (1,0)	\$84,000	Arrived in 2006; NSF
Ben Wang (IME)	40	18	186	151	15	8	39 (18,21)	\$7,268,454	Lockheed Martin, Georgia Aerospace Systems, Ohio State University Research, NSF, Florida Board of Governors, U.S. Army Research Lab, Simula, Inc., Boeing Company, 2Phase Technologies, Spirit Aerosystems, Inc., Siemens Westinghouse Power Corporation, TA Instruments, Air Force Office of Scientific Research, Office of Naval Research, Air Force Research Lab, ATK Launch Systems Inc., General Dynamics Corporation, Sikorsky Aircraft Corporation, Transformational Technologies Inc., Northrop Grumman Corporation
Maitri Warusawithana (Phy)			17	3	0	0			Arrived in 2009

TABLE IX.C. - M.S. and Ph.D. students, publications, and external research funding (page 4 of 4)

Faculty Member (Dept.)	M.S. Theses	Ph.D. Dissertations	Professional Publications (in referred journals) ¹				Externally-funded research activities – 2005 through 2010 ^{1,2}		
			Referred Journal Arts.	Proceedings	Book Chpts.	Books	No. of research contracts and grants Total (PI, CoPI)	Total \$ from grants	Entities that funded the research
Chuck Zhang (IME)	13	9	111	149	8		23 (12, 11)	\$3,827,159	NSF, Universal Technology Corporation, Federal Highway Administration, Univ. of Florida, Transformational Technologies, Inc., Lockheed Martin, Ohio State University Research, ATK Launch Systems, Inc., General Dynamics Corporation, Office of Naval Research, Sikorsky Aircraft Corporation, Georgia Aerospace Systems, U.S. Army Research Laboratory, Spirit Aerosystems, Inc., National Composite Center, Air Force Office of Scientific Research
Mei Zhang (IME)	0	0	24	11	1	0	2 (1,1)	\$99,000	Arrived in 2007: NSF, Air Force Research Lab
Jim Zheng (ECE)	10	6	92	100	1	0	9 (8,1)	\$989,513	NSF, Ionova Technologies, Inc., Savannah River Nuclear Solutions, LLC, General Technical Services, Battelle Energy Alliance, LLC, BAE Systems, Bing Energy, Inc.
Total Research \$								\$31,074,484	

¹ Career total for numbers of M.S. and Ph.D. students and publications.

² The total dollar figures were calculated so as not to double count any dollars. The total amount is conservative as some people show smaller amounts than would ordinarily be accredited to them.

The algorithm that was used to calculate the funding is as follows.

- a. Each contract and grant that spanned years before or after 2005 – 2010 was prorated to count only the fraction of money for 2005 – 2010.
- b. The amount of money in each contract and grant in 2005-2010 was divided by the number of co-PIs on the grant. For multi-investigator awards, each co-PI was credited with an equal amount of money. If one of the PIs on the award was not an MS&E faculty member, the \$ for that PI were not counted in the table. This leads to a conservative calculation of the total research money brought in for research on materials.
- c. This table was started during summer 2010, so only contracts awarded by June 30, 2010 have been counted. Funds awarded in the second half of 2010 were not counted. This also leads to a conservative calculation of the total research money for materials.

³ Some of the MS&E faculty members receive funding from the \$26M per year from NSF that funds the NHMFL. None of this funding is counted in the table. This also leads to a conservative calculation of the total research money brought in for research on materials.

- D. Provide evidence that the academic unit(s) associated with this new degree have been productive in teaching, research, and service. Such evidence may include trends over time for average course load, FTE productivity, student HC in major or service courses, degrees granted, external funding attracted, as well as qualitative indicators of excellence.**

MS&E is a Ph.D. program with a strong emphasis on research. It is composed of faculty members with tenure homes in 9 different departments. Each of the nine departments in which MS&E faculty members have their tenure homes has been productive in teaching, research, and service. However, since this Ph.D. program is administered by the Graduate School, instead of giving statistics for each of these departments, we have taken the pertinent portion of this question to be about the external research funding awarded. This is the strongest indicator of the ability of the faculty members to support the MS&E Ph.D. program. The table for Section IX.C includes additional information listing a summary of the contracts and grants the MS&E faculty members have won over the past 5 years (2005-2010). As described in the footnotes for this table, the total amount listed on the table is conservative and does not double-count any of the funds.

Conservatively, the total research funding brought in by the MS&E faculty members over the past 5 years is more than \$31M. This shows that the faculty members have productive research programs. Creating MS&E will increase the research productivity since some of the faculty members on this list are relatively new hires at FSU, including 6 NSF CAREER awardees (Chiorescu, Lattuner, Oates Shanbhag, Shatruck, and Vafek) and a DARPA Young Faculty Award recipient (Oates), who all do materials science research. They are just starting their research programs and having MS&E will help them strengthen their research portfolios and output by being able to recruit students whose primary interest is studying materials science and engineering. Englander, Lenhert, and Warusawithana have submitted full proposals in fall, 2010 for Career Award to the Department of Energy.

X. Non-Faculty Resources

- A. Describe library resources currently available to implement and/or sustain the proposed program through Year 5. Provide the total number of volumes and serials available in this discipline and related fields. List major journals that are available to the university's students. Include a signed statement from the Library Director that this subsection and subsection B have been reviewed and approved for all doctoral level proposals.**

Students enrolled in the Ph.D. MS&E program will have access to all library resources owned or licensed by FSU. Resources related to MS&E are in the following areas: materials, materials science and engineering, physics, chemistry, mechanical engineering, industrial engineering, chemical engineering, nanoscience and nanotechnology engineering as well as bio-materials and computational science. These resources include

4,010 print books, 422 print journal titles, journal back files in print and micro forms, 4,785 eBooks, and 3,726 e-journals. Thirteen electronic databases give students access to over 6,000,000 summaries of journal articles, technical reports, and conference papers and proceedings dating from 1970 to this present time as well as more than 10,000 web site abstracts, and 80 full-text searchable handbooks, patents and standards. Excellent science databases, including Web of Science, Engineering Information Village, IEEE Explore, ACM Digital Library and SciFinder Scholar are available by remote access on the students' computers, or can be accessed at the libraries. Students and faculty members are included in the FSU IP Address Ranges for all electronic resources, and with their FSU computer account or FSU ID cards, they can access these resources through EZProxy or the Proxy Service. In addition, interlibrary loan is available through the FSU Libraries' website via the ILLiad interlibrary loan management system. For research support, students and faculty have access to chat virtual reference systems and face-to-face assistance from professional librarians and support staff located at the College of Engineering or on the main campus.

Engineering books, electronic resources, databases and journal holdings may be accessed on the FSU Libraries' website at <http://www.lib.fsu.edu/>. This website address gives access to resources and services available to all graduate students in the program.

FSU University Libraries, as a member of the Association of Research Libraries (ARL), is among the top academic research libraries in the nation. The libraries' holding report to ARL in 2007-2008 lists 2,844,624 volumes, 62,093 current periodicals and serials subscriptions, 300,000+ e-books, 450+ databases, and 9,109,694 in microforms. The electronic journals are available instantly via password-protected EZ-Proxy service. Article-specific linking capabilities, along with the cooperative borrowing arrangement, bring the world's literature to students or faculty members at their desktop or notebook computers.

In 2010, addition and expansion of statewide electronic journal packages are planned and the University Libraries at FSU will be a beneficiary of receiving access to additional science journal content. The new electronic packages cover all disciplines. Statewide electronic journal packages include Wiley-Blackwell, Nature, Sage and Taylor & Francis, Elsevier, Springer, Cambridge, Oxford, Univ. of Chicago, and bePress. In summary, the library volumes and serials resources are sufficient to meet the requirements of course instruction and research for the proposed program.

B. Describe additional library resources that are needed to implement and/or sustain the program through Year 5.

Include projected costs of additional library resources in Table 3.

No additional library resources are needed to implement and sustain MS&E through Y-5.

Library Director

Date

C. Describe classroom, teaching laboratory, research laboratory, office, and other types of space that are necessary and currently available to implement the proposed program through Year 5.

The MS&E program uses existing courses that are currently taught in classrooms equipped with computers, LCD projectors, and overhead projectors. The courses will be taught in the buildings where they are normally taught, which may be on the College of Engineering campus or on the FSU main campus in the biology, chemistry, physics, and scientific computing buildings. Students can ride the FSU shuttle bus to commute between COE and the main campus.

The courses with associated labs sections already have the laboratory space and equipment they need. MS&E students will have access to these laboratories when they register for the courses.

Research laboratories belonging to the individual MS&E faculty members will be available for their students' research. In addition, through the Pathways program, FSU Centers and Laboratories (see Section VI.B for a list of Centers), and the Office of the Vice-President for Research, an inter-college initiative is underway to provide a network of shared facilities for student and faculty research.

Students in MS&E will be provided with office space by their advisor's home department.

D. Describe additional classroom, teaching laboratory, research laboratory, office, and other space needed to implement and/or maintain the proposed program through Year 5.

Include any projected Instruction and Research (I&R) costs of additional space in Table 2. Do not include costs for new construction because that information should be provided in response to X (J) below.

Due to the relatively small size of MS&E student body and the availability of classrooms and laboratories in participating departments, MS&E does not require additional space to implement and maintain MS&E through Year 5.

E. Describe specialized equipment that is currently available to implement the proposed program through Year 5. Focus primarily on instructional and research requirements.

Since the curriculum is based on already existing courses, any specialized equipment needed for course instruction is already in place and no additional, new equipment is needed for instructional purposes.

In addition, no new equipment for research is needed. Over the past few years, FSU has invested heavily in equipment for research on materials. As an example we describe FSU's support of electron microscopes, which are central to research in materials science and engineering. FSU has purchased a state-of-the-art scanning electron microscope with a focused ion beam that allows one to cut into a sample where one wants to study the microstructure below the surface of the sample. FSU's latest investment is a new scanning transmission electron microscope (TEM) that can resolve individual columns of atoms. This microscope, a JEOL ARM200F, which has the highest resolution in its class, is the first of its kind in Florida and is only the second such TEM in the US.

There is an enormous amount of equipment at FSU available for MS&E students to use for their research. Since it is a very long list, we have included only a partial list of some of the larger pieces of equipment in Appendix B, which is in research centers (see Section VI.B) and also distributed over many individual faculty members' research laboratories. It will be available to MS&E students on an as-needed basis.

Further, through the Pathways program, FSU Centers and Laboratories, and the Office of the Vice-President for Research, an inter-college initiative is underway to provide a network of shared facilities for student and faculty research.

F. Describe additional specialized equipment that will be needed to implement and/or sustain the proposed program through Year 5. Include projected costs of additional equipment in Table 2.

Because faculty members in MS&E have their own research equipment and because of FSU's extensive investment in shared equipment for materials research, no additional specialized equipment is needed to implement and sustain MS&E through Year 5.

G. Describe any additional special categories of resources needed to implement the program through Year 5 (access to proprietary research facilities, specialized services, extended travel, etc.). Include projected costs of special resources in Table 2.

No special categories of resources are needed to implement MS&E through Year 5.

H. Describe fellowships, scholarships, and graduate assistantships to be allocated to the proposed program through Year 5. Include the projected costs in Table 2.

The Graduate School will provide 6 full fellowships (\$20,000 each for the academic year) plus in-state tuition waivers and up to three out-of-state tuition waivers for first year students.

It is expected that, as an ongoing policy of MS&E, the MS&E faculty members will actively seek “training grant” funds to support the new students. These include proposals to the Department of Education Graduate Assistance in Areas of National Need (GAANN), NASA Graduate Student Researchers Program (GSRP), and NSF Integrative Graduate Education and Research Traineeship (IGERT).

I. Describe currently available sites for internship and practicum experiences, if appropriate to the program. Describe plans to seek additional sites in Years 1 through 5.

N/A

J. If a new capital expenditure for instructional or research space is required, indicate where this item appears on the university's fixed capital outlay priority list. Table 2 includes only Instruction and Research (I&R) costs. If non-I&R costs, such as indirect costs affecting libraries and student services, are expected to increase as a result of the program, describe and estimate those expenses in narrative form below. It is expected that high enrollment programs in particular would necessitate increased costs in non-I&R activities.

N/A

Appendix A –Abbreviations used in the body of the proposal

Initials	Full Name		
MS&E	MS&E refers to the proposed program in materials science and engineering. Its use includes faculty members, departments, colleges, facilities, funding, and students associated with the new program.		
Initials	Full Name	Initials	Full Name
AAU	Association of American Universities	IGERT	NSF - Integrative Graduate Education and Research Traineeship
ASC	Applied Superconductivity Center	IMB	Institute of Molecular Biophysics
BOG	(Florida) Board of Governors	IME	Industrial and Manufacturing Engineering
BS	Biological Science (in CAS)	INSI	Integrative NanoScience Institute
CAPS	Center for Advanced Power Sources	ME	Mechanical Engineering
CAS	College of Arts and Sciences at FSU	MIRT	NSF – Materials Interdisciplinary Research Teams
CBE	Chemical and Biomedical Engineering	MRSEC	NSF – Materials Research Science and Engineering Center
CEE	Civil and Environmental Engineering	NEMS	Nano-Electromechanical Systems
CEMRI	NSF - Centers of Excellence for Materials Research and Innovation	NHMFL	National High Magnetic Field Laboratory
Chem	Chemistry and Biochemistry (in CAS)	NIH	National Institutes of Health
COE	College of Engineering at FSU	NSEC	NSF – Nanoscale Science and Engineering Centers
DoD	Department of Defense	NSF	National Science Foundation
ECE	Electrical and Computing Engineering	Phys	Physics (in CAS)
FCAAP	Florida Center for Advanced Aeronautics and Propulsion	SBIR	Small Business Innovation Research
FGAMP	Florida-Georgia Alliance for Minority Participation	SC	Scientific Computing (in CAS)
FIU	Florida International University	STEM	Science, Technology, Engineering and Mathematics
FSU	Florida State University	STTR	Small Business Technology Transfer
GAANN	Department of Education - Graduate Assistance in Areas of National Need	SUS	(Florida) State University System
GSRP	NASA - Graduate Student Researchers Program	UCF	University of Central Florida
HPMI	High-Performance Materials Institute	UF	University of Florida

Appendix B - Partial list of equipment available for materials science research

Microscopes SEM and TEM

- Zeiss 1540EsB Field emission scanning electron microscope
- ElectroScan E3
- FEI CM300 FEG (TEM)
- FEI Nova 400
- JEOL-2011
- JEM-ARM200F

Optical Microscopy

- Zeiss LSM 510 laser scanning confocal microscope
- Titan Krios (cryo TEM); currently being installed
- Nikon Eclipse Ti inverted fluorescence microscope
- Leica DMLP polarizing microscope with fluorescence source, digital imaging and thermal stage
- Olympus Scanning laser confocal microscope
- Magneto optical imaging microscope facility
- Standard polarized and dark field light microscopes
- Low Temperature laser Scanning Microscope (LTLSM)

Magnet Systems

- Quantum design 16 T PPMS
- Quantum design 9 T PPMS
- Quantum design 5.5 T SQUID magnetometer MPMS
- Oxford 14 T dedicated VSM
- Oxford 14/16T general purpose 2 inch magnet with VTI set up for nV transport
- Oxford 15/17T general purpose 2 inch magnet set up for high current testing with 2000 A battery supply
- 1 T transverse access electromagnet
- SQUID (AC/DC) (Quantum Design MPMS 7T)

- Magneto-circular dichroism (7/8 T; RT to 2.1K)
- Quantum Design 5T MPMS SQUID magnetometer
- Lakeshore Cryotronics 7300 series vibrating sample magnetometer (VSM) with high and low temperature attachments

NMR, EPR

- 500 MHz solid state NMR
- 500 MHz wide bore imaging NMR spectrometer
- 500 MHz solid state NMR spectrometer
- Fully outfitted condensed matter NMR instrumentation to 17 T and 0.3 K
- EPR (Bruker); X-band, Q-band

X-ray Diffraction

- Powder diffractometer (Rigaku dMax Ultima 3, Mercury COD)
- Single crystal diffractometer (Bruker AXS Apex II)
- Siemens D500 powder diffractometer
- Siemens D500 powder diffract. w/ high/low/near ambient heads
- Powder X-ray w/ 10 K stage
- Rotating anode X-ray
- Single Xtal X-ray

Thermal Analysis

- DTA/TGA (Differential thermal analysis/Thermal gravimetric analysis) with mass spectrometry
- Perkin Elmer Diamond differential scanning calorimetry (DSC)
- Thermomechanical Analyzer (TA Instruments TMA 2940)

DNA Analysis

- FSU-NimbleGen microarray facility
- Applied Biosystems 3130xl genetic analyzer (DNA sequencer)
- 7500 ABI real-time OCR (gene expression analysis)

Spectrometers

- X-ray fluorescence (Oxford ED 2000)
- PHI 5100 X-ray photoelectron spectroscopy (XPS)
- Mossbauer spectrometer with magnet and cryostat
- Biorad IR spectrometer
- Infrared absorption FT-IR (Perkin Elmer Spectrum)
- Raman (Horiba JY LabRam HR800), microscope
- Absorption (Perkin Elmer Lambda 950)
- Photoluminescence/Lifetime TCSPC (JY Fluoromax 4)
- FTIR spectrometer
- Dynamic light scattering
- IXRF energy dispersive X-ray spectroscopy (EDS)
- Gaertner single wavelength (HeNe) ellipsometer (non-scanning)

Scanning Probe Microscopes

- AFM (Asylum MFP-3D)
- Environmental AFM
- Digital Instruments Dimension 3000 scanning probe microscope (SPM)
- Omicron UHV scanning probe microscope (SPM), LEED and Auger electron spectroscopy (AES)

Lithography

- Tencor Alpha-step 200 scanning profilometer
- Photolithography (including spinner, hot-plate/oven, mask aligner)
- Electron-beam lithography (JEOL 840 SEM with Raith Elphy Quantum)
- Reactive ion etcher (Southbay Technology 2000)
- Westbond ultrasonic wire bonder
- Thermal evaporators (Edwards and home-built)
- AJA UHV Sputtering system (five 2" magnetron sources, 2 DC and 2 RF power supplies, two gases)

Facilities for computation and modeling

Shared-High Performance Computing (HPC) facility: The HPC has 12 login nodes, 526 compute nodes (2688 cores), 156 TB usable storage, and Infiniband and IP communication fabrics. The system is divided into general access and owner-based components. General access consists of 812 cores and the owner-based part consists of 1876 cores. Physics owns 152 cores (11.3 TB) and the PI's group has full access.

Scientific Visualization: The general access laboratory for scientific visualization hosts five high-end visualization workstations each equipped with NVIDIA GPU video cards that are compatible with the CUDA SDK. One workstation has software and emitters for 3D visualization. All workstations have access to over 15 TB of storage. It has a high-resolution stereographic projection system to support multidisciplinary scientific visualization.

Appendix C – Support letters



February 21, 2011

Dean Nancy Marcus
Graduate School
Westcott Hall
Florida State University
Tallahassee, FL 32306

Dear Dean Marcus:

At the recommendation of the Materials Science and Engineering group and the Chair of the Department of Mechanical and Materials Engineering, I am pleased to support your PhD program in Material Science and Engineering.

Researchers at Florida International University and Florida State University have discussed the Florida State University proposal for a PhD in Materials Science. From these discussions, they determined there is little overlap between the materials science research areas here at FIU and at FSU. A topic they discussed was equipment and infrastructure and the possibilities for cooperative use of the specialized equipment at the two universities. For instance FIU has an electron microprobe analyzer that is useful for materials science research, which they do not have at FSU. Likewise FSU has just purchased a new state-of-the-art transmission electron microscope for materials science research that can be used by FIU researchers.

We do not anticipate that a new PhD program in Materials Science and Engineering at FSU will negatively impact the MS&E program at FIU. Materials Science and Engineering is an important area for Florida and the nation, and the new PhD program will help satisfy the need for more people in this area.

For the above reasons, I endorse your PhD program in Materials Science and Engineering.

Sincerely,

A handwritten signature in black ink, appearing to read "Amir Mirmiran", is written over a light blue horizontal line.

Amir Mirmiran, PhD, PE, FASCE, FACI
Professor and Dean
College of Engineering and Computing

CC: Douglas Wartzok, Provost and Executive Vice President

OFFICE OF THE DEAN
COLLEGE OF ENGINEERING AND COMPUTING

10555 W. Hügler Street, EC 2130 Miami, FL 33171 • Tel: 305-548-2522 • Fax: 305-548-1401 • www.eng.fiu.edu

Head, Office of Dean, College of Engineering and Computing: 305-548-2522



Mechanical, Materials and Aerospace Engineering

March 1, 2011

Dean Nancy Marcus
Graduate School
Florida State University
Westcott Hall
Tallahassee, FL 32306

Dear Dean Marcus,

This letter is to support the PhD program in Materials Science and Engineering (MS&E) that is being proposed by Florida State University. There have been discussions between UCF faculty in MSE and FSU about the proposal and the research thrusts in each of the programs. While there is necessarily overlap in the course offerings of both programs, the research areas at FSU including fundamental magnetism, applied superconductivity, superconducting devices, and chemical vapor deposition methods for nanostructured materials are real strengths at FSU that would be enhanced by a doctoral program in MS&E.

The discussions also included ways in which UCF and FSU can collaborate in the future. One thing that was discussed was the possibility of setting up an annual meeting of the directors of Florida's Materials Science and Engineering programs to learn what the different programs are doing and look for areas to collaborate.

We expect that this new PhD program in MS&E will not negatively impact our successful graduate student recruitment. We also think that FSU will be successful in recruiting graduate students in the areas of their unique research thrusts.

Sincerely,

A handwritten signature in black ink, appearing to read "Suhada Jayasuriya".

Suhada Jayasuriya, Ph.D., P.E.
Distinguished Professor and Chair
Department of Mechanical, Materials and Aerospace Engineering
University of Central Florida
Orlando, FL 32816-2450
Phone: (407)-823-5792
Email: suhada.jayasuriya@ucf.edu

College of Engineering and Computer Science
P.O. Box 162450 • Orlando, FL 32816-2450 • 407-823-2416 • Fax: 407-823-0208

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Office of the Provost
and Senior Vice President

235 Tigert Hall
PO Box 113175
Gainesville FL 32611-3175
352-392-2404 Tel
352-392-8735 Fax

March 16, 2011

Dr. Robert Bradley, Interim Provost
Florida State University
212 Westcott Bldg
Tallahassee, FL 32306-1310

Dear Bob:

I apologize for this last-minute letter and its perfunctory nature, but this matter came to my attention only yesterday. (It would be helpful to have a uniform understanding in the SUS that these matters need to run through Provost offices for official response.)

Based on my understanding of discussions that have taken place between the relevant chairs and deans of engineering, UF has no objection to FSU's proposal to establish a Doctor of Philosophy degree in Materials Science and Engineering.

Regards,

A handwritten signature in black ink, appearing to read "Joe", written over a horizontal line.

Joseph Glover
Provost

xc: Cammy Abernathy
Dottie Minear
Richard Stevens

The Foundation for The Gator Nation
A Legal Opportunity Institute



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Florida Agricultural and Mechanical University

TALLAHASSEE, FLORIDA 32307-2200

TELEPHONE: (850) 599-2276
FAX: (850) 561-2551

OFFICE OF THE PROVOST AND
VICE PRESIDENT FOR ACADEMIC AFFAIRS

March 1, 2011

Dr. Robert Bradley
Interim Provost
Florida State University
212 Westcott
Tallahassee, FL 32306

Dear Dr. Bradley:

Thank you for sharing with me a copy of Florida State University's (FSU) proposal for a PhD in Materials Science. Former Dean Chen and Dr. Eric Hellstrom have discussed the proposal with me.

Florida A&M University (FAMU) is supportive of this proposal to establish an interdisciplinary PhD program administered by the Graduate School at FSU. The proposed degree appears to provide opportunities to students in a field that is important to the State of Florida, and to have the potential for cooperation between our two institutions that would be mutually beneficial. FAMU faculty in the joint College of Engineering may participate, as appropriate, provided that their responsibilities pertaining to FAMU are not adversely affected. We do not want the initiation of this program by FSU to preclude FAMU from initiating its own MS and PhD degree programs in Materials Science in the future in niche areas that are not duplicative of FSU's research efforts. We would appreciate FSU's expression of support of FAMU, should we seek to implement MS and PhD degrees in Materials Science in the future, and your offer to collaborate on such an endeavor, thus making efficient use of the resources at the two universities.

Sincerely,

Cynthia Hughes Harris, PhD
Provost and Vice President for Academic Affairs

Cc Dr. John Collier, Interim Dean FAMU-FSU College of Engineering
Dr. Eric Hellstrom

FAMU IS AN EQUAL OPPORTUNITY/EQUAL ACCESS UNIVERSITY

Appendix D – External review of the proposal by John Wiley



WISCONSIN INSTITUTES FOR
DISCOVERY

ADVANCING INSTITUTE FOR RESEARCH
WISCONSIN INSTITUTE FOR DISCOVERY

Dr. Eric Hellstrom
2034 East Paul Dirac Drive
Tallahassee FL, 32310

February 5, 2011

Dear Dr. Hellstrom,

Enclosed is my review of the proposal for establishing a PhD program in Materials Science and Engineering at Florida State University. As you will see, I found it to be an excellent proposal in all respects. If you, or the Florida Board of Governors, have any further questions or requests for clarification, please don't hesitate to contact me.

Sincerely,

John D. Wiley, Interim Director
Wisconsin Institute for Discovery
and
Chancellor Emeritus
University of Wisconsin-Madison

Wisconsin Institute for Discovery

University of Wisconsin-Madison

302 Cattrap Hall 1150 University Avenue Madison, WI 53706-1304
Phone: 608.765.4444 Fax: 608.262.4881

**EXTERNAL REVIEW OF A PROPOSAL BY FLORIDA STATE
UNIVERSITY FOR THE ESTABLISHMENT OF A PHD PROGRAM IN
MATERIALS SCIENCE AND ENGINEERING**

John D. Wiley, Chancellor Emeritus
University of Wisconsin – Madison
February 2, 2011

I have reviewed the proposal entitled "Request to offer a new Degree Program: Doctor of Philosophy in Materials Science and Engineering at Florida State University". This review was conducted to judge compliance with the Florida Board of Governors New Degree Criteria.

This is an extremely well-conceived, timely, and well-written proposal that addresses all of the Board of Governors' criteria, and includes both qualitative and quantitative documentation that the proposal does, indeed, meet all those criteria. The inter-departmental, inter-college model being proposed has been successfully implemented at other institutions (including Wisconsin). Indeed, several of the FSU faculty have already helped to build or have participated in Materials Science PhD programs of this sort at other institutions before joining FSU. The proposal to house this program in the FSU Graduate School (as opposed to within one of the participating Colleges) is a wise one that bodes well for successful implementation.

Because of the quality and quantity of excellent materials science research at FSU, approval and implementation of this proposal would almost immediately vault FSU into the very top ranks of Materials Science and Engineering PhD programs nationally. I could argue that they are already there, but the PhDs they are awarding carry the names of the academic departments of the faculty advisors: Physics, Electrical Engineering, Chemistry, etc – not Materials Science and Engineering, even when the research is clearly materials science and engineering.

Please allow me to digress and offer some background context. Doctor of Philosophy degrees are unique among academic credentials: They are research degrees, as opposed to degrees awarded for successfully completing rigid curricula of coursework. After some relatively flexible set of graduate-level courses and some comprehensive evaluations and

examinations, PhD candidates undertake the sole essential work required for the awarding of a PhD: They conduct an original piece of research, under the approval and guidance of a thesis advisor and a thesis committee of experienced faculty, and then publish their findings. In effect, PhD candidates must answer some previously unanswered question or solve some previously unsolved problem, thereby adding significantly to the store of human knowledge, as judged by the faculty committee and the peer reviewers of their publications. In this sense, every PhD that has ever been awarded is unique. They could all be given different names: "PhD in German History from 1881-1895" or "PhD in Elliptic Differential Equations." Instead, we traditionally group similar PhDs under (usually departmental) umbrella names such as PhD in History or PhD in Mathematics. What the FSU faculty are asking is that you approve moving appropriate PhDs from under the departmental umbrellas and label them more accurately and appropriately as PhDs in Materials Science and Engineering. This is more a matter of packaging and marketing than a matter of establishing an entirely new program from scratch.

In contrast, adding a new, strictly curricular degree (a baccalaureate, masters, or professional degree) generally requires significant new investments in new space, new equipment, and a whole new set of faculty. Adding a Dentistry program, or a College of Engineering, or even a department of Anthropology where one did not previously exist requires new investments in the millions or tens of millions of dollars. That's not what is being requested here, and it explains the very modest cost of the proposed new PhD in Materials Science and Engineering.

Another criterion the Board of Governors is rightly concerned about is wasteful duplication: "Are we being asked to devote new state resources to a program that already exists elsewhere?" Again, PhD programs are different, making this question almost irrelevant. FSU already has a strong materials science and engineering faculty. They simply need authority to name the degree appropriately, in a way that is recognized by potential faculty, students, and recruiters. These points are addressed in Section II.B of the proposal.

Having said that, I must also say that the FSU faculty did an exceptionally good job of surveying the other Materials Science degree

programs in Florida (UF, UCF, and FIU) and consulting with their colleagues at those institutions. FSU has unique strengths in areas of materials science not as strongly represented elsewhere, so the fit is more complementary than competitive or redundant. This should not be a controversial or contentious change at all.

I believe this is an excellent proposal that can be easily and comfortably approved by the Board of Governors. To be sure there is no uncertainty, though, I will list the Florida Board of Governors Criteria separately and address each one briefly and individually:

(a) INSTITUTIONAL AND STATE LEVEL ACCOUNTABILITY

1. THE PROGRAM IS CONSISTENT WITH INSTITUTIONAL AND BOG STATE UNIVERSITY SYSTEM STRATEGIC PLAN

Yes. This case is made strongly in sections I and II of the proposal. If anything, I believe the demand projections (for Materials Science and Engineering PhDs in Florida's mix of high-tech industry) are conservative.

2. DEMONSTRATE NEED FOR PROGRAM GRADUATES, RESEARCH, OR SERVICE

Yes. Same answer as in (1), above.

3. FINANCIAL PLANNING AND RESOURCES ARE SUFFICIENT FOR IMPLEMENTATION

Yes. The faculty lines already exist, and normal turnover will provide for replacement and possible augmentation as the relevant fields evolve. The Graduate School has allocated fellowships for this program, as well as modest (but appropriate) funds for administration and oversight. The FSU materials science faculty already have a superb complement of instruments that would be the envy of most any materials science program in the country. No other campus or Florida institutions will be seriously impacted by the reallocations implied here.

4. PROJECTED BENEFIT OF THE PROGRAM TO THE UNIVERSITY, LOCAL COMMUNITY, AND STATE

Yes. The benefits to FSU, the community, and the state (indeed, the nation) are thoroughly and convincingly presented in Section IV of the proposal.

5. ACCESS AND ARTICULATION ARE MAINTAINED FOR ALL PROGRAMS

Yes. Sections a, b, and c of this criterion are tailored for baccalaureate programs, and are largely irrelevant, here. Section II.D of the proposal outlines the strong track record and future plans FSU faculty have for continuing to assure access and diversity.

(b) INSTITUTIONAL READINESS

1. INDICATION OF ABILITY TO IMPLEMENT A HIGH QUALITY PROGRAM

Yes. There is no doubt, whatsoever, that FSU has a high-quality Materials Science and Engineering program already, and is poised to take it to a new level of excellence.

2. CURRICULUM IS APPROPRIATE FOR THE DISCIPLINE AND PROGRAM LEVEL

Yes. FSU already offers an impressive array of graduate-level courses that can fill any holes in the undergraduate preparation of new graduate students and prepare all students for their comprehensive examinations prior to commencing dissertation research.

3. SUFFICIENT QUALIFIED FACULTY ARE AVAILABLE

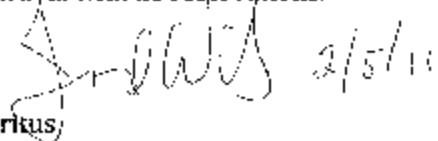
Yes. The existing faculty, based on their records of accomplishment, range from very promising (for the relatively new faculty) to internationally recognized leaders in Materials Science and Engineering. The flexible, collaborative, inter-departmental structure being proposed for this degree program assures that the program will always be able to recruit new faculty from the participating departments, and to change the mix of faculty expertise as the field evolves. The very existence of a Materials Science and Engineering PhD program will undoubtedly help those participating departments in attracting new faculty and graduate students to FSU, so everyone "wins."

4. SUFFICIENT INSTITUTIONAL RESOURCES ARE AVAILABLE

Yes. As noted previously, this proposal requests and requires no new resources, aside from some modest reallocations already approved by the Graduate School. All other resources needed to implement a strong Materials Science and Engineering PhD program already exist and are already being used to produce Materials Science and Engineering PhD graduates under different labels.

After completing this report and re-reading it, I had the nagging feeling that I should have been able to find some areas of concern or some things to suggest for improvement. So I re-read the proposal again. I find no such things to criticize or suggest. It is a superb proposal, and I recommend approval with no reservations.

John D. Wiley
Chancellor Emeritus
University of Wisconsin-Madison



**EXTERNAL REVIEW OF A PROPOSAL BY FLORIDA STATE
UNIVERSITY FOR THE ESTABLISHMENT OF A PHD PROGRAM IN
MATERIALS SCIENCE AND ENGINEERING**

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examinations, PhD candidates undertake the sole essential work required for the awarding of a PhD: They conduct an original piece of research, under the approval and guidance of a thesis advisor and a thesis committee of experienced faculty, and then publish their findings. In effect, PhD candidates must answer some previously unanswered question or solve some previously unsolved problem, thereby adding significantly to the store of human knowledge, as judged by the faculty committee and the peer reviewers of their publications. In this sense, every PhD that has ever been awarded is unique. They could all be given different names: “PhD in German History from 1881-1895” or PhD in Elliptic Differential Equations.” Instead, we traditionally group similar PhDs under (usually departmental) umbrella names such as PhD in History or PhD in Mathematics. What the FSU faculty are asking is that you approve moving appropriate PhDs from under the departmental umbrellas and label them more accurately and appropriately as PhDs in Materials Science and Engineering. This is more a matter of packaging and marketing than a matter of establishing an entirely new program from scratch.

In contrast, adding a new, strictly curricular degree (a baccalaureate, masters, or professional degree) generally requires significant new investments in new space, new equipment, and a whole new set of faculty. Adding a Dentistry program, or a College of Engineering, or even a department of Anthropology where one did not previously exist requires new investments in the millions or tens of millions of dollars. That’s not what is being requested here, and it explains the very modest cost of the proposed new PhD in Materials Science and Engineering.

Another criterion the Board of Governors is rightly concerned about is wasteful duplication: “Are we being asked to devote new state resources to a program that already exists elsewhere?” Again, PhD programs are different, making this question almost irrelevant. FSU already has a strong materials science and engineering faculty. They simply need authority to name the degree appropriately, in a way that is recognized by potential faculty, students, and recruiters. These points are addressed in Section II.B of the proposal.

Having said that, I must also say that the FSU faculty did an exceptionally good job of surveying the other Materials Science degree

programs in Florida (UF, UCF, and FIU) and consulting with their colleagues at these institutions. FSU has unique strengths in areas of materials science not as strongly represented elsewhere, so the fit is more complementary than competitive or redundant. This should not be a controversial or contentious change at all.

I believe this is an excellent proposal that can be easily and comfortably approved by the Board of Governors. To be sure there is no uncertainty, though, I will list the Florida Board of Governors Criteria separately and address each one briefly and individually:

(a) INSTITUTIONAL AND STATE LEVEL ACCOUNTABILITY

1. THE PROGRAM IS CONSISTENT WITH INSTITUTIONAL AND BOG STATE UNIVERSITY SYSTEM STRATEGIC PLAN

Yes. This case is made strongly in sections I and II of the proposal. If anything, I believe the demand projections (for Materials Science and Engineering PhDs in Florida's mix of high-tech industry) are conservative.

2. DEMONSTRATE NEED FOR PROGRAM GRADUATES, RESEARCH, OR SERVICE

Yes. Same answer as in (1), above.

3. FINANCIAL PLANNING AND RESOURCES ARE SUFFICIENT FOR IMPLEMENTATION

Yes. The faculty lines already exist, and normal turnover will provide for replacement and possible augmentation as the relevant fields evolve. The Graduate School has allocated fellowships for this program, as well as modest (but appropriate) funds for administration and oversight. The FSU materials science faculty already have a superb complement of instruments that would be the envy of most any materials science program in the country. No other campus or Florida institutions will be seriously impacted by the reallocations implied here.

4. PROJECTED BENEFIT OF THE PROGRAM TO THE UNIVERSITY, LOCAL COMMUNITY, AND STATE

Yes. The benefits to FSU, the community, and the state (indeed, the nation) are thoroughly and convincingly presented in Section IV of the proposal.

5. ACCESS AND ARTICULATION ARE MAINTAINED FOR ALL PROGRAMS

Yes. Sections a, b, and c of this criterion are tailored for baccalaureate programs, and are largely irrelevant, here. Section II.D of the proposal outlines the strong track record and future plans FSU faculty have for continuing to assure access and diversity.

(b) INSTITUTIONAL READINESS

1. INDICATION OF ABILITY TO IMPLEMENT A HIGH QUALITY PROGRAM

Yes. There is no doubt, whatsoever, that FSU has a high-quality Materials Science and Engineering program already, and is poised to take it to a new level of excellence.

2. CURRICULUM IS APPROPRIATE FOR THE DISCIPLINE AND PROGRAM LEVEL

Yes. FSU already offers an impressive array of graduate-level courses that can fill any holes in the undergraduate preparation of new graduate students and prepare all students for their comprehensive examinations prior to commencing dissertation research.

3. SUFFICIENT QUALIFIED FACULTY ARE AVAILABLE

Yes. The existing faculty, based on their records of accomplishment, range from very promising (for the relatively new faculty) to internationally recognized leaders in Materials Science and Engineering. The flexible, collaborative, inter-departmental structure being proposed for this degree program assures that the program will always be able to recruit new faculty from the participating departments, and to change the mix of faculty expertise as the field evolves. The very existence of a Materials Science and Engineering PhD program will undoubtedly help those participating departments in attracting new faculty and graduate students to FSU, so everyone “wins.”

4. SUFFICIENT INSTITUTIONAL RESOURCES ARE AVAILABLE

Yes. As noted previously, this proposal requests and requires no new resources, aside from some modest reallocations already approved by the Graduate School. All other resources needed to implement a strong Materials Science and Engineering PhD program already exist and are already being used to produce Materials Science and Engineering PhD graduates under different labels.

After completing this report and re-reading it, I had the nagging feeling that I should have been able to find some areas of concern or some things to suggest for improvement. So I re-read the proposal again. I find no such things to criticize or suggest. It is a superb proposal, and I recommend approval with no reservations.

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Chancellor Emeritus
University of Wisconsin-Madison

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March 16, 2011

Dr. Robert Bradley, Interim Provost
Florida State University
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Tallahassee, FL 32306-1310

Dear Bob:

I apologize for this last-minute letter and its perfunctory nature, but this matter came to my attention only yesterday. (It would be helpful to have a uniform understanding in the SUS that these matters need to run through Provost offices for official response.)

Based on my understanding of discussions that have taken place between the relevant chairs and deans of engineering, UF has no objection to FSU's proposal to establish a Doctor of Philosophy degree in Materials Science and Engineering.

Regards,



Joseph Glover
Provost

xc: Cammy Abernathy
Dottie Minear
Richard Stevens