

FLORIDA BOARD OF GOVERNORS

October 21, 2004

SUBJECT: Implementation Authorization for a Ph.D. in Biomedical Engineering at the University of South Florida

PROPOSED BOARD ACTION

Consider implementation authorization for a Ph.D. in Biomedical Engineering (CIP 14.0501) at the University of South Florida.

AUTHORITY FOR BOARD OF GOVERNORS ACTION

Article IX, Section 7 (d), Constitution of the State of Florida

BACKGROUND INFORMATION

The University of South Florida requests authorization to implement a Ph.D. in Biomedical Engineering that will prepare scholars expected to generate new knowledge, pursue academic and research careers, and provide leadership committed to developing solutions in interdisciplinary areas crossing the life sciences, medical sciences, and engineering. The proposed program has a substantial number of resources in close proximity, including a national comprehensive cancer center, a children's hospital, and a VA hospital in which students can apply classroom knowledge in authentic settings. USF has provided data that demonstrate the need for more doctoral-level graduates in biomedical engineering, evidence of anticipated demand, and a demonstration of program alignment with the Board of Governors' strategic plan.

Biomedical is currently one of the top three engineering fields in terms of growth. USF believes this program will contribute to medical advances and healthcare through the integration of engineering with the biomedical sciences and clinical practice. Strong support for this program has been expressed by university administrators, prospective students, community partners, government agencies, advisory boards, and consultants. Dr. Eric Guilbeau, Chair of the Bioengineering Department at Arizona State University conducted a favorable review in 2001. Subsequently, Dr. Bruce Hamilton, of the National Science Foundation, was retained as a consultant to review the Ph.D. proposal, and strongly endorses the program's approval.

The program would require students to take a total of ninety degree hours and achieve specific learning outcomes. Given that the University would begin the program with only ten students, there are sufficient faculty with varied research foci and experience in directing master's- and doctoral-level committees to implement the program.

The USF Board of Trustees approved the proposal for the Ph.D. in Biomedical Engineering at its January 23, 2004 meeting. If the Board of Governors approves the proposal, the University plans to implement the program in the spring of 2005.

**Supporting Documentation Included:
Facilitators / Presenters:**

Staff Analysis
Chancellor Austin / R. E. LeMon
USF Representatives

STAFF ANALYSIS
Proposed Ph.D. in Biomedical Engineering
University of South Florida

Estimated Costs:

	Total	% & \$ Current	% & \$ New	% & \$ C&G	Cost per FTE	SUS 02-03 Average Costs
Year 1	\$215,000	100% \$215,000	0	0	\$21,500	\$23,319 for CIP 14
Year 5	\$831,690	71% \$591,690	0	29% \$240,000	\$23,668	

NOTE: SUS Average Costs are calculated using the 2002-03 Expenditure Analysis.

Projected FTE and headcount are:

	Projected Headcount	Student FTE
First Year	10	10
Second Year	17	17
Third Year	19	19
Fourth Year	22	22
Fifth Year	25	25

On April 30, 2003, the Florida Board of Governors approved eight criteria, divided into the two categories of Readiness and Accountability, by which implementation authorization of new doctorates were to be assessed. The following is an analysis of the University's proposal based on further delineations of those eight criteria.

Evidence that the proposed program is listed in the current State University System Master Plan, and/or that the goals of the proposed program relate to the institutional mission statement as contained in the Master Plan.

The proposed program is consistent with the University's mission to excel in research that advances knowledge and promotes social, cultural, economic, educational, and technological development. It is also consistent with the mission to build university-community partnerships and collaborations as evidenced by partnerships with the College of Medicine, the H. Lee Moffitt Cancer Center and Research Institute, James Haley Veteran's Administrative Hospital, and Shriners's Orthopedic Hospital for Children. The proposed program is also congruent with the Board of Governors' targeted degree programs.

Evidence of a relationship to specific institutional strengths

With an enrollment of 3,500, the USF College of Engineering is the 27th largest in the country and ranks among the top 50 engineering colleges nationwide in Hispanic or African American graduates. Faculty specializing in the areas of biomedical and biomechanics have received national recognition and federal funding from programs such as Rehabilitation Engineering and Technology and the National Science Foundation. Two of the faculty have also received funding from the National Institutes of Health. The College of Engineering has undergone building renovations and construction, which resulted in more than 10,000 square feet for bio-related research. It also has collaborations and partnerships with the College of Medicine, the H. Lee Moffitt Cancer Center and Research Institute, James Haley Veteran's Administrative Hospital, and Shriner's Orthopedic Hospital for Children.

The H. Lee Moffitt Cancer Center and Research Institute is Florida's only National Comprehensive Cancer Center. The Institute is currently ranked in the top ten centers for oncology. It also receives more than \$40 million in research grants annually. The VA Hospital is a significant resource for research in biomedical engineering, treating more than 12,000 inpatients annually, with outpatient care approaching 40,000 annually. Shriner's Orthopedic Hospital for Children provides care to more than 21,000 children. Research for this facility is directed towards providing an understanding of the musculo-skeletal problems affecting children, as well as developing new and better treatments for these programs. Several collaborations with engineering faculty have been underway for the last few years related to this research.

Evidence that planning for the proposed program has been a collaborative process involving academic units and offices of planning and budgeting at the institutional level, as well as external consultants, representatives of the community, etc.

Planning for this program has involved faculty from several of USF's Engineering programs, community partners, the Moffitt Cancer Center, the Health Sciences Center, and industry advisors. In 2001, Dr. Eric Guilbeau, Chair of the Bioengineering Department at Arizona State University, conducted an external assessment. Another external review was conducted August 9, 2004 by Dr. Bruce Hamilton of the National Science Foundation. Dr. Hamilton contended that USF's Biomedical Engineering will be a strong and much-needed program, and fully endorsed its implementation, noting strengths in faculty expertise, industry support, and the curriculum.

Evidence of an appropriate timetable of events leading to the implementation of the proposed program

The proposal was finalized in the fall of 2003. The program was approved by the USF Board of Trustees in January, 2004. If approved by the BOG, the program will be implemented in the spring of 2005.

Evidence that progress has been made in implementing the recommendations from program reviews or accreditation activities in the discipline pertinent to the proposed program

Dr. Eric Guilbeau, Chair of the Bioengineering Department at Arizona State University,

conducted an external assessment of the then Bioengineering Institute, and also USF's readiness for further developments in its Bioengineering program, specifically related to the implementation of a PhD in Biomedical Engineering. His 2001 review noted a significant deficiency in dedicated office and research space. This issue has since been addressed through the allocation of dedicated space in the newly renovated Kopp Engineering Building. Second, his report noted that barriers to interdisciplinary and cross-college and cross-institutional research projects might still exist at USF. Implementing the proposed doctorate, which crosses the life sciences and engineering disciplines, may remove some of these barriers. It was further noted that new sections of some medical science courses would need to be developed, because medical school enrollment filled these classes at the time of the review. Subsequently, two courses have been formalized as permanent 6000 level-BME courses. The 2001 review also noted that the number of bioengineering courses available to students in the MBE was low. A review of USF's current graduate catalog indicates that more courses have been developed in preparation for the Ph.D. Dr. Guilbeau's review also stated that more bioengineering faculty members would be needed if USF wanted to implement a doctorate. Faculty were hired following his recommendation. His last recommendations were to move the administrative responsibility for the M.S. BME from the Department of Chemical Engineering to the Biomedical Institute. This recommendation could not be met because the Institute is inactive.

As explained by Dale Johnson, former Dean of USF's Graduate School, in 1999 the Bioengineering Institute was one of five USF interdisciplinary programs selected for internal funding from over 40 applications. Each of the five programs received \$50,000 for a two-year period as "seed" money in support of important areas of interdisciplinary innovation at USF. Although there was no continuation funding for any of the programs, the Bioengineering Institute continued to function on a "no-cost extension" basis for one more year. By that time, the principle USF biomedical engineering activities had evolved into the establishment of a Master's degree program, the development of the current Ph.D. proposal and the initial planning for establishment of a Biomedical Engineering Department jointly administered by the College of Engineering and the College of Medicine. The one-time nature of the funding for the Institute (and thus the basis for its limited life) had evolved into the long-term funding commitments necessary to support the Master's program and the proposed Ph.D. program. In summary, the Bioengineering Institute played a limited-in-time but, important transition role in moving USF toward formal biomedical engineering degree programs and departmental status.

Dr. Bruce Hamilton of the National Science Foundation has more recently reviewed the proposal and conducted a site visit on August 9, 2004. Dr. Hamilton has provided a favorable report for implementation of the program and believes that this particular program will contribute greatly to the field. He noted in his report that USF has had a successful M.S. BME in place since 1998, with steadily growing numbers of graduates. He further states that the USF faculty associated with this program are already in place, and there is a commitment to hire additional faculty as the program grows. The faculty all have successful records in teaching and research, and the facilities and curriculum are sound. Dr. Hamilton stated that the National Institutes of Health have recently emphasized the importance of biomedical engineering, as well as increased financial support for BME.

Evidence of an appropriate, sequenced, and fully described course of study; evidence of

specific learning outcomes and industry-driven competencies for any science and technology programs

Seven learning outcomes have been identified for students completing the Ph.D. in Biomedical Engineering. The proposal specifically states that, upon completion of the PhD, students should be able to apply basic and advanced engineering principles to the solution of contemporary problems in the biomedical engineering field; conduct specific research, advance the biomedical engineering discipline and contribute to improved health care and the quality of life advances, as possible; evaluate relevant medical and clinical literature as it relates to biomedical problems of interest, including appropriate statistical design and analysis; function effectively as part of multidisciplinary teams; communicate effectively; have an appreciation for safety and regulatory issues; and become sound professionals and leaders/visionaries in industry, academia, and the health professions.

Ninety credit hours are required to complete the degree. Twenty-two hours are given to core requirements, 18 for the specialization area, and 50 hours for the dissertation. The curriculum has also been designed so that industry-driven competencies have been identified and incorporated. These competencies were identified in conjunction with the following companies: Linvatec, Bausch & Lomb, Smith & Nephew, Baxter Healthcare, and Cardinal Medical. The courses proposed also address legal, regulatory, and product development issues associated with biomedical industries.

Evidence that, if appropriate, the bachelor's and master's degree programs associated with the program are accredited and that the institution anticipates seeking accreditation for the proposed program if available

Throughout the country, undergraduate programs in BME can be accredited by the Accrediting Board for Engineering and Technology (ABET). However, USF does not have a B.S. in Biomedical Engineering. All existing USF undergraduate programs in engineering are ABET accredited. At this time, there are no accrediting entities that address graduate programs in BME.

Evidence that the proposed institution has analyzed the feasibility of providing all or a portion of the proposed program through distance learning technologies via its own technological capabilities, as well as through collaboration with other universities

The program will be delivered through traditional delivery mechanisms on the Tampa campus. Many faculty are already making use of e-learning educational software to provide technological learning experiences for their students. Students are also provided with CD/DVD-based materials for anatomy and physiology. Exploratory discussions have been held with the University of Florida's BME program faculty to consider the possibility of off-campus semesters, where BME students from either institution would spend one or two semesters at the other institution.

Evidence that there is a critical mass of faculty available to initiate the program based on estimated enrollments

Given that the University is expecting to begin the program with only ten students and ten FTE, there are sufficient faculty (14) in place to implement the program. Four of the 14 faculty are

listed with a specialization in Biomedical Engineering. Comparable faculty numbers were found at peer programs at the University of Iowa, Florida International University, and the University of Pittsburgh.

Evidence that the faculty in aggregate have the necessary experience and research activity to sustain the program

It is evident from the faculty vitae that most of the faculty have directed master's-level theses; some have chaired, directed, or served on doctoral committees. Of the current faculty, all have published articles in refereed and nonrefereed journals, as well as authored books and chapters in their particular fields of study. They have also contributed \$1,918,155 in research grants between 1995 and 2001; \$3,208,436 between 2002 and 2003; and more recently \$1,822,467 from 2003 – present. Dr. Hamilton noted in his onsite review that the current amount and source of funding is a strong base for initial implementation of a doctoral program in Biomedical Engineering.

Evidence that, if appropriate, there is a commitment to hire additional faculty in later years, based on estimated enrollments

The proposal indicates that no new hires are needed to initiate the program or sustain it by year five. Affiliated faculty from the Moffitt Cancer Center, Life Sciences, Arts and Sciences, and the medical school will also be available to support the program as it grows from year to year. Having this cross-disciplinary focus and support from different colleges enhances opportunities for students.

Evidence that library volumes and serials are sufficient to initiate the program

Library resources have been developed through the years to support academic and research efforts in the medical and clinical sciences, biology, chemistry, and engineering. USF currently has 707 holdings, serials, and journals in fields related to biomedical engineering. This number of holdings is comparable to other institutions in the State of Florida who also have doctoral-level programs in Biomedical Engineering.

Evidence that classroom, teaching laboratory, research laboratory, office, and any other type of space that is necessary for the proposed program is sufficient to initiate the program

The proposal indicates that existing facilities within medical sciences and biomedical engineering are sufficient to support the proposed program and that this space was sufficient to allow ABET to grant six-year accreditation for all USF engineering departments. The College of Engineering consists of three main buildings with over 182,000 square feet of space. The proposal provided a detailed description of facilities as well as space allocation for office and laboratory research. During the onsite review, Dr. Hamilton toured the newly renovated Kopp Engineering Building and also visited several laboratories as well as the Moffitt Cancer Center. His report following the visit specifically noted that USF's BME facilities are sound and sufficient for the implementation of a PhD in Biomedical Engineering.

Evidence that necessary and sufficient equipment to initiate the program is available

Existing teaching and research equipment is sufficient to initiate the program. Available equipment for use in the research areas of biomechanics, imaging, sensors, cardiovascular, cellular, and tissue engineering is inventoried in the proposal as well as in the consultant's report. The College expects to expand its research resources as the program continues to grow. Dr. Hamilton noted in his report that each department and partner facilities has ample space and equipment available for faculty and student research.

Evidence that, if appropriate, fellowships, scholarships, and graduate assistantships are sufficient to initiate the program

The university awards five presidential scholarships each year for which Biomedical Engineering doctoral students will be eligible. Faculty will also support students through their research grants. The VA Hospital also awards pre- and postdoctoral fellowships. All of these types of financial support will be available for students enrolled in the doctoral program in biomedical engineering. Some of these funding sources will include a stipend and tuition waiver.

Dr. Hamilton noted that the current number of scholarships available to students is sufficient given that the University would begin the program with only ten students. However, as the program grows, there may be a need to increase the amount of support awarded to graduate students. The Dean of Graduate Studies has also indicated that the university is looking to increase the amount of scholarships available to graduate students and also the possibility of dedicating scholarships for specific programs such as Biomedical Engineering.

Evidence that, if appropriate, clinical and internship sites have been arranged

An internship is not required. However, the following local biomedical companies already accept BME student interns: Baxter Healthcare, Linvatec, Bausch & Lomb, and Smith & Nephew. Moffitt Cancer Center also accepts research assistants, as does the VA Hospital.

Evidence that there is a need for more people to be educated in this program at this level

The proposal provides national, state, and local data relating to the need for more students educated in the field of biomedical engineering. As background information, it provides information from the *Report on the Medical Products and Biomedical Industry: Florida High Tech Corridor* conducted in 1999. This report identified 190 bioproduct companies along the I-4 "High Tech Corridor," most of which were focused on biomedical products. The highest concentration of such companies was within Pinellas County. Within this study, industrial representatives indicated that workforce and employee training and concerns related to the supply of qualified engineers were important issues that, if not corrected, could slow the growth of bioproduct companies within this region of Florida.

Since 2000, the Pinellas County Economic Development Group, Enterprise Florida, and the Tampa Bay Partnership have collaboratively been developing infrastructure to continue the growth of biomedical companies in the area. In 2002, the Tampa Bay Business Journal identified 176 biomedical companies in the Tampa Bay area, with this growth projected to continue in the next decade. Also, the U.S. Bureau of Labor Statistics reported that the attractiveness of the Tampa Bay area to industrial growth and business investment was the highest in the U.S. between December 2000 and December 2001. In summarizing U.S.

Department of Labor data, the Whitaker Foundation also projected that biomedical engineering jobs would climb 31.4% through 2010, a rate double that of all other jobs combined.

National data presented in an *InfoBrief* published by the National Science Foundation also states that graduate enrollment in science and engineering fields is increasing, especially in engineering. NSF reports that engineering enrollment rose 5 percent in 2001. The engineering fields with the greatest gains were biomedical engineering, which was up 11 percent (2,750 students in 1994 to 3,593 students in 2001).

Four universities (UF, FSU, FAMU, and FIU) within the SUS currently have doctoral programs in biomedical engineering. Five universities (UF, FSU, FAMU, FIU, and USF) offer master's-level programs in BME. Between 1998 and 2003, the total number of graduates enrolled in biomedical engineering programs in the SUS was 119. Of that number, 91 students were beginning graduates and 28 were advanced graduates. Of all graduates, 72% were enrolled full-time. USF's master's ranked third among the total number of graduates enrolled. The average enrollment for the first year of implementation for all BME programs in the SUS was five students. However, the universities projected enrollments ranging from 8 students in Year One to 59 in Year Five, far greater than the range of students actually enrolled (3-10).

The University of South Florida projected a headcount of 8 for Year One in its BME program and enrolled 2 students in the first year; Florida International projected a headcount of 17 and enrolled 10 students; the University of Florida projected a headcount of 49 and enrolled 11; and FAMU/FSU projected 4 and enrolled 1. By year two, the institutions had not met their projected headcounts for the second year. USF had projected 12 students in Year Two and enrolled 4; FIU had projected 29 students and enrolled 24. UF had projected 53 students and enrolled 32. FAMU/FSU had projected 10 students and enrolled 1 student. By Year Three, FIU had met its third-year projections at 33 students, but USF, UF, and FAMU/FSU still were below their initial projections. Beginning Year Four, University of South Florida met and exceeded its fourth-year projections. It also exceeded its projections in Year Five. Also, more collaborations have been developed with industry advisory groups, the Moffitt Cancer, the VA Hospital, and Shriners's Hospital for Children.

USF's industry advisory group is associated with more than 300 companies within the Tampa Bay area. During the site visit, the advisory group's president indicated that there was a great need for this program because of the demand for medical devices and biomedical products, as well as for researchers of a high quality.

Information presented in the following table shows how each institution compares in terms of projected headcounts and actual enrollments in current BME programs.

	Year One Headcounts: Enrollment	Year Two	Year Three	Year Four	Year Five
FAMU/FSU	4:1	10:1	19:2	N/A	N/A
FIU	17:10	29:24	33:33	37:30	N/A

UF	49:11	53:32	55:40	57:50	59:48
USF	8:2	12:4	12:6	14:23	17:21

Information is not available for the fifth year for all programs because some began enrolling students in 2000 and 2002.

A strong support structure is in place to initiate and sustain this program, and students are eager to enroll. During the site visit, the consultant met with approximately ten students who are either currently enrolled in the Master's BME or in the doctoral program in Engineering Science. Each planned to pursue a Ph.D. in biomedical engineering, if approved. The students who are currently enrolled in Engineering Science would have liked to pursue a Ph.D. in Biomedical Engineering at USF; however, a program was not available to them. They have a strong commitment to the research being done in the labs at USF and also at the Moffitt Cancer Center, which is why they chose to stay at USF even though their program of choice was not available.

Evidence that the proposed program does not duplicate other SUS or independent college offerings or, otherwise, provides an adequate rationale for doing so

There are three BME PhDs currently being offered in Florida and another that will begin fall 2004. The University of Florida is in relative proximity to USF. However, USF engaged in discussions with other Florida institutions, the position expressed being that Florida could support additional programs in this field because of the high demand nationally and locally. Even though the program duplicates others in the State, the resources available to the USF program (a national comprehensive cancer center, a medical school, community and general hospital, children's hospital, and a VA hospital all within close proximity to the campus for students to conduct applied research) are unique.

Evidence of reasonable estimates of student headcount and FTE who will major in the proposed program, and commitment to achieve a diverse student body

All students will be enrolled full time; therefore, the headcount and FTE are the same. The program will begin with 10 students, but is expected to grow to 25 by Year Five. The proposal includes a statement on how the university plans to ensure diversity in its enrollments.

Evidence of a budget for the program that is complete, reasonable, comparable to the budgets of similar programs at other SUS institutions, and reflective of the proposal's text

All of the courses are currently being offered by the existing engineering departments, and all necessary faculty are already in place, so no new budgetary allocations are requested or required to initiate the Ph.D. program. The calculated first-year costs per FTE are at approximately \$21,500 for Year One and \$23,668 for Year Five respectively. The average SUS cost per FTE in Engineering for 2002-2003 was approximately \$23,319 and \$22,839 for the Life Sciences, as calculated from the annual expenditure analysis.

Evidence that, in the event that resources within the institution are redirected to support the new program, such a redirection will not have a negative impact on undergraduate education

USF does not currently have an undergraduate program in biomedical engineering. Most efforts have been focused on graduate education in this field. USF's College of Engineering has followed a national trend that has seen an increase in research experiences for undergraduates in other engineering programs.

Evidence that the academic unit(s) associated with this new degree have been productive in teaching, research, and service

Based on the faculty's vitae and the consultant's report, USF faculty associated with the proposed program have been productive in all three areas of teaching, research, and service. All of the faculty have published in refereed journals and directed a master's thesis. All but one has directed a doctoral committee.