PROGRAM PLANNING SUMMARY

Master of Science with a Major in System Design
College of Engineering and Computing

University of South Carolina – Columbia Campus

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President Harris Pastides

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Date

Commission on Higher Education Program Planning Summary

Name of Institution: University of South Carolina – Columbia Campus

Designation: New Program Proposal

Name of Degree: Master of Science

Name of Program: System Design

Number of credit hours in program: 30 hours

If undergraduate, designation as four- or five-year program: N/A

Program qualifies for supplemental Palmetto Fellows Scholarship/LIFE Scholarship awards: No

Proposed date of implementation: Fall 2012

CIP Code: 15.1501

Justification of need for the proposed program:

The planning, design, construction, production or manufacturing, and operation of complex projects and systems requires the input and participation of different engineering disciplines and may involve design and test phases that may span many levels of hierarchy and abstraction. Traditionally and within specific domains, design and test processes at the level of individual components or sub-systems are well-understood and sound methodologies and tools are presently available. However, comprehensive design at the networked system-of-systems or infrastructure level remains largely ad hoc in nature. Far reaching design decisions are made early on with little or no analysis and major flaws are often not discovered until final integration testing or system deployment. Typically such an approach results in a system that is inefficient or not cost effective and many times leads to enormous cost increases or complete project failures. Recent examples include the Airbus A380 and Boeing 787 which were delayed over a year due to integrated design failures between the electrical and mechanical systems. Given exponential rising complexities, such an approach to system design will not be feasible in the future and an optimum design will require a comprehensive approach where the entire system is considered as a whole rather than individual components or sub-systems. The Apollo program and International Space Station are examples of successful system-level projects.

For this purpose, a new field called system design is developing which is inter-disciplinary and focuses on the design and management of complex projects primarily at the design phase, but also over the lifespan of the project. This requires coordination and management of teams, scheduling processes, tools and facilities to optimize costs and resources, to reduce risk and to meet deadlines and schedules and combines knowledge of both technical and human-related activities and interactions. In addition to the technical knowledge and expertise in the related area of specialization, these activities require a multi-disciplinary approach utilizing knowledge of modeling, simulation and visualization, optimization, risk and reliability analysis, design, development, production and operation of physical systems, operations research, etc.

Almost all undergraduate engineering programs in the United States concentrate mainly on the technical subjects in the area of specialization. However, the topics listed above that are necessary for system design are usually not covered in typical undergraduate curriculum. Thus, a significant number of engineers lack suitable training and learn by trial-and-error once they are on the job. As expected,

this could have disastrous consequences for the project. Several educational institutions in the United States have already started to offer an MS degree in Systems *Engineering* in recent years.

To date, systems *engineering* has been mainly focused on structuring the management aspect of the design and test process, such as tools for documentation and planning at the block diagram level. Furthermore, many system level approaches are limited to specific domains in areas such as automotive or aerospace, but still do not encompass the totality of the system. While cross-disciplinary approaches such as Mechatronics, MEMS or cyber-physical systems (CPS) have begun to emerge in recent years, truly holistic approaches are lacking. Systems of the future will increasingly consist of heterogeneous, intelligent, autonomous and distributed electronic, mechanical or biological subsystems deeply immersed and embedded within their environment. Individual subsystems will sense, act and interact through combinations of electric, RF, optical, electromechanical, electrochemical and other interfaces. Due to their entrenched nature, a key aspect of future systems will be the development of non-traditional, natural and intuitive human-computer interfaces (HCI), such as direct brain-machine connections. The proposed program will incorporate the latest such developments in the field of system *design*.

No other institution in South Carolina offers a program for engineers and technical personnel that lead to a Masters degree in System Design – we note a recent graduate certificate program in Systems Engineering at Clemson.

The proposed program is planned to fill this gap to produce necessary, qualified manpower for the economic development of the state and is distinct and complementary to other existing programs. It will build upon existing expertise in the College of Engineering & Computing and fit in with the strategic direction of the college and university. The output of the program would benefit a range of industries already in the State of South Carolina including defense organizations (communications, weapon systems), power generation and control (including nuclear power stations, grid control), manufacturing systems, automotive and aerospace. An excellent example of the benefits of such a program is to reduce flaws in the design of software and hardware systems used in computer hardware/software design and communication severely reducing the impact of cyber attacks the affects of viruses. Ideally, this will be offered as an executive program but will emphasize a distance education format nationally and internationally.

The proposed program is a natural extension of the work currently in place in the College of Engineering & Computing and brings together the technology research in a way that benefits the totality of the engineering and computing industry, and especially those based in South Carolina. We aim to bring the work of the top-ranked research programs in the State to the commercial sector.

Anticipated program demand and productivity:

The proposed program should be of interest to a wide group of engineers whose career goals are to assume technical managerial positions and encompass all engineering disciplines, e.g., chemical, civil, electrical, mechanical, and nuclear engineering in South Carolina as well as in the neighboring states of North Carolina and Georgia. The distance education component will attract students nationally and internationally as well as US citizens on overseas deployment. The program will be offered as an executive program, offered in synchronous and asynchronous delivery modes during each semester to make it attractive to practicing engineers employed full-time.

Once fully developed, we anticipate enrollment of about 20 for in-class instruction and about 20 through distance education.

Preliminary discussions have been held with a number of companies within the state who have shown significant enthusiasm for the proposed program.

Assessment of extent to which the proposed program duplicates existing programs in the state:

To the best of our knowledge, there is no other program in the state leading to a Masters of Science degree in System Design. Different institutions may have individual courses related to systems *engineering* but not a coherent program leading to a degree in System Design.

Relationship of the proposed program to existing programs at the proposing institution:

The proposed program will significantly add to the educational and research activities of the McNair Aerospace Institute and will complement the management and aerospace programs of the College of Engineering and Computing. The proposed program will complement the existing graduate programs of the College of Engineering and Computing by making more graduate courses available to the full-time graduate students as well as those enrolled in the distance education program. For this MS program in System Design, plans are to provide courses on system design, projects and processes, risk and reliability analysis, modeling and simulation, planning and scheduling, operations research, etc. Courses will be developed as needed for this program.

Several nationally recognized programs in management techniques, operational research, supply chain management, psychology/human factors etc. at the University of South Carolina will be an added advantage that this proposed program can offer for attaining national eminence in a short period of time in addition to attracting quality graduate students.

The College of Engineering and Computing has been running successful distance-education graduate programs in all departments for about four decades. This planned program in system design will be a good addition to the existing programs and provide additional options to the graduate students in the future.

Relationship of the proposed program to other institutions via inter-institutional cooperation:

An MOU for collaboration between the Colleges of Engineering of USC and the Citadel has been signed that will allow students to take courses at the partner institution. This program will complement their project management program. We plan to contact Clemson for developing similar collaboration.

Total new costs associated with implementing the proposed program (general estimates):

It will be possible to develop this program with the present facilities and staff and with the existing faculty, including the three new faculty already approved, and no additional resources are necessary.