CLEMSON UNIVERSITY

COLLEGE OF ENGINEERING & SCIENCE

REQUESTING TO OFFER A NEW DEGREE PROGRAM

MASTER OF ENGINEERING

IN

INDUSTRIAL ENGINEERING

Submitted to the South Carolina Commission on Higher Education
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President
Clemson University

CLEMSON UNIVERSITY

Master of Engineering in Industrial Engineering
Full Proposal

Classification: Masters of Engineering (MEngr)

Program Title: Masters of Engineering in Industrial Engineering with a concentration in Supply Chain and Logistics

Academic unit: Clemson University, College of Engineering and Science, Department of Industrial Engineering and Department of Civil Engineering; and College of Business and Behavioral Science, Department of Management

Designation, type, and level of degree: Masters degree

Proposed date of implementation: January 2009

CIP code from the current USDOE's Classification of Instructional Programs: 143501

Identification of Program as New or Modification: New

Site: On-line, distribution throughout SC and beyond

Program qualifies for supplemental Palmetto Fellows Scholarship and LIFE Scholarship awards: Yes _____ No:___x__

Delivery mode: Internet

Justification

Statement of the purposes and objectives

This Master of Engineering (MEngr) in Industrial Engineering (IE) is a degree program designed to take advantage of research and teaching excellence that currently resides at Clemson in supply chain logistics and the huge demand that exists among working professionals for a targeted educational program in this field. The interdisciplinary nature of this subject is reflected in pockets of research expertise that are scattered across departments at Clemson and has led to this program being developed in collaboration between the Department of Management in the College of Business and Behavioral Science and the Department of Civil Engineering in the College of Engineering and Science. As will be discussed later, the demand for this program is significant and largely populated by working professionals who wish to pursue their masters' degrees while working full time at their highly mobile jobs. Hence, the purposes for this program are:

1) Provide a professional master's degree, the MEngr, in supply chain logistics of outstanding technical quality that is delivered completely in an asynchronous, distance learning format using state-of-the-art technology so that the total learning experience for the students is among the best in the world.
2) Leverage the fact that this venture is a collaborative effort with the Department of Management in the College of Business and Behavioral Science and the Department of Civil Engineering in the College of Engineering and Science to advance the overall visibility of all departments as leaders in research and education in the supply chain issues.
3) Raise the visibility of Clemson University and its complementary research expertise in both the Department of Industrial Engineering's supply chain logistics and the Department of Management's supply chain management area with a variety of companies locally and world-wide through their employees who become students of this program.

Need for the program

Since the earliest days of mass production, logistics has been cornerstones of successful companies because logistics involves the processes required to efficiently convert raw materials into finished goods and then deliver the products to customers. Over the past decade, the focus on material flow has broadened significantly to include, among other things, procuring materials from lower tier suppliers, contracts, customer interactions after delivery, and the information and human systems that support these tasks. The label has also changed to reflect this comprehensiveness and we now refer to these interconnected processes and networks as the supply chain. The strategy for control has also dramatically changed from optimizing each small area of the logistics network to simultaneously managing multiple parts in a way that addresses global goals for a company – and a significant impact on financial performance is being realized by companies who do this well. As one might expect, having personnel with a skill set that allows them to effectively address supply chain problems comprehensively is critical to success. The foundational knowledge in supply chain logistics and optimization resides within the IE Department and the expertise in supply chain management, including sourcing, B2B services, strategy, and other business and behavioral issues, resides within the Management Department's prowess. Thus, a collaborative program involving both Industrial Engineering and Management makes tremendous sense.

The demand for educating current employees so they obtain the supply chain skill set is large and growing at a rapid rate as more companies attempt to improve their supply chain - or improve it further. There is no secret that higher efficiency in converting raw materials to finished good and delivering them translates into higher profits. The increase in interest has arisen as executives who understood this fact have realized that supply chains are much larger than just the production process and they occur in nearly all businesses, not just manufacturing. Whether the "product" is the result of classic production and distribution like the tires that Michelin produces, is a service like having your appendix removed through a health care delivery system at the hospital, or is a huge oil refinery that Fluor constructs, improving and optimizing the supply chain is profitable and becoming a business necessity. *Business Wire* (10/7/03) reported that a Deloitte survey of 600 companies in 22 countries revealed that only 7% effectively managed their supply chain but these 7% had 73% greater profit margins. In *Management Review* (4/99) Charles Fine of MIT found that "the design of the supply chain is the key factor that will determine whether or not a company will survive, let alone whether it will maintain a competitive advantage." Further, in 2006, it was estimated that the costs associated with moving and storing material along the supply chain accounted for 9.9% of gross domestic product or something over $1 trillion. Some studies suggest that for individual companies, this cost represents 10% of sales. Regardless of how is it measured, there are huge opportunities associated with

improving the supply chain and companies are realizing this fact at an increasing rate. The need for employees who have the requisite technical and management skill set to address these challenges is currently quite large and is growing as a direct result of this realization.

Finally, Fluor Corporation's Chairman and CEO Alan Boeckmann articulated the most accurate description of the acute need for this degree during his remarks at the ceremony when the Center of Economic Excellence was formed. Boeckmann said, "As the globe continues to shrink and economies become more integrated, procurement, supply chain and logistics skills have become the lifeblood of the engineering and construction industry's ability to execute projects at home and abroad. By supporting this endowed chair at Clemson, we are ensuring that the next generation of engineers and procurement specialists are equipped with the knowledge to excel in our industry."

This MEngr program is targeted at providing practicing supply chain professionals with the necessary foundational and supply chain specific tools to identify opportunities for improving their supply chains and to execute effectively projects to take advantage of those opportunities. There is a huge need for this type of asynchronous program that allows these professionals the flexibility of continuing their careers but adding the skill set so desperately needed in industry. This proposed program is designed to meet this need.

Clemson faculty within the IE and Management departments have proven expertise in addressing these problems and are well suited to offer a program to meet this student need. In addition to an active research programs routinely producing refereed publications in the best supply chain and logistics journals, faculty in both departments have been adding "structural" components as well to continue building a supply chain presence that is recognized as world-class. In 2005, the South Carolina Commission on Higher Education approved formation of the Clemson Institute for Supply Chain Optimization and Logistics (CISCOL) through which faculty have been able to develop an environment where interdisciplinary teams work together to successfully resolve these complex, integrated types of problems. CISCOL is collaboration between IE and Management, governed by a Memorandum of Understanding between the two colleges.

The two academic departments have also built expertise and recognition independently. In 2006, the IE Department was named a research site for the Center for Engineering Logistics and Distribution, a National Science Foundation Industry/University Cooperative Research Center. In 2007, Fluor Corporation presented a $2 million gift to Clemson University that matches a State gift of $2 million to form a Center of Economic Excellence in Fluor Endowed Chair of Supply Chain and Logistics the Department of IE. This MEngr program in another step that builds on the expertise that the IE faculty have developed and provides a tangible outreach to industry in a way that transfers research to practice through education and that directly supports economic development.

In 2006, the Department of Management recruited as the Burlington Industries Endowed Chair in Supply Chain Management. Professor Roth has been instrumental raising the scholarly visibility of Management's SCM area globally and also in the rejuvenation of SCM doctoral program's curriculum to world-class status. SCM doctoral students are actively engaged in cutting edge research in supply chain management, including operational risk, sourcing strategies and B2B services. In addition, she and the SCM faculty have forged strong professional relationships with industry and the IE Department. Prof. Janis Miller is co-director of the Clemson Institute for Supply Chain Optimization and Logistics (CISCOL). Also housed within the College of Business and Behavioral Science's Management Department is the Enterprise Management Laboratory--an active learning facility that brings leading-edge business management software into the

classroom. This lab exemplifies the SCM strength in advanced enterprise technology that is used by leading companies.

Anticipated program demand and productivity

Since the formation of the Center for Economic Excellence, Fluor and Clemson have been working together to develop a general outline of knowledge that would be desirable in this MEngr degree and the potential market. The results have been quite positive.

- Consistent with the cash flow analysis that is presented later in this document, Fluor believes that they can easily supply 20 new students each year to this program.
- Within days of the announcement of the Center for Economic Development, Bill Ferrell (IE faculty member at Clemson) and Jim Scotti (VP and Chief Procurement Officer at Fluor) received several e-mails from Fluor employees around the world asking if this program was to include a distance learning master's program.
- Jim Scotti was invited to speak to a meeting of very senior procurement executives in the construction industry. He mentioned that this program was being contemplated and before leaving that meeting, he had requests from several other construction companies who indicated interest.
- Bill Ferrell has spoken informally with executives and potential students from Jacobs Engineering, Foster Wheeler, Black and Veatch, and S&B Engineering and Constructors. All have indicated that they would have a number of employees who would be interested in the program and that it would be approved for tuition reimbursement. Some of these companies recommend programs to their employees and have suggested that this MEngr program would be their #1 recommended program because the anticipated content is exactly the type of knowledge that is so desperately needed in their company.

Clearly, the above evidence is all anecdotal but we submit that it is a very strong endorsement to move forward. The very high level of interest that has been expressed along the spectrum from very senior executives to potential students is very encouraging. It should be noted that in all cases the expected costs have been discussed so these expressions of interest are with full knowledge of the total anticipated scope of the program.

Relationship to the mission Clemson University

The MEngr in IE, which is complemented by the Department of Management's SCM faculty expertise and initiatives, supports several aspects of Clemson's mission. First, research on the supply chain is a priority at Clemson and is contained in its Academic Plan. This document lists eight "emphasis areas" that faculty and administrators have identified as key to the future and Supply Chain Management is a niche area within the emphasis area Information and Communication Technology. Second, the program will support Clemson's vision of becoming one of the nation's top 20 public universities by raising the visibility of the University and the interdisciplinary faculty strength in the supply chain among a variety of companies both locally and world-wide.

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

We are not aware of any programs in the state that are similar in any way to this one. First, Clemson has the only Industrial Engineering program in the state that offers graduate degrees. The Management department's MS degree allows specialization in Supply Chain Management but courses are offered on campus not via distance education. Many universities have a course or two that address the supply chain within a business or management program; none offers an entire program that is rooted in the fundamentals of both engineering and management, and then addresses practical issues in supply chain logistics from this perspective.

Relationship of the proposed program to existing programs at Clemson

Clemson has established expertise in supply chain logistics that includes a variety dimension. All of these support the proposed MEngr program.

1) Center of Economic Excellence in Supply Chain and Logistics
This CoEE located in the Department of Industrial Engineering is supported by a $4M endowment created by Fluor Corporation and the State of South Carolina to further the research expertise and educational programs in supply chain and logistics.
2) The Clemson Research Site of the Center for Engineering Logistics and Distribution (CELDi)
CELDi is a prestigious National Science Foundation sponsored Industry/University Cooperative Research that brings industry and academia together for the improvement of supply chain logistics. CELDi currently has nine university and over thirty industry members. In 2006, research within CELDi totaled over $3M.
3) The Clemson Institute for Supply Chain Optimization and Logistics (CISCOL)
CISCOL is an interdisciplinary institute that provides tangible products and services that support economic development within the state of South Carolina. Approved by the Commission on Higher Education in October 2005, the institute focuses on theoretical and applied research on integrated production planning, inventory control, scheduling, distribution, and logistics within the supply chain.
4) The Burlington Industries Professor of Supply Chain Management
Dr. Aleda Roth, a world-renowned expert in supply chain management, holds this distinguished position in the College of Business and Behavioral Science and conducts cutting-edge research in supply chain issues. Her research productivity was ranked in the top 1% (non-tied) in the MS/POM field by the H-index ranking analysis of 1,376 management science (MS)/production and operations management (POM) professors in the US, according the H-index. The H-index provides an estimate of the importance, significance and broad impact of a scholar's academic achievement.
5) A number of undergraduate and graduate courses are taught in supply chain and logistics in both the Departments of Industrial Engineering and Management. As noted above, Clemson offers a MS degree in Management, with emphasis in Supply Chain Management.

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

Since the proposed program is a professional degree that is designed to be self-pay on a credit hour basis, a comparison is now made to programs that target roughly the same audience. An extensive search found the following programs:

Comparison with Similar Programs

School	Program Title	Emphasis	Distance Learning	Requirements (# 3 hr classes)	Estimated Program Price
MIT	MEngr in Logistics	Logistics and supply chain management	No	<10	>$50,000
Penn State	Master of Professional Studies in Supply Chain Management	Supply chain management	Yes (90%)	<10	$21,900
Texas A&M	Master of Industrial Distribution	Executive	Yes (80%)	10	$42,000
U of San Diego	MS in Supply Chain Management	Executive	Yes (80%)	12	$36,000
Michigan State	MS in Supply Chain Management	Logistics, Ops Mgt, Procurement	Yes (33%)	12	
Arizona State	MBA in Supply Chain Management	Executive	Yes	15	
Clarkson	MS in Engineering and Global Operations Management with Supply Chain Track	Executive	Yes (80%)	10	$28,800

Within this landscape, the proposed program is unique and competitive. First, only one of these programs is delivered entirely in a distance learning format which we believe is critical for a professional degree targeted at today's very mobile employees. Second, the only program with a similar focus is Michigan State and their procurement angle is different from ours and the rest of the program is quite different. Finally, our projected price will be under $30, 000 so we are positioned near the middle of the group.

Enrollment

Admission Criteria

This is a professional degree is targeted at full time employees working in general area of supply chain logistics. As such, the admission criteria will be:

1) An undergraduate degree from an accredited college or university

2) Mathematical skills required to complete successfully the quantitative aspects of the curriculum that are equivalent to any of the following two semester sequences:

- MTHSC 102 Introduction to Mathematical Analysis and MTHSC 207 Multivariable Calculus
- MTHSC 106 Calculus of One Variable I and MTHSC 108 Calculus of One Variable II

- MTHSC 106 Calculus of One Variable I and MTHSC 207 Multivariable Calculus

3) At least one year of relevant industrial experience

Projected Total Enrollment

Year	Fall		Spring		Summer	
	Headcount	Credit Hours	Headcount	Credit Hours	Headcount	Credit Hours
2009 – 2010	40	120	40	120	40	120
2010 – 2011	60	180	60	180	60	180
2011 – 2012	80	180	60	180	60	180
2012 – 2013	80	180	60	180	60	180
2013 – 2014	80	180	60	180	60	180

These estimates are very conservative and have been made through discussions with upper management at several large companies who plan to supply students. In particular,

- Fluor Corporation alone believes that they can supply 20 new students each year to this program.
- Foster Wheeler is in the process of gaining corporate approval for tuition reimbursement for their employees and has several students ready to enroll.
- The senior VP of Procurement at Black and Veatch told Bill Ferrell in a telephone call that he will recommend this program as the preferred one to all of his 100+ employees. He further stated that he believes there will also be a number of the 2000+ engineering in their Overland Park, KS office that will view this degree very favorably when looking for graduate programs.
- Employees at Jacobs Engineering and S&B Engineering and Constructors have also contacted Bill Ferrell about this program.

Estimated New Enrollment

A new group of 20 cohorts will be admitted each fall and attend Clemson for 10 semesters. During the cohorts first academic year as new students they will enroll in three courses generating 180 credit hours.

Year	Fall		Spring		Summer	
	Headcount	Credit Hours	Headcount	Credit Hours	Headcount	Credit Hours
2009 – 2010	20	60	20	60	20	60
2010 – 2011	20	60	20	60	20	60
2011 – 2012	20	60	20	60	20	60
2012 – 2013	20	60	20	60	20	60
2013 – 2014	20	60	20	60	20	60

Curriculum

The MEngr curriculum consists of 30 credit hours of new coursework and roughly parallels the structure of the existing nonthesis MS in IE. The MEngr contains 5 core classes, 1 class in management, and 4 concentration classes with the first concentration area being capital projects supply chain. All courses are 3 credit hours and new. The details are now presented.

Core classes

- IE 851, Data Collection, Analysis and Interpretation
  Collection and presentation of data for decision making in industry with a focus on design and control of industrial processes; application of inferential statistics to data from industrial engineering situations
- IE 852, Modeling and Decision Making
  Formulating and resolving models of industrial engineering systems with a focus on decision making.
- IE 853, Foundations of Quality
  Quality control and quality assurance techniques including control charting and supplier surveillance. Special attention is devoted to nontraditional applications like in the non-manufacturing supply chain
- IE 854, Fundamentals of Supply Chain and Logistics
  Applications of model building and analytical techniques to design, optimize, and control the supply chain and other logistics systems.
- IE 857, Industrial Safety and Risk Management
  Safety and risk management issues in industrial engineering systems including hazard information systems, process safety, export control and federal and international safety regulation requirements.

Management class

- MGT 856, Business Fundamentals for Supply Chain Management
  Principles and techniques of economic analysis of engineering projects; Consideration of time, value of money, short- and long-term investments, replacement analysis, depreciation methods, cost allocation, measures of cost effectiveness, and first cost vs. life cycle costing, Communication, team-building, intellectual property, people management

Concentration classes

- IE 850 Introduction to Capital Projects Supply Chain
  Introduction to the phases of capital projects; design and control of the capital projects supply chain; challenges associated with each of the primary supply chain entities - owners, contractors, and suppliers
- IE 855, Capital Projects Supply Chain
  Application of quantitative and qualitative tools and techniques to the design, control, management, and optimization of the capital projects supply chain.
- IE 858, Case Studies in Capital Projects Supply Chain
  Analysis of case studies in the capital projects supply chain.
- IE 859, Capstone Design Project
  A capstone experience in the design, control, management and optimization of capital projects supply chains.

Typical Student Schedule

Since this curriculum is targeted solely for full time employees and is to be delivered only in an asynchronous, distance learning format, students will typically progress through the program as a cohort, taking one class each semester (e.g., one class in each of the fall, spring and summer). This means that it will take students 3 years to complete the 27 hour of lecture-based coursework and one additional semester to complete the capstone design project. A student's typical schedule is presented below:

Year	Fall	Spring	Summer
1	IE 850	IE 851	IE 852
2	MGT 856	IE 853	IE 854
3	IE 857	IE 855	IE 858
4	IE 859		

Assessment

The Department of Industrial Engineering currently uses an assessment plan that has been approved by the faculty for assessment of the MS degree program. This plan will be used for assessment of the MEngr program. In general, specific learning objectives for the program are established and, then, the courses are identified where these learning objectives are addressed. After this matrix is created, specific courses are identified to collect data on each learning objective so that the cumulative effect is that each learning objective is assessed in at least one course during a student's career. The assessment plan allows the instructor or the class to identify the particular method to be used for assessment but it typically involves monitoring performance on a homework problem or test question.

Faculty

List Staff by Rank	**Highest Degree Earned**	**Field of Study**	**Teaching in Field (Yes/No)**
Professor #1	Ph.D.	IE/Logistics	Yes
Professor #2	Ph.D.	IE/Supply Chain	Yes
Professor #3	Ph.D.	Management/Logistics	Yes
Professor #4	Ph.D.	Management/Supply Chain	Yes
Professor #5	Ph.D.	Supply Chain Management	Yes
Professor #6	Ph.D.	Construction	Yes
Associate Professor #1	Ph.D.	IE/Logistics	Yes
Associate Professor #2	Ph.D.	Management	Yes
Associate Professor #3	Ph.D.	Environmental Management Systems	Yes
Assistant Professor #1	Ph.D.	IE/Logistics	Yes
Assistant Professor #2	MBA	Management	Yes
Adjunct Professor #1	Ph.D	Capital Projects Project Management	Yes
Adjunct Professor #2	Ph.D.	Capital Projects Project Management	Yes

Discussion

There is no plan to add new faculty and staff as a result of this program. The curriculum is being constructed to be taught in lockstep fashion with a cohort of students entering each fall and taking one class each fall, spring, and summer term. This means that in steady state, a maximum of three classes will need to be offered in any term. By augmenting full time Clemson faculty members with highly qualified adjunct faculty members who have industrial experience in the supply chain, the curriculum does not require additional faculty. On a semester by semester basis, the administrators in Industrial Engineering, Management, and Civil Engineering will decide which classes, if any, should be taught by an adjunct faculty member and if the courses being taught by full time Clemson faculty members will be part of their regular teaching load for that semester or if the class will be taught as an overload and compensated with dual pay.

The institutional definition of the full-time equivalents (FTE) includes 100% effort is equal to one FTE. The percent of effort for a staff member is based on time committed to the project. Faculty workload is based on a "four-course" workload equal to 100% or 1 FTE. Faculty may substitute research and service for courses in calculating the workload.

Unit Administration/Faculty/Staff Support

Year	New		Existing		Total	
	Headcount	FTE	Headcount	FTE	Headcount	FTE
Administration						
2009 – 2010	0	0	1	.25	1	.25
2010 – 2011	0	0	1	.25	1	.25
2011 – 2012	0	0	1	.25	1	.25
2012 – 2013	0	0	1	.25	1	.25
2013 – 2014	0	0	1	.25	1	.25
Faculty						
2009 – 2010	0	0	6	1.5	6	1.5
2010 – 2011	0	0	9	2.25	9	2.25
2011 – 2012	0	0	10	2.50	10	2.50
2012 – 2013	0	0	10	2.50	10	2.50
2013 – 2014	0	0	10	2.50	10	2.50
Staff						
2009 – 2010	0	0	2	1.0	2	1.0
2010 – 2011	0	0	2	1.0	2	1.0
2011 – 2012	0	0	2	1.0	2	1.0
2012 – 2013	0	0	2	1.0	2	1.0
2013 – 2014	0	0	2	1.0	2	1.0

Physical Plant
The current physical plant will be adequate for this program. Since all classes will be delivered in an asynchronous, distance learning format, the only physical space required is a small studio to capture the lectures in software and this is already in place in Freeman Hall.

Equipment
All equipment required for this program is currently in place and operational within the Department of Industrial Engineering.

Library Resources
Since this program leverages ongoing research programs in Industrial Engineering, Management, and Civil Engineering, the faculty involved in planning this curriculum know that the current library resources are adequate. The archival journals that Clemson faculty and students can now access electronically through various library subscriptions are sufficient for this program.

Accreditation, Approval, Licensure, or Certification
- This program is not subject to specialized or professional accreditation nor is it subject to approval by any state agency other than the Commission.
- Graduates of the proposed program are not subject to licensure or certification by any public or private agency.
- This program is in no way associated with teacher certification or to licensure/certification of other school personnel (e.g., principals, superintendents, counselors)

Articulation
The MEngr degree is normally considered to be a terminal degree. Student who wish to pursue a PhD are expected to complete the MS, not the professional MEngr degree.

Estimated New Costs

NEW COSTS TO THE INSTITUTION AND SOURCES OF FINANCING

ESTIMATED NEW COSTS BY YEAR						
CATEGORY	**1st**	**2nd**	**3rd**	**4th**	**5th**	**TOTALS**
Program Administration	46,660	33,660	20,720	22,841	25,026	148907
Faculty Salaries	60,000	105,000	150,000	150,000	150,000	615000
Graduate Assistants	16,000	28,000	40,000	40,000	40,000	164000
Clerical/Support Personnel	20,200	20,806	21,430	22,073	22,735	107244
Supplies and Materials	7,500	7,500	7,500	7,500	7,500	37500
Library Resources						
Equipment	14,000	14,000	14,000	14,000	14,000	70000
Facilities	1,000	1,000	1,000	1,000	1,000	5000
Other (Identify)						
TOTALS	165,360	209,966	254,650	257,414	260,261	1,147,651
SOURCES OF FINANCING BY YEAR						
Estimated FTE Revenue Generated from the State	86,475	86,475	86,475	86,475	86,475	432,375
Tuition Funding (New students only)	135,000	135,000	135,000	135,000	135,000	675,000
Other State Funding (Legislative Approp.)						
Reallocation of Existing Funds						
Federal Funding						
Other Funding (Endowment, Auxiliary etc.)Tuition from Continuing Enrollment		135,000	270,000	270,000	270,000	945,000
TOTALS	221,475	356,475	491,475	491,475	491,475	2,052,375

Institutional Approval

Department Chair, Industrial Engineering	17.Sep.07
Dean, College of Engineer and Science	27.Sep.07
Provost, Clemson University	27.Sep.07
President, Clemson University	1.Feb.08
Board of Trustees, Clemson University	8.Feb.08
Department of Industrial Engineering Curriculum Committee	5.Mar.08
College of Engineer and Science Curriculum Committee	5.Mar.08
Clemson University Graduate Curriculum Committee	1.May.08