May 25, 2004

TO: Dr. Jeannine Blackwell, Dean, Graduate School

FROM: Dr. Eric Grukle, Associate Dean for Research and Graduate Studies

SUBJECT: BS Engr/MS Manufacturing Systems Joint Degree Program

Attached is a proposal submitted by Dr. Larry Holloway, director of the UK Center for Manufacturing, to create a joint degree program for a BS in Engineering (Electrical or Mechanical Engineering) and a MS in Manufacturing Systems Engineering. The program will allow undergraduate students in electrical and mechanical engineering who are interested in manufacturing to pursue a MS degree in Manufacturing Systems Engineering.

The proposed program does not reduce the number of credit hours required for either program but does allow students to begin taking manufacturing courses early in their college career in a way that complements their undergraduate degree courses.

This proposal has been reviewed by the College of Engineering’s Graduate Studies Team and was approved unanimously. I concur with their decision and ask that you approve this request.

cc: Dr. Larry Holloway
March 8, 2004

Eric Grulke
Associate Dean of Research and Graduate Studies
College of Engineering
University of Kentucky
Lexington, KY 40506

Dear Professor Grulke:

Please find attached a proposal to create a joint degree program for a MS in Manufacturing Systems Engineering with a BS in either Electrical Engineering or Mechanical Engineering. The program will allow students who are interested in manufacturing to pursue studies in Manufacturing Systems Engineering while they complete their undergraduate engineering degree, and will be particularly attractive to students who will be participating in the “lean manufacturing summer boot camps” that have developed under the recent sponsorship from Ford Motor Company.

The proposed joint degree program does not reduce credit requirements – the number of credits required is equal to the sum of the credits required for the undergraduate degree and the Manufacturing Systems Engineering degree. (This is in contrast to the “University Scholars” Manufacturing Systems Engineering program, which was approved by the Graduate School in Fall 2003.) Admission criteria for the program is above the standard entrance criteria of the Manufacturing Systems Engineering MS degree and the Graduate School, but below the criteria of the previously approved University Scholars program. The goal of the program is to allow students to begin taking manufacturing courses early in their college career in a way which complements their undergraduate degree courses. This can be especially helpful to students who are co-ops during their undergraduate years.

The proposal has received letters of approval from both the Mechanical Engineering and Electrical Engineering departments. I request that you present the proposal for approval of the appropriate college committee, and then forward to the appropriate university bodies for approval.

Please contact me if you have any questions.

Sincerely,

Larry Holloway
Director, UK Center for Manufacturing
Kentucky Utilities Professor of Electrical and Computer Engineering
Proposal for a Dual Degree Program
for the M.S. in Manufacturing Systems Engineering and
B.S. in Electrical or Mechanical Engineering

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Proposal for a Dual Degree Program
for the M.S. in Manufacturing Systems Engineering and
B.S. in Electrical or Mechanical Engineering

OVERVIEW
The MS in Manufacturing Systems Engineering (MSMSE) is a multidisciplinary program administered by the College of Engineering at the University of Kentucky. This document proposes the establishment of a dual degree program resulting in the MSMSE degree and a BS degree in either Electrical or Mechanical Engineering. The dual degree program is structured to appeal to engineering students who plan a career in manufacturing, and is especially structured to allow students to be involved in engineering co-op employment while pursuing the dual degree.

MOTIVATION
The undergraduate engineering degree programs at the University of Kentucky teach students how to design products and how to develop machinery and processes for the production of those products. These programs, however, do not emphasize the strong interplay between product design and the ease, quality, and costs of manufacturing. Nor do they focus on the management and control of production systems that make those products. Here one must effectively integrate man, material, machinery, and methods. For the successful and efficient delivery of materials, goods, and services in business, product design, process design, and production systems must be carefully integrated. To address this need, the Manufacturing Systems Engineering Program at the University of Kentucky was established as an interdisciplinary program that combines faculty and curriculum from across the College of Engineering and the College of Business and Economics in a master's degree program that prepares students for the design, engineering, operation, and management of manufacturing systems. It is a program intended to complement our other engineering disciplines for those individuals who wish to apply those disciplines in manufacturing.

A large proportion of undergraduate engineers at the University of Kentucky co-op and intern with manufacturing firms and ultimately take jobs in the manufacturing sector upon their graduation. Rather than postpone the study of manufacturing until their graduation, talented engineering students would have a much richer educational experience if the study of manufacturing could be integrated with their undergraduate engineering education and the work experience they undertake during their undergraduate years. With a strong manufacturing background they would be more fully prepared for the jobs they assume, and their career progress would be accelerated. The purpose of this proposal is to create a degree program that meets this need.

A major impetus for this dual degree program is a gift given to the Center for Manufacturing from Ford Motor Company. Ford asked that U.K. establish a program to give co-op students a stronger manufacturing background, particularly in the area of lean
manufacturing, where the Manufacturing Systems Engineering program courses are held in high regard by industry. Consequently, an innovative educational program was developed and piloted in the 2003 4-week Session called the Lean Manufacturing Bootcamp. This program involved 6 credit hours of instruction, where two courses addressing technical and managerial components of lean manufacturing were taught in an integrated manner. It was as an immersion experience built around hands-on laboratories called "training factories" where students had to analyze, design, implement, operate, manage, and continuously improve realistic manufacturing systems. They were taught technical, interpersonal, teamwork, problem solving, and managerial skills.

Subsequently, they applied these skills in their factories, receiving strong coaching from the teaching assistants and faculty who delivered the program. They then carried this education into their summer jobs and activities completing projects such as redesign of an order fulfillment system from the warehouses at the Bluegrass Army Depot, and later went on to coop work terms at Ford, Toyota, and Honda. This "bootcamp" program will be expanded into the future into three summer programs (to be taken in consecutive summers) offering a total of 18 credit hours addressing the philosophy and basic tools of lean manufacturing, lean operations management, design of lean production systems, organizational learning, production control, and total productive maintenance. Students in the bootcamps and in the dual-degree program will apply their first summer toward their undergraduate degree as electives, and subsequent summers toward their future MSMSE. (Example curricula are attached that show possible applications of summer credits to undergraduate electives, as well as show how the co-op work rotations fit into the dual degree program.)

BACKGROUND
The College of Engineering offers 4-year, 132 credit-hour Bachelor of Science degrees in several engineering disciplines. The College of Engineering is accredited by the Accreditation Board of Engineering and Technology (ABET).

The MS in Manufacturing Systems Engineering (MSMSE) is a multi-disciplinary program administered by the College of Engineering at the University of Kentucky. The program is taught by faculty from departments across the College, including Mechanical Engineering, Chemical and Materials Engineering, Mining Engineering, and Electrical and Computer Engineering. The MSMSE program is available as a thesis option (Plan A) requiring 24 hours of course work, or as a project option (Plan B) requiring 30 hours of course work plus a project (MFS784), for a total of 33 hours. All students are expected to take a series of four core courses (MFS505, MFS605, MFS611, and MFS606). In addition, Plan A students must take two manufacturing electives and two other electives as well as write a thesis. Plan B students must take the four core courses with three manufacturing electives and three other electives, as well as present a written project at a final oral examination.

PROGRAM STRUCTURE
The dual degree program proposed herein is not limited to students interested in lean manufacturing, but would also be open to students with other manufacturing interests represented in the MSMSE program. The proposed structure of the program in many
ways parallels the existing joint MBA/engineering degree program. Specifically, the proposal is as follows:

- Upon completion of their sophomore year in Electrical or Mechanical Engineering, students should apply to the Graduate School to be conditionally admitted into the program. Full admission would require formal application to the Graduate School and a minimum GPA of 3.0 and completion of their junior year. Students must have a strong interest in manufacturing, and preference will be given to students who will be in a co-op work program.

- Students would take MSMSE courses offered during the summer sessions. In particular this would involve the lean manufacturing boot camps, but it might also involve other MSMSE courses should the MSMSE program elect to offer these classes. Summer delivery is employed so that the course schedule is compatible with a co-op rotation (see the attached rotation schedules) and the effective immersion approach to delivery can be practiced. Moreover, by taking these courses in concert with their co-op experiences, we believe this program will make the student’s manufacturing internships a much stronger learning experience.

- Courses during the first summer bootcamp (during the summer session immediately following completion of the sophomore year) would not count directly towards the MSMSE degree, but would potentially apply as electives in the student’s undergraduate degree program depending on the technical elective program of that department. For example, the courses for a student’s first boot camp would count as technical electives for the ME and EE degrees.

- Students would be formally admitted to the Graduate School and the MSMSE graduate program during their junior year. Students who follow the curricula attached would then have courses during their second bootcamp count directly towards the MSMSE program as would any MSMSE course thereafter. Admission into the Graduate School will be through application to the Graduate School, and the student will be expected at the minimum to meet the admission standards of the Graduate School.

- Note that under this program, all course requirements required for both degrees as they currently exist must be fulfilled. In no case would it reduce the number of credit hours required for both degrees. For undergraduate majors where the courses taken after the sophomore year count as electives within their BS program, it would not increase the number of credit hours for both degrees.

Attached to this proposal are course schedules for students who enter the program after their sophomore year for Mechanical Engineering or Electrical Engineering majors. It assumes co-op rotations starting after the sophomore year. The course plans are for students who will take the project option (Plan B) of the MSMSE, but students would also be permitted to take a thesis option (Plan A).
Curriculum Plan: BSEE/MSMSE (Plan B)

Degree Requirements

The following curriculum meets the requirements for a B.S. in Electrical Engineering (provided the student satisfies University Studies requirements and graduation requirements of the College of Engineering) and a MS in Manufacturing Systems Engineering (Plan B).

First Semester
- EE 101: Electrical Engineering Professions Seminar...
- MA 113: Calculus I...
- CHE 105: General College Chemistry I...
- CS 115: Introduction to Computer Programming...
- ENG 101: Writing I...
- University Studies...

Total hours = 17

Second Semester
- MA 114: Calculus II...
- PHY 221: General University Physics...
- PHY 241: General University Physics Laboratory...
- ENG 102: Writing II...
- University Studies: Oral Communication...

Total hours = 15

Sophomore Year

First Semester
- MA 213: Calculus III...
- PHY 222: General University Physics...
- PHY 242: General University Physics Laboratory...
- EE 211: Circuits...
- EE 260: Design of Logic Circuits...

Total hours = 18

Second Semester
- MA 214: Calculus IV...
- EE 222: Electrical Engineering Laboratory I...
- Engineering/Science Elective...
- EE 360: Introduction to Semiconductor Devices...
- EE 380: Computer Organization...

Total hours = 17

Summer Semester 1
- MFS 503: Lean Manufacturing Principles and Practices...
  - MFS 505: Operations Management in Lean Manufacturing...

Total hours = 6

Summer Semester 2
- EE 421G: Signals and Systems I...
- EE 415G: Electromechanics...

Total hours = 6

Junior Year

First Semester
- Co-op Tour #1...

Second Semester
- EE 416G: Energy Conversion Laboratory...
- EE 481: Logical Design Laboratory...
- EE 461G: Introduction to Electronics...
- Engineering/Science Elective (A/B)...
- Electrical Engineering Technical Electives...
- Mathematics Elective...
- University Studies...

Total hours = 17

Summer Semester 1
- MFS 594/512 (FP 1)...
- MFS 525: Organizational Leadership for Lean Man...

Total hours = 6

Summer Semester 2
- Co-op Tour #2...

Senior Year #1

First Semester
- EE 482G: Electronic Circuits Laboratory...
- EE 462G: Introduction to Engineering Electromagnetics...
- Engineering/Science Elective (A/B)...
- EE 422G: Signals and Systems II...
- MFS Elective...

Total hours = 15

Second Semester
- Co-op Tour #3...

Senior Year #2

First Semester
- Engineering/Science Elective (A/B)...
- Electrical Engineering Technical Electives...
- University Studies...
- MFS 505: Modeling of Manufaturing and Machining...

Total hours = 18

Second Semester
- EE 496: Electrical Engineering Design...
- Electrical Engineering Technical Electives...
- University Studies...
- MFS 611:...

Total hours = 15

Senior Year #3

First Semester
- MFS 784: Research Project...
- MFS 605: Systems for Factory Information and Control...
- MFS 606: Seminar and Project in MFG...
- MFS Elective...

Total hours = 12

Years = 5.5
  - Undergrad degree – complete
  - Graduate degree – complete

MFS 503 to be counted as undergraduate "Technical Elective", and
will not count toward MSMSE degree.

MFS 526 to be counted as undergraduate "Supportive Elective", and
will not count toward MSMSE degree.
Curriculum Plan: BSME/MSMSE (Plan B)

Degree Requirements
The following curriculum meets the requirements for a B.S. in Mechanical Engineering (provided the student satisfies University Studies requirements and graduation requirements of the College of Engineering) and a MS in Manufacturing Systems Engineering (Plan B).

Freshman Year
First Semester
ENG 101 Introduction to Engineering ........................................ 4
CHE 105 General College Chemistry I ...................................... 3
MA 113 Calculus I .................................................................. 4
ENG 101 Writing I .................................................................. 3
University Studies* .................................................................. 3
Total hours - 17
Second Semester
ME 151 Manufacturing Engineering ........................................... 3
CHE 107 General College Chemistry II ..................................... 3
MA 114 Calculus II ................................................................. 4
ENG 102 Writing II ................................................................ 3
COM 101 Basic Public Speaking ............................................... 3
Total hours - 16

Sophomore Year
First Semester
PHY 231 General University Physics ......................................... 4
PHY 241 General University Physics Laboratory ..................... 1
MA 213 Calculus III ............................................................... 4
CS 231 First Course in Computer Science for Engineers ........... 2
ME 205 Computer Aided Engineering Graphics ......................... 3
University Studies* ................................................................ 3
Total hours - 17
Second Semester
ME 220 Engineering Thermodynamics I ................................... 3
PHY 232 General University Physics ......................................... 4
PHY 242 General University Physics Laboratory ..................... 1
MA 214 Calculus IV ............................................................... 3
EM 221 Statics ...................................................................... 3
University Studies* ................................................................ 3
Total hours - 17

Summer Semester 1
MFS 503 Lean Manufacturing Principles and Practices ........... 3
MFS 528 Operations Management in Lean Manufacturing .......... 3
Total hours - 6

Summer Semester 2
Co-Op tour #1 ....................................................................... 1

Junior Year
First Semester
Co-Op Tour #1 ....................................................................... 1

Second Semester
ME 321 Engineering Thermodynamics II .................................. 3
ME 330 Fluid Mechanics ....................................................... 3
EM 392 Mechanics of Deformable Solids ................................. 3
EM 313 Dynamics ................................................................ 3
EM 305 Electrical Circuits and Electronics .............................. 3
Technical Elective* ................................................................ 3
Total hours - 18

Summer Semester 1
MFS 599/691 (FP) ................................................................. 3
MFS 525 Organizational Learning for Lean Man ....................... 3
Total hours - 6

Summer Semester 2
Co-Op tour #2 ....................................................................... 1

Senior Year #1
First Semester
ME 310 Engineering Experimentation I ..................................... 3
ME 344 Mechanical Design .................................................... 3
ME 325 Elements of Heat Transfer ......................................... 3
ME 340 Introduction to Mechanical Systems ......................... 3
Mathematics Elective* ......................................................... 3
Total hours - 15
Second Semester
Co-Op tour #3 ....................................................................... 1

Summer Semester 2
MFS (514 - TPM) ................................................................. 3
MFS (813 - FP 2) .................................................................. 3
Total hours - 6

Senior Year #2
First Semester
ME 407 Engineering Ethics .................................................... 1
ME 311 Engineering Experimentation II ................................. 3
ME 440 Design of Control Systems ...................................... 3
ME 501 Mechanical Design with Finite Element Methods ....... 3
University Studies* ................................................................ 3
MFS 505 Modeling of Man. Process and Machines ............... 3
Total hours - 16
Second Semester
ME 408 Safety Engineering .................................................. 2
ME 412 Senior Design Project ............................................... 3
University Studies* ................................................................ 3
MFS 505 Systems for Factory Information and Control ........... 3
MFS 611 ............................................................................... 3
MFS Elective ........................................................................ 3
Total hours - 17

Senior Year #3
First Semester
MFS 761 Research Project ..................................................... 3
MFS Elective ......................................................................... 3
MFS 626 Seminar and Project in MSE ................................. 3
Total hours - 8
Years - 5.5
Undergraduate degree - complete
Graduate degree - complete

MFS503/ME503 counts as undergraduate "Technical Elective", and
does not count towards the MSMSE.
MFS526 counts as undergraduate "Supportive Elective", and does
does not count towards the MSMSE.
October 23, 2003

Graduate Studies C.Q.I. Committee
College of Engineering
University of Kentucky
Lexington, KY 40506-0108

To Whom It May Concern:

This letter represents my support for the proposed joint degree program for a BS in Electrical Engineering and a MS in Manufacturing Systems Engineering. This program with Manufacturing Systems Engineering would provide an option for our undergraduates who may be interested in graduate study in the manufacturing systems area.

Sincerely,

[Signature]

Professor Vijay Singh
Department Chair
Electrical and Computer Engineering
February 13, 2004

Dr. Larry Holloway  
Director, Center for Manufacturing  
CRMS Building  
College of Engineering  
Lexington, KY 40506-0108

Dear Larry,

I am writing this letter to support the proposed Dual Degree Program for the M.S. in Manufacturing Systems Engineering and B.S. in Chemical, Electrical, Materials, or Mechanical Engineering. As understood, under this program, all course requirements required for both degrees as they currently exist must be fulfilled.

Our Student Affairs Officer, Janet Prewitt, encourages our mechanical engineering students interested in Manufacturing and Co-Operative Education to participate in the Lean Manufacturing Boot Camps and advises of the opportunity to earn the BS/MSE degree.

The feedback received has been extremely positive from students, faculty and employers.

Sincerely,

[Signature]

Kozo Saito  
Professor and Director of Undergraduate Studies  
TVA Professor  
Mechanical Engineering