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Service Systems Engineering: New Course Development - Service Systems Operations

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Abstract
A new curriculum in Service Systems Engineering, which consists of eight new courses, is being established. Four courses were developed in the first year. One of the courses was Service Systems Operations (SSO). Since most OM authors have integrated the production of goods and services in single text, with much emphasis still on manufacturing operations, coupled with the lack of emphasis on co-creation or co-production, the course developers experienced pedagogical and contextual challenges in creating the course. This paper will outline the comparison of traditional OM with service systems operations to highlight the similarities and differences between the two. Additionally the course objectives and pedagogy that will be used in instruction of the course will be shared. Also presented will be the link between the program and course objectives to position the course and curriculum for ABET accreditation.

Course Development
The Service Systems Operations course was designed and developed to provide the foundation in several areas:

(a) Continue from the fundamentals course, Introduction to Service Systems Engineering, which establishes the foundation for SSO, with emphasis on organizational context and quantitative problem solving,
(b) Apply of operations management, with emphasis on service systems,
(c) Integrate of systems engineering design and analysis principles with traditional and new OM concepts, tools, and techniques, and
(d) Understanding several different service sectors.

Several articles and presentations have outlined the process, from inception to course offering, for the newly developed Service Systems Engineering Curriculum [1] [3] [4]. Primary emphasis has been to integrate the curriculum as a part of the existing Bachelor of Science in Engineering to ensure it was aligned with the requirements of the Accreditation Board for Engineering and Technology (ABET). Alignment of the course with the ABET programmatic objectives was essential in developing a congruent set of course objectives. The course objectives are presented in the next sections.

Course Objectives
SSO is a survey course introducing major concepts and techniques used to manage the service system operations function. The course considers both managerial and analytical issues, since an effective decision-maker must be proficient in both areas.

After completing this course, students will be able to: (1) describe the operations function in service and manufacturing firms, (2) integrate service system operations with other disciplines, (3) apply specific operational tools and techniques, including quantitative and qualitative, to make more informed decisions, and (4) provide solutions to real-life service systems problems through analysis, evaluation, and selection of solutions.

The specific course objectives are aligned with the program objectives and outcomes to ensure congruence with the Bachelor of Science in Engineering program and ABET accreditation. The

specific course objectives have been matched with the program objectives and outcomes with the details presented in Appendix A.

Course Textbooks

The course was developed during the summer 2007. The initial texts used for curriculum development have since been replaced with new editions, with similarities in content. Below is the information on the prior and current texts.

Editions of Texts used for Development

Operations Management for Competitive Advantage, 11th ed., Chase, Jacobs, and Aquilano, McGraw-Hill Irwin, @2006. (ISBN 0-07-298393-0).

Service Management: Operations, Strategy, Information Technology, 5th ed., Fitzsimmons and Fitzsimmons, McGraw-Hill Irvin, @ 2006. (ISBN 0-07-298230-6).

Current Editions of Texts

Operations and Supply Management, 12th ed., Jacobs, Chase, and Aquilano, McGraw-Hill Irwin, @2009. (ISBN 0-07-327873-4).

Service Management: Operations, Strategy, Information Technology, 6th ed., Fitzsimmons and Fitzsimmons, McGraw-Hill Irvin, @ 2008. (ISBN 0-07-722849-9).

Course Topics

The topics covered in this course are listed with major categorical description along with a list of some of the key concepts, tools, and techniques.

Process Analysis
- Process analysis
- Process flowcharting
- Types of processes
- Performance measures
- Process analysis examples
- Process throughput time reductions

Service Productivity
- The Data Envelopment Analysis (DEA) Model
- DEA and strategic planning

Work Measurement
- Job design decisions
- Behavioral considerations
- Work methods
- Work measurements and standards
- Financial incentive plans

Service Facility Layout
- Servicescapes
- Facility design
- Process analysis
- Facility layout

Service Facility Location
- Location considerations
- Estimating geographic demand
- Location techniques
- Site considerations
- GIS systems

Forecasting
- Subjective methods
- Causal models
- Time series models

Managing Waiting Lines
- The psychology of waiting
- The economics of waiting
- Features of queuing systems (review)

Simulation
- Systems simulation
- ServiceModel simulation software
- Process analysis
- Build a Model: Tutorial

Capacity Planning
- Capacity planning
- Analytical queuing models (review)
- Capacity planning criteria

Service Supply Relationships
- Supply chain management
- Service supply relationships
- Sources of value
- Outsourcing services
- Mass customization

Vehicle Routing
- Field service
- The Clark-Wright Algorithm
- Vehicle routing with constraints
- A manual routing system

Inventory Management
- Inventory theory
- Order quantity models
- Inventory management under uncertainty
- Inventory control models
- Single-period models

Aggregate Planning
- Sales and operations planning
- Aggregate operations planning
- Aggregate planning techniques
- Aggregate planning in services
- * Strategies for managing demand
- * Yield management

Service Scheduling
- Work centers
- Priority rules and techniques
- Personnel scheduling in services
- * Strategies for managing capacity

The next section presents a comparison of the topical content in a Service Systems Operations course versus a traditional Operations Management course.

Comparison of Course Topics to Traditional OM Course

In order to compare the topical content of the SSO course with traditional Operations Management course, the contents of a typical OM text will be used. In this case, the 7th edition of the *Principles of Operations Management* by Heizer and Render, 2008 [2], was selected. This is one of the more popular OM texts used and that is the reason for its selection as a basis for comparison. There are a number of operations management texts in publication with similar chapters.

The table on the next page includes information about the content to be covered in the Service Systems Operations course along side the similar topics in the *Principles of Operations Management* textbook.

Service Systems Operations	Principles of Operations Management
Process Analysis	Chapter 7: Process Strategy – a section on Process Analysis and Design
Service Productivity	Chapter 1: Operations and Productivity – one page of coverage
Work Measurement	Chapter 10: Human Resources and Job Design and Chapter 10 Supplement: Work Measurement – major emphasis is manufacturing
Service Facility Layout	Chapter 9: Layout Strategies – major emphasis is manufacturing and not service
Service Facility Location	Chapter 8: Location Strategies – major emphasis is on manufacturing
Forecasting	Chapter 4: Forecasting
Managing Waiting Lines	NA
Simulation	NA
Capacity Planning	Chapter 7 Supplement: Capacity Planning
Service Supply Relationships	Chapter 11: Supply Chain Management – emphasis on goods more than services
Vehicle Routing	NA
Inventory Management	Chapter 12: Inventory Management – combination of goods and services
Aggregate Planning	Chapter 13: Aggregate Planning – although there is discussion regarding service, examples and major emphasis is on manufacturing
Service Scheduling	Chapter 15: Scheduling – more emphasis on manufacturing, with some discussion at end of chapter about services

Table 1: Comparison of Service System Operations and Principles of OM

Topics Not Included in Service Systems Operations Course

There are a number of topics covered in a traditional OM course but have not been included in this Service Systems Operations course for two primary reasons. The first reason is some of the content was included in the Introduction to Service Systems Engineering course. It was necessary to lay the foundation for service industries. Content covered in the first course from Service Management by Fitzsimmons and Fitzsimmons, 5th edition, included the following:

- Role of Services in an Economy
- Nature of Services
- Service Strategy
- New Service Development
- Technology in Services
- Service Quality
- Service Encounter
- Growth and Globalization of Services

There are some topics included in the *Principles of Operations Management* by Heizer and Render, 7th edition that were not included in the SSO class but were covered in the Introduction to Service Systems Engineering course. They are:

- Operations and Productivity – primary emphasis in the productivity chapter is on goods and manufacturing
- Operations Strategy – focus on goods
- Project Management – there is a separate course for this topic
- Design of Goods and Services – the design strategy for service is extensively discussed in the introductory course
- Managing Quality – covered in the context of service quality
- Statistical Process Control – covered in a later course with emphasis on service
- Supply Chain Management – more emphasis on goods
- Outsourcing as a Supply Chain Strategy – primary focus on goods
- Material Requirements Planning (MRP) and ERP – although this is relevant in managing supplies for service operations, it has primary focus on goods manufacturers
- JIT and Lean Operations – discussion centers on goods
- Maintenance and Reliability – more in the context of goods but there is discussion on utilities

Differences in Service and Goods

It is important to recognize that the production of goods and services go hand in hand. Most traditional operations management books evolved from the manufacturing world and not the service world. Most of the traditional OM books have added the service industry applications at the end or sometimes in the middle of the chapter as a way to recognize the increasing impact of the service sector. However, in some cases, it looks like these changes may have been an after thought, and thus the changes are not well integrated into the overall textbook flow.

Can a course be taught solely on the topics of service system operations? The course developers believe not because goods are often involved in many of the transactions as enablers of the service. There have been some textbooks specifically written in the area of service operations management. However, because of the lack of demand for this type of textbook, some are no longer in print. The textbook, Service Management and Operations, by Hakesever, Render, Russell, and Murdick [5], 2nd edition, would have been a great textbook to use for this course as it had the right mix of service management and operations, with emphasis on quantitative decision making. This was the book we intended to use but found out that it was no longer being published by Prentice Hall. In discussion with one of the authors, it may be picked up by one of the other publication companies based on a growing demand in this field.

There are a number of service management books which serve as a starting point for a text but in their entirety do need meet the needs for a course of this nature. Some of these books focus primarily on traditional management skills and less on the quantitative decision making skills needed to prepare today's students. There are one or two traditional OM books that have specifically addressed the integration of goods and services but are at a level that the developers believed to be more appropriate for graduate students than for undergraduate students.

Gaps in Most Traditional OM Textbooks
Several major gaps that prevail in traditional OM textbooks are listed here.

1. There is a lack of emphasis on co-creation or co-production as a critical element in the service sector.
2. Major emphasis is in the production of goods and not the co-production of services.
3. Service operations management has been added but still does not dominate the content to reflect the issues associated with the service sector.
4. Much of the discussion related to service operations has focused on fast food restaurants, retail, and other non-technical service settings. Although these are good examples that the students may be able to relate to, they are not representative of the many career opportunities that college graduates would pursue.

Course Grading Components
The Service Systems Operations course has been developed so that the grade a student receives for a course is based on a number of different components in addition to exams. Although exams are a part of the summative evaluation of students, pedagogical research indicates that experiential activities and exercises greatly affect learning, and as a result these activities/ exercises should contribute to the overall course grade. With this in mind, the following course components were developed:

Component # 1: End-of-Chapter Problems
Students will be responsible for completing these on their own and solutions will be provided.

Component # 2: Interactive Exercises
These are short write-ups which will be required from each student. Each write-up will serve as a vehicle for participation and items will be selected from the write-up for outcome assessment.

Component # 3: Case Analyses
These will be completed by teams and will also be used for assessment.

Component # 4: Course Project
A course project will be completed by the same group of students that worked on the case studies as a team. The student teams will make presentations of their service system projects at the end of the semester. Grading will be based on the student's performance of the system studied.

Component # 5: Exams
Three evenly distributed exams will be given throughout the semester to evaluate the students' understanding of the course concepts, tools, and techniques.

Challenges in Developing Course
When developing new curriculum, there are several challenges to be addressed. Because this course was a part of a series of eight courses being developed, it was necessary to have a clear understanding of the preceding and prerequisite courses. Statistics serves as a formal prerequisite for this course. There are two preceding courses offered in the sophomore year, Introduction to Service Systems Engineering and Service System Design and Dynamics. These

courses are informal prerequisites. It is assumed that the students have completed these courses prior to entering the Service Systems Operations course in their junior year.
Although some overlap is needed, there needs to be a balance of picking up where from where the instructor in prior course left off and where the class begins. To achieve this balance, developing the course in isolation was avoided and the entire development team collaborated.

With any new course, there is a need to be able to select the most appropriate content in the given timeframe of one semester. The combination of topics should parallel what may be expected in a comparable course if offered by another university. Because the Service Systems Engineering program is setting the stage for other universities and colleges to promote this new, it is necessary to carefully select the content to promote this new, exciting engineering field.

Assessment
As a part of the curriculum development process, it is necessary to develop an assessment plan that allows for assessing the programmatic outcomes in the context of the course learning objectives. Appendix B includes the assessment plan for this course.

Conclusion
Because this course was newly developed, similar courses in systems engineering were reviewed along with syllabi from service operations and service management courses offered by other universities. Courses from other universities were not replicated. This course represents and integration of old and new methods of instructing systems engineering with emphasis on a new subject area, service systems. Foundational knowledge in service management was also important so students had a starting point for differentiating between goods and services. Finally, primary emphasis on co-creation and active involvement of the customer was prevalent through the entire course.

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APPENDIX A: ***SSE 3500 Service Systems Operations***
Matching Program Educational Objectives and Program Outcomes to Course Learning Objectives

Course Objective 1: Describe the operations function in service and manufacturing firms.
Program Objectives:

- A sound technical foundation with a Service Systems Engineering focus and the flexibility to pursue professional interests in areas outside of engineering that could lead to a wide variety of career paths.
- The knowledge, skills, and attitudes needed to facilitate a lifetime of professional success. These attributes would include excellent communication skills, an understanding of ethical and global issues, and a commitment to life-long learning and professional development.

Program Outcomes:

- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a knowledge of contemporary issues

Course Objective 2: Integrate service system operations with other disciplines.
Program Objectives:

- A sound technical foundation with a Service Systems Engineering focus and the flexibility to pursue professional interests in areas outside of engineering that could lead to a wide variety of career paths.
- The knowledge, skills, and attitudes needed to facilitate a lifetime of professional success. These attributes would include excellent communication skills, an understanding of ethical and global issues, and a commitment to life-long learning and professional development.
- The ability to design and improve systems and processes that provide services by applying a system perspective coupled with a thorough understanding of the customer.

Program Outcomes:

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- an ability to function on multi-disciplinary teams
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

- an ability to use engineering judgment to make decisions relating to systems, processes, and components.

Course Objective 3: Apply specific operational tools and techniques, including quantitative and qualitative, to make more informed decisions. [1, 2, 3, 4, 5] [a, b, c, d, e, f, g, h, j, k, l]
Program Objectives:

- A sound technical foundation with a Service Systems Engineering focus and the flexibility to pursue professional interests in areas outside of engineering that could lead to a wide variety of career paths.
- In-depth technical preparation in Service Systems Engineering that could serve as a springboard to professional degree programs such as the Master of Engineering.
- The knowledge, skills, and attitudes needed to facilitate a lifetime of professional success. These attributes would include excellent communication skills, an understanding of ethical and global issues, and a commitment to life-long learning and professional development.
- The ability to function on multidisciplinary teams that extend the traditional boundaries of engineering.
- The ability to design and improve systems and processes that provide services by applying a system perspective coupled with a thorough understanding of the customer.

Program Outcomes:

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- an ability to function on multi-disciplinary teams
- an ability to identify, formulate, and solve engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a recognition of the need for, and an ability to engage in life-long learning
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- an ability to use engineering judgment to make decisions relating to systems, processes, and components.

Course Objective 4: Provide solutions to real-life service systems problems through analysis, evaluation, and selection of solutions. [3, 4, 5] [All program outcome]
Program Objectives:

- The knowledge, skills, and attitudes needed to facilitate a lifetime of professional success. These attributes would include excellent communication skills, an understanding of ethical and global issues, and a commitment to life-long learning and professional development.

- The ability to function on multidisciplinary teams that extend the traditional boundaries of engineering.
- The ability to design and improve systems and processes that provide services by applying a system perspective coupled with a thorough understanding of the customer.

Program Outcomes:

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- an ability to function on multi-disciplinary teams
- an ability to identify, formulate, and solve engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a recognition of the need for, and an ability to engage in life-long learning
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- an ability to use engineering judgment to make decisions relating to systems, processes, and components.

Program Educational Objectives

1. A sound technical foundation with a Service Systems Engineering focus and the flexibility to pursue professional interests in areas outside of engineering that could lead to a wide variety of career paths.
2. In-depth technical preparation in Service Systems Engineering that could serve as a springboard to professional degree programs such as the Master of Engineering.
3. The knowledge, skills, and attitudes needed to facilitate a lifetime of professional success. These attributes would include excellent communication skills, an understanding of ethical and global issues, and a commitment to life-long learning and professional development.
4. The ability to function on multidisciplinary teams that extend the traditional boundaries of engineering.
5. The ability to design and improve systems and processes that provide services by applying a system perspective coupled with a thorough understanding of the customer.

Service System Engineering Program Outcomes

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multi-disciplinary teams

(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) an ability to use engineering judgment to make decisions relating to systems, processes, and components.

Appendix B: Assessment Plan

An assessment rubric was developed to assess the achievement of programmatic objectives. The assessment rubric will serve as a starting point for the course. The course will be offered for the first time in Fall 2008. Assessment will take place at that time.

Assessment Rubric:

	Outstanding	Above Average	Average	Below Average	Not Acceptable
Identify and Apply Forecasting Methods (a)	Thorough knowledge of quantitative methods and accurately solves all problems (4)	Able to identify the quantitative methods and accurately solves most problems (3)	May be able to identify most quantitative methods and accurately solve some problems (2)	Experiences difficulty in identifying quantitative methods and/or cannot solve problems (1)	Not able to properly identify quantitative methods and is unable to solve problems (0)
Identify process strategies to be used for different services or products (b)	Identifies the appropriate process strategy and understands why the strategy was selected (7-8)	Identifies the appropriate strategy and has some idea of why it was selected (5-6)	Identifies the appropriate strategy but is not clear why it was selected (3-4)	Selects the wrong strategy but understands some elements of the strategy (1-2)	Did not select the correct strategy nor understand which one should be selected (0)
Apply work measurement techniques to estimate number of workers. (c)	Has thorough knowledge of quantitative methods and accurately solves all problems (4)	Is able to identify the quantitative methods and accurately solves most problems (3)	May be able to identify most quantitative methods and accurately solve some problems (2)	Experiences difficulty in identifying quantitative methods and/or cannot solve problems (1)	Is not able to properly identify quantitative methods and is unable to solve problems (0)
Apply the appropriate scheduling technique based on the information provided (d)	Has thorough knowledge of quantitative methods and accurately solves all problems (4)	Is able to identify the quantitative methods and accurately solves most problems (3)	May be able to identify most quantitative methods and accurately solve some problems (2)	Experiences difficulty in identifying quantitative methods and/or cannot solve problems (1)	Is not able to properly identify quantitative methods and is unable to solve problems (0)

Assessment Methods

(a) Exam question using a problem
(b) Facility layout exercise
(c) Exam question using a problem
(d) Exam question using a problem