

Service Science, Management and Engineering Curricula and Research at NC State University

Steven Allen

Associate Dean, College of Management, NC
State University
Raleigh, NC 27695-7229
steve_allen@ncsu.edu
(919) 515-6941

Ioannis Viniotis

Professor, Department of Electrical and Computer
Engineering, NC State University
Raleigh, NC 27695-7911
candice@ncsu.edu
(919) 515-7357

Andrew Rindos

Head, RTP Center for Advanced Studies (CAS)
and Coordinator, IBM Research/AIM Joint
Program
Research Triangle Park, NC 27709
rindos@us.ibm.com
(919) 486-2016

Lynda Aiman-Smith

Associate Professor, Department of Business
Management NC State University Raleigh NC
27695-7229 Lynda_Aiman-Smith@ncsu.edu
(919) 515-8699

Mitzi Montoya-Weiss

Professor, Department of Business Management
NC State University Raleigh NC 27695-7229
Mitzi_Montoya-Weiss@ncsu.edu
(919) 515-8080

Harry Perros

Professor, Department of Computer Science, NC
State University
Raleigh, NC 27695-8206
hp@csc.ncsu.edu
(919) 515-2041

Michael Devetsikiotis

Professor, Department of Electrical and Computer
Engineering, NC State University
Raleigh, NC 27695-7911
mdevets@ncsu.edu
(919) 515-5253

Craig Nygard

Senior Technical Staff Member and Manager,
South Service Delivery, Executive Briefing Center
IBM Global Services
Research Triangle Park, NC 27709
nygard@us.ibm.com
(919) 254-7754

John McCreery

Associate Professor, Department of Business
Management NC State University Raleigh NC
27695-7229 John_McCreery@ncsu.edu
(919) 515-4093

ABSTRACT / SUMMARY

With the support of IBM, NC State's Colleges of Engineering and Management will begin offering masters-level curricula in Service Sciences, Management and Engineering (SSME) in fall 2006. This paper reports the rationale for these new programs, describes their content, summarizes some SSME research that is underway, and notes future directions.

INTRODUCTION

The term "service sector" once was associated with unskilled, labor-intensive activities in industries such as wholesale and retail trade, personal services, and

restaurants. Now services dominate our economy (three-fourths of all jobs), and a rising share of service jobs are highly skilled and technology-intensive, including such activities such as outsourcing, consulting, and process re-engineering. Large corporations in the service sector, including IBM, Hewlett Packard, Accenture, Oracle, and EDS, are asking universities to re-evaluate degree programs in light of these changes. The key drivers are

- Fear of outsourcing: Many young people today, especially those in IT-related disciplines, have seen what has happened to jobs where the skills are purely technical. They are looking for a blend of managerial and technical skills that creates greater value.
- Need for customer focus: Hiring managers bemoan

the failure of recent graduates to grasp the customer's perspective and how it relates to technology and business processes. A quote from a manager in a highly visible IT firm: "We would rather hire someone from Starbucks who understands customers than someone from MIT who only knows technology."

- Baby-boomer exodus: This generation obtained an integrated perspective about customer wants, business processes, and technology through informal and lengthy on-the-job experiences. They will soon be retiring – in droves. Companies need the next generation to hit the ground running.

The standard programs offered by universities in technology and management are not set up to meet these challenges. Leading-edge corporations in the new service sector are now asking universities to respond. This article summarizes the experience at NC State University, reporting recent innovations in its curricula and research.

NC STATE'S COMPETITIVE ADVANTAGE

NC State is in an excellent position to form a service science partnership with IBM because

- IBM and NC State have a strong relationship: IBM hires more graduates from NC State than from any other university. Also, IBM has been a long time supporter of research at NC State.
- NC State works collaboratively: NC State's Colleges of Engineering (COE) and Management (COM) have a history of successful collaboration in high-tech entrepreneurship, product innovation and management, electronic commerce, and computer networking
- NC State moves fast: NC State was able to plan a program in summer and fall of 2005 to launch in fall 2006. We did this because we already had a platform of courses in place in the MBA and MS in Computer Networking programs
- NC State is a leader in innovation research: NC State's motto is "Innovation in Action." NC State is ranked 6th in technology strength of patents, 7th among national research universities in industry-funded research, and 12th among national research universities in non-federally funded research. NC State also is home to a virtual research organization, the Center for Innovation Management Studies (CIMS), with a network of over 100 researchers in varied disciplines from many universities and a solid track record in research on innovation.

THE CURRICULUM INITIATIVE

New Courses at NC State

NC State will begin admitting students in fall 2006 to new service science concentrations in two degree programs that

are designed to bridge technical and management education. The College of Engineering will add a Services Engineering concentration to its Masters of Computer Networking (MSCN) program. The College of Management will add a Services Management concentration to its MBA program.

With IBM's support, five new courses will be developed that will be combined with existing courses to launch these new concentrations:

1. Services Management (team-taught by MBA and MSCN faculty)

The course will provide an overview of service management from an integrated viewpoint with a focus on customer satisfaction. The material will integrate operations, marketing, strategy, information technology and organizational issues with examples and case studies.

2. Process Analysis and Design

Business processes cut across traditional functional and organizational boundaries to create value and satisfy customer needs. This course will develop a process-centric view of the organization and provide students will knowledge and skills in business process management.

3. Organizational Culture

This course is intended as an overview of different aspects, artifacts, rituals and languages of different organizational cultures. The course will provide students with tools, knowledge, and first-hand experience in understanding the cultural values of a services-oriented organization.

4. Architecture and Design of IT Service Systems

The course will survey the state-of-the-art in the area of overall system design for efficient Web services. Customer service requirements in terms of throughput, availability, power, and cost will be included in the course.

5. Design and Performance Evaluation of Network Services and Systems

The course will provide an introduction to advanced topics in providing services based on modern high-speed telecommunication networks and in the related quantitative design and performance evaluation methods for the design of service-driven network systems.

Services Management in the MBA

The services management concentration in the MBA will teach service management from an integrated viewpoint -- including operations, marketing, strategy, information technology and organizational issues -- with a focus on customer satisfaction. Students will have the opportunity to choose between a Relationship Management track or an Innovation Management track within the services management curriculum.

The relationship management track focuses on the co-production relationship that is critical in the services

context. Service engagements must be designed and managed to meet the client's and provider's expectations, to achieve satisfactory returns and performance. The relationship management curriculum will provide essential tools and frameworks for effective customer analysis and engagement management. Students who select the Relationship Management track would take courses in Business Relationship Management, Consulting, and Services Management as well as an additional elective from the following: Organizational Culture, Market Analytics, Marketing Research, Marketing Strategy, Project Management, Service Modeling, or Supplier Relations.

The innovation management track focuses on the analysis and optimization of business processes and value chains or networks. One of the major challenges in managing new service development is the need for integration between management skills, technical & design capability, and market analysis. The service innovation curriculum will provide essential tools and frameworks for successful service innovation. Students who select the Innovation Management track would take courses in Consulting, Process Analysis and Design, and Services Management and then select an elective from the following: Organizational Culture, New Service Development, Project Management, Marketing Strategy, Service Modeling, or the IT Practicum.

Networking and IT Services Curriculum

The Computer Networking program is a joint effort between the Colleges of Engineering and Management to deliver a unique educational program that addresses the needs of North Carolina's computer networking industry. By working together, the colleges deliver a curriculum that allows students the flexibility to pursue studies that emphasize the technical and management aspects of computer networking.

The program is intended for students with electrical and computer engineering or computer science undergraduate degrees who wish to pursue careers in research, development, operations, and information technology management in the computer networking and IT industry. It is designed to address a specific need in the computer networking industry in North Carolina, and, as such, is consistent with the land-grant mission of the university. The program is unique in the UNC system (and nationally) in blending the technical and management aspects of computer networking to offer students a truly unique educational opportunity.

Evolving in a direction consistent with the emerging SSME trends and requirements, the MSCN program will initially add a *track* in Services Engineering, which we envision as a precursor to a new masters program. Students in the Services Engineering track of MSCN would take the new Services Management course (jointly taught with MBA faculty) as their required business course. They then would take three MBA courses: Management of Technology,

Managing People in the High-Tech Environment, and Process Analysis and Design. The MSCN program also would launch two new technical courses: (1) Architecture and Design of IT Service Systems and (2) Design and Performance Evaluation of Network Services and Systems.

Currently the program offers a non-thesis and a thesis option, structured around a core set of courses, and three areas, namely, network design, network hardware and network software.

As the program evolves towards a new Master's in Networking and IT Services, we envision a new core, consisting of a service management course in addition to a performance evaluation course, and additional courses from three groups, namely, networking, information technology and business.

Overall, we intend to maintain a close link between the curriculum and the key skills required by industry, government and academia, in the emerging "service oriented" world. An important ingredient in our thinking is finding a balance between depth and breadth (the ongoing discussion about the so-called "T-model"), as well as a balance between science/engineering, business and even broader subjects – related to the similarly motivated "liberal arts" view of engineering and technology education.

THE RESEARCH INITIATIVE

Traditionally, businesses model and enact their processes largely independently of each other. Notwithstanding the shortcomings of traditional approaches (slow accommodation of external changes and potential sub-optimality), an advantage is that they are easy to manage. A "services focus" addresses those shortcomings by enabling reconfiguration of processes, including outsourcing processes to specialized vendors. However, doing so introduces major challenges. When processes cross enterprise boundaries and are provisioned across multiple administrative domains, organizational modeling and project management become harder (COM) as well as computational modeling and provisioning of services and SLAs (COE). Our interdisciplinary research effort seeks to address these challenges in a uniquely cohesive manner.

Even though doctoral students will matriculate in one of the three colleges, we anticipate co-supervision by faculty in all colleges. We have identified over 15 specific research topics; we intend to request support for 18 doctoral students. More specifically, we propose to do research in the following broad areas:

A. Research on the technical aspect of services (led by faculty in COE). The problems will center on dynamic representations and techniques necessary to support adjustable pricing and resource allocation suitable for service businesses: (i) Service Level Agreements (SLAs) for IT services, and, (ii) SLAs for network services. SLAs formalize requirements customers pose on the IT or network system that delivers the service. They are typically

expressed in terms of quality of service (QoS) metrics such as performance, reliability, availability, security.

A.1 Network Services. Simple SLAs have been proposed, researched and even implemented in the context of networks, at the network, not the business process level. The bundling of multiple services together, the abundance of Web-based new business opportunities create the need for offering entirely new, bandwidth-provisioned SLAs that extend beyond the customary “T1-leasing” type. Two such SLAs we will study are the following:

(SLA1): Point-to-multipoint bandwidth pipes to any destination. A user requests a bandwidth pipe of x Mbps. This, however, is a point-to-multipoint pipe, from the user's access point to virtually any point in the network. This service requirement is an enabler for e-commerce, and other applications in which the clients are geographically dispersed and access the server through multiple points.

(SLA2): Bandwidth pipes with “upgrades” and differential premiums. Consider a user who classifies his/her traffic into N classes (for example $N=3$ diffserv classes). The user purchases from the network x_i Mbps of bandwidth (with certain attributes, e.g., quality of service, level of security) and is willing to pay y_i premium for it, where $i=1,2,\dots,N$ and $y_i > y_{i+1}$. If the user does not fully utilize bandwidth at a class with a high premium, the user wants traffic from a lower premium class or classes to be “upgraded”. The “upgrade” can take different forms; for example, if only half of the class 1 bandwidth is presently used, the excess could be given to the second class in its entirety; or, it could be distributed to the remaining classes proportionately. This service requirement is suitable for enterprise-like users and Virtual Private Networks (VPNs), i.e., “volume” but cost-aware customers with traffic that can take advantage of bandwidth pipes with different sizes. An example application is distance education.

A.2 IT Services. Three major factors make SLAs in an IT service environment different from those in networks; they all give rise to new research topics. First, the complexity of the IT system offers the “service designer” plenty of design choices to satisfy an SLA. For example, such choices may include: the number of CPUs (servers in the server farm); the logical organization of the databases in the disk system; the organization of the Web caches; the physical implementation of the storage subsystem; the balancing of the request load to the server farm; the order in which requests are processed inside a server. Second, the service designer may have to rely on incomplete system feedback. For example, a Web portal may have to support a throughput guarantee “for 1,000 transactions per second”, under the constraint of relying on server utilization measurements only. Third, IT SLAs are more “subjective” in nature. They often go beyond classic QoS metrics (used

in networks) to include Quality of Experience, which would arise from business requirements, such as customer satisfaction.

B. Research on the business aspect of services (led by faculty in COM). The research problems will center around two thematic areas: (i) how can organizations most effectively deliver services that meet customer needs and (ii) how organizations create service innovations.

B.1 Service effectiveness. Service Project Estimation. Estimating the time and level of effort for service projects is difficult and uncertain. As services become more customized and non-routine, traditional methods for estimation fall short. The objective of this research is to develop a predictive, contingent model that considers project technical characteristics as well as individual and group decision-making behaviors when developing estimates.

Services Supply Chain Assessment. This project will develop analytics to measure the effectiveness of the supply of resources to service engagements. The objectives will be to (A) Develop a thorough understanding of the most effective and appropriate measures of performance to enable superior management of services supply chains and (B) Create a comprehensive services supply chain current state map for use of technical subcontractors to capture existing activities and performance

B.2 Service Innovation. This research lies at the intersection of technology and marketing. It focuses on innovation processes and strategies and the role of technology as an enabler of decision-making. Two key issues are (A) analysis of the key drivers of success and failure in open source software development projects and (B) identification of the differentiators between product versus service innovation and the extent to which the same processes and best practices apply.

CONCLUSIONS

The new courses for the MBA and MSCN concentrations in services will be added between fall 2006 and fall 2007; the first graduates would be available in spring 2008. The Colleges of Engineering and Management also would be engaged in the following activities:

- Conduct basic and applied research relevant to services
- Support doctoral training in services
- Launch modules for executive education and lifelong learning
- Develop additional masters-level courses to enrich the curricula
- Create a joint masters degree program