Services Research and Education

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We outline herein the progress made at Rensselaer's Department of Decision Sciences and Engineering Systems (DSES) in regard to services research and education. More specifically, DSES' Center for Services Research and Education (CSRE) – established in 1990 under the directorship of Daniel Berg – has been responsible for our substantial activities in furthering services research and services education.

Services Research

Several factors have accounted for our progress in services research. First, the department, formally established in 1987, brought together faculty from science (in operations research), management (information systems and statistics) and engineering (industrial and systems engineering) – that is, from those disciplines that are required for services research. Second, a majority of the DSES faculty have always had a research interest in services, especially public (including transportation and infrastructure) and financial services. Third, the department's decision informatics (i.e., decision-driven, information-based, real-time, adaptive, human-centered, and computationally-intensive) approach to data analysis (e.g., fusion, mining), decision modeling (e.g., genetic algorithms, simulation), and systems engineering (e.g., Bayesian networks, distributed control) is especially appropriate for developing innovative electronic services**.**

We have been especially successful at developing services methodologies and processes by exploring the similarities (e.g., cycle time, system performance), complementarities (e.g., plane/traveling, plant/financing), and differences (see table below) between manufacturing – where considerable research have been undertaken – and services. (Interestingly, as we move toward real-time mass customization or personalization, products and services will become so integrated that they will become

FOCUS	SERVICES	MANUFACTURING
Production	Co-Produced	Pre-Produced
Variability	Heterogeneous	Identical
Physicality	Intangible	Tangible
Product	Perishable	Inventoriable
Objective	Personalizable	Reliable
Satisfaction	Expectation-Related	Utility-Related
Life Cycle	Reusable	Recyclable
OVERALL	CHIPPER	PITIRUR

indistinguishable.) Of course, even when there are similarities, it is critical that the co-producing nature of services be carefully taken into consideration. For example, in manufacturing, physical parameters, statistics of production and quality can be more precisely delineated; on the other hand, since a service operation depends on an interaction in the process of producing the service with the recipient, the characterization is necessarily different and difficult. Consequently, issues related to technologies, systems, organization and cognitive science loom large in service delivery, quality, and productivity. A process orientation is paramount. As indicated in the table, a key difference between manufacturing and services is that in the former, the physical assets depreciate with use and time, while in the latter, the virtual assets are generally reusable, and may in fact increase in value with repeated use and over time. The virtual assets are predominantly processes and associated human resources that derive from the skill and knowledge base established by repeated interactions with the service receiver, who is involved in the co-production of the service.

More importantly, the service being provided is based on intellectual property that is rarely protected by any patents belonging to the service provider. Usually the service provider uses physical technologies or products that belong to outside suppliers who protect their intellectual property by patents. However, the use of the intellectual property, either by product purchase or by license, is available non-exclusively to all competing service providers. Examples abound: the airline industry uses jet airplanes, which technology is protected by patents owned by the aircraft manufacturers and other suppliers; Wal-Mart, as part of its vaunted supply chain leadership, relies on point-of-sales cash registers developed and sold by IBM, which holds the intellectual property for those devices; and Citibank, the leader in employing the automated teller machine (ATM) innovation, does not hold the ATM-related patents – Diebold does.

Rather than the service processes being protected by intellectual property owned by the service provider itself, the service businesses often obtain competitive advantages in a different manner and by employing intangible assets. Among the other methods, they use branding (e.g., Starbucks) to differentiate themselves from competitors; they use high switching costs (e.g., Microsoft) to make it difficult for customers to switch to other vendors; and they use cost advantages (e.g., Wal-Mart), derived from supply chain or other organizational strengths. Another approach to create competitive advantages or service value, not necessarily derived from intellectual property, is to utilize network externalities (e.g., eBay) for increasing the number of users. Admittedly, eBay and Microsoft also protect their intellectual property by patents and copyrights, but there is disproportionately more intellectual property protection in manufacturing than in services – that is, much more than 20% of the patents issued are in the goods sector, or conversely, much less than 80% of the patents issued are in the services sector, which is now employing some 80% of the workforce.

As a consequence and for the reasons enumerated above, innovations in the services sector focus on a knowledge-based understanding of technologies and how to employ them to generate new and valuable services and/or experiences (which, like Starbuck, can be considered to be a closely integrated product and service). Therefore, the ability of service organizations to readily understand, adapt, utilize, incorporate technologies and processes developed by others is essential for commercial success.

Services Education

Coincidentally, following the establishment of DSES in 1987, the hiring of Rensselaer graduates by employers in the goods sector began to decrease in favor of services employment; today, the majority of our graduates are entering the workforce as services employees. Indeed, while some of the same well-known goods companies (e.g., IBM, GE) are still hiring large numbers of our graduates, it is their services divisions that are doing the hiring. Given this new market reality and the findings of our services research, we have been revising our courses and curricula to be more services relevant, at both the undergraduate and graduate levels. As an example, we revised and expanded our Master's curriculum in Manufacturing Systems Engineering, and in 2004, it became the Services and Manufacturing Systems Engineering (SMSE) curriculum. The catalog description of the curriculum follows.

All students seeking the MS degree in Services and Manufacturing Systems Engineering (SMSE) must complete the following courses in their 30-credit-hour program of study. The prerequisite course – Operations Research I (or equivalent – may be counted toward the 30-credit hour total if taken at Rensselaer and included in the Master's Plan of Study. In addition to the prerequisite course, a student's core course work will include:

- *DSES-6570 Information Technology and Systems for E-Business*
- *DSES-6610 Systems Modeling and Decision Sciences*
- *DSES-6620 Discrete Event Simulation*
- *DSES-6820 Queuing Systems and Applications*
- *MGMT-6960 Knowledge Based Operations Management*

Concentrations: Students must select the remaining 4 to 5 courses in the Plan of Study from either the Service Operations or Manufacturing Processes concentrations. The Service Operations concentration includes the following courses:

- *DSES-6110 Introduction to Applied Statistics*
- *DSES-6140 Exploratory Data Analysis*
- *DSES-6180 Knowledge Discovery with Data Mining*
- *DSES-6470/MGMT-6610 Global Strategic Management of Technological Innovation*
- *DSES-6480/MGMT-6480 Services Operations Management*
- *DSES-6500 Information & Decision Technologies for Industrial and Service Systems*
- *DSES-6600 Models for Production Control & Service Logistics*
- *DSES-6630 Continuous Simulation and Financial Mathematics*
- *DSES-6640 Quantitative Analysis of Health Systems*
- *DSES-6860 Evaluation Methods for Decision Making*
- *DSES-6870 Introduction to Neural Networks*
- *DSES-6990/6980 Master's Project in Services Systems*
- *MATH-4740 Mathematics of Finance*
- *MGMT-6240 Financial Trading and Investing*
- *MGMT-6690 Supply Chain Management for E-Business*