

Proposal to Establish a Partnership of Two
Centers for "Service Enterprise Engineering" (SEE Centers)
within
The Harold & Inge Marcus Department of Industrial and Manufacturing Engineering
College of Engineering of the Pennsylvania State University, USA
and within
The Davidson Faculty of Industrial Engineering and Management
Technion, Israel Institute of Technology, ISRAEL
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Executive Summary

"Industrial Engineering as a discipline is at a crossroads. We have an opportunity to change directions, to re-energize, and to stake a legitimate claim for an important class of engineering systems problems. Now is the time for action."
(IIE Council of Fellows retreat, IIE Solutions, Dec 2002)

Service Enterprise Engineering (SEE) is an emerging scientific field that is gaining importance and recognition in both academia and practice. The Harold & Inge Marcus Department of Industrial and Manufacturing Engineering (IME) at Penn State, and the William Davidson Faculty of Industrial Engineering and Management (IE&M) at Technion are both internationally known as leaders and innovators within the core disciplines that will play central roles in SEE, including industrial engineering, operations research, statistics, information systems, behavioral sciences, economics, and functional areas of management. As such, IME and IE&M are ideally positioned to lead the development of two globally recognized research and teaching centers for service enterprise engineering (SEE), as proposed herein. The two envisioned centers will be designed from the outset to promote and maintain a lasting partnership between one another. The core mission of the sister centers will be to:

- Provide a coherent framework and focus for existing SEE research, both within IME and IE&M as well as elsewhere at Penn State and the Technion.
- Stimulate new SEE research through seed funding, conferences and workshops in academia and industry, form cooperation with other research centers at Penn State, Technion and worldwide, develop regular seminars and establish a joint SEE laboratory.
- Identify and solicit sources of financial funding for graduate students, visitors (short- and long-term), post-doctoral fellows and research projects.
- Create a body of knowledge that is research-based, and which will be disseminated through documents, software, educational instruments and consulting services.

Concomitant with establishing the centers, the existing Marcus Penn State-Technion Exchange endowment will give priority to the new initiative in Service Enterprise Engineering and will fund a newly established Harold & Inge Marcus Lectureship series. The above key features, along with metrics for success and evaluation are discussed in greater depth in the body of the proposal below.

The Centers for Service Enterprise Engineering

1 Introduction

This is a proposal to create two new centers for *Service Enterprise Engineering (SEE Centers)*: one within The Harold & Inge Marcus Department of Industrial and Manufacturing Engineering (IME), College of Engineering of the Pennsylvania State University, USA; and the other within The Davidson Faculty of Industrial Engineering and Management (IE&M), Technion, Israel Institute of Technology, ISRAEL. It is also proposed that funds made available from the existing Marcus Penn State –Technion Exchange Program endowment will give priority to support this initiative.

The two centers will emphasize the application of engineering and scientific principles to the description, design and operation of the infrastructure, processes, and systems that comprise the service sector, both *private* and *public*. The Centers' activities will emphasize the service sectors of the U.S. and Israel, exploring their interactions with each other as well as with the global economy.

The proposed new centers will be housed administratively within IME and IE&M, and open to the active participation of faculty and graduate students campus-wide. The first Center Directors will be Terry L. Friesz, Marcus Professor of Industrial Engineering, reporting to the Department Head of IME, and Avishai Mandelbaum, Benjamin & Florence Free Professor of Service Engineering, Operations Research and Statistics, reporting to the Dean of IE&M. The initial appointment of the Directors will be for a period of five years. Upon review, this appointment will have the opportunity for renewal. The directors will retain close collaboration with one another throughout the development of the centers.

There is now wide agreement that the U.S. and Israel economies have entered a new phase wherein the production and delivery of services has surpassed manufacturing as the largest component of the nation's gross national product. Responding to this change, IME and IE&M have acknowledged the desirability and practicality of establishing major centers devoted to service sector research. Both have identified a clear opportunity for growth of its own as well as Penn State's and Technion's reputation as centers of excellence for research on the service sector.

2 Motivation

The envisioned new centers are being proposed because of the confluence of several key considerations at this point in time:

- *Research:* There is an emerging sense among first tier IE programs worldwide that one of the greatest contributions universities can make to economic development over the next decade is to conduct scholarly inquiry and engage in teaching that addresses the special needs of the service sector. For example, the National Science Foundation in the U.S. has recognized *Service Enterprise Engineering* as the essential engineering research and educational specialty dealing with the design, planning and control of operations and processes

associated with the delivery of service. As another example, Service Engineering R&D has been developing within the Stuttgart IAO branch of the Fraunhofer Institute in Germany; indeed, the leader of this R&D effort, Prof. Dr. Hans-Jorg Bullinger, is now heading the whole institute (about 10,000 engineers and scientists, all over Germany).

- *Teaching*: IME continues to be ranked among the top few industrial engineering departments in the US News and World Report annual evaluation of graduate programs. IE&M has long been the leading IE program in Israel. To maintain and improve our rankings, our academic and research programs must be perceived as timely and responsive to the shifting focus of the world economy from manufacturing to the provision of services.
- *Knowledge*: Academic and research programs, by their very nature, involve the creation and transfer of knowledge. Accelerating global technological change means that it will be necessary to develop new academic and research initiatives more rapidly than allowed by the traditional processes for course approval and grant competition. The envisioned centers will allow just such rapid responses to emerging service engineering academic and research “hot topics”.

3 Background and Scope of the SEE Centers

In the Western economy, individual consumers as well as firms, large and small, procure a vast array of services. In fact, the service sectors of the US and Israeli economies have become, according to some estimates, larger than the manufacturing sector. Certainly more new jobs are being created in the service sector than in traditional manufacturing enterprises. Innovations in computing technologies, such as web services and service-oriented computing architectures, provide striking enablers to this phenomenon.

With the aforementioned growth of the service sector comes a host of new phenomena. Foremost among these is the emergence of what may be called *service enterprises*, which are firms or institutions that possess some unique features that distinguish them from traditional firms and institutions. These include both physical and virtual services, as well as recasting of existing ways of doing business that introduces a service component. In fact, some or all of the following features will be manifested by most service enterprises:

1. service enterprises tend to hold little physical inventory as output, in the sense that their output in most cases is intangible and ‘perishable’;
2. service enterprises tend to be data-intensive, thus providing opportunities for data-based online mass-customization and skills-based matching of customers with their service-providers;
3. bundling of goods and services, which presents significant opportunities for effective and efficient management of lines of business, both to improve internal efficiencies as well as to offer innovative services to customers;
4. interactions between service enterprises and their customers are increasingly via tele-channels (telephone, internet), which requires careful design of these service interactions and appropriate training and life-long education of the service providers;

5. service enterprises participate in potentially fierce competition, primarily by setting prices and by influencing consumers' learning processes regarding available services;
6. service enterprises are highly sensitive to technological advances in service provision and infrastructure – this makes long range planning and workforce management very difficult;
7. the fixed costs of service enterprises are substantially more significant than their variable costs, and frequently their variable costs are highly structured.
8. the order of entry of service enterprises into a given service market is often very important to competitiveness and long-run success;

Each of the service enterprise features mentioned above is a potential topic for basic research to be performed by the proposed centers. Basic research activities notwithstanding, a significant part of the Centers' research energies will be applied in nature, focusing on data-based application of mathematics, operations research, statistics and information technology to service enterprise engineering design and control.

4 SEE: An Emerging Consensus

The scholarly community has recognized that maintaining a service firm's competitiveness or a service institution's rank, in the face of the special properties of service enterprises mentioned above, poses a significant challenge that may be best addressed using quantitative tools. Specific observations supporting this point of view are the following:

1. The Institute for Operations Research and the Management Sciences (INFORMS) publishes a relatively new journal entitled *Manufacturing & Service Operations Management (M&SOM)* that promotes scholarly discourse and research on the service sector. In general the field of inquiry addressed by the journal M&SOM is called manufacturing and service operations management and given the acronym MSOM to distinguish it from the journal. Similar initiatives are seen in the growth of service-related conferences (e.g. sponsored by the Institute of Electrical and Electronics Engineers - IEEE), and new journals (e.g. *International Journal of Web Services Research*).
2. Important fields of inquiry and practice, for example supply chain management (SCM), transportation, distribution and logistics (TDL) and technical support (TS) have significant service-components. Moreover, external firms increasingly take charge of virtually all related SCM, TDL and TS activities associated with a client firm's presence in its output markets. Consequently, such activities may also be considered a branch of service enterprise engineering.
3. Revenue management (RM) is another relatively new field that may be thought of as a sub-discipline of the MSOM field. In RM one concentrates on revenue maximization since costs are largely fixed, while in MSOM one maximizes profits either alone or in combination with other investment criteria. Revenue management stresses dynamic price discrimination to extract all unused willingness to pay from service consumers.

4. Still another new field that is directly relevant to service engineering is financial engineering (FE), which focuses on the pricing of both financial options and real options. Moreover, the theory of real options is now being used to value flexibility (defined as the ability to respond effectively to unanticipated events) in both manufacturing and service provision. It is literally revolutionizing the practice of project evaluation in the service sector by providing an alternative to the way net benefits are calculated in classical net present value (NPV) analysis in engineering economics.
5. Operations Research has become the dominant academic and professional vehicle for disseminating and refining MSOM, SCM, TDL, RM and FE quantitative and mathematical modeling innovations. This means that industrial engineering departments are a natural “home” for MSOM, SCM, TDL, RM and FE activities since Operations Research is considered a fundamental component of industrial engineering.
6. Service computing and service-oriented architectures (SOA) are increasingly seen as essential elements to support the design and deployment of virtual services either on their own or in combination with physical services.
7. In addition to the SEE topics of inquiry and discourse mentioned above, there are additional service engineering activities that are continually present in the U.S. and Israel economies, including but not limited to the following:
 - electronic commerce (EC)
 - hospitality and leisure (HL)
 - telecommunications (TC) and tele-services (TS)
 - healthcare (HC)

Taken together, the above observations help to define the human resources needed to create a successful service engineering center, namely experts in optimization, simulation, stochastic processes, dynamic systems and control, engineering economy, and financial engineering as well as specific technologies that are at the heart of the MSOM, SCM, TDL, RM, FE, EC, HL, TC, TS and HC application domains discussed above.

The engineering faculty in IME and IE&M cover most of the identified SEE application domains (MSOM, SCM, TDL, RM, FE, S, HL, TC, TS and HC) to some degree. However, that coverage is extremely thin in some cases. Consequently, one of the most important steps the envisioned SEE centers must take early on is that of inducing the faculty to place their research and teaching more directly in line with recent and anticipated trends in service enterprise engineering. We discuss in the sequel how this critical task might be accomplished.

5 The Notion of a Center

Establishing the SEE centers within IME and IE&M will encourage and enable the faculty to focus its research activities in a way that explicitly recognizes the importance of service enterprises and allows close contact with firms and institutions engaged in service enterprise engineering.

The central mission of the envisioned centers will be to establish the foundation and maintain a framework for research, teaching, and professional training that are relevant to service enterprises, in both the private and public sectors. This will be accomplished through a variety of activities, including but not limited to:

- sponsored research, both theoretically- and practically-oriented
- support graduate students, post-docs, research assistants/associates, visitors
- teach courses, conduct workshops, develop seminars
- offer continuously updated technology-transfer program (including workshops, seminars, non-degree professional training, etc.) to practicing industrial engineers needing timely knowledge on the service sector and quantitative tools for its management
- establish a SEE Laboratory, as described in the following section

Both centers will nurture each other through these activities. We shall be guided by our intention to make direct links between theory and practice so as to shorten the lag between research on new service enterprise engineering tools and their deployment in the real world. Consequently, we need to provide inducements for faculty to focus on SEE teaching and research. Such inducements will be directly linked to service engineering and available only to those faculty members who participate actively in the life of the Centers.

6 The SEE Laboratory

An important ingredient of the SEE Centers is envisioned to be a *data-based laboratory* that will serve IME and IE&M researchers and students, as well as authorized practitioners. The SEE Laboratory will aim to establish and maintain an accessible repository of resources and data pertaining to the design, management and operation of service enterprises, for the purposes of research and teaching.

The SEE Laboratory will have three components: databases, teaching resources and scientific resources. More specifically:

- *Databases*: Data from active service enterprises will be imported and put into a source-independent data format that is amenable for analysis. These data will be made accessible through either a specially designed interface for extracting data and summaries, or through some direct interface. The system will be installed on a dedicated Internet server, allowing access to accredited parties.
- *Teaching Resources*: The resources bank will include a set of teaching units, each involving data from the above-mentioned databases. The units will revolve around SEE themes and problems. For teachers' benefit, solutions to these problems will be provided, based on both supporting theory and analysis of the laboratory data..

- *Scientific Resources:* The resource bank will maintain a library of IME and IE&M research publications on SEE topics, and eventually also a bibliography of publications related to SEE. Where relevant important commercial, as well as faculty developed, service sector decision support software and models will also be available.

IE&M at the Technion has already a proof-of-concept for the SEE Laboratory, based on the growing sector of telephone call centers; for detailed information see

<http://ie.technion.ac.il/serveng/References/DataMOCCA.pdf>

and

http://ie.technion.ac.il/serveng/References/US7_CC_avi.pdf

Presently IE&M is planning to expand their SEE Laboratory to encompass the health care system.

Other possible avenues for the SEE Laboratory include the development of a complementary laboratory at IME focusing on one or more of the following topics: electronic commerce, hospitality and leisure, transportation and logistics, /and telecommunications.

7 Using the Existing Harold & Inge Marcus Endowment Fund

The current endowment fund that was donated by Harold & Inge Marcus to the Technion and Penn State will give high priority to supporting faculty collaboration on SEE topics. It is expected that a significant part of the endowment's yearly income will be made available for SEE purposes. These endowment funds are provided on a continuing basis and will remain a continuous thread of collaboration beyond the four-year start-up period proposed here. In particular, the fund will support a new lectureship series as described below.

7.1 The Technion-Penn State Marcus Lectureship in Service Enterprise Engineering

The Technion and Pennsylvania State University will use some of the existing Harold & Inge Marcus Endowed Fund to establish, in perpetuity, a distinguished lecture in service enterprise engineering. This lecture will bring leaders in industry and academia to campus to visit with faculty and present a distinguished lecture. The lecturer will be internationally recognized and agreed upon by both institutions. Formal hosting of the lecture will rotate between the Technion and Penn State on alternating years. The lecture will be broadcast via teleconference to the sister institution.

8 Initial Activities

The two centers will support the following activities:

1. *SEE Marcus Graduate Fellows:* Each Center will award several SEE Marcus Research Fellowships to support graduate students and post-doctoral fellows who are pursuing their studies in areas relevant to the service sector. The SEE Marcus Graduate Fellow award will be renewable, contingent on performance. Annually, a virtual conference between the Technion and Penn State will be held in which the SEE Fellows and faculty have opportunity to present their work to one another.
2. *SEE Marcus Research Initiation Awards:* Through a peer-reviewed process, faculty may submit to receive seed funding for creative and innovative ideas in applying industrial engineering and supporting methodologies (for example Operations Research, Statistics, Computer Science) to the service sector. Accepted proposals will be funded (either fully or partially) for a period of one-to-two years, with the possibility of renewal upon review. Grant recipient will be encouraged to prepare and submit a research proposal to an approved SEE external sponsor.
3. *The Marcus Visiting Scholar Program:* Visiting scholars with renowned reputation in the service sector will be invited to each campus for an extended stay. These scholars will present their research in workshops/colloquia, interact with graduate students and engage with the faculty. Funds will be used to offset expenses incurred by the Visiting Scholars during their stay, including an honorarium.
4. *Travel Grants:* The center will provide travel awards for faculty to pursue research opportunities related to the service sector. While these funds could be used for conference attendance, their main purpose is that of garnering support for the center and of encouraging and supporting faculty exchanges between the Technion and PSU.
5. *Personnel, Administrative Support:* The directors of the SEE centers will receive one course-release annually in support of responsibilities running the center. In addition, a half-time administrative assistant will be provided to assist in coordination and marketing of the center activities. Also, the requisite supplies and office equipment to support the center shall be provided throughout the period of this award.
6. *Research Facilities and Laboratory Support:* During the first year, necessary research facilities will be established and equipped to support faculty endeavors. During subsequent years, support will be given to research associates, computer programmers and technicians who support SEE Center activities and its funded research.
7. *Technology Transfer Programs.* IME and IE&M will offer various programs, including workshops and continuing education, for service sector engineers and managers of service engineering enterprises.

9 Planned Activities beyond the Period of Funding

There is a close coupling of the sustainability of the sister centers and the manner in which the Marcus gift is spent. The request for four years of funding is meant to take the sister centers through their critical start-up phase. Funds from the gift will be spent according to a scheme that will lead to sustainability and self-perpetuity of the centers by the start of the fifth year.

Succinctly put, the Marcus gift will be used to identify and redirect highly motivated faculty toward service enterprise engineering research and a level of scholarly accomplishment that will allow those faculty to successfully compete for external service-related research grants. Development of the ability for IME and IE&M faculty to successfully compete for external service-related grants will be an important factor in perpetuating the activities of the sister centers after the Marcus gift is spent.

The initial funding provides resources to engage new partners within the universities and build momentum to assure continuation of this initiative past the period of initial funding. Long-term sustainability is a primary responsibility of the Directors. The activities planned beyond the period of funding will include:

1. Public and Private Research Funding

Faculties at the Technion and Penn State have been successful at securing research sponsorship for their areas of inquiry. Through the programs outlined in this proposal, faculty research will be directed toward the service sector. It is therefore expected that faculty who participate in the center will carry the responsibility of pursuing external funding through government and private sources.

2. SEE Technology Transfer Programs

It is expected that the centers will carry forward the mission of disseminating their research into practice through offering a variety of technology transfer programs including short courses and seminars (which will be managed through the Continuing Education offices for each university), in-house training programs, in-campus workshops, etc. It is envisioned that such programs would become a continuing source for additional funding for the centers' activities.

3. SEE Industrial Affiliates Program

Through the center, companies will have opportunity to access the expertise of affiliated faculty for specific applied problems within their organization. This program is aimed at creating long-term relations between the centers and service-oriented firms that will be affiliated with the centers' activities. It is anticipated that this program will also generate additional funding for the centers.

10 Measures of Success

At the completion of the funding period, the two departments will be recognized as joint international leaders in the application of industrial engineering to the service sector. Specific primary metrics have been established which will be used to evaluate the degree of success. In particular:

- Number of papers published in archival journals by Technion and PSU faculty related to Service Enterprise Engineering,
- Number of papers presented at conferences by Technion and PSU faculty related to Service Enterprise Engineering,
- Number of Technion and PSU students that took service engineering courses prepared and delivered by faculty affiliated with the centers,
- Number of graduate students who pursue theses and dissertations in this area,
- Number of research proposal prepared by the sister centers that received high ranking by competitive funding agencies,
- Amount of external funding obtained in support of the service orientation.