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SSME curricula: an overview

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Abstract

Services Science (SSME) is a reality. After the 2006 manifesto published by Communications of ACM several universities are launching SSME curricula. In order to give a well founded overview of SSME and related curricula, we first address SSME scope issues. Later on we summarize the main contents of the curriculum and particularly the learning approach in the core classes. As case studies, we describe the SSME curriculum of University of Peking and University of Pavia. Finally we consider results. Graduate service engineers are designers of IT-enabled services who know how to analyze and design business service chains and to identify, customize and integrate appropriate IT modules. Differently from traditional IT engineers, service engineers use a critical value based approach with a faster and comprehensive analysis

Keywords— Service Sciences, SSME, Services Engineering, Engineering Education, Information Analysis, Business Process Analysis, Business Process Design, Business Process Modeling

Introduction : towards a Services Science Paradigm

A. Service Science references

In July 2006, "Communications of ACM" published a special issue on Service Sciences, with a comprehensive domain definition with[6]. Service sciences or SSME (Services Science Management and Engineering) is an interdisciplinary approach where different fields, from information engineering to management and mathematical/scientific disciplines, are integrated. SSME is the topic of "Frontiers on Service" [3] conferences promoted by IBM (www.ibm.com), IITA International Conference on Services Science, Management and Engineering, a co-located sessions in IFIP conferences[8] and an issue of the IBM Systems Journal (Volume 47, Number 1, 2008). SSME sessions are hosted in international conferences (e.g. in IFIP's WCC08, SCC2010, IESS1.12011, ICSSME2011, ICMSS2011, NISS2010, MASS2011, QUIS122011, LISS2011, IJCSS2011 and SSME2010).

SSME is discussed also in some books. Sauss [11] collects papers from German context; Cheng Hsu

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explains the transformation of systems and business practices enabled by digital services; Katzan[5] provides a comprehensive reference manual on service taxonomy and concepts, that is oriented to IT (COBIT framework) and telecommunication services; Fitzsimmons synthesizes both strategic and operational issues on service management. Generally, the analysis of business processes is neglected and an SSME textbook are in early stages . A Service Science reference book is being prepared by IBM .

New journals are emerging on SSME topic. In 2008 "Journal of Service Science and Management" and "Journal of Service Science" published their first volume; in 2009 the Service Science Section of INFORMS published the first volume of "Service Science", a fully refereed online journal focusing on fast-track publication; in 2010, the Information Resource Management Association (IRMA) published its first volume of the "International Journal of Service Science, Management, Engineering, and Technology" (IJSSMET) in order to pursue the mission of advancing the service sciences in their theoretical and practical aspects, serving as a vehicle for the development of service science, management and engineering (SSME).

B. European research projects related to Services Science

The taxonomy of research is a key to design curricula, specifically at MS and doctoral level. SSME related research programs are carried out by several universities, research institutions, corporations and government.

The Seventh Framework Program for research and technological development (FP7) puts research-related EU initiatives together under a common roof. The Program includes Calls, each funding a certain set of projects. Call 5, published on 9 December 2008 and closed on 17 March 2009, specifically includes service systems. Within this call, the Challenge 1, "Pervasive and Trustworthy Network and Service Infrastructures" includes Internet of Services, Software and Virtualization that can be considered a solid part of SSME. The aim is to join forces to research on software & services technologies, to bring these advances to the market and to ensure European leadership in the new Internet economy, "the Internet of Services". The framework is clearly illustrated by Figure 1.

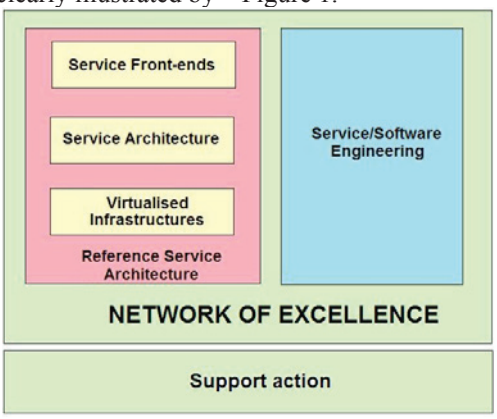

Figure 1 The framework of Internet of Services (From: http://cordis.europa.eu/fp7/ict/ssai/internet-services_en.html)

The Service Front-ends projects reflect the challenge to give users the control of web applications and enable them to mix services and data to compose services which are useful for them. The projects classified in the "Service Architectures" area are on the service oriented architectures and service oriented computing. These approaches allow pieces of software to be made available as "services" that can be easily used and composed into applications. Network of excellence concerns (a) service architectures

and platforms and (b) novel service/software engineering technology. Support actions include NESSI 2010, Service Web 3.0, and Floss. They help reach the purpose of Objective 1.2.
FP7 is giving a set of hints on the IT side of services, but does not offer a comprehensive paradigm, that includes both IT and business aspects.

C. A potential SSME paradigm

Also in EU research programs, a specific SSME does not emerge. Very recently, a specific taxonomy for research has been proposed, that identifies four main categories, depending on their respective focus: Service Science Foundations, Service Engineering, Service Management, Service Technology. Specifically:

- Service Science Foundations include theoretical foundations of services; it involves formal theories on service systems, economic and formal models of service ecosystems etc.
- Service Engineering includes service analysis, design and modelling methodologies, service lifecycle management, service composition and mash-up, etc. Its purpose it is to develop service modellers that cover the whole service life cycle.
- Service Management includes all the disciplines and tools that enable organizations to mange services over their whole life cycle, from the definition of service strategy, to the operation, controlling and monitoring of services.
- Service Technology focuses on Service-Oriented Architecture (SOA) that develops technology platform to support the operation of IT services.

Services Sciences Curricula : an analysis framework

Within higher education, some Universities are delivering curricula close to SSME issues ,[10][4]. In 2008 [9] about twenty Universities were offering graduate classes and/or curriculum on Service Sciences. Accordingly the majority of curricula considered focus either on business or IT issues, while organizational aspects ("people") are not popular at all. However, if we consider the overall definition of Service Sciences, other curricula should be added. For instance, Software Engineering in HIT (Harbin Institute of Technology) is close to service engineering issues as well as it happens in other Chinese universities [15], that are addressing industry informatization [13][16].

Choudaha's [2] research on SSME curricula structures the topics that Universities actually propose. The focus are theoretical and conceptual foundations for a competency-based curriculum on SSME. The study used three rounds of an online Delphi survey to identify, prioritize, and define competencies and classes. The panel made of industry professionals and university faculty, totalled 51, 40, and 39 people, respectively. Based on the consensus of the participants, a final list of 10 competencies and 14 classes. The results of this study may serve as a common language among stakeholders to prepare future service scientists or "T-shaped" professionals for the service economy that is illustrated by Figure 2. This study also contributed to the body of literature of competency-based curriculum development in higher education. In a simplified way we put curricula on x, y axes, where x is the amount of credits given to non IT topics and y is the amount given on IT topics.

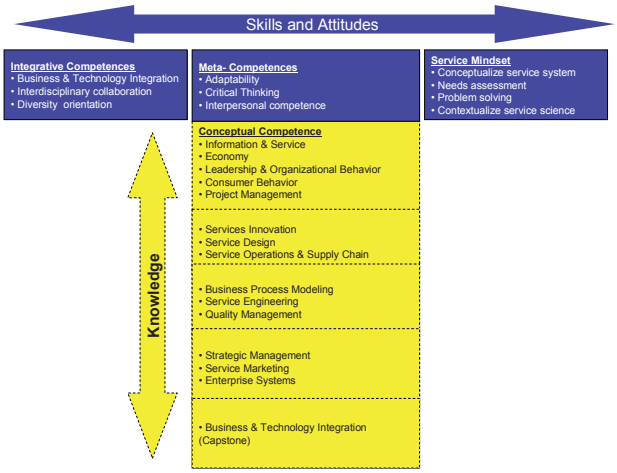

Figure 2 Choudada's framework on SSME curricula

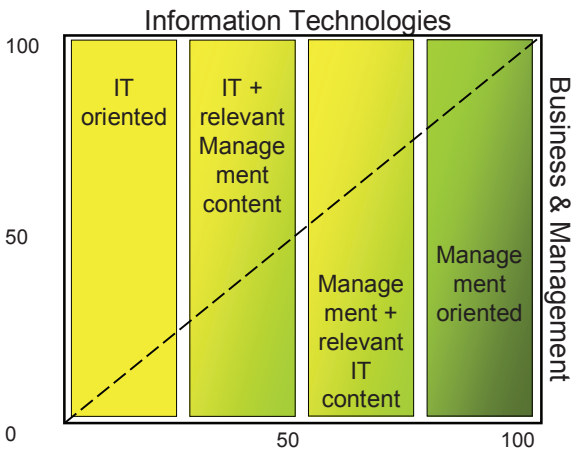

Figure 3 Orientation grid of SSME curricula

According to [9] we have selected a list of nine curricula and mapped against the Chouchada's framework in order to evaluate conceptual competence coverage. To better visualize results we have grouped the conceptual competences in fives areas:

- Area 1 includes Information & Science, Economy, Leadership & Organizational Behavior, Consumer Behavior and Project Management
- Area 2 includes Service Innovation, Service Design and Service Operations & Supply Chain
- Area 3 includes Business Process Modeling, Service Engineering and Quality Management
- Area 4 includes Strategic Management, Service Marketing and Enterprise Systems
- Area 5 includes Business & Technology Integration

A curricula offering more than 10 credits in an area gets a full mark, whilst a curricula offering

from none to 10 gets a half mark, finally a curriculum not offering classes on a specific area gets a null mark. **Table 2** illustrates the results of the mapping.

D. Case studies: University of Peking

The proposed reference curriculum has five modules plus an introduction course and a practice lab as shown in Table 1. The introduction provides the students a bird's eye of the field and a roadmap for further studies. A lab is essential to the engineering discipline. The proposed lab is meant to span one academic year with students in groups working on projects under the faculty supervision. Each module represents a field of knowledge that is relevant to service engineering, illustrated by a collection of representative "knowledge points". Apparently, there are no clear boundaries between all these modules, hence one would recognize some overlapping in contents, which are – one may argue – necessary in order to make each module self-contained.

Table 1 University of Peking - Curriculum on Service Sciences

Module	Contents
1.Business Perspective	*Business Innovation & Transformation Business value analysis covers understanding business strategy, IT strategy, developing business case, designing service system and transformation planning.*
2. Implementation (Technology) Perspective	*Service-enabling Technologies and Methodologies The key points to cover in the Service-oriented Architecture (SOA) are the concept that SOA serves to bridge the business and ICT architecture, SOA-based business process management, SOA solution life cycle, enterprise service bus, SOA reference architecture, service relationship modelling, etc. Web services modelling includes web services standards and technologies as well as business process modelling. Requirement driven services composition is concerned with business requirements modelling, service discovery, optimization for business services composition and service integration framework.*
3. Data/Knowledge Perspective	*Data-based Decision Support and Knowledge Management Emphasis in this module is placed on data and knowledge and their roles in business. Decision support would cover database management, content management, data warehouse, data mining, Online Analytical Processing (OLAP), customer relationship management (CRM). Knowledge management expert system, help desk, wikis, etc.*
4.Usage Perspective	*Use & Reuse Quality assurance includes concept of quality and quality assurance, and their impact on business, quality assurance model, quality assurance planning, etc., the technologies of quality assurance, including testing, technique assessment, static analysis, dynamic analysis, model checking, etc. Governance issues in SOA are standards and their compliances, change management, etc. Service asset reuse covers the concept of service assets, and asset reuse as well as asset management, asset evolution, and the reuse process in the service lifecycle.*

Module	Contents
5. Application Perspective	*Horizontal Applications Candidates for coverage in business resource & operation management include the following common services for enterprises: human resources, accounting, sales and distribution, production planning, material management, supply chain management, logistics, etc. IT Service Management (ITSM) is concerned with managing large-scale IT systems; a related framework is the Information Technology Infrastructure (ITIL).*

E. Case studies: University of Pavia

The Pavia's SSME curriculum is on Services Engineering. The curriculum is for students who come from an undergraduate minor on Information Engineering. Therefore incoming students have a good knowledge of Computer Science and Information. Conversely their business background is limited to 5 credits on general foundations of economics and organization theory. In short, the Service

Table 2 Universities curricula mapped on Chouchada's framework

University Curricula	Conceptual Competence				
	Area 1	*Area 2*	*Area 3*	*Area 4*	*Area 5*
Geneva Businss School, Master of Science in Business Administration	●			◗	
Hanken Swedish School of Economics adn Business Adminsitraiton	◗	◗	◗	◗	◗
Politecnico Milano, Services Engineering Master's program		◗	◗		◗
University of Pavia, Ingegneria dei Servizi (Services' Engineering)	●	●	◗	●	◗
University of Tilburg Holland			◗	◗	
North Carolina State University, SSME	●	●	◗	●	◗
Carnegie Mellon University, IT Services Qualification Center (ITSQC)	◗	◗			◗
University of California at Berkeley, SSME	●	◗	●		◗
Peking University, Service Science and Engineering	◗	●	●	◗	◗
Tsinghua University, Peking, Service Science	●	◗	●	◗	

Engineering curriculum puts together three competences, respectively Business and Service Engineering, Information Technology Foundations, Mathematical Classes; 30 credits are allocated to the final graduation activities and to the thesis ().

Business and Services Engineering classes give students a solid understanding of organizational and business process theory and the ability of identifying and analyzing business processes; in classes CRM, ERP and Management Information Systems students learn the architecture of on enterprise systems and test hands on how to customize these software platforms in order to automate processes and services. These core classes total 50% of all classes (over 30% if considering also final graduation activities and thesis). Information Technology Foundations include classes on modelling techniques such as advanced software engineering and databases, while complementary classes provide architectural foundations and some hand on knowledge on network and computer architecture. Finally, math classes provide the necessary background of techniques to size and optimize processes and services.

However, a class program is ineffective without hands on. Based on a previous multi year experience with Laboratories on Business Process Analysis given within the Industrial Engineering curriculum of

Politecnico di Milano we developed an approach based on case studies and project works. In the following paragraphs we describe the approach of our flagship class, Business Analysis.

The curriculum has been a success. Actually, Business Analysis classes in Politecnico di Milano and University of Pavia have educated, respectively, over 2.000 industrial engineers from 2003 to 3009 and 100 Services Engineers. Graduates have easily found new jobs. In the case of Pavia's Service Engineers, companies have offered internship and immediate hiring already in the last semester. Also, Business Analysis class is being replicated or planned by other Universities in Italy (University of Salento) and also abroad (I-School of Syracuse, Harbin Institute of Technology). Finally, the learning approach has proved to be extremely effective, with very high quality outputs, often superior than the corresponding professional ones.

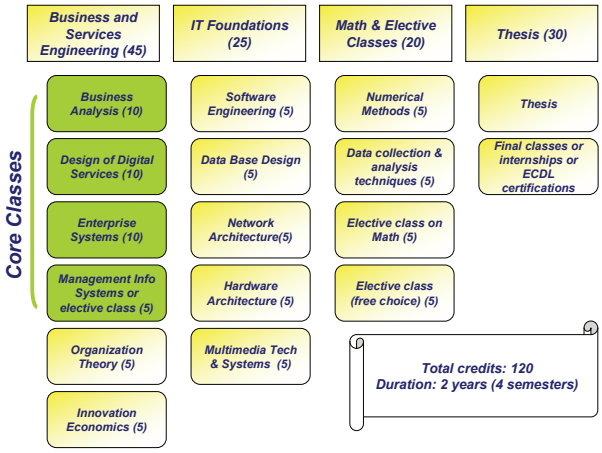

Figure 4 Curriculum of Services Engineering at Pavia University (brackets are indicated the credits of each class; 1 credit is worth 8 hours lecture or 20 hour hours lab)

Conclusions

We have described the emerging paradigm of SSME as a discipline and sketched out a SSSME curriculum that has the ambition to mate an engineering oriented to business to a business oriented approach to information engineering. Within SSME the service Engineering focus enable design abilities i.e. the capability of being architect and designer of Service Systems, with an analysis approach that spans from business level requirements down to the IT implementation that typically relies on SOA like paradigms. Our case studies show that SSME competence requires some key skills:

- Hands on: in Pavia's case study, 6 classes include analysis and design activities (Business Analysis I & II, Enterprise Systems I & II, Project work I & II)
- Design Ability: in Pavia's and in Peking case studies, the students learns how to assess existing process and systems design and how to design well formed processes and systems; this is also a point in Choudada's framework;
- Integrated Perspective: the curriculum bridge economic, organization and information engineering, including the innovation cycle, to which elective classes are oriented

Finally, SSME appears to be rather global. E.g. Pavia's curriculum and/or classes will be used in China (Harbin Institute of Technology) in a joint double master program, starting form 2010-2011 academic year.

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