The Cambridge-IBM SSME White Paper Revisited

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In July 2007, IBM and Cambridge University's Institute for Manufacturing (IfM), in conjunction with BAE Systems, convened a group of leading academics and senior industrialists in a two-day symposium to address the critical questions facing the emerging field of Service Science, Management and Engineering (SSME). The meeting, together with a consultation process involving over a hundred international respondents, created a white paper for universities, businesses and governments globally (IfM and IBM 2008). The report called for (1) the advancement of SSME as a distinct subject of research and education through intensive collaboration across disciplines, and (2) the creation of national Service Innovation Roadmaps (SIR) to double investment in service research and education worldwide by 2015. Since the white paper was released, exciting progress has taken place; many universities have started SSME courses while various governments released SIR reports (see Appendices I and II for lists of such initiatives). In the remainder of this chapter, we provide an updated summary of the white paper and revisit its original recommendations for SSME stakeholders.

Acknowledgments: Thanks to Cambridge University's Institute for Manufacturing (IfM), IBM, BAE Systems, and US NSF grant IIS-0527770 for support. We especially thank the symposium participants, correspondents, and respondents for their efforts; a complete list of over one hundred names can be found in Appendix II and Appendix III of the original white paper (IfM and IBM 2008). The diverse backgrounds of this multicultural and multidisciplinary group produced remarkable commonality of view as to how we can move the field forward, as well as points of ongoing debate (see in the original white paper, Appendix VIII: On-going debate)

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Executive Summary

Innovation, a term applied almost exclusively to technologies in the past, is increasingly used in relation to services (Miles 2003). *Service systems*[1], which form a growing proportion of the world economy, are dynamic configurations of *people, technologies, organisations* and *shared information*, creating and delivering value to customers, providers and other *stakeholders* (Spohrer *et al.* 2007). Thanks to globalisation, demographic changes and technology developments, today's service systems have been driven to an unprecedented level of scale, complexity and interdependence. The rising significance of service and the accelerated rate of change mean that *service innovation* is now a major challenge to practitioners in business and government as well as to academics in education and research (Chesbrough and Spohrer 2006).

In response, *Service Science*, *Management and Engineering (SSME)*, or in short *Service Science*, is emerging as a distinct field aimed at improving our knowledge of service systems (IBM 2005). Its vision is to discover the underlying logic of complex service systems and to establish a common language and shared frameworks for service innovation. To this end, we can no longer afford to work in unconnected silos; instead, an *interdisciplinary* approach has to be adopted. And to encourage knowledge and skill development, governments and businesses should double the investment in service research and education.

Developing Service Science is no easy task. Drawing upon the expertise and experience of leading academics and senior practitioners, this article provides a starting point to raise awareness and establish benchmark. More specifically, it makes the following interrelated recommendations:

For education: Enable graduates from various disciplines to become *T-shaped professionals* or *adaptive innovators*; promote SSME education programmes and qualifications; develop a modular template-based SSME curriculum in higher education and extend to other levels of education; explore new teaching methods for SSME education.

For research: Develop an interdisciplinary and intercultural approach to service research; build bridges between disciplines through grand research challenges; establish *service system* and *value proposition* as foundational concepts; work with practitioners to create data sets to understand the nature and behaviour of service systems; create modelling and simulation tools for service systems.

For business: Establish employment policies and career paths for T-shaped professionals; review existing approaches to service innovation and provide grand challenges for service systems research; provide funding for service systems research; develop appropriate organisational arrangements to enhance industry-academic collaboration; work with stakeholders to include sustainability measures.

[1] Words in *italics* are defined in the glossary.

For government: Promote service innovation and provide funding for SSME education and research; demonstrate the value of Service Science to government agencies; develop relevant measurements and reliable data on knowledge-intensive service activities; make public service systems more comprehensive and citizen-responsive; encourage public hearings, workshops and briefings with other stakeholders to develop service innovation roadmaps.

Service Science is still in its infancy; but we are confident that, by adopting these recommendations, we can accelerate its development and benefit from service innovations in the future (e.g. a smarter planet).

The structure of this chapter follows the diagram below.

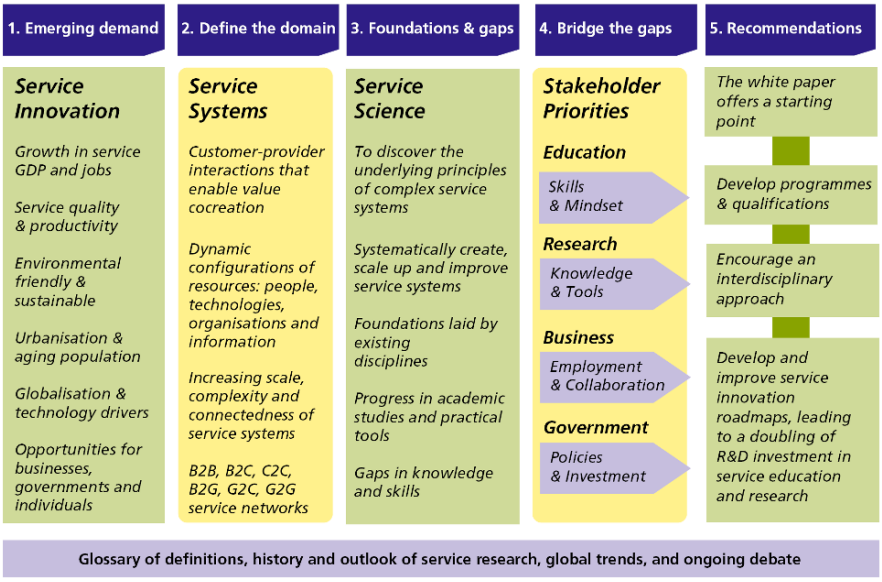

Figure 1. Succeeding through service innovation: a framework for progress.

Introduction

Growing demand for service innovation

While service growth[2] is broadly recognised across industries, our understanding of *service systems* remains rudimentary. Today's service systems are increasingly dispersed yet inter-connected, and their effectiveness, efficiency and sustainability matter to billions of people. Besides economic factors, service systems are complicated by our values in social, ecological and political dimensions.

Thanks to the application of science, management and engineering to the improvement of agriculture and manufacturing, remarkable products, from disease resistant crops to automobiles and personal computers, can be produced flexibly and efficiently and are widely available (Cohen & Zysman 1988). As a result, more time and more resources are used to search for, obtain, install, maintain, upgrade and dispose of products than production itself (Womack & Jones 2005). This trend offers a wealth of opportunities for *service innovation* – both incremental and radical.

To start with, service innovation can improve customer-provider interactions and enhance organisations' capabilities to create value with stakeholders. It often takes the form of better self-services, eliminating waiting and allowing 24/7 access via modern devices such as mobile phones, web browsers and kiosks. The benefits of service innovation can also be extended into government programmes, such as health care and education. For families and individuals, service innovation is needed to improve the quality of life and deal with important issues such as aging populations. In the virtual world, new service models, such as Amazon and Google, are changing our behaviour in decision making and in many other areas.

New skills and knowledge required

The rising demand for service innovation has huge implications for skills and the knowledge base that underpins them (NAE 2007). People are needed who can understand and marshal diverse global resources. Quite often, these resources are accessed using advanced information and communication technologies (ICT) and novel business models. The people with such skills are known as *adaptive innovators* – those who identify and realise a continuous stream of innovation in service

[2] By service growth we mean both the growth of the service sector in the economy as traditionally measured by statistics, as well as the growth of service activities in agriculture and manufacturing sectors (Vargo and Lusch 2004).

systems (Council on Competitiveness 2008). The demand for service innovation does not mean that the need for science, management and engineering in agriculture and manufacturing has gone away. But as the scope of innovation continues to move beyond products, we must prepare ourselves with the right skills and knowledge (BHEW 2008).

Service Science: an emerging field

The prominence of service in modern economies has gradually driven scholars to service-related studies. While research into service can be traced to as early as the 1940s, significant development was seen in the late 1970s when service research was broken free from product-centric concepts and theories (Fisk *et al.* 1993). The field of Service Science, Management and Engineering (SSME)[3] now covers a wide range of subjects, including *service economics, service marketing, service operations, service management, service engineering, service computing, service human resources management, service sourcing, service design,* and many others. Nevertheless, a more integrated approach is needed if real progress is to be made.

Key concepts and world view

There are four key concepts in Service Science: *service system* (entity), *value proposition* (interaction), *adaptive innovator* (individual trait), and *Service Science, Management and Engineering (SSME) graduates* (education focus). These concepts provide a service perspective on the traditional concepts: factory (entity), trade (interaction), problem solver (individual trait), and *Science, Technology, Engineering and Mathematics (STEM) graduates* (education focus). Based on the four concepts, the changing landscape of business and society can be viewed as a large global ecosystem, consisting of service system entities that are interacting via *value propositions* to co-create value (Anderson *et al.* 2007). Individuals with suitable traits fill roles in complex service systems, which in turn fill roles in even more complex service networks. When challenges and opportunities arise, individuals may want to change, improve or create service systems. With such a world view, adaptive innovators will benefit from their SSME knowledge and skills (Spohrer and Maglio 2009).

[3] Considering the integral role of design and the arts in customer experience, SSME could be logically extended to SSMED or SSMEA (Service Science, Management, Engineering and Design/Arts). In recent publications (Spohrer & Kwan 2008; Spohrer & Maglio 2009), the term SSMED has been used along with a discussion of ten basic concepts: ecology, entities, interactions (networks), outcomes (ISPAR), value-proposition-based interactions, governance-mechanisms-based interactions, stakeholders, measures, resources, and access rights.

Clarifying the rationale and defining the domain

What is a service system?

A service system is a dynamic configuration of resources (people, technology, organisations and shared information). Primary interactions take place at the interface between the provider and the customer, each with their own constellation of resources. Moreover, with the advent of ICT, interactions among customers and those among suppliers have also become prevalent. The interactions create a complex system whose behaviour is difficult to explain and predict. As a convenient illustration, the present global financial crisis started with subprime mortgage loans in the US, but has quickly rippled around the world and put most economies into a downturn.

Why are we interested in service systems?

We live in a world where it is a daily experience to interact with various service systems such as banking, communications, transport and health care. We all suffer frustrations (or worse) when service quality is poor and we all pay more when productivity is low. Yet this business-to-consumer (B2C) or government-to-consumer (G2C) view of service systems is just the tip of the iceberg. Although invisible to most consumers and citizens, service systems in business-to-business (B2B), business-to-government (B2G) and government-to-business (G2B) environments are also experiencing enormous change and growth.

In 2006, for the first time in human history, worldwide service jobs (42%) outnumbered jobs in agriculture (36.1%) and manufacturing (21.9%) (ILO 2007). If we consider service activities in manufacturing, even the latest figures are an understatement. However, although service sector accounts for over two thirds of GDP and jobs in many developed economies, investment in services represents less than one third of total R&D spending (RTI international 2005). This mismatch hinders our ability to address service challenges.

Businesses, competing in a global economy, are familiar with many of the issues and challenges that need to be addressed. Service performance relies on both *front-stage* and *back-stage* components (Teboul 2006). The ‘front stage’ is about provider-customer interactions: how can customer satisfaction be ensured in the presence of multiple customer touch points and various channels of contact? The ‘back stage’ is about operational efficiency: how can productivity be improved through skilled employees, advanced technology, streamlined processes and ro-

bust global sourcing relationships? More than anything else, businesses want to know: how can an extended *service network* be managed in a seamlessly integrated manner (Allee 2002; Nambisan & Sawhney 2007)? Service businesses are not alone in asking the questions; manufacturers are keen to understand the same issues as they embark on a *servicisation* journey (Ren 2009).

Similarly, government agencies and non-profit organisations feel the compelling need to provide better service to the public (Collins 2006). Commercial competition is replaced by demands for transparency, fairness, and accountability. For households, there is a growing recognition of the need to seek better education, health care and financial planning. And environmental concerns are high on everyone's agenda. The constellations of resources around individuals, families, non-profit organisations, government agencies, and businesses generate an enormous number of service interactions to be studied, designed, engineered and managed.

What is the vision for Service Science?

Our ability to address the practical challenges relies on our understanding of service systems. Unlike the IT industry, however, there is no *Moore's Law* roadmap for the service domain to guide organisations on what investments to make in order to see predictable performance improvements. As a result, we have poor knowledge about: (1) how to invest in service systems to sustainably improve key performance indicators (e.g. revenue, margin, growth, customer satisfaction, productivity, innovation, quality of life, social responsibility, environmental sustainability, and regulatory compliance), and (2) how to develop new service offerings, together with creative value propositions and improved business models.

The vision of Service Science, therefore, is to discover the underlying principles of complex service systems (and the value propositions that interconnect them into service networks). It should provide the structure and rigour for building a coherent body of knowledge to support ongoing innovation in service systems. To this end, it must provide answers to the following questions:

- What are the architectures of service systems?
- How is hierarchical complexity and diversity built up from simpler elements?
- How might we best understand the origins, lifecycles and sustainability of service systems?
- How can service systems be optimised to interact and co-create value?
- Why do interactions within and between service systems lead to particular outcomes?

For each question, we have pieces of the answer today, spread across many disciplines, but not yet a unified whole. Thus, Service Science provides motivation,

methods and skills for integration, optimisation and sustainability, equipping adaptive innovators with knowledge and tools for service innovation.

Who are the stakeholders of Service Science?

The stakeholders of Service Science include both individuals and organisations dependent on complex service systems. Businesses want to improve their service revenues and profit margins. Non-profit organisations want to deliver desired service offerings sustainably. National and local governments want to create a high-skilled workforce and develop infrastructures to improve the competitiveness and quality of life of their citizens. These stakeholders all need the knowledge and skills for service innovation, though they sometimes work at cross purposes (Reich 2007). Knowledge workers (academics and professionals alike) across a wide range of disciplines and professions are also important stakeholders. Indeed, the system of disciplines and professions has to evolve if it is to remain relevant to the changing landscape of service systems (Abbot 1988).

Why now?

Global trends, such as demographic shift, technology advancements and global sourcing, challenge us to create new ways of doing things. As we become more and more technology-enabled, globally integrated (interconnected), many new challenges and opportunities emerge. Physics, chemistry, biology, cognitive science, and computer science are some of the sciences that have enabled the development of today's service system ecology. Service Science has the potential to be as important in the future as these earlier sciences have proven in the past (Spohrer & Maglio 2009). However, modern tools of Service Science, such as a computer-aided design for service system simulation, will require significant investment.

Recognising the foundations and identifying the gaps

What foundations have been laid by existing theories?

The resources used to form service systems offer a useful starting point for developing Service Science. They can be divided into four clusters:

- Whole businesses and organisations: Studied primarily by schools of management (marketing, operations management, operations research and management sciences, supply chain management, innovation management)
- Technology: Studied primarily by schools of science and engineering (industrial engineering, computer science, statistical control theory)
- People: Studied primarily by schools of social sciences and humanities (economics, cognitive science, political science, design, humanities and arts)
- Shared information: Studied primarily by schools of information (communications, management information systems, document engineering, process modelling, simulation)

The white paper (IfM and IBM 2008) provided a list of 35 disciplines, from Architecture to Total Quality Management, and related each of them to the four types of resources above. Since then, a number of publications have provided further explanation of the relationship between disciplines and resource types (Spohrer and Kwan 2009; Spohrer & Maglio 2009).

Discovering fundamental building blocks of service systems and the way they can be combined to form our current service system ecology is well underway. Pioneering attempts to develop a normative view on how service systems can be described and their behaviours explained, include the Customer Contact model (Chase 1978), the Service Quality GAPS model (Parasuraman 1985), Service-Dominant Logic (Vargo and Lusch 2004), Unified Theory of Service (Sampson 2001), Service as Leasing (Lovelock and Gummesson 2004), and Work System Method (Alter 2006), to name but a few. These form initial efforts at resource classification schemes, along with associated access rights, service level agreements, standards and protocols, safeguarding mechanisms, intellectual property and failure recovery methods. They also provide foundational views from multiple stakeholder perspectives (customer, provider, authority, competitor, criminal, victim, etc.) on associated measures of service system performance (quality, productivity, compliance, sustainability, etc.).

Meanwhile, tools, methods and data sets for practical use are emerging (e.g. IBM's Component Business Modelling approach and toolkit) (Sanz *et al.* 2006). The use of service-oriented architectures (SOA) for describing information technology 'services' that support work and business practices is on the rise and has gained widespread acceptance. And more broadly, there have been new developments to model industrial evolution, which has generated interest among historical economists and organisation theorists (Beinhocker 2006).

Where is the knowledge gap?

Still, despite significant progress, achieving the vision of Service Science is perhaps a decade or more away. For one thing, there are still challenges within in-

dividual disciplines. For example, operations research and industrial engineering often model people waiting in queues, but the model fails to recognise people as emotional and psychological beings that can learn and adapt over time (e.g. Mansfield 1981). Computer science and information science often model information system architectures on the basis of well-understood environmental variations, but governance mechanisms that allow information systems to respond proactively to strategy changes and predictable technological advances are less understood.

In a similar vein, economics and business strategy need to accommodate predictable innovations (e.g. Christensen *et al.* 2004). Service management and operations need to create a better knowledge of service system scaling and lifecycle (Normann 2001). Law and political science need to build a better comprehension of social innovation and the way that legislation can improve service system productivity (March 1991). Complex systems engineering should provide more specific insights into the robustness of service systems (Sterman 2000). Last but not least, integration across all these disciplines and areas of study remains the ultimate challenge.

The current situation stems from the tradition that academic institutions are structured along disciplines and sub-disciplines (or areas of study). As shown in Figure 2, academic silos encourage deeper understanding of a specialised subject. The expectation from institutions and funding bodies is that academics conduct research and provide courses within their disciplines. Although often addressing similar matters, each discipline or department usually has a presumed set of interests, paradigms and methodologies. Over time, academics see interdisciplinary research as being highly risky and potentially career-damaging.

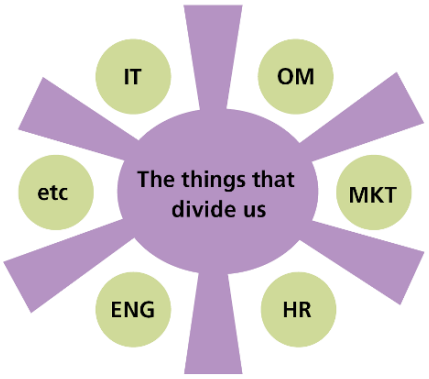

Figure 2. The gaps between academic disciplines.

As a result, service research is often imbalanced; studies tend to focus on either customers from a marketing perspective or providers from an operations perspective. This is reflected, and indeed reinforced, by top journals, which tend to be highly specialised. For instance, less than 20 percent of the papers in operations management journals focus on service topics while research on operations has a

similar profile in service journals (Johnston 2007). Moreover, disciplines also tend to focus on specific sectors; marketing tends to be concerned with business-to-consumer and operations with business-to-business (Johnston 2005). Gradually, a gap has emerged between academic output and practical interest.

Where is the skill gap?

Similarly, the supply of people with the right skills is increasingly inadequate. The role of education in the 20th century was in a large part to prepare students for jobs. Universities have been rewarded for creating people with specialised knowledge. The increasing complexity of service systems, however, requires an extended role of education in the 21st century – universities must prepare people to be adaptive innovators (NAE 2007).

Adaptive innovators are still taught in their home disciplines. In parallel, however, they also develop the ability to think and act across multiple disciplines. They can build consensus across functional silos and work in inter-inter-organisational and inter-cultural environments. They can communicate with specialists who may not have the same background. They embrace a service mindset, which is supported by intellectual, psychological and social capital components. They are driven by an integrative 'service logic' rather than the competing logics associated with individual functions or units. These adaptive innovators are in short supply as the service economy grows (Council on Competitiveness 2008).

Working together to bridge the gaps

What are the possible approaches to addressing the gaps?

The gaps in knowledge and skills needed to deal with complex service systems indicate that we need to reassess our approach to research and education. Figure 3 shows three possible routes to address the gaps. To some people, Service Science is seen as a *multidisciplinary* 'superset' embracing all appropriate, but as yet not agreed, disciplines and functions. To others, Service Science is seen as a multidisciplinary 'subset' embracing select elements of the major disciplines and functions. Finally, Service Science can be seen as an *interdisciplinary* activity which attempts to create an appropriate set of new knowledge to bridge and integrate various areas based on *transdisciplinary* and *crossdisciplinary* collaboration.

In this document, we advocate the interdisciplinary approach. Since many barriers to integration are well established, attempts to remove them would not only require considerable effort but deflect attention from purposeful bridging activities. Therefore, one way to overcome the barriers is to accept their existence and build bridges over them. This approach will lead to

> "curricula, training, and research programs that are designed to teach individuals to apply scientific, engineering, and management disciplines that integrate elements of computer science, operations research, industrial engineering, business strategy, management sciences, and social and legal sciences, in order to encourage innovation in how organisations create value for customers and stakeholders that could not be achieved through such disciplines working in isolation" (US Congress HR 2272, 2007).

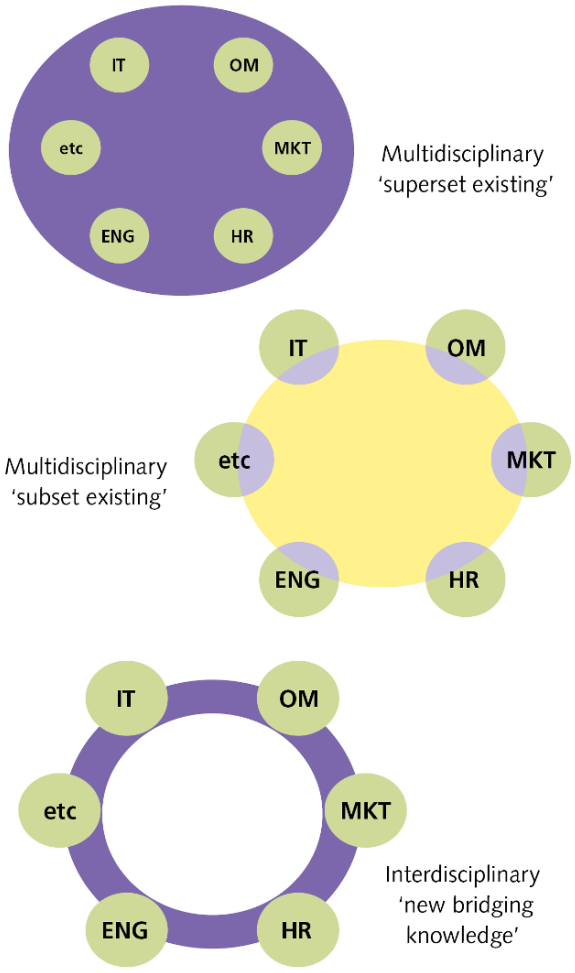

Figure 3. Three perspectives of service science.

Adam Smith (1776) laid the foundations of modern economics with his exploration of the division of labour (specialists) and its role in creating the wealth of nations. Today specialisation alone is not the answer to increasing value creation capacity of nations. To grow the wealth of nations sustainably, we must become far more systematic. We need both specialization and integration to create, improve and sustain service systems.

Where are the opportunities to address the knowledge gap?

Interdisciplinary activities are not new (e.g. Derry *et al.* 2005). In fact, they are practiced in many universities, often in close cooperation with industries. Opportunities exist at all levels to address the barriers between disciplines.

Individual level: Leaders in academia, business and government are well positioned to highlight the value of interdisciplinary work and to reduce the risks associated with moving outside a specialism or discipline. The potential of service science to improve society, not just business, can attract diverse people to the field.

Project level: Interdisciplinary interactions happen at a project level. Exemplary service system improvement projects (e.g., design the X of the future, given societal constraints Y) in the form of case studies can stimulate more cooperative behaviours with common purpose across disciplines or functions.

Business interactions: Business opportunities are often best explored via interdisciplinary and cross-functional teams. Businesses can supply engaging challenges and hard data for academic research to reach robust and practical conclusions (e.g., design the X of the future, given business reality Y).

Academic journals: Leading journals in the field of service research are extremely influential in setting the tone and agenda of academic research. They are uniquely placed to encourage interdisciplinary studies. Major specialised journals should be encouraged to initiate special issues on interdisciplinary topics. One of the tools that can be used is web-based communication (e.g., http://www.sersci.com/ServiceScience/).

Funding agencies: Except in certain areas of physics and mathematics, little is known about the methods needed to create integrated yet parsimonious theories that span multiple areas. Besides discipline-specific studies, funding should also be provided to support interdisciplinary service research through mechanisms such as dual appointments and shared rewards.

Where are the opportunities to address the skill gap?

Discipline-based education remains a vital role of modern universities. Yet in order to close the skill gap and create more adaptive innovators, universities

should offer students the opportunity to gain qualifications in the interdisciplinary requirements of SSME. Such qualifications help equip graduates with key concepts and essential vocabulary to discuss the design and improvement of service systems with peers from other disciplines. Industry refers to these people as T-shaped professionals, who are deep problem solvers in their home discipline but at the same time are also capable of interacting with and understanding specialists from a wide range of disciplines and functional areas (Leonard-Barton 1995).

Widely recognised SSME programmes would help ensure the availability of a large population of T-shaped professionals (from many home disciplines) with the ability to collaborate to create service innovations. Graduates with SSME qualifications, including improvement projects across industries and performance measures, would be well prepared to 'hit the ground running' and make significant contributions when joining a service innovation project (Spohrer & Kwan 2009).

Interdisciplinary course development requires significant effort to develop because different faculty members might find it hard to work together sustainably over time. Educational innovations are vulnerable because they are often reliant on the efforts of one or two people. Interdisciplinary programmes are even harder to organise, and more expensive to initiate and maintain, than conventional ones. Rapid progress in the design and delivery of these programmes would require support and resources from business and government.

Recommendations

Even though the service sector contributes over two thirds of GDP and employment in developed economies, investment in services accounts for less than one third of total R&D expenditure (RTI 2005). To address this imbalance, we urge the development of more national Service Innovation Roadmaps (SIR)[4], leading to a doubling of service R&D investment by 2015. Public Private Research Partnership (PPRP) programmes should be encouraged to support the improvement of service systems, e.g. to create a smarter planet. The following recommendations are offered as a starting point for a more inclusive conversation of all stakeholders as nations formulate and update their SIR reports:

[4] For an example of an innovation roadmap, see Appendix VII Example of innovation roadmap, in the original white paper (IfM and IBM 2008), as well as Appendix II of this chapter.

Recommendations for education

Enable graduates of disciplines to become T-shaped professionals, adaptive innovators with a service mindset.

All students and employees, who wish to, should have the opportunity to learn about Service Science and develop themselves into T-shaped professionals. This can be achieved by adding an SSME specialisation to an existing discipline. As adaptive innovators, they will have a good background in the fundamentals of service innovation. With a service mindset, they can work effectively in project teams across disciplines, functions, and cultural silos. As research creates a truly integrated theory of service systems, students of Service Science will become system thinkers prepared to succeed in a 21st century service-driven globally integrated economy.

Promote SSME education programmes in conjunction with industry recruitment of SSME qualified graduates.

SSME qualifications should include interactional skills across the main disciplines of Service Science. Such skills enable proficiency in the concepts and vocabulary for framing problems and discussing potential solutions across disciplines (Collins & Kusch, 1999). The main disciplines of Service Science include service economics, service marketing, service operations, service management, service quality (especially customer satisfaction), service strategy, service engineering, service human resource management (especially in a professional service firm), service computing, service supply chain (especially eSourcing), service design, service productivity, and service measurement.

Develop a modular template-based SSME curriculum in higher education at all levels of education.

SSME qualifications should employ a template-based curriculum model and specify modules that can be switched in and out across different faculty and courses. Practical or industry capstone projects are essential for students to develop a service mindset and to acquire the ability to solve problems cross-functionally in real-time. Capstone projects prepare students to understand service systems in action. The design and provisioning of such projects should ideally involve student teams with members from different areas, including business, government, and different universities (cultures). Attention should also be given to primary and secondary education. The design of Service Science laboratory space would enable multidisciplinary project teams to work together with collaborators in remote locations (ideally, via tele-presence technology). Projects should en-

courage links between real world, virtual world, and simulated world service systems.

Explore new teaching methods for SSME education across industries.

SSME qualifications should be accessible through a range of channels, including on-line eLearning and virtual worlds. They should offer access to cases, simulations, and lab activities in major sectors of the modern economy, including the public sectors (government and security, healthcare and education, environment and recreation), commercial sectors (retail and franchise, hospitality and entertainment), information sectors (financial and banking, consulting and professional, media and internet), and infrastructure sectors (transportation and communications, utilities and construction, manufacturing and mining).

Recommendations for research

Develop an inclusive interdisciplinary and intercultural approach to service research.

Many of the pioneering service research journals and conferences have made this a stated priority. However, much more needs to be done to measure and reward efforts that increase the actual amount of interdisciplinary and intercultural work in this emerging field.

Build bridges between disciplines through grand research challenges.

A good architecture helps to reduce a complex problem to separable components. However, when decomposition is not fully effective or has enormous complexity associated with it, a deeper foundational understanding is often needed. Researchers from multiple disciplines should look for opportunities to bridge between disciplines, especially in the context of grand research challenges that span multiple disciplines.

Establish service system (entity) and value proposition (interaction) as foundational concepts.

Every science must clearly define its boundaries in terms of the entities that it studies and the relevant interactions between those entities. Service systems and value propositions represent a starting point for Service Science.

Work with practitioners to create data sets to better understand the nature and behaviour of service systems.

Much real world data about service systems often has a proprietary nature and security concerns associated with it. The confidential feature of the data may require novel methods of archiving and releasing. Unlike many other subjects, service science researchers must focus their efforts on establishing appropriate legal, social, and economic conventions around data sharing for specific purposes.

Create modelling and simulations tools for the complete service systems ecology.

Perhaps more than any other subjects, advancement in Service Science depends on models and simulations of alternative service systems designs, where local optimisation may not lead to global optimisation (Ricketts 2007). When data are not readily available, service practitioners need simulation and computer-aided design (CAD) tools to support their decision-making processes.

Recommendations for business

Establish employment policies and career paths for T-shaped professionals.

Businesses should define career paths for T-shape professionals and indicate their preference for SSME qualifications in recruitment. This would demonstrate the demand for academic programmes and encourage the formation of interdisciplinary Service Science communities.

Review existing approaches to service innovation and provide grand challenges for service systems research.

Understanding, modelling and measuring service activities that take place in business today is already underway; for example, activity-based costing and service-oriented architecture. Despite promising progress, surprisingly little is known about (a) how to make optimal investment for service innovation (Ricketts 2007), (b) how to scale up margins as service revenues increase (Spohrer et al. 2007), (c) how to systematically reduce the complexity of service systems, and (d) how to devise measurement systems that can be used internally and shared externally to protect privacy and preserve competitive advantage (Spitzer 2007). These issues and others are potential grand challenges.

Provide funding for service systems research.

Businesses should provide resources for service systems research, through regional Public Private Research Partnerships (PPRP), with a focus on smart water systems or smart transportation systems, that create win-win-win's for local government agencies, businesses, and universities. Businesses can also fund industry Special Interest Group (SIG) initiatives via global organisations such as the Service Research and Innovation Initiative (SRII). Benchmarks on the current level of service research investment are a starting point.

Develop appropriate organisational arrangements to enhance industry-academic collaboration.

Businesses can also encourage employees to participate in SSME relevant SIG membership organizations, conferences and to support academic SSME programmes with the latest projects and case studies. Tools, methods and data sets are an ideal focus for business-academic collaborations.

Include sustainability measures and create actionable service innovation roadmaps.

As sustainability becomes an increasingly urgent global concern, businesses should take the opportunity to expand the definition of stakeholder value. Roadmaps for service innovation should include updated performance measures and better balance efficiency, effectiveness, and sustainability.

Recommendations for government

Promote service innovation for all parts of the economy and fund SSME education and research.

History repeatedly shows that focused research and development efforts can advance science and build a body of knowledge with long-term practical benefits. The separate discipline areas of service research have developed to a point that an integrated theory is within reach. National funding for university-based research in Service Science is critical and has far-reaching benefits for economy and society. Benchmarks on the current level of service research investment are a starting point.

Demonstrate the value of Service Science on national projects that create a smarter planet.

Improvements in government service systems, which employ over 20% of the populations in some nations, would lead to a ripple effect through the rest of the economy. Smarter transportation systems, water management systems, health care systems, education systems, energy systems, and green jobs initiatives create tools, methods, and data sets and can stimulate Public Private Research Partnerships (PPRP).

Develop relevant measurements and reliable data on knowledge-intensive service activities across sectors to underpin leading practice for service innovation.

Measuring service activities across sectors of the economy to better understand service quality, productivity, regulatory compliance, and sustainable innovation is an important starting point. More funding is needed for nationally directed data collection about multiple aspects of the service economy, including employment, skills and career paths, exports, investment, pricing, and IT-enabled activities, among others (Innovate America 2004).

Make government service systems more comprehensive and citizen-responsive.

Government service systems are especially in need of comprehensive review by engaging citizens. Transforming from a provider-centric to a citizen-centric perspective is a good first step (Clarke et al. 2007).

Encourage public hearings, workshops to develop national service innovation roadmaps (SIR) reports.

Continuous improvement of service systems requires an investment roadmap to focus and align academic, industry, and government stakeholders. Investment is needed in three categories: run, transform, and innovate (March 1991). Priority should be given to investment, legislative and policy initiatives that can systematically support the growth of the knowledge economy (knowledge creation) and the service economy (knowledge application to create value); both are needed in an innovation economy (Bell 1973).

In conclusion, we applaud the nations, universities, and businesses acting on these recommendations to advance SSME-related education and research and establish and revise SIR reports to guide ongoing investment in service innovation.

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Glossary

Adaptive innovators: People who are entrepreneurial and capable of systems thinking in the many project roles they may fill during their professional life. In contrast to the specialised problem solvers of the 20th century, who are sometimes called 'I-shaped' professionals for their knowledge depth, adaptive innovators of the 21st century are still grounded in their home disciplines but have strong communication skills across areas of business, technology and social sciences. Hence, they are sometimes called T-shaped professionals.

Back-stage service activities: Activities that do not involve direct interaction with the customer, for example, back office operations of a retail bank or marking of student coursework by a teacher. Information processing is a common back-stage service activity.

Crossdisciplinary: The teaching of one discipline from another disciplinary perspective (e.g., physics for poets). The knowledge of one discipline is used as a lens through which another discipline is studied.

Customer service system: A service system from the viewpoint of a customer or consumer. A customer service system searches provider value propositions looking for win-win value-cocreation opportunities. For example, a task the customer currently does (self service) may be outsourced to a provider, a problem the customer does not have the knowledge, capability, or authority to solve may be outsourced to a provider, or the customer may learn of a novel service offered by a provider that they desire (demand innovation).

Goods-dominant logic: Goods-dominant logic is the traditional economic world view, which considers services (plural) and products as two distinct value-creating mechanisms.

Front-stage service activity: Activities that involve direct interaction with a customer, for example, a doctor talking to and examining a patient or a teacher lecturing to a class of students. Customer communication is a common front-stage service activity.

Interactional Skills: Also known as complex communications skills, the ability to communicate across knowledge domains or disciplinary boundaries, without necessarily possessing deep contributory expertise. Contributory expertise allows experts or specialists to extend the knowledge in a discipline.

Interdisciplinary: The creation of new knowledge that bridges, connects, or integrates two or more disciplines (e.g., biophysics).

Moore's Law: In 1965, Intel co-founder Gordon Moore forecasted that the number of transistors on a chip will double about every two years. The prediction, popularly known as Moore's Law, has proved to hold for more than 40 years.

Multidisciplinary: Relating to two or more existing, separate disciplines (e.g., physics and biology). The knowledge of individual disciplines is viewed as separate and additive to each other.

Organisations: From a service system perspective, an organisation is an accessible non-physical resource that has the ability to establish formal contractual relationships as well as informal promissory relationships. Organisations themselves are either formal (legal entities that can contract and own property) or informal service systems. Organisations that are formal service systems include businesses and government agencies. Organisations that are informal service systems include open source communities, temporary project teams and working groups.

People: From a service system perspective, people are legal entities that have knowledge, capabilities, authority and can create contracts (formal value propositions) and promises (informal value propositions) with other service systems. People can own property (such as technology and shared information). People exist in modern society as roleholders (see Stakeholder) in many service systems. People are complex and adaptive, with the ability to learn and change their knowledge and capabilities over time. People have unique life cycles and life spans. People are resources that can be accessed in creating value propositions. They are also the atomic type of service systems, capable of configuring resources and creating value via interactions with other service systems.

Provider service system: A service system from the viewpoint of a provider (see Stakeholder). A provider service system aims to meet the customer's needs better than competing alternatives consistently and profitably (in business context) or sustainably (in non-business context). Provider service systems seek deep knowledge of customer service systems (their own service activities, their unsolved problems, and their aspirations) to improve existing, and create new, value propositions.

Service or service activity:

(1) Archaic: Referring to economic residual; any economic exchange or production process that does not result in a physical product transfer or output; non-productive labour.

(2) Modern: The application of competences (knowledge, skills and resources) by one entity for the benefit of another entity in a non-coercive (mutually agreed and mutually beneficial) manner.

(3) Modern: Value-cocreation interactions (typically with well-defined customer-provider entities as parties who initiate, directly or indirectly, front-stage and back-stage activities in anticipation of value-cocreation results).

(4) Modern: An economic activity offered by one party to another, most commonly employing time-based performances to bring about desired transformation results in recipients themselves or in objects or other assets for which purchasers are responsible. In exchange for their money, time and effort, service customers expect to obtain value from the access to goods, labour, professional skills, facilities, networks and systems; but they do not normally take ownership of any of the physical elements involved.

Many typologies of service exist: external customer (market-based) and internal customer service; direct and indirect customer and provider interactions; automated, IT-reliant and non-automated service; customised, semi-customised

and non-customised service; personal and impersonal service; repetitive and non-repetitive service; long-term and short-term service; service with varying degrees of self-service responsibilities.

Service computing: The use of information technology (IT) to support customer-provider interactions. Topics include web services, e-commerce, service-oriented architectures (SOA), self-service technologies (SST), software as a service (SaaS) and IT Infrastructure Library (ITIL).

Service design: The application of design methods and tools to the creation of new service systems and service activities with special emphasis on perceptions of quality, satisfaction and experience.

Service-dominant logic: The service-dominant logic advocates that service (singular) involves value-cocreation interactions as service systems create, propose and realise value propositions. The interactions may include things, actions, information and other resources. Value propositions are built on the notion of asset sharing, information sharing, work sharing (actions), risk sharing as well as other types of sharing that can create value in customer-provider interactions. Service Science embraces the world view of the service-dominant logic.

Service economics: The definition and measurement of service activities in an economy. Typical measures include productivity, quality, regulatory compliance and innovation.

Service engineering: The application of technologies, methodologies and tools to the development of new service offerings and the improvement of service systems.

Service experience and service outcome: The customer's perceptions of the process and result of a service interaction or relationship. The perceptions are based in large part on customer expectations and hence there is always a subjective as well as objective component to the customers' evaluation of the process and result. Expectations may inflate over time, resulting in degradation of service experience even when objective measures have not changed. Exceptional recovery from a service failure has been shown, under certain conditions for repeated service, to lead to greater customer lifetime value for a provider.

Service human resources management: The application of human resource management to service activities. This term is rejected by many social scientists and those who do not believe it is appropriate to talk about people as resources. The term human relations management is sometimes seen as a more appropriate alternative. Many service firms have the motto to treat employees like they treat valued customers.

Service innovation: A combination of technology innovation, business model innovation, social-organisational innovation and demand innovation with the objective to improve existing service systems (incremental innovation), create new value propositions (offerings) or create new service systems (radical innovation). Often radical service innovation will create a large population of new customers (public education – students; patent system – inventors; money markets – small

investors). Service innovation can also result from novel combinations of existing service elements.

Examples of service innovation include: On-line tax returns, e-commerce, helpdesk outsourcing, music download, loyalty programs, home medical test kits, mobile phones, money market funds, ATMs and ticket kiosks, bar code, credit cards, binding arbitration, franchise chains, instalment payment plans, leasing, patent system, public education and compound interest saving accounts.

Service management: The application and extension of management methods and tools to service systems and service activities, including capacity-and-demand management that integrates insights from service operations (supply capacity) and service marketing (customer demand).

Service marketing: The study of value-creating customer-provider interactions, outcomes and relationships. It uses and extends the tools and methods of marketing. It is gradually replacing 'services marketing', with the emphasis on the outcome of all economic activity being service (or value) whether the service/value comes from things ('goods') or activities ('services').

The notion of service marketing is supported by relationship marketing and customer relationship management, both primarily focused on the two-party relationship between customer and provider, and the new concept of many-to-many marketing (a network and stakeholder perspective).

This discipline places special emphasis on quality and customer satisfaction, demand forecasting, market segmentation and pricing, customer life-time value, and the design of sustainable value propositions.

Service mindset: An orientation geared towards the innovation of customer-provider interactions (service systems and value propositions), combined with interactional skills to enable teamwork across academic disciplines and business functions. It is one of the characteristics of adaptive innovators.

Service operations: The study of value-creating (work) processes, which include customer-input as a key component. It uses and extends the tools and methods of operations research, industrial engineering, management science, operations management, human resource management, lean methods, six sigma quality methods, logistics and supply chain management.

Service networks: Also known as service system networks. As service systems connect to other service systems, they form networks of relationships, which may have one or more associated value propositions. Social network analysis (people as service systems) and value network analysis (businesses as service systems) are tools that can be used to analyze service networks for robustness, sustainability, and other properties.

Service Science: An umbrella term for the emerging discipline of Service Science, Management and Engineering (see SSME below), it is named as a symbol of rigour in pursuing the truth. Service Science is the study of service systems and value propositions. It is the integration of many service research areas and service disciplines, such as service economics, service marketing, service operations, service management, service quality (especially customer satisfaction), service strat-

egy, service engineering, service human resource management (especially in a professional service firm), service computing, service supply chain (especially eSourcing), service design, service productivity, and service measurement.

Service sourcing: The make-versus-buy decision for service activities, including the study of outsourcing, contracts, service level agreements, and business-to-business on-line markets.

Service system: Service systems are dynamic configurations of resources (people, technology, organisations and shared information) that can create and deliver service while balancing risk-taking and value-cocreation. The dynamics are in part due to the ongoing adjustments and negotiations that occur in all systems involving people. People are the ultimate arbiters of value and risk in service systems (in part because people are legal entities with rights and responsibilities).

Service systems are complex adaptive systems. They are also a type of 'system of systems', containing internal smaller service systems as well as being contained in a larger service system (see Stakeholder). They typically interact with other service systems via value propositions, which may form stable relationships in extended value chains or service networks (see Service networks).

Formal service systems are legal entities that can create legally binding contracts with other service systems. Informal service systems cannot create contracts, though individual people within them may be able to do so.

Servicisation: A process whereby manufacturers moves from product-led towards a service-oriented business model. For example, instead of selling jet engines, manufacturers develop service offerings in which customers are charged for propulsion usage.

Shared information: From a service systems perspective, an accessible conceptual resource that does not have the ability to establish formal contractual relationships. It includes language, laws, measures, methods, process descriptions, standards, and others. It can be codified and turned into explicit information. If people can talk about it and name it, then from a communication perspective, it is a type of shared information.

Stakeholders: Stakeholders include participants in service systems and others who are indirectly affected. Stakeholders who are 'named participants' are also known as roleholders, who can be people or other service systems that fill named roles in service systems.

The two main roles in any service system are customer and provider. To create successful value propositions, it is also important to consider authority and competitor roles. Examples of roleholders are employees and customers in businesses, politicians and citizens in nations, teachers and students in schools, doctors and patients in hospitals, and parents and children in families.

SSME: Service Science, Management and Engineering (SSME), or in short Service Science, is an emerging field. It includes curricula, training, and research programs that are designed to teach individuals to apply scientific, engineering, management and design disciplines that integrate elements of computer science, operations research, industrial engineering, business strategy, management sci-

ences, social and legal sciences, and others in order to encourage innovation in how organisations create value for customers and stakeholders that could not be achieved through such disciplines working in isolation.

STEM: The Science, Technology, Engineering and Mathematics (STEM) fields are widely considered to be the driving force behind a modern society. The STEM workforce is viewed by many governments, academic and business organisations as the key to a nation's innovation capacity and long-term competitiveness.

Systems and systems world view: Systems are dynamic configurations of entities (elements or components) that interact over time and result in outcomes (internal changes to entities and external changes to regions of the system and the system as a whole). The study of physical, chemical, biological, computational, cognitive, economic, legal, social, political, service or any other type of systems, typically begins with a statement of the entities, interactions and outcomes of interest. Reductionist science attempts to discover more fundamental building blocks out of which the entities of the system are composed (new architectures), often with the goal of finding simpler or more parsimonious explanations of observed variety.

In complex adaptive systems, entities have life spans and the types of entities change over time in ways that are difficult to predict. Service Science studies the evolution of entities known as service systems, which interact via value propositions and result (normatively) in value-cocreation outcomes. Understanding the evolution may shed light on the shifts from social to economic, political to legal, and cognitive to computational systems. The shift seems to depend heavily on an increasing amount of shared information to solve motivation and coordination problems.

T-shaped professionals: Those who are deep problem solvers with expert thinking skills in their home discipline but also have complex communication skills to interact with specialists from a wide range of disciplines and functional areas (see also Adaptive Innovators).

Technology: From a service systems perspective, technology is an accessible physical resource that does not have the ability to establish formal contractual relationships. It includes any human-made physical artefact or portion of the environment accessible to service system stakeholders. Technology (physical) and shared information (codified conceptual) are two important types of properties that service systems can own and provide access rights to others in value exchanges.

Transdisciplinary: Transcending, or extending beyond the knowledge of any existing disciplines. For example, symbolic reasoning and general systems theory are considered to be applicable to all disciplines and hence labelled as transdisciplinary knowledge.

Value proposition: A specific package of benefits and solutions that a service system intends to offer and deliver to others. Division of labour is at the root of many value propositions. By traditional economic and marketing definitions, value propositions may be confined to either products (things) or services (activi-

ties). However, the modern meaning of service is value-cocreation that involves both products and services.

Value proposition emphasizes key points of difference in comparison to competing alternatives. They may be rejected because a potential customer does not trust the provider's capabilities or believes the proposal violates a law or policy. They may also be rejected in favour of self service, a competitor's proposal, or other options. Designing, proposing, negotiating, realising (actualising), and resolving disputes around value propositions are an integral part of the formation and improvement of service systems.

Appendix I: University initiatives

The following list provides some examples of SSME-related university initiatives. In April 2009, there were 250 universities in 50 countries with related work.

Table 1. Illustrative list of service science related efforts at universities

University	SSME initiatives
Arizona State University (USA)	Center for Services Leadership
Bahcesehir University (Turkey) and Northeastern University (USA)	Information Technologies Service Management
Carnegie Mellon University (USA)	IT Services Qualification Center
Howe School of Technology Management (USA)	Service Management tracks, Master of Science in Information Systems
Karlstad University (Sweden)	Master Programme with a Profile in Service Science
Masaryk University (Czech)	SSME Master Degree in the Faculty of Informatics
Michigan Technological University (USA)	Service Systems Engineering courses for undergraduate studies
National Tsing Hua University (Taiwan)	Institute of Service Science
North Carolina State University (USA)	Service Engineering concentration, MS in Computer Networking; Service Management and Consulting concentration, MBA
Ohio State University (USA)	Initiative for Managing Services, Fisher College of Business
Peking University (China)	Department of Service Science and Engineering
Politecnico di Milano (Italy)	Service Engineering and Technologies Master Program
San Jose State University (USA)	SSME Undergraduate and MBA concentration
Swiss Institute of Service Science (Switzerland)	Zurich University of Applied Sciences, University of Applied Sciences Western Switzerland and University of Applied Sciences North-West Switzerland
University of Cambridge	Service and Support Engineering Programme
University of Manchester (UK)	SSMEnetUK
University of Porto (Portugal)	Master in Services Engineering and Management
University of Alberta (USA)	Service Systems Research Group
University of California at Berkeley (USA)	Information and Service Design Program
University of California at Merced (USA)	Minor in Service Science and Management
University of California at Santa Cruz (USA)	Knowledge Services and Enterprise Management
University of Maryland (USA)	Center for Excellence in Service
University of Pennsylvania (USA)	Fishman-Davidson Center for Service and Operations Management
University of Sydney (Australia)	IT Professional Services course
University of Tokyo (Japan)	Service Innovation Working Group

Appendix II: Service innovation roadmaps

The following list provides a selection of national service innovation roadmap (SIR) reports. These reports are intended to focus and align stakeholders, benchmark existing and guide further service innovation investments, report progress and challenges, and increasingly provide the foundation for Public Private Research Partnership (PPRP) programmes to create improved service systems for a smarter planet.

Table 2. Illustrative list of service innovation roadmaps by nation

Nation	Service Innovation Roadmap title	Year
Finland	Serve - Innovative Services Programme, Tekes	2006
USA	Service Enterprise Systems Program, National Science Foundation	2006
USA	Study of Service Science, The National Competitiveness Investment Act	2007
UK	Supporting innovation in services	2008
Netherlands	Service innovation and ICT: vision and ambition	2008
Ireland	Catching the Wave: A Service Strategy for Ireland	2008
Australia	Science and Technology-Led Innovation in Services for Australian Industries	2008
Korea	Measures to Vitalize R&D in Service Industry	2009