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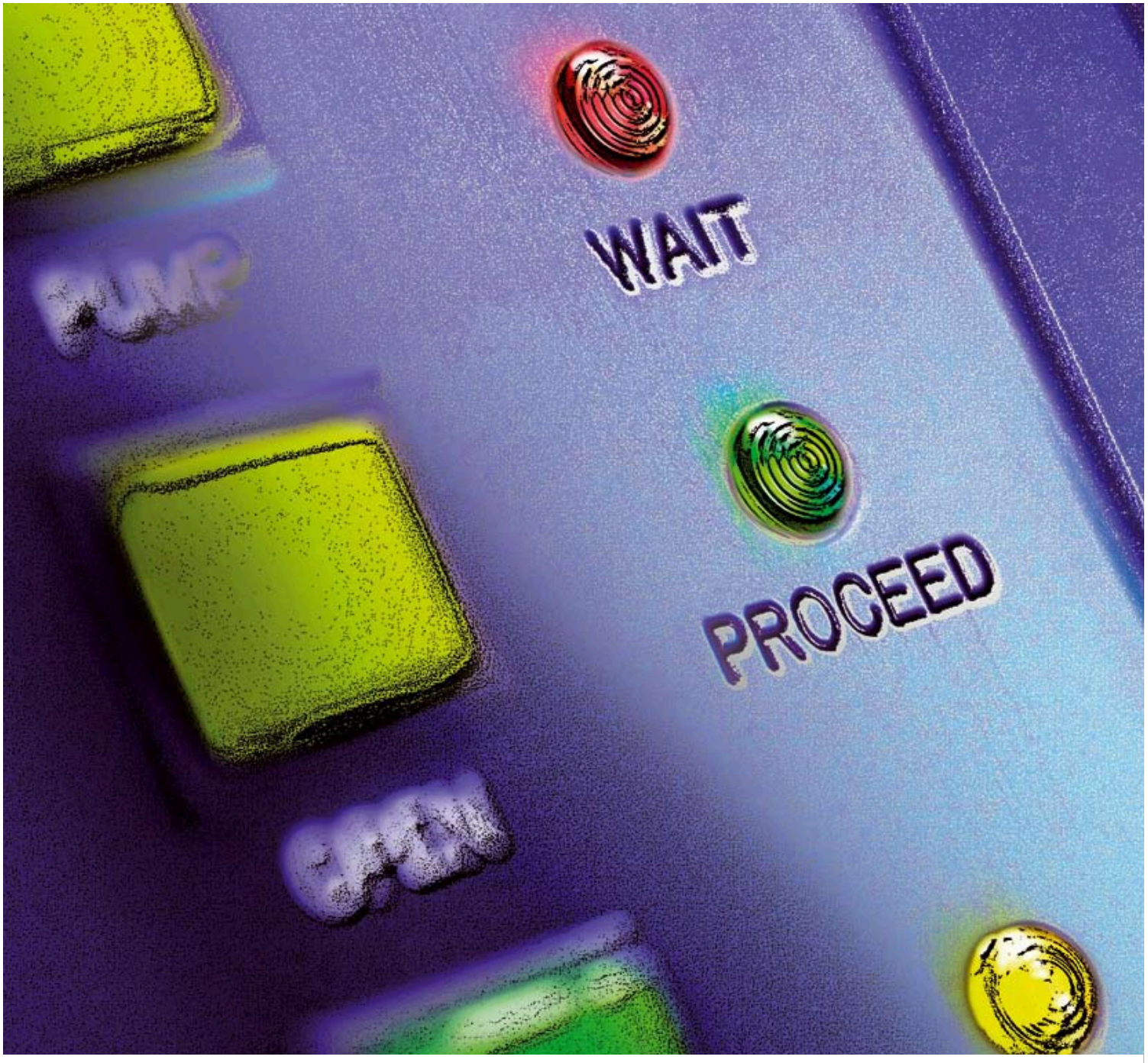
Succeeding through service innovation

A service perspective for education, research, business and government



A White Paper based on
- **Cambridge Service Science, Management and Engineering Symposium (July 2007)**
- **The consultation process (October – December 2007)**

Succeeding through service innovation: A service perspective for education, research, business and government

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Executive summary

Service systems[1] are dynamic configurations of *people, technologies, organisations* and *shared information* that create and deliver value to customers, providers and other *stakeholders*. They form a growing proportion of the world economy and are becoming central to the way businesses, governments, families and individuals work. Innovation, a term applied almost exclusively to technologies in the past, is increasingly used in relation to service systems.

Ideas of service are, of course, not new. However, the scale, complexity and interdependence of today's service systems have been driven to an unprecedented level, due to globalisation, demographic changes and technology developments. 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. A better understanding of service systems is required.

Many individual strands of knowledge and expertise relating to service systems already exist, but they often lie in unconnected silos. This no longer reflects the reality of interconnected economic activities which, for example, sees manufacturers of engineering products adopting service-oriented business models and health care providers learning lessons from modern manufacturing operations. Indeed, there are wide gaps in our knowledge and skills across silos.

In response, *Service Science, Management and Engineering (SSME)*, or in short *Service Science*, is emerging as a distinct field. 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, an *interdisciplinary* approach should be adopted for research and education on service systems.

Developing Service Science is no easy task; it not only requires intensive collaboration across academic disciplines but also a doubling of R&D investment in service education and research by governments and businesses. All stakeholders must start to engage each other and make plans for service innovation.

For those responsible for creating a service innovation roadmap, this white paper provides a starting point to raise awareness. For those who have already developed such roadmaps, it serves as a benchmark for improvement. More specifically, drawing upon the expertise and experience of leading academics and senior practitioners, this document 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.

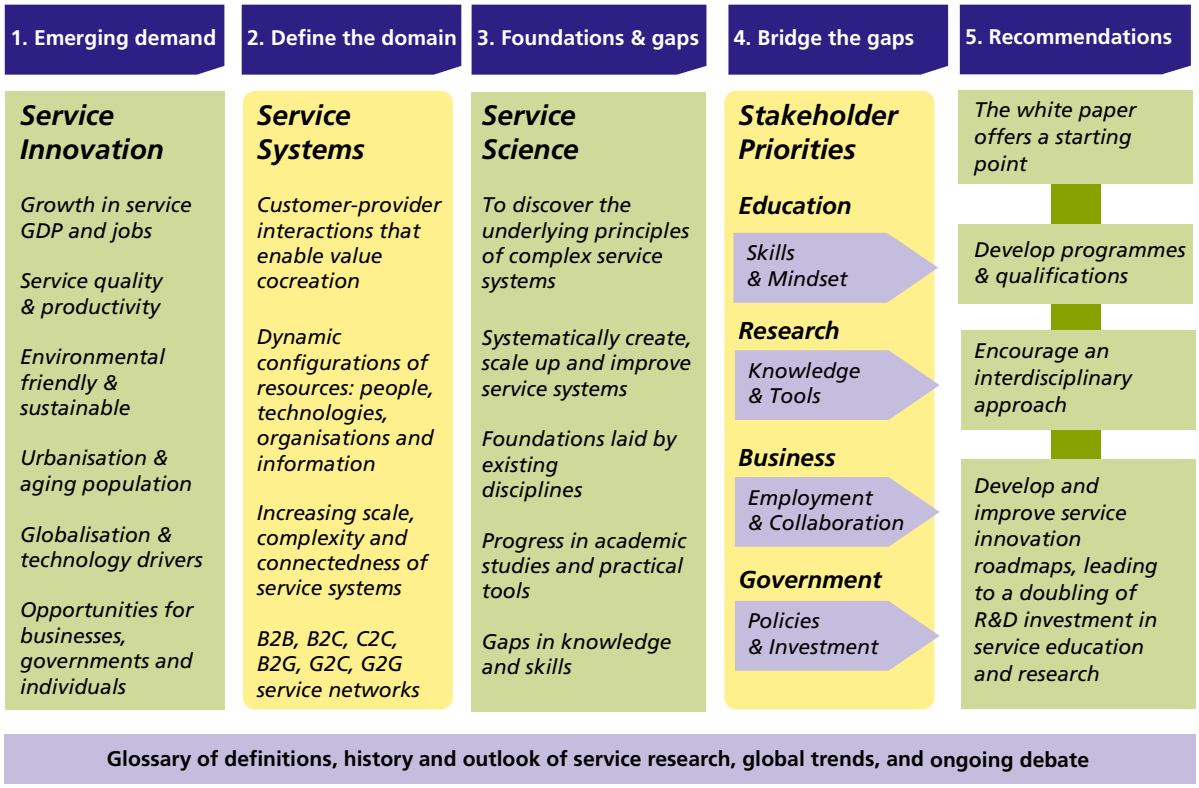
For business: Establish employment policies and career paths for T-shaped professionals; review existing approaches to service innovation and provide grand challenges for service systems research; provide funding for service systems research; develop appropriate organisational arrangements to enhance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

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 place ourselves in a better position to create and benefit from service innovation in the future.

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

Succeeding through service innovation: A framework for progress



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1. Introduction

1.1 The demand for service innovation

Growth in service

The growth of service activity across industries is now widely recognised. However, is it really anything new? Service is as old as the division of labour and has been provided in various forms since record keeping began. Indeed writing records was a form of service! What has changed, however, is the scale and complexity of *service systems* –configurations of resources that create and deliver value to stakeholders through service activities.

Service systems are growing rapidly and have become an ever greater part of value creation in modern economies. We are paying proportionally more for services in the form of experience, advice, information, assurance, infrastructure and leasing, and proportionally less on growing, building and owning physical goods. And more than ever before, we are constrained by natural resources and have to achieve the triple targets of effectiveness, efficiency and sustainability. The rise in complexity is partly due to the expansion of our values in social, ecological and political dimensions.

Opportunities for service innovation

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. However, as product complexity and diversity increase, it can take more time and consume more resources to search for, obtain, install, maintain, upgrade and dispose of products than production itself. This offers great opportunities for *service innovation* – including both incremental improvements and radical changes to service systems.

Service innovation can impact customer-provider interactions and improve the experience of finding, obtaining, installing, maintaining, upgrading and disposing of products. Service innovation can enhance the capabilities of organisations to create value with stakeholders. Service innovation can deliver better self services, eliminating waiting and allowing 24/7 access via modern devices such as mobile phones, web browsers and kiosks.

Opportunities for service innovation can be extended well beyond the business world. Government programmes, for instance, have become increasingly complex and diverse, requiring innovative solutions to cope with the vast scale of the demand. For families and individuals, each generation aspires to a richer and more fulfilling life than their predecessors. Service innovation is required to improve the quality of life and help society deal with important issues such as aging populations.

Service innovation has also found its place in the virtual world. Information and communication technologies (ICT) and on-line spaces have enabled the creation of new service businesses such as Amazon and Google, not to mention the fast emergence of 'Web 2.0'. These new services in turn are changing our behaviour in decision making and in many other areas.

1.2 New skills and knowledge required

The rising demand for service innovation has huge implications for skills and the knowledge base that underpins them. People are needed who can understand and marshal diverse, and increasingly global, resources to create value. Quite often, these resources are accessed using advanced ICT and new globe-spanning business models. The people with such skills are known as *adaptive innovators* - those who identify and realise a continuous stream of innovation in service systems.

The need for science, management and engineering in relation to agricultural and manufactured products has not gone away. They are an integral part of service innovation and have a strong impact on the way that products behave and perform in larger service systems. For example, cutting-edge technologies such as biotechnology and nanotechnology can be applied to enhance consumer experience. But as the scope of innovation continues to move beyond products, we must prepare ourselves with skills and knowledge required for service innovation.

1.3 Service Science: an emerging field

The growth of service in modern economies has gradually driven scholars to service-related studies. Whilst research into service can be traced to as early as the 1940s, significant developments were not possible until the late 1970s when service research was broken free from product-centric concepts and theories (see Appendix I: History and future outlook of service research). The field of service research 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.

Despite these advances in the service field, however, there has been a growing perception that it is time to take stock and to explore the possibility of bringing coherence into the various strands of knowledge and experience. Without a clear understanding of the domain and how it relates to existing theories, knowledge will continue to be fragmented. Indeed, a more integrated approach is needed if real progress is to be made. In response, *Service Science, Management and Engineering (SSME)*, or in short *Service Science*, is emerging as a distinct field to look for a deeper level of knowledge integration[2].

1.4 Drawing the threads together: the white paper

Since 2004, IBM has been working with many other pioneers to call for a systematic approach to service research and education. The initiative was clearly driven by IBM's own substantial growth in services and its recognition of a potential future shortage of knowledge and skills required for service innovation. Over the past few years, this movement has led to dozens of SSME-related meetings in various countries.

The Cambridge symposium

In July 2007, IBM and Cambridge University's Institute for Manufacturing (IfM), in conjunction with BAE Systems, orchestrated an international symposium to help distil the key issues surrounding the nature of service and to identify guidelines for future development. The two-day meeting was attended by a group of leading academics and senior business leaders with a wide and deep knowledge of service research and practice – some 200 years experience in all. The symposium was also informed by 'correspondents', those who were unable to attend the meeting but made contributions through completed questionnaires and position statements or papers. In spite of the diverse backgrounds of this multidisciplinary group (see Appendix II: Contributor list), the event produced a remarkable commonality of view as to how we can move the field forward.

White paper development

An important outcome of the Cambridge symposium was a discussion document (IfM and IBM, 2007)[3]. To collect views from a wider group of stakeholders, the document was then put into a broad consultation process, involving over one hundred respondents from academic, business and governmental organisations all over the world (see Appendix III: Consultation respondents). Based on their comments, the discussion paper was further developed into this white paper.

Target audience and key messages

The paper is aimed at all those who have the responsibility to understand service innovation and improve their organisation's capacity to meet future demands. It describes the changing structures of the modern economy, demonstrates the growing significance of service activities, and examines the nature of service systems. It identifies knowledge and skill gaps in service innovation and proposes potential ways to address those gaps. It continues to invite discussion about service innovation - new ways that service systems can improve our economic and social well-being sustainably.

1.5 Key concepts

To establish a basis for an inclusive discussion, this document would like to create a shared view on the key concepts of Service Science: service system, value proposition, adaptive innovator, and Service Science, Management and Engineering (SSME) graduates. These concepts provide a service perspective on the traditional concepts: factory, trade, problem solver, and *Science, Technology, Engineering and Mathematics (STEM)* graduates.

The changing global landscape of business and society can be described, for the purpose of increasing service innovation, as a very large global service ecosystem. The ecosystem is populated by many species (types) of *service systems* (from individuals to complex businesses and government agencies) interacting via *value propositions* to exchange service for service (with value-cocreation as desired outcomes). Individuals fill roles in complex service systems. Complex service systems can fill roles in even more complex service systems. When problems arise, individuals may want to change, improve, or create new types of service systems. In this context, adaptive innovators will benefit from their knowledge of Service Science, Management and Engineering (SSME) or Service Science.

[2] 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).

[3] IfM and IBM. (2007). Succeeding through Service Innovation: A Discussion Paper. Cambridge, United Kingdom: University of Cambridge Institute for Manufacturing. ISBN: 978-1-902546-59-8.

2. Clarifying the rationale and defining the domain

2.1 What is a service system?

A service system can be defined as a dynamic configuration of resources (people, technology, organisations and shared information) that creates and delivers value between the provider and the customer through service. In many cases, a service system is a complex system in that configurations of resources interact in a non-linear way. Primary interactions take place at the interface between the provider and the customer. However, with the advent of ICT, customer-to-customer and supplier-to-supplier interactions have also become prevalent. These complex interactions create a system whose behaviour is difficult to explain and predict.

2.2 Why are we interested in service systems?

A world of 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.

Indeed, service systems in business-to-business (B2B), business-to-government (B2G) and government-to-business (G2B) environment are invisible to most consumers and citizens, but are experiencing enormous change and growth. This is driven by global sourcing of organisational capabilities. It is also enabled by an increasing use of technologies to ensure the fulfilment of service level agreements between organisations.

The shift to service as an economic driver is clear. The 2007 report by the International Labour Organisation indicates that, for the first time in human history, worldwide service jobs (42%) outnumbered jobs in agriculture (36.1%) and manufacturing (21.9%)[4]. While developed economies are dominated by the service sector, developing countries also start to assess their role in the service economy (see Appendix IV: Service sector in global economy). If we take into account service activities in manufacturing, even the latest figures become an understatement.

However, the importance of service has not led to increased investment in service research and development. Indeed, despite the fact that the 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[5]. This mismatch hinders the progress we could make to address many challenges.

Critical questions for businesses

Businesses, competing in a global economy, are familiar with many of the service issues and challenges that need to be addressed. Service systems can be divided into 'front stage' and 'back stage'. 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, streamlined processes and robust relationships with partners and suppliers (*service networks)*? Service performance relies on both *front-stage* and *back-stage* components: how can the 'voice of the customer' (customer needs) and the 'voice of the process' (provider capability) be matched for the best overall performance?

Changes in the modern world have posed additional questions. Increasingly, service excellence implies the use of global resources: how can opportunities in global sourcing and constraints in regulatory compliance be balanced? Growing competition means service leadership never stands still: how can service innovation be stimulated, realised and sustained? Service growth requires the ability to rapidly create a definable, repeatable, scalable and unique market success: how can promising service offerings be scaled up with growth in both revenue and margin? More than anything else, businesses want to know: how can the enterprise work in a seamlessly integrated manner?

Service businesses are not the only ones concerned with these questions. Increasingly, manufacturers are also keen to understand the same issues as they embark on a *servicisation* journey (see Appendix V: Business challenges for service research).

Pressure in non-business areas

Perhaps somewhat less intuitively, organisations in non-business areas are under similar pressure to improve service systems. Government agencies feel the need to provide better service to the public. Commercial competition is replaced by demands for transparency, quality and efficiency. Similarly, non-profit organisations are also urged to improve quality, productivity and innovation. For households, there is a growing recognition of the need to

[4] Key Indicators of the Labour Market (KILM), 5th edition, 2007

[5] RTI international. (2005). Measuring Service-Sector Research and Development. RTI Project Number 08236.002.004.

seek better education, health care and financial planning. And environmental concerns are high on everyone's agenda.

2.3 What is the vision for Service Science?

Discovering the fundamentals
Challenges facing modern organisations are, to a large extent, due to our poor understanding of the nature and behaviour of service systems. Unlike the IT industry, 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.

The vision of Service Science, therefore, is to discover the underlying principles of complex service systems (and the value propositions that interconnect them). It should provide the structure and rigour for building a widely accepted and coherent body of knowledge to support ongoing innovation in service systems.

Key questions for Service Science
While it is important to acknowledge the differences between the many types of service systems, it is crucial to accept their variability and get on with the task of discovering the fundamentals. We still need specialists to deal with the complexity within individual areas but, to extract the full potential, we must develop our 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 service systems.

These enquiries lead to the following questions:

- What are the architectures of service systems?
- How can service systems be understood in terms of a small number of building blocks that get combined to reflect the observed variety?
- How might architectures and building blocks help us 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?

Potential benefits of Service Science
Service Science is about integration, optimisation and sustainability. We have pieces of knowledge today, but they are not integrated into a unified whole. Service Science provides motivation, methods and skills for integration. Service Science has the potential to benefit individuals, businesses and society, drawing upon the integrated talents of a diverse community. Service Science will enable adaptive innovators to identify the seeds around which innovation can take root and grow.

2.4 Who are the stakeholders of Service Science?

Individuals and organisations dependent on complex service systems are all stakeholders of Service Science in that they need the knowledge and skills required for service innovation. Businesses that want to improve their service revenues and profit margins have a clear interest in Service Science. Organisations in non-profit sectors share similar concerns and aspirations as they seek to deliver unique service offerings sustainably. Governments, at both national and local levels, wishing to create a high-skilled workforce and develop infrastructures to improve their competitiveness would benefit from the insights provided by Service Science.

Clearly, knowledge workers across a wide range of disciplines are also stakeholders. The past twenty years have seen the establishment of disciplines such as service marketing, service operations, service management, service engineering, service design, service computing, and many others. Different strands of knowledge would contribute more value to practice if they were brought together to form an integrated theory. For individual disciplines, Service Science in turn provides a platform for critical examination of their relevance, assumptions, strengths and limitations.

2.5 Why now?

Global trends, such as demographic shift, self-service and web-based technologies, outsourcing and offshoring, are challenging us to create new ways of doing things (see Appendix VI: Global trends and service innovation). This requires a solid scientific foundation if we are to understand increasingly complex service systems. Service Science has the potential to be as important as the foundation provided by physics, chemistry, biology, cognitive science and computer science for agriculture and manufacturing. We must act now in order to create the next generation of innovation.

3. Recognising the foundations and identifying the gaps

3.1 What foundations have been laid by existing theories?

Resource clusters

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

(1) Whole businesses and organisations: Studied primarily by schools of management (marketing, operations management, operations research and management sciences, supply chain management, innovation management)

(2) Technology: Studied primarily by schools of science and engineering (industrial engineering, computer science, statistical control theory)

(3) People: Studied primarily by schools of social sciences and humanities (economics, cognitive science, political science, design, humanities and arts)

(4) Shared information: Studied primarily by schools of information (communications, management information systems, document engineering, process modelling, simulation)

Academic disciplines

Our knowledge of service systems benefits from the following disciplines, which study some or all of the four resource clusters:

- Architecture and designed systems (1,2,3,4)
- Behavioural sciences and education (3, 4)
- Cognitive science and psychology (1,2,3,4)
- Complex adaptive systems theory (1,2,3,4)
- Computer science and AI/web services (2,4)
- Computer supported cooperative work (1,2,3,4)
- Economics and law (1,3,4)
- Engineering economics and management (1, 2, 4)
- Experience design, theatre and arts (3)
- Financial and value engineering (1,2,3,4)
- Game theory and mechanism design (3,4)
- Human resource management (1,3)
- Industrial engineering (IE) and systems (1,2,3,4)
- Industrial and process automation (1,2,3,4)
- International trade (1)
- Knowledge management (1,2,3,4)
- Management of information systems (1,2,3,4)
- Management of technology & innovation (1,2,3,4)
- Marketing and customer knowledge (1,2,3,4)
- Mathematics and non-linear dynamics (1,2,3,4)
- Operations management (OM) (1,2,3,4)
- Operational research (OR) (1,2,3,4)
- Organisation theory and learning (1,2,3,4)
- Political science (1,3)
- Project management (1,2,3,4)
- Queuing theory (1,2,3,4)
- Simulation, modelling visualization (1,2,3,4)
- Sociology and anthropology (1,2,3,4)
- Software metrics and development (2)
- Statistical control theory (2,4)
- Strategy and finance (1,2,3,4)
- Supply chain management (1,2,4)
- System design and software architecture (2,4)
- Systems dynamics theory and design (1,2,3,4)
- Total quality management, lean, six sigma (1,2,3,4)

Progress in academic studies

Discovering fundamental building blocks of service systems and the way they can be combined to reflect the reality is already underway. Resource classification schemes are being developed, along with associated access rights, service level agreements, standards and protocols, safeguarding mechanisms, intellectual property and failure recovery methods. Multiple perspectives are being established on service systems (such as provider, customer, governance authority, competitor, partner, employee) to introduce systematic approaches to service innovation. Encouragingly, pioneering attempts are being made to develop a normative view on how service systems can be described and their behaviours explained, including the Customer Contact model, the Service Quality GAPS model, Service-Dominant Logic, Unified Theory of Service, Service as Leasing, and Work Systems Theory, to name but a few.

Development of practical tools

Meanwhile, tools, methods and data sets for practical use are also emerging (e.g. IBM's Component Business Modelling approach and toolkit). They provide starting points for practitioners to establish an overarching framework and outline the problem space at multiple levels. They are used to model not only businesses but also government agencies and the public sector. Tools and methods are also being developed to model industrial evolution, which has generated interest among historical economists and organisation theorists. The development 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.

3.2 Where is the knowledge gap?

Challenges facing individual disciplines

Despite significant progress, we are far away from achieving the vision of Service Science. For one thing, there are still challenges within individual 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. Computer science and information science often model information system architectures on the basis of well-understood environmental variations, but the design of governance mechanisms that allow information systems to respond proactively to strategy changes and predictable technological advances is less understood.

In a similar vein, economics and business strategy need to accommodate predictable innovations. Service management and operations need to create a better knowledge of service system scaling and lifecycle. Law and political science need to build a better comprehension of social innovation and the way that legislation can improve service system productivity. Complex systems engineering should provide more specific insights into the robustness of service systems.

More fundamental challenges

In addition to challenges within disciplines, there are more fundamental challenges in integrating various strands of knowledge. Specialisation remains important, but one shortcoming is that each discipline tends to focus on particular configurations of resources. And academics have well defined research agendas to deal with discipline-specific issues. The complexity of service systems, however, requires an integrated approach.

The key to understanding service systems is not just to examine one aspect of service but rather to consider service as a system of interacting parts. As service systems become more complex, our ability to understand them is hampered by the isolation of different disciplines. The hard work of creating an integrated theory that spans many disciplines has not been done.

Causes of the knowledge gap

The current situation stems from the tradition that academic institutions are structured along disciplines and sub-disciplines. Academic silos are created to encourage deeper understanding of a specialised subject (see Figure 1). 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.

As a result, there is an imbalance in service research; 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. In operations management journals, for example, less than 20 per cent of the papers focus on service topics although the majority of the economy is service-based. Moreover, disciplines also tend to focus on specific sectors; marketing tends to be concerned with business-to-consumer and operations with business-to-business. Gradually, a gap has emerged between academic output and practical interest.

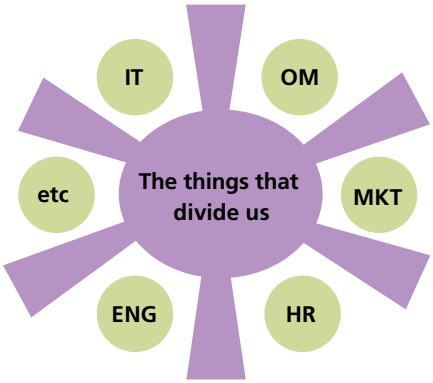

Figure 1 The gaps between academic disciplines

3.3 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.

Adaptive innovators are still deeply educated in their home disciplines. However, they also have the ability to think and act across multiple disciplines. They can build consensus across functional silos and work across inter-organisational boundaries. They can communicate with specialists who do not necessarily 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 one of the competing logics associated with organisational functions and units. As the service economy continues to grow, adaptive innovators will be in high demand.

4. Working together to bridge the gaps

4.1 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 2 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.

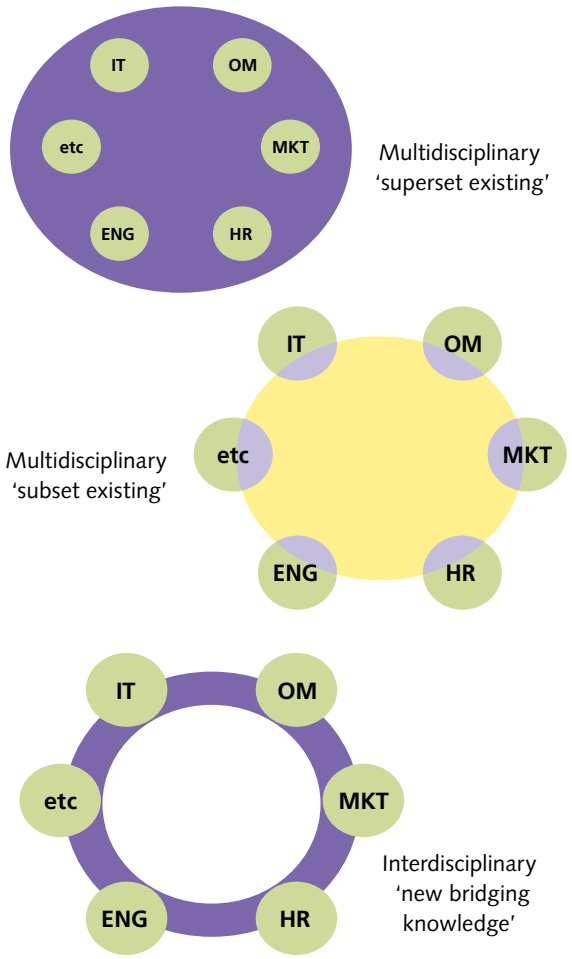

Figure 2 Three perspectives of Service Science

The interdisciplinary approach

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).

From a practical perspective, the approach would help develop a rigorous methodology to invest in the improvement of service systems and the design of high-value service offerings. From an academic perspective, the approach would provide a rigorous foundation based on which research and education could be advanced more rapidly.

4.2 Where are the opportunities to address the knowledge gap?

Interdisciplinary activities are not new. They are in evidence in many universities and industries. Indeed, there is an established body of knowledge about how to undertake interdisciplinary work, which can be adapted to service research. Opportunities exist at all levels to address the barriers between disciplines.

Individual: 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. They can help articulate challenges in service innovation. The potential of service science to improve business as well as society will attract sophisticated and capable people to the field.

Structural: Interdisciplinary interactions happen at a project or activity level. Cross-functional teamwork on specific projects with common goals encourages mutual awareness and creates respect for other disciplines. A shared belief in customers-provider interactions can provide a useful starting point. Exemplary projects in the form of case studies can stimulate more cooperative behaviours with common purpose across disciplines

or functions. However, rigour and relevance in interdisciplinary research is still important in order to generate robust and reliable knowledge.

Business: Business challenges are often interdisciplinary and cross-functional. Business problems commonly require participants with different disciplinary backgrounds to learn enough about each other's perspective in order to achieve effective and productive work. Problems should be clearly expressed in the business context, which demonstrates that no single academic community has exclusive 'ownership' of the problems. Businesses can also supply hard data for academic research to reach robust and practical conclusions. Industrial structures focused on service are already emerging, through which businesses can encourage the development of business professionals and academic fellows in service, and the cultivation of a service ethos. Employment policies should start to include psychological and emotional qualities into the assessment of existing employees as well as the recruitment process.

Academia: 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. This is not straightforward; more work is needed to define precisely what constitutes 'good' interdisciplinary research. One of the tools that can be used is web-based communication. This could enable the required multidisciplinary social networks to form as needed and facilitate the shift from knowledge silos to webs of knowledge.

Funding and Incentives: 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. Funding bodies should introduce interdisciplinary requirements into the proposal assessment and therefore encourage interdisciplinary studies. Close partnerships between funding bodies and industry stakeholders can help academics to develop relevant research agenda. This will lead to the development of interdisciplinary tools, models and frameworks that reflect interactions between a firm's different departments and its external partners.

4.3 Where are the opportunities to address the skill gap?

Developing T-shaped professionals

Discipline-based education remains a vital role of modern universities. In order to close the skill gap, however, universities should also offer students the opportunity to gain qualifications in the interdisciplinary requirements of SSME. Such qualifications would equip graduates with the concepts and 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 also capable of interacting with and understanding specialists from a wide range of disciplines and functional areas.

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. SSME qualifications would indicate that these graduates could communicate with scientists, engineers, managers, designers, and many others involved in service systems. Graduates with SSME qualifications would be well prepared to 'hit the ground running', able to become immediately productive and make significant contributions when joining a service innovation project.

Support needed from business and government

Establishing SSME qualifications is a challenging task. 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.

5. Recommendations

In many ways, Service Science is in a similar position to the science, management and engineering of agriculture and manufacturing two centuries ago. Although better tools and information systems may exist today to develop Service Science, the problems facing service scientists are far more complex.

However, 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. To address this imbalance, we urge the development of service innovation roadmaps, leading to a doubling of service R&D investment, as well as specific government programmes to support service innovation.

The following recommendations are offered as a point of departure for a more inclusive conversation as various stakeholders start to formulate action plans for service innovation (see Appendix VII: Example of innovation roadmap).

5.1 Recommendations for education

1 ***Enable graduates from various disciplines to become T-shaped professionals, who are adaptive innovators with a service mindset and can make early contributions to the service-driven economy.***

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 SSME qualifications to an existing deep home discipline of study. 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 discipline and functional 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.

2 ***Promote SSME education programmes and qualifications as a way of developing a service mindset, in conjunction with industry recognition and recruitment of SSME qualified graduates.***

SSME qualifications, which we see as critical to developing adaptive innovators with a mindset for service innovation, should include interactional skills across the main disciplines of Service Science. Interactional skills enable proficiency in the concepts and vocabulary for framing problems and discussing potential solutions across disciplines.

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.

Within the disciplinary areas, additional topics include service process analysis, SERVQUAL and TQM (including when to use and when not to use these methods), Lean and Six Sigma, servicisation, self service, integrating competing logics of different disciplines, managing the service experience over time, managing service failure and recovery, managing organisational change, and service provisioning (including interpersonal skills such as cross-functional teamwork and conflict resolution).

Many universities are piloting SSME-related courses, programmes and degrees, so a wealth of materials is being created. Much remains yet to done in order to establish standard curricula templates and associated quality standards.

3 ***Develop a modular template-based SSME curriculum in higher education, add new materials and refinements as research develops over time, and then extend to 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 could help prepare students to become adaptive innovators with a balance of practical and theoretical knowledge of service systems. They also allow students to see service systems in action. The design and provisioning of such projects should ideally involve student teams with members from different areas, including business, engineering, social sciences and information science, and sometimes from different universities.

The design of Service Science laboratory space would enable small multidisciplinary project teams to work together with collaborators in remote locations. Service Science labs should focus on entrepreneurial projects.

Support should be given to tele-presence meetings and the design of remote collaborations. Projects should especially be encouraged to link service systems in the real world, those in virtual worlds and those in simulated worlds.

Along with the development of SSME curriculum at the university level, attention should also be given to primary and secondary education. Students should be encouraged to work in teams and explore ways to improve the service systems around them.

4 ***Explore new teaching methods for SSME related education.***

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).

5.2 Recommendations for research

1 ***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.

2 ***Build bridges between disciplines through grand research challenges.***

With good architecture, we would be able 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.

3 ***Establish service system and value proposition 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.

4 ***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.

5 ***Create modelling and simulations tools for service systems.***

Perhaps more than any other subjects, advancement in Service Science depends on models and simulations of alternative service systems designs. When data are not readily available, service practitioners need simulation tools to support their decision-making processes.

5.3 Recomendations for business

1 ***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.

2 ***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, (b) how to scale up margins as service revenues increase, (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. These issues are potential grand challenges for multidisciplinary research teams to work on.

3 ***Provide funding for service systems research.***

Businesses should provide funding for service systems research, directly through many regional industry-academic-government collaboration forums, or indirectly via global organisations such as the Service Research and Innovation Initiative (SRII). A starting point is to establish benchmarks on the level of service research investment compared to other areas.

4 ***Develop appropriate organisational arrangements to enhance industry-academic collaboration.***

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

5 ***Work with stakeholders to 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 to include new measures. More emphasis should be placed on the balance between efficiency, effectiveness and sustainability. Roadmaps for service innovation should include updated performance measures and adjust mechanisms of measurement.

5.4 Recommendations for government

1 ***Promote service innovation for all parts of the economy and provide funding for SSME education and research.***

Service innovation is still poorly understood considering its growing importance to the economy. Nevertheless, history has shown 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. Cataloguing existing funding opportunities and increasing the level of national funding in Service Science are important steps in advancing research and academic curricula.

2 ***Demonstrate the value of Service Science to government agencies, and thereby create methods, data sets, and tools to inform and challenge current education and research support.***

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. As with business stakeholders, government agencies are well positioned to challenge existing education and research efforts.

3 ***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.

4 ***Make government service systems more comprehensive and citizen-responsive.***

Government service systems are especially in need of comprehensive review by engaging citizens concerned. A first step is to change the orientation of existing service systems from a provider-centric one to a citizen-centric one.

5 ***Encourage public hearings, workshops, briefings with other stakeholders to develop service innovation roadmaps.***

It is critical to carry out a review of service innovation roadmaps for collaborations between academia, industry and government. 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).

6. Taking it forward

Over one hundred people have contributed their knowledge and experience to the issues discussed in this document. However, we are acutely aware that our journey to develop a Service Science is far from complete (see Appendix VIII: Ongoing debate). We see this white paper as just a step in an ongoing dialogue that will engage many more stakeholders who seek to improve service systems and to develop successful adaptive innovators.

This document will be widely distributed to universities, research institutions, business organisations, non-profit organisations, government departments and agencies. We will continue to challenge academics, researchers, practitioners and policy makers to perform or support the interdisciplinary work needed to lead to a breakthrough in Service Science and bring about the positive impact on business and society that more systematic and sustainable service innovations could achieve.

Adam Smith laid the foundations of modern economics with his exploration of division of labour (specialists) and its role in creating the wealth of nations. Our consensus is that today, to grow the wealth of nations sustainably, we must become far more systematic about service innovation in a world of increasing division of labour and specialization (Smith was right, in part). Nevertheless, the foundations of Service Science are based on the premise of the need for knowledge integration (adaptive innovators, SSME T-shaped professionals).

We know division of labour alone is not the answer to increasing value creation capacity of nations (or else we would still be using scribes for our record keeping and communications!). We need both specialization and integration to solve the complex coordination problems of applying new knowledge to improve service systems and that value propositions that interconnect them.

We continue to invite feedback on this important topic and comments on this document are welcome.
Please find further information at:

www.ifm.eng.cam.ac.uk/ssme
www.research.ibm.com/ssme

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 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.

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 sciences, 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 (activities). 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

History and future outlook of service research

To assist new students of service in gaining an overview of the field, the evolution of service research has been characterized in six periods:

Pre 1980: *Crawling out* period is when service marketing and service operations became distinct from product marketing and operations, in part as conventional service economics reports started to categorize more of the economy as value derived from service activities.

1980-1985: *Scurrying about* period with more published services research moving beyond goods and products but literature still mostly conceptual. A core group of academics and business practitioners developed.

1985–1992: *Walking erect* period with increasing number of scholars of service, and explosive growth in the literature including service research journals, dissertations and textbooks. Academic events, centres and pioneers in Europe as well as US emerged.

1993-2000: *Making tools* period with more quantitative research - measurement, statistics, and decision support modelling; broadening, deepening and sharpening of the research; continued globalisation and multidisciplinary research; expanded topic areas including service design and delivery, service experiences, service quality and customer satisfaction, service recovery and technology infusion, service computing, service supply chains and eSourcing.

2000-now: *Creating language* period with nearly a dozen models of service emerging, and the concept of a service system beginning to take hold to unite the many perspectives. The field is expanding rapidly with an expansion of literature worldwide and increasing numbers of conferences and centres, with IBM and industries' Service Science, Management and Engineering (SSME) initiative seeking to strengthen industry-academic-government interactions. The service-dominant logic view is gradually replacing the traditional view of goods-versus-services, with a view of service as value-cocreation that involves both things and activities.

The future: *Building communities* period with an inclusive multidisciplinary approach to service innovation, with science, management, engineering and design being supporting academic disciplines, and with T-Shaped professionals as adaptive innovators to link and unite these disciplines. This will create a measurable growth in service innovation for business and society

Appendix II

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Appendix III

Respondent list

Feedback on the original discussion paper (in alphabetical order)

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In total, 115 people from over 20 countries provided us with their feedback, many of which were about the same size of the original discussion paper. We wish to thank these respondents for their time and support. A selection of comments can be found at www.ifm.eng.cam.ac.uk/ssme

Appendix IV

Service sector in global economies[6]

In recent years service industries have become a fast growing sector in world economies as measured by traditional economic measurement methods (see Service-Dominant Logic in the Glossary for an alternative view). Services now account for more than 50 percent of the labour force in Brazil, Russia, Japan and Germany, as well as 75 percent of the labour force in the United States and the United Kingdom. Figure 3 shows the value of services to economies compared to that of industry, construction and agriculture.

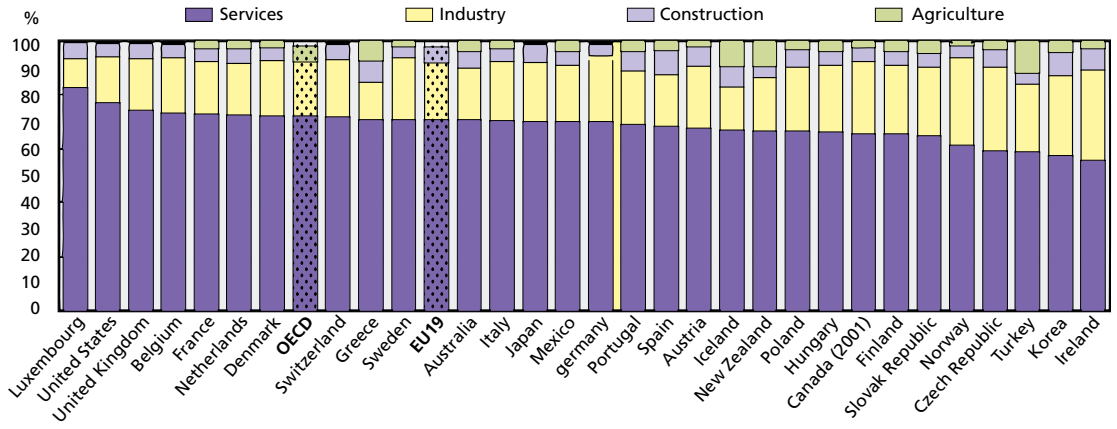

Figure 3 Share of total gross value added by sector, 2002

Figure 4 indicates the gross added value of service sector industries within OECD countries. By 2002 services accounted for about 72% of value added and manufacturing for about 17%. OECD reports show that the gap has widened steadily in recent years as demand for services has risen. Belgium, France, Switzerland, the United Kingdom and the United States mainly reflect a high share of value added in finance, insurance, real estate and business services, and a large community, social and personal services sector. The construction sector is also relatively small in most OECD countries, accounting for about 5.5% of OECD value added. Wholesale and retail trade, restaurants and hotels is a more important economic sector and is often large in countries with a strong tourism industry (e.g. Greece, Portugal and Spain).

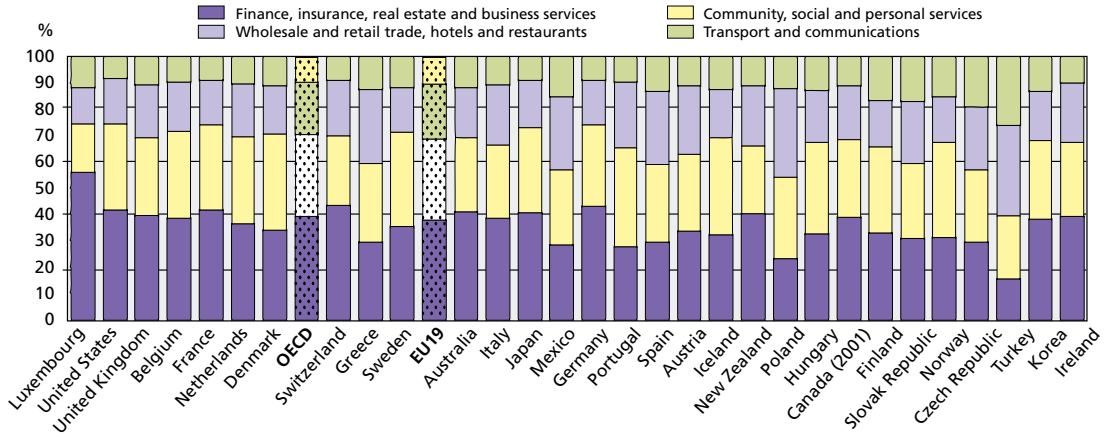

Figure 4 Distribution of gross value added of the services sector, 2002

[6] Source: OECD Science, Technology and Industry Scoreboard 2005 - Towards a knowledge-based economy, p.168-9.

Appendix V

Business challenges for service research

Business participants of the symposium identified five specific challenges for service research:

1 Understanding service systems

- Establishing a language and taxonomy for service systems and value propositions;
- Developing and using systems architectures;
- Understanding the role, sources and use of data in service provision.

Business-academic collaboration is required in service research, but the lack of a shared language, which is both relevant to businesses and rigorous to academics, slows progress and makes collaboration difficult. Measurement of productivity and quality is more challenging in service businesses. This has led to further difficulties in establishing appropriate service level agreements and aligned incentive across stakeholders in a service supply chain and in eSourcing relationships.

2 Business issues

- Determining the nature, the function and structure of service contracts;
- Establishing new legal requirements and intellectual property models;
- Building the business case for service systems and value propositions.

Business models, and ways that margins evolve over the product or service life cycle, need to be better understood. Without a good understanding of service business models, it is difficult to create business cases for services and to justify investment in service.

3 Developing new and better types of service

- Innovation – speeding up the new service introduction process;
- Service design, including new types of service systems and value propositions;
- Defining and developing tools for service improvement.

Most businesses emphasize cost cutting more than revenue growth, leading to a bias of service research towards productivity rather than customer satisfaction (quality) or new market segments (growth). Traditional businesses are concerned with standardization, which may lead to a commodity trap. Often customization and personalization can be high margin, but hard to scale up. The challenge of consistent service delivery when scaling a service business needs to be addressed.

4 Organisation and people issues

- Service organisation structure and behaviour;
- Migrating to a service culture, with better methods to create deep customer insights;
- Recruiting and keeping people with the right skills.

Businesses describe new science, engineering, management and design graduates with limited service thinking and service mindset. Service-oriented people seem to be difficult to find and, because they are in high demand, they are even more difficult to keep.

5 The service environment

- Managing the transition to a service organisation;
- Developing services based on products;
- Reducing the complexity of services and their delivery;
- Providing service in a changing environment.

Businesses find it difficult to transform from a product to a service business model (the servicisation process). Part of the transitional challenge is being able to articulate what a service business looks like and what its constituent elements are. It is seen as a significant challenge to create a language that can be used to define and describe service businesses, their component elements and how they fit together.

Appendix VI

Global trends and service innovation

As businesses and governments decide investment and innovation policies, it is important for them to review global trends that entail service innovation as well as important areas that challenge sustainable improvement efforts.

1 ***Demographic trends and sustainability concerns will drive increased demand for public sector service activities and service research to focus on quality of life and environmental problems.***

Demographic trends toward a more aged, more educated and wealthier population in many developed countries, a younger population in many developing countries and more immigration between countries will continue to drive demand for healthcare and investment management, education and employment experience, as well as government and local community service activities. Human impact and sustainability concerns will increase energy-related (such as transportation and construction) and environmental service activities.

The society is changing; in developed countries, there are growing market segments with rising expectations of service quality, along with aging populations. Different demographic segments will demand different levels of service, be they low-cost service or premium high-cost high-value service. Service design and experience will depend on individual and cultural differences. Research needs to address the balance of social, technical and economic requirements of customer segments.

Sustainability concerns, such as the need for CO_2 reduction, increasingly affect the design and provisioning of service. Service innovation increasingly must achieve high-productivity and high-quality service within sustainability targets. Regulatory compliance issues will drive both legal and new sensor-based monitoring service activities.

2 ***Trends in business and technology (globalisation, automation, self-service technologies, 'service industrialization', the 'servicisation' of manufacturing, and the continued rise of the type of service system known as the globally integrated enterprise) will further drive demand for business transformation service activities, and service research to improve productivity and revenue growth, consistent with a triple bottom line of people, planet and profit.***

The rise of the globally integrated enterprise, including franchises as well as other global service providers, will continue to drive demand for ICT infrastructure improvements that allow value to migrate to the more knowledge-intensive business and professional service activities built upon the infrastructure service providers. The need for more business-to-business service research, including global logistics and lean operations is growing. The trend toward self-service technologies that provision service locally, but are often deployed and maintained by globally integrated enterprises, will drive demand for in-the-field maintenance and security service capabilities.

There is an increase in globalisation of service activities through off-shoring and regional specialization and competition is growing across highly diverse cultures. Economic linkages across the globe are not new but they have intensified and accelerated over the past decade. Countries are experiencing growth in the contribution of service activities to their national economies, hence research needs to have global application, be cross cultural, transcend traditional economic barriers and keep pace with the speed of change. Because of sustainability concerns, globally integrated enterprises will increasingly be held to a triple bottom line (people, planet, profit, which may all be summarized in a fourth 'P', predictability of sustainable value-cocreation).

Technology is becoming more pervasive and ubiquitous, IT-enabled service has risen rapidly and the worldwide IT service industry is expected to increase in value from US$ 635 billion in 2005 to US$ 780 billion by 2008. More small businesses depend on technology and web service infrastructure as markets increase in complexity. The time to global markets can be instantaneous as can be on-demand service enabled by smart sensors without human intervention. Research must help harness the power of ICT to design and provision new types of self-service technologies, as well as mobile phone service offerings.

Recent decades have witnessed the rise of 'service industrialization', and the growing value of service

innovation. However there remains a great deal of craft-like organisation in some service industries that lack the rigour of traditional manufacturing and engineering disciplines. The growth in service activities is creating a skills gap which requires adaptive workers who change with the business; who can lead market innovation, technology innovation, and who can exploit the accelerating pace of technological and societal change. Researchers and educators must address the need for people with both breadth of understanding and depth in service industry specific skills.

3 ***Trends in internet collaboration and web-based service, such as open source software and software as a service (SaaS), continue to mature and are driving service research around business model innovation and regulatory compliance issues.***

Peer-to-peer collaboration is increasing through use of internet mediated communication and social computing tools (web 2.0, YouTube, MySpace and Wikipedia) and virtual worlds (multi-user games, Second Life). In turn this is leading to service exchanges between individuals and growth in ad-hoc service network formation. Research must recognise the extension of service provision beyond the traditional boundaries of business.

Napster serves as a reminder of the regulatory compliance issues that can arise in peer-to-peer collaboration and web-based service systems. New types of service systems will explore new types of business models, and as a consequence regulatory compliance issues may arise.

4 ***Trends in organisational innovation are particularly important to service activity growth, and more service research is needed to understand the co-evolution of customer demand, technology, business models, governance, and organisational innovation.***

Analyses of European Innobarometer data indicate that a substantial share (almost one third) of service firms consider their major innovations to be solely organisational. It has long been commonplace that a large share of the benefits (value) through the application of IT in firms flows from the reorganisation of activities accompanying the new technology. This has particular relevance to service sectors because many types of service until recently have scored low on technology-intensity. New information technologies have constituted a technological and industrial revolution in service provisioning that challenges many to consider redesigning their work practices and corporate structures in unprecedented ways.

Appendix VII

Example of innovation roadmap

The extract below is from a European Commission report on innovation strategy and it provides an example of innovation roadmap[7].

"The following 10 actions are of particularly high political priority as part of the Lisbon strategy for growth and jobs:

Action 1: Member States are invited to significantly increase the share of public expenditure devoted to education and to identify and to tackle obstacles in their education systems to promoting an innovation friendly society. In particular, they should implement the 18 Communication from the Commission "Investing in research: an action plan for Europe", COM (2003) 226 final/2, 4.6.2003. EN 17 EN recommendations included in the Communication "Delivering on the Modernisation Agenda for Universities" for better education and innovation skills.

Action 2: A European Institute of Technology should be established to help improve Europe's innovation capacity and performance. The Commission intends to put forward a proposal in October 2006 and the EIT should be operational by 2009.

Action 3: The Community and Member States should continue to develop and implement a strategy to create an open, single, and competitive European labour market for researchers, with attractive career prospects, including possible incentives for mobility.

Action 4: In order to address the poor up-take of research results in Europe, the Commission will adopt a Communication in 2006 - including voluntary guidelines and actions of Member States and concerned stakeholders - to promote knowledge transfer between universities and other public research organisations and industry.

Action 5: The EU's cohesion policy for the period 2007-2013 will be mobilized in support of regional innovation. All Member States should seek to earmark an ambitious proportion of the 308 billion € available for investing in knowledge and innovation.

Action 6: A new framework for State aid to research, development and innovation will be adopted by the Commission before the end of 2006, to help Member States better target State aid on market failures preventing research and innovation activities. Member States should reorient their State aid budgets to target these objectives, in full respect of their overall commitment to "less and better targeted aid". The Commission will also present a communication later in 2006 with detailed guidance for the design and evaluation of generally applicable tax incentives for R&D.

Action 7: Drawing on the recent public consultation, the Commission will present a new patent strategy before the end of 2006 and prepare a more comprehensive IPR strategy in 2007, facilitating inter alia the circulation of innovative ideas.

Action 8: Building on its review of the copyright acquis, the Commission will continue its work to ensure that the legal framework and its application are conducive to the development of new digital products, services and business models. In particular, it will bring forward an initiative on "copyright levies" before the end of 2006.

Action 9: The Commission will test in 2007 a strategy to facilitate the emergence of innovation friendly lead-markets. In this context, it will conduct, after a public consultation including in particular the Technology Platforms and the Europe INNOVA innovation panels, a detailed analysis of potential barriers to the take-up of new technologies in a limited number of areas. In parallel, using this experience, the Commission will prepare a comprehensive lead-markets strategy.

Action 10: The Commission will publish and distribute a Handbook on how pre-commercial and commercial procurement can stimulate innovation by end 2006 to support Member States in availing themselves of the opportunities offered by the new procurement Directives."

[7] Source: Putting knowledge into practice: A broad-based innovation strategy for the EU, 2006, p. 16-7.

Appendix VIII

Ongoing debate

While a consensus is emerging among contributors and respondents, there are still different views as to how we can best proceed to lay the foundations for service innovation. Below is a summary of key points on which we welcome ongoing debate:

A. Two dominant views of service

IHIP (intangibility, heterogeneity, inseparability, and perishability) View: Service should be defined and studied as different from and a complement to products.

SDL (service dominant logic) View: Service should be defined and studied as everything involving purposeful value-cocreation between entities.

B. Two dominant views of innovation

Broader: Innovation should be defined and studied as any value-creating changes, ranging from incremental improvements to radical breakthroughs.

Narrower: Innovation should be defined and studied as certain types of value-creating changes, i.e. those significantly beyond incremental improvements and optimizations of existing systems.

C. Two dominant views of SSME as science

Emerging: Yes, the phenomenon is worthy of a new science. However, data and models are in early stages of development, borrowing from many existing fields, and better tools are needed for modelling and simulating the complexity of service systems and their interactions. Another challenge to the new science is that much of the data required to build the science is considered confidential.

Too broad: No, the scope is too broad and no useful progress can be made until we can focus on a smaller piece, for example, starting with discipline X and then developing new interdisciplinary knowledge that connects with disciplines Y and Z. Otherwise, Service Science is little different from a science of complex adaptive systems.

D. Customer versus engineering focus

Customer dominates: Too much customer focus and not enough engineering consideration. The conceptual foundation of value proposition is too complex to formalize because it involves customers who are people with preferences.

Engineering dominates: Too much engineering focus and not enough customers focus. The conceptual foundation of service systems is an engineering thought.

E. Marketing versus operations focus

Marketing dominates: Too much marketing focus and not enough operations. Overemphasis on customer expectations may lead to mismatch in service operations.

Operations dominates: Too much operations and not enough marketing. Optimizing productivity is being emphasized over innovating customer experience.

F. Science versus engineering focus

Science dominates: Too much abstract and conceptual discussion of Service Science, and not enough pragmatic engineering examples of the best way to design specific service systems based on SOA (service-oriented architecture) and quantifiable SLAs (service-level agreements).

Engineering dominates: Systems, technology and productivity focus are all engineering oriented, but the underlying scientific concepts and foundations, on which to build an engineering discipline for service systems, are often people-intensive and market-facing.

G. Education versus management focus

Education dominates: Too much education focus and not enough practical management recommendations and exemplar success stories. Adaptive innovators and T-shaped professionals may be important concepts, but ultimately managers are responsible for making investment decisions in skills and innovation, and that should be the main focus.

Management dominates: Too much management and business focus, and not enough on what and how to educate a new generation of adaptive innovators, who can work in government, public and social sectors, where profit is not a key driving force.

H. SSME versus SSMED

SSME: Design is already covered under engineering, beside SSME is already an established acronym and SSMED is too long.

SSMED: Design is different from engineering in that it involves more aesthetic, artistic, and stylistic judgments. User experience (both customer and provider) is a critical success factor in service innovation, so it is more inclusive to speak of SSMED.

I. Integrating disciplines: pairs versus lists

Discipline pairs: Service Science is just too ambitious, listing over a dozen disciplines and expecting progress on integrating them all. Be more practical, and start with a pair or at most a few pairs. Show real progress first.

Discipline lists: While there are many disciplines, there is underlying simplicity. In principle, there are only four types of resources (people, technology, organisations, and shared information). In addition, the four measurements related to value (quality, productivity, regulatory compliance, and sustainable innovation) can provide the basis for a deep theory that cuts across all the relevant disciplines. Disciplines create knowledge and service applies knowledge to co-create value.

J. People are not resources

Ownership: The term resource should only be applied to things that can be owned. Hence, the application of the term resource to people is entirely inappropriate.

Access: The term resource should be applied to things that can be accessed for a purpose. Hence, the notion of people as resource is perfectly appropriate from an 'access to capabilities' perspective.

K. What kind of systems are service systems?

Static types: Service system must be less general and therefore falls into one type of the following classes of systems: economic, social, legal, political, computational, cognitive, socio-technical, linguistic-information, knowledge, business/organisation, and human.

Dynamic types: The populations of types of service systems change over time, becoming increasingly formal and dependent on shared information to solve motivation and coordination problems, while simultaneously becoming increasing innovative and expanding the number and diversity of informal service systems.

L. Abstract versus pragmatic

Abstract: The paper is very clearly focused on establishing the four foundational concepts: service system, value proposition, adaptive innovator and SSME. The paper is very clearly intended to stimulate follow-on meetings and publications, and provide the outline and structure to align stakeholders.

Pragmatic: The paper does not have enough concrete examples of service innovation, existing roadmaps of service innovation in nations and organizations, pragmatic advice to managers and leaders, references to existing academic foundational work.

M. Doable versus too hard

Doable: Given advances in computer-based education and cross-disciplinary curricular materials, it is entirely within our grasp to create adaptive innovators and T-shaped professionals who are both deep in their home discipline and have interactional expertise across the other SSME disciplines. There is enormous need for these types of people in business and society

Too hard: Despite the need for adaptive innovators and T-shaped professionals, the drive to specialization and disciplinary silos is just too strong to be overcome. This effort is doomed to failure because, while there is the need, there is no market demand. Also, this is too much for any but a few polymath individuals to ever aspire to learn, even with new augmentation tools and organizations.

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