Introduction

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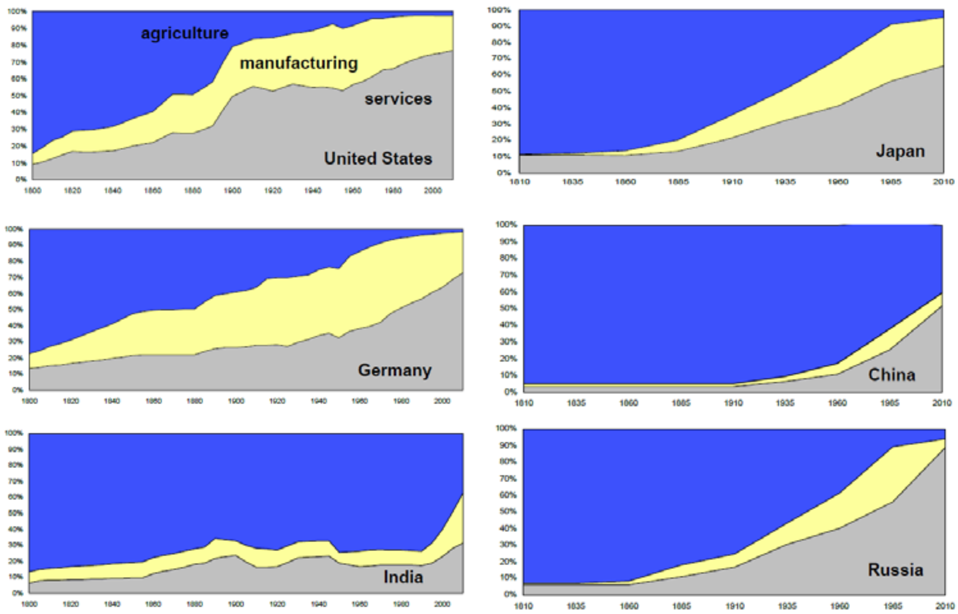
Biographical notes: Cees Bil is a Professor of Aerospace Design at RMIT University in Melbourne, Australia. He received his PhD in Aerospace Engineering, Master of Science and Graduate Diploma (Education) from Delft University of Technology in The Netherlands. He has 30 years research experience in aerospace systems design, through-life support, unmanned air systems, occupant safety, air traffic management and knowledge-based engineering. He has published over 300 conference and journal articles on various topics in aerospace design and operations. He is a member of the Royal Aeronautical Society and an Associate Fellow of the American Institute of Aeronautics and Astronautics. He is a board member of the International Society for Productivity Enhancement (ISPE) and Australian representative on the International Council of the Aeronautical Sciences (ICAS).

The workforce in the *service sector* has increased sharply worldwide. Figure 1 shows the change in the percentage working population in agriculture, manufacturing and services sector (Maglio, 2007). In developed countries, mainly in Europe and North America, the working population in the secondary manufacturing industry increased sharply after the first industrial revolution, which was ushered in by the steam engine in the late 18th century and the second industrial revolution which took place as a result of the increased use of oil and electricity in the late 19th century. However, after the 20th century the service industry had gained momentum. Newly industrialised countries such as China and India are shifting directly from the age of agriculture to that of services (Hikada, 2006).

The manufacturing industry is undergoing a major transition to services, not just sales but also in business structures. The business structure is transitioning from manufacturing and supplying of goods alone to providing goods with added value and eventually to promoting service business strategies. Providing goods together with added value refers to combining products with maintenance, usage assistance, information provision, support for user communities and other services that increases the value to the customer, also referred to as *servicising* or *product-service systems* (*PSS*). For example, for IBM, the contribution of services accounts for 50% of total sales in 2004, exceeding combined sales of hardware and software. These services include system construction, consulting, systems integration, outsourcing, maintenance and support services.

Promoting service business strategy represents extending the scope of service to support and maintain even competitor's products, in a quest to broaden the service business from the viewpoint of customer value orientation. This move towards more extensive, customer-oriented services has become common in many manufacturing industries. This suggests that the importance of services to companies in the global economy is rapidly increasing, both quantitatively and qualitatively, in manufacturing and service industries alike.

Figure 1 Percentage workforce in agricultural, manufacturing and service sector (see online version for colours)



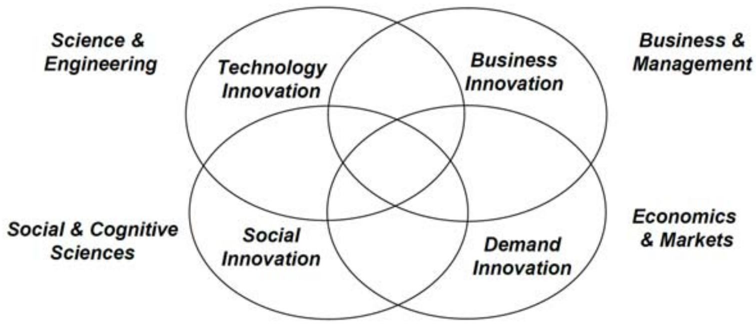
To address these issues, a new discipline called *service science* is emerging (Abe, 2005; Spohrer and Maglio, 2010). Service science has evolved in response to the need to combine technological and non-technological innovation in this rapidly growing sector. Service science has been re-named by IBM to *Service Science Management and Engineering* (*SSME*) (Chang et al., 2012; Spohrer and Kwan, 2009).

Services can be paraphrased in terms of their key characteristics:

- Services are intangible and insubstantial: they cannot be touched, gripped, handled, looked at, smelled, and tasted.
- Services have little or no tangible components and therefore cannot be stored for a future use. Services are produced and consumed during the same period of time.
- The service provider is indispensable for service delivery as he must promptly generate and render the service to the requesting service consumer.
- Each service is unique: it is one-time generated, rendered and consumed and can never be exactly repeated as the point in time, location, circumstances, etc.
- One of the most important characteristic of services is the participation of the customer in the service delivery process. A customer has the opportunity to get the services modified according to specific requirement.

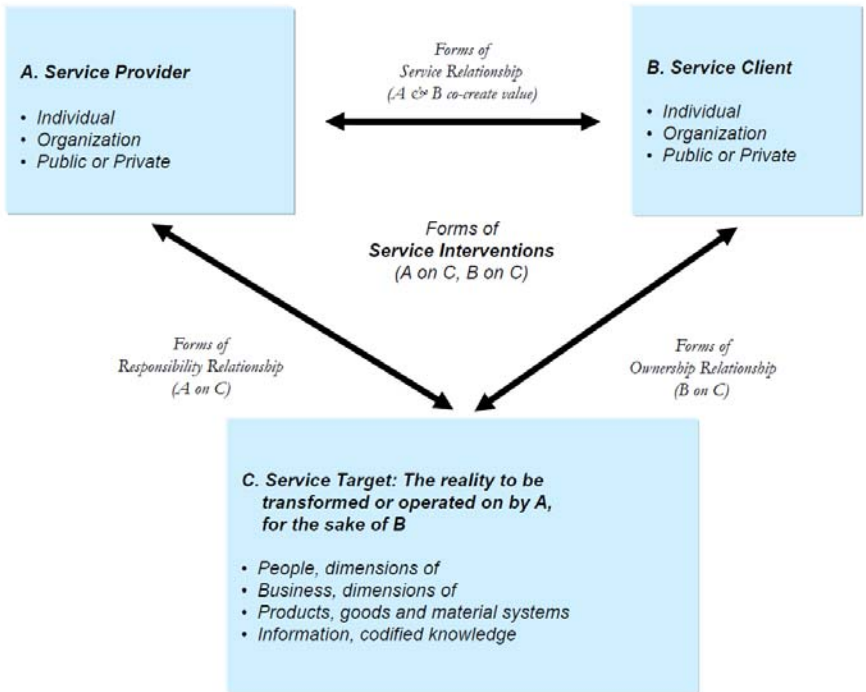
The discipline addresses the service sector's unique problems by adopting multiple approaches. It draws on ICT, business, management, industrial engineering, socio-legal sciences, and economics. The innovative creation of value for both customers and shareholders lies at the core of this interdisciplinary approach (Figure 2).

Figure 2 The interdisciplinary service environment



Source: Maglio (2007)

Figure 3 Service systems as a system of relationships (see online version for colours)



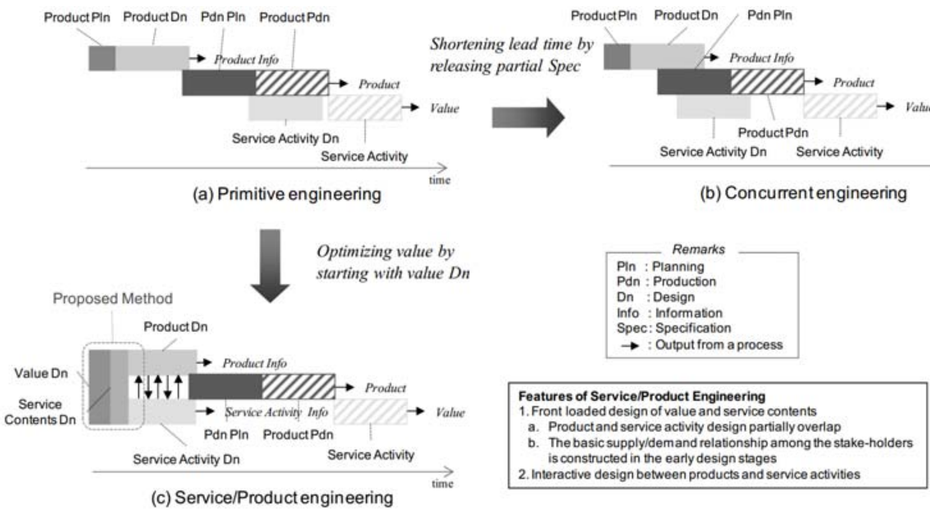
Source: Gruhl et al. (2007)

Service involves at least two entities, one applying competence and another integrating the applied competences with other resources and determining benefit (also called, value co-creation). A *service system* is a configuration of technology and organisational networks designed to deliver services that satisfy the needs, wants, or aspirations of customers. They are value coproduction configurations of people, technology, internal and external service systems, connected by value propositions, and shared information (language, laws, measures, etc.) (Maglio, 2007; Dubberly and Evenson, 2010):

- Services depend critically on people, technology, and co-creation of value.
- People work together and with technology to provide value for clients.
- So a service system is a complex socio-techno-economic system.
- Growth requires innovation that combines people, technology, value, clients.

Service/product engineering (*SPE*) provides concepts and methodologies that consider the relationship between products and service activities from the viewpoint of total value (Hara et al., 2007). In SPE, product planning is replaced with value design and service contents design. Figure 4 shows the differences in the design process (a) intraditional design, (b) concurrent engineering and (c) SPE:

Figure 4 Design process for SPE, primitive engineering and concurrent engineering



Source: Hara et al. (2007)

Its features are as follows:

- Front-loaded design of value and service contents

  Customer value is emphasised in SPE more than in traditional engineering and CE. Design for value means focusing on the outcome for the customer, i.e., the preferred state change of the receiver. On the other hand, designing service contents means designing output of product functions and/or service activities. SPE creates a design methodology that works as a bridge between this outcome and this output. By front-loading the design of value and service contents, product and service activity design partially overlap, and the basic supply/demand relationship among the stake-holders is constructed in the early design stages.

- Interactive design between products and service activities

  In SPE, products and service activities are designed in parallel according to the designed value and service contents. After that, production planning, production, and service activities are performed. While CE designs components of the product concurrently, SPE emphasises concurrent design of both products and service activities. By releasing early and partial information, products and service activities can be produced using mutually adaptive designs.

The increasing importance of services and the business shift to complete services solutions, i.e., integrated products and services, will direct the process of concurrent engineering likely to evolve closer to that of SPE.

This special edition includes invited papers selected from contributions to the 20th ISPE International Conference on Concurrent Engineering held in Melbourne, Australia, on 2–5 September 2013.

Margherita Peruzzini and Michele Germani's paper discusses sustainability of *PSS* defines an integrated product-service lifecycle and proposes a methodology to identify a set of sustainability indicators to be applied to both PSS and products with the final aim to compare different application scenarios. The methodology is illustrated by means of an industrial case study focusing on water heaters; it analyses an innovative PSS 'hot water as a service' supported by an extended network, and compares it with the traditional scenario based on product selling supported by a vertical supply-chain.

Evelina Dineva et al. address human factors associated with team work in a multidisciplinary *collaborative design* environment. The human involvement in a concurrent design environment is critical. The extraction and representation of information from a very large dataset that can be interpreted, understood and shared is an important element in a concurrent design facility.

Raymond M. Kolonay's paper presents a design exploration and technology assessment process for military aerospace vehicles. It utilises physics-based analyses and a distributed *collaborative computational environment* to predict vehicle performance which in turn is used in mission level simulations to assess the impact of a given configuration or technology on the combat effectiveness.

Jeremy Hills and Yongmin Zhong present a heat conduction method for optimal robot path planning by drawing an analogy between heat conduction and path planning of mobile robots. The proposed method generates real-time, optimal and collision-free paths without any prior *knowledge* of the dynamic environment and without explicitly searching over the global free work space or searching collision paths. It can also respond to the real-time changes in dynamic environments.

Jingyu Sun et al.'s paper proposes a system for tacit *knowledge-based* elicitation in curved shell plates' manufacturing process using Ripple-Down-Rules. By virtualising the manufacturing process and automatically suggesting manufacturing plans, the system would allow the knowledge-interrelated information more specific and understandable.

Sergej Bondar et al.'s paper identifies seamless *data communication* in all phases of the product development process as a prerequisite for cost-optimal and successful collaboration processes. Automotive suppliers face the challenge of ensuring that they make CAD data available in the format required by their customers and with a high level of reliability. The main problem in this process chain is the insufficient data quality. The paper describes the approaches taken in cooperation between the supplier portal http://www.opendesc.com and Heidelberger Druckmaschinen AG.

Fredrik Elgh's paper addresses the added value of *product customisation*. The possibility to design and manufacture highly customer adapted products brings a competitive edge to manufacturing companies and is in some areas required for business success. In the paper, an approach for documentation and knowledge management of systems supporting the design and manufacture of customised products is explored.

Danni Chang and Chun-Hsien Chen's paper identifies a lack of mathematical analysis to reveal the underlying relations between the customer-related innovation inputs and outputs of product innovation results. The study aims to:

1 identify the factors fostering product innovation during *new product development* (*NPD*)

2 investigate the significance of customers to product innovation

3 explore the quantitative relations between the input information from customers/clients and the output of product innovation results.

Teruaki Ito's paper discusses the issues associated with participants who work in a *collaborative environment*, but who are physically separated. They do not have the same communication experience as face-to-face meetings. The paper focuses on the issues of tele-presence and virtual immersion associated with these problems, and proposes an idea of body movement-based interaction based on two types of interaction approaches.

Maarten Zorgdrager et al.'s paper introduces a method to collect time series datasets for aircraft non-routine maintenance material demand. Non-routine material consumption is linked to scheduled maintenance tasks to gain insight in *demand patterns*. For the small time series datasets associated with non-routine maintenance, exponentially weighted moving average (EMA) outperformed smoothing methods. To validate the practical applicability of EMA for non-routine maintenance material demand, the method has been applied and verified in the prediction of actual demand for a maintenance C-check.

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References

Abe, T. (2005) *What is Service Science?*, The Fujitsu Research Institute, Research Report No. 246.

Chang, A-C., Trappey, A.J.C. and Trappey, C.V. (2012) 'Providing customized products and services based on service science', *2012 International Conference on Education and Management Innovation, IPEDR*, © (2012), IACSIT Press, Singapore, Vol. 30.

Dubberly, H. and Evenson, S. (2010) 'Designing for service: creating an experience advantage', in Salvendy, G. and Karwowski, W. (Eds.): *Introduction to Service Engineering*, Chapter 19, Wiley.

Gruhl, D., Bailey, J., Spohrer, J. and Maglio, P.P. (2007) 'Steps toward a science of service systems', *Computer*, January, Vol. 40, No. 1, pp.71–77, DOI: 10.1109/MC.2007.33.

Hara, T., Arai1, T., Shimomura, Y. and Sakao, T. (2007) 'Service/product engineering: a new discipline for value production', *19th International Conference on Production Research (ICPR-19)*, 27 July–2 August, Valparaiso, Chili.

Hikada, K. (2006) 'Trends in services sciences in Japan and abroad', *Science and Technology Trends – Quarterly Review*, April, No. 19, ISSN 1349-3671.

Maglio, P.P. (2007) *Service Science, Management, and Engineering (SSME): An Interdisciplinary Approach to Service Innovation*, IBM Almaden Research Center, 16 January.

Spohrer, J. and Kwan, S.K. (2009) 'Service science, management, engineering, and design (SSMED): an emerging discipline – outline & references', *International Journal of Information Systems in the Service Sector*, July–September, Vol. 1, No. 3, pp.1–31.

Spohrer, J. and Maglio, P.P. (2010) 'Service science: toward a smarter planet', Karwowski, W. and Salvendy, G. (Eds.): *Introduction to Service Engineering*, Wiley & Sons, New York.