# SYSTEMS THINKING : A SERVICE SCIENCE PERSPECTIVE

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## システム思考：サービスサイエンスからの展望

システム思考は複雑適用系を理解し，モデル化するための接近法の１つである．一方，サービスサイエンスはサービスシステムを研究するために発展しつつある分野である．サービスシステムは，能力，制約，権利，責任などの概念を必然的に取り扱う複雑適応系となっている．最近，サービスシステムは，階層的なネットワーク生態系の中で急速に発展しつつあり，特に，家計，大学，市街などのサービスシステムにおいては，よりよい生活の実現のために，全体的（ホリスティック）な観点から研究を行うことが重要となってきている．サービスサイエンスは比較的新しい学問分野であるが，サービスサイエンスの進歩によって，将来のシステム思考に対する考え方が大きく変化する可能性がある．
【本稿サマリー】

## INTRODUCTION

Systems thinking is an approach to understanding the complex systems that we live in as well as the complex systems we are [23] :

"Accelerating economic, technological, social, and environmental change challenge managers and policy makers to learn at increasing rate, while at the same time the complexity of the systems in which we live is growing. Many of the problems we now face arise as unanticipated side effects of our own past actions. All too often the policies we implement to solve important problems fail, make the problem worse, or create new problems. Effective decision making and learning in a world of growing dynamic complexity requires us to become systems thinkers – to expand the boundaries of our mental models and develop tools to understand how the structure of complex systems creates their behavior. This book introduces you to system dynamics modeling for the analysis of policy and strategy, with a focus on business and public policy applications." (Page. vii);

Furthermore, general systems thinking spans many disciplines and is an approach to complex systems that can be used by professionals and laypersons alike [26] :

"The general systems movement has taken up the task of helping scientists to unravel complexity technologists to master it, and others to learn to live with it." (Page. 3);

All complex systems have capabilities and constraints that can be described and modelled to some degree [23), 26)].

Business and societal organizations continually innovate to adapt available resources to changing competition, regulation, and requirements of customers and other stakeholders [9]. Organizations innovate to improve efficiency, quality and speed of their operations, through mergers and networks that adapt their resource base to changing needs, and through rapid services offerings. In other words, they attempt to manipulate what are perceived of as the controllable variables within their systems. However, they often discover that these manipulations do not achieve desired outcomes and/or create unwanted side-effects – mainly because their system is much more complex than they anticipated. Changes to the scale of service delivery may impact service quality in unanticipated ways, the introduction of a new service may create demand for different or even more services and service innovations may unintentionally shift the market from a product to a service quality focus. Unanticipated consequences result in unnecessary costs, lack of responsiveness to customers, and missed opportunities for innovation. For example, manipulating the systems can result in fragmented service delivery. Reduced fragmentation and complexity, improved efficiency and higher levels of agility in systems can only be achieved when multiple, complex trade-offs are carefully balanced (Table 1).

Influenced by the emerging field of service science, service-oriented strategies, technologies, and management have gained attention in the past few years, offering approaches to developing more flexible business processes that co-create value with customers to manage trade-offs more carefully. For example, Rolls Royce leveraged its expertise in aircraft engine manufacturing to implement a service-oriented Power-by-the-Hour offering for their customers. This new business model better met customer needs and gave Rolls Royce more information about the way their customers use resources to create value. Zara achieved this success by exploiting its vertical integration to redesign customer oriented service processes [25]. Idea of analysing the customer has been around for many years in manufacturing industry [27]. Examples abound of traditionally product-oriented companies adopting a service-orientation when they can put in place service-oriented systems as a platform for continuous innovation with their customers and partners [7]. The growing literature associated with service-dominant (S-D) logic and service science document some of these examples [24] and illuminates the associated orientation.

In addition to the service orientation and service transformation, service industries are also growing exponentially. These include financial, education, transportation and telecommunication, information technology services, logistics, human resources management and many others. In fact, these modern service industries have become the pillars of many national economies.

Although research and experiential findings on services in many disciplines have achieved impressive results, systematic research on modern service systems is still very limited. In this article, after discussing holistic service systems, we explain how systems thinking and theory can shed light on the evolution of this new science of service and service systems. We conclude our article with opportunities and challenges.

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|---|---|
| Systematize | Customize |
| Cost | Effectiveness |
| Consistency | Variance |
| Standardized | Differentiated |
| Independent | Interdependent |
| Available | Convenient |
| Speed | Accuracy |
| Secure | Open |
| Stable | Dynamic |

Table 1. Examples of Tradeoff Challenges

## SYSTEMS THINKING : HOLISTIC SERVICE SYSTEMS

Holistic service systems vary enormously in scale and are very complex, but they also may be entering an era of accelerated innovation, or rapid learning from each other's best practices.

The types of entities that are capable of service interactions (service for service exchange) vary enormously in scale and structure. Nations, states, cities, hospitals, universities, businesses, non-profits, families, and individual people are capable of service interactions. They apply knowledge, competencies, and resources for the benefit of other entities, and engage in service for service exchange (value-cocreation) The knowledge, competencies, and resources, they needed to survive were largely contained within their population and local environment. While there are many benefits of being largely self-sufficient, nevertheless, because they had minimal interaction with other entities, processes such as learning and sharing innovations, or best practices could be quite slow, and take many generations to jump from one holistic service system to another [1), 12)].

In the interconnected world of today, if a nation, state, or city were to become cutoff from the rest of the world, quality of life would begin to suffer almost immediately. There is a much greater degree of interdependence amount service system entities today than in the past. Quality of life is a function of the quality of service from many systems such as transportation, water, food, energy, communications, buildings, retail, finance, health, education, and governance.

Could we be entering an era of dramatically accelerated improvement of holistic service systems? There is some data that suggests this may be the case. For example, Figure 1 below shows the correlation between a nation's percentages of world-wide GDP (Gross Domestic Product) and percentage of top-500-ranked universities. The strong correlation exists over time, and for nations like China and Japan that have seen rapid GDP growth, there is also a rapid growth in top ranked universities. This is likely a case of dual causality, in the sense that improved universities can help boost GDP, and improved GDP can help boost the quality of faculty, facilities, and graduates at the university [10), 11)].

Furthermore, it appears we are entering an era, where

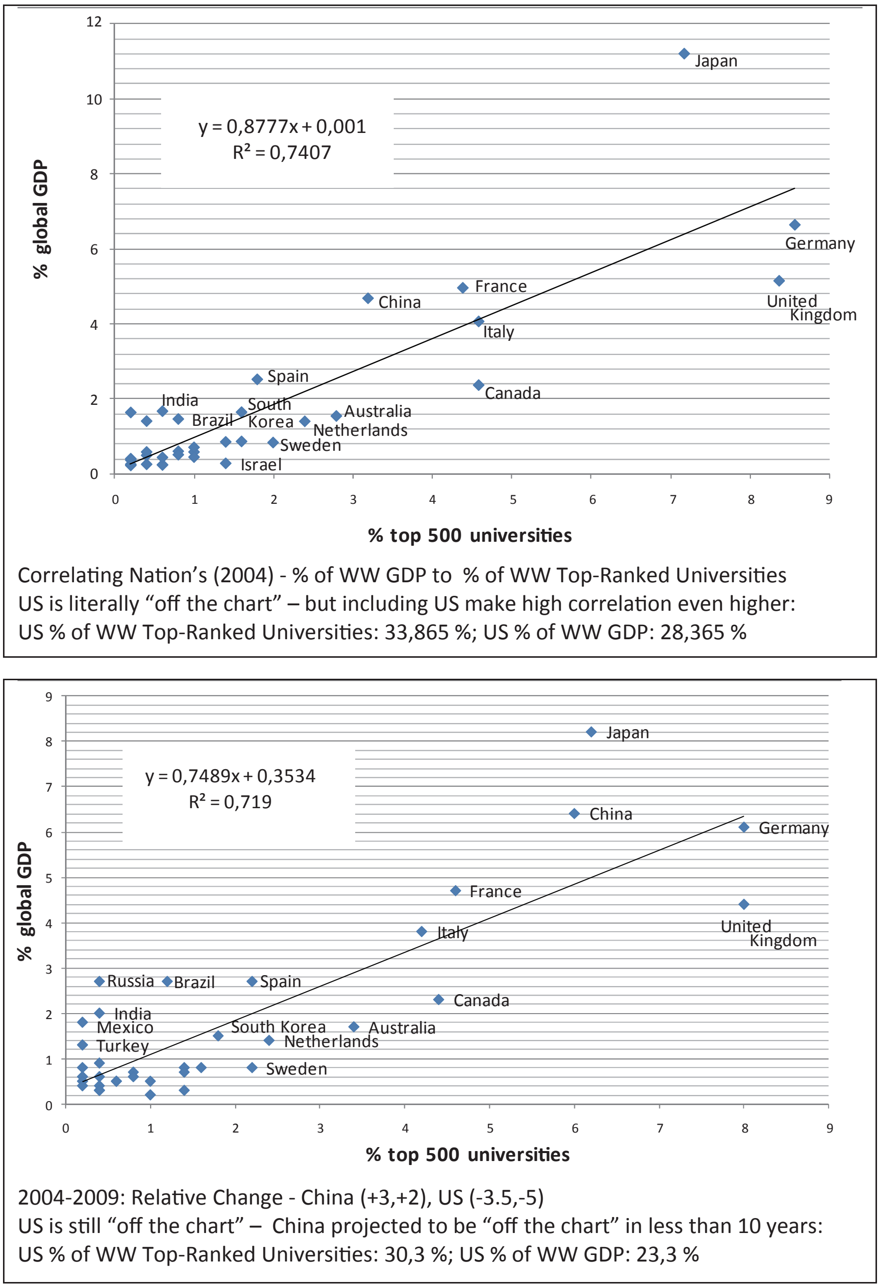


Figure 1. The correlation between a nation's percentages of world-wide GDP and % of top-500-ranked universities (Source : http://www.arwu.org/ARWUAnalysis2009.jsp)

our understanding of holistic service systems, will enable accelerated improvements, as they learn best practices from each other. Quality of life has the potential to improve consistently generation after generation, including quality of service from multiple systems, quality of jobs in those systems, and quality of investment opportunities based on more predictable change. The service science community is composed of researchers and practitioners working together to better understand service systems and to manage, engineer, and design best practice improvements (Figure 2).

ECOLOGY (Figure 3) is the study of the abundance and distribution of entities in an environment, and how the entities interact with each other and their environment over successive generations of entities [4), 16)].

The concept of ecology is more general and can be applied to entities as diverse as the populations of types of atoms in stars to the types of businesses in a national economy. About 14B years ago (indicated by the top of this purple bar), our universe started with a big bang. And through a process of known as fusion, stars turned populations of lighter atoms like hydrogen into heavier atoms like helium, and when stars of a certain size have done all the fusion they could, they would start slowing down, and eventually collapse rapidly, go nova, explode and send heavier atoms out into the universe, and eventually new stars form, and the process repeats over and over, creating stars with different populations of types of atoms, including heavier and heavier elements. Eventually after about ten billion years in the ecology of stars and atoms

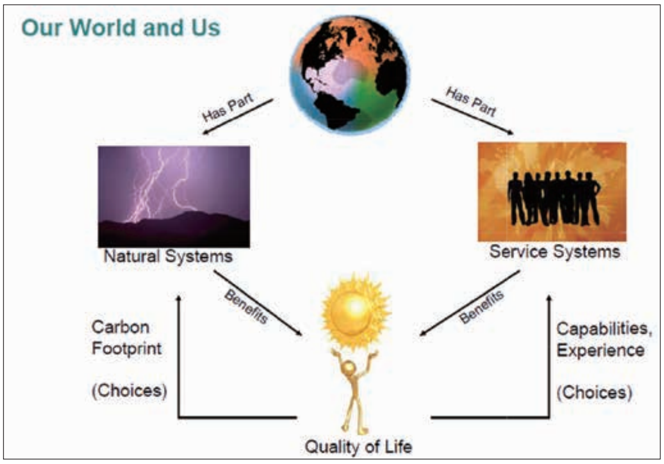


Figure 2. Interactions of Natural Systems and Service Systems for Quality of Life


Figure 3. ECOLOGY

within stars, a very important star formed our sun (the yellow on the left) – and there were plenty of iron and nickel atoms swirling about as our sun formed, and began to burn 4.5B years ago, and the Earth formed about 4.3B years ago (the blue on the left)... In less than a billion years, the early earth evolved a remarkable ecology of complex molecules, including amino acids, and after less than a billion years, an ecology of bacteria took hold on early earth (the bright green on the left).

The ecology of single cell bacteria flourished and after another billion years of interactions between the bacteria, the first multi cellular organisms formed, and soon the ecology of sponges (the light blue on the left) and other multi-cellular entities began to spread out across the earth. Then after nearly two billion years, a type of division of labor between the cells in multi cellular organism lead to entities with cells acting as neurons in the first clams (the red on the left), and these neurons allowed the clams to open and close at the right time. After only 200 million years, trilobites appeared the first organisms with dense neural structures that could be called brains appeared (the black on the left), and then after about 300 million years, multi-cellular organisms as complex as bees appeared (the olive on the left), and these were social insects, with division of labor among individuals in a population, with queens, drones, worker bees. So 200 million years ago, over 13B years after the big bang, the ecology of living entities is well established on planet earth, including social entities with brains and division of labor between individuals in a population...

Living in colonies that some have compared to human cities – where thousands of individuals live in close proximity and divide up the work that needs to be done to help the colony survive through many, many generations of individuals that come and go. Bees are still here today. And their wingless cousins, called ants, have taken division of labor to incredible levels of complexity in ant cities in nearly every ecological niche on the planet.

Now take 1% of this little olive slice, which is 2 million years... that is how long people have been on earth, just one percent of the little olive slice on the left. What did people do in most of that 2 million years? Basically, they spread out to every corner of the planet, and changed their skin color, eye colors, and hair colors, they spread out and became diverse with many different appearances and languages. It took most of that 200 millions just to spread out and cover most of the planet with people. The bar on the right represents 10,000 years or just 500 generations of people, if a generation is about 20 years. 500 generations ago humans built the first cities, prior to this there were no cities so the roughly 100M people spread out around the world 0% lived in cities, but about 500 generations ago the first cities formed, and division of labor and human-made service interactions based on division of labor took off – this is our human big bang – the explosion of division of labor in cities.

So to a service scientist, we are very excited about cities as important types of service system entities, and division of labor as an important type of value-cocreation mechanism, and all this really takes off in a big way just 500 generations ago when the world population was just getting to around 100M people spread out all around the world – so 10,000 years about 1% of the worlds population was living in early versions of cities. It wasn't until 1900 that 10% of the world's then nearly 2B people lived in cities, and just this last decade that 50% of the worlds 6B people lived in cities, and by 2050 75% of the worlds projected 10B population will be urban dwellers. It should be noted that the growth of what economist call the service sector, parallels almost exactly the growth of urban population size and increased division-of-labor opportunities that cities enable – so in a very real sense SERVICE GROWTH IS CITY GROWTH OR URBAN POPULATION GROWTH... in the last decade service jobs passed agriculture jobs for the first time, and urban dwellers passed rural dwellers for the first time.

But we are starting to get ahead of ourselves, let's look at how the human-made ecology of service system entities and value-cocreation mechanisms evolved over the last 10,000 years or 500 generations. The population of artifacts with written language on them takes off about 6000 years ago or about 300 generations ago (the yellow bar on the right).

Written laws (blue on right) that govern human behavior in cities takes off about 5000 years ago – and this includes laws about property rights, and punishment for crimes. Shortly thereafter, coins become quite common as the first type of standard monetary and weight measurement system (green on right).

About 50 generations ago, we get the emergence of another one of the great types of service system entities – namely universities (light blue line) – students are the customers, as well as the employers that need the students. Universities accelerate the division of labor in cities and the supply and demand for specialized skills, including the research discipline skills needed to deepen bodies of knowledge in particular discipline areas. The red line indicates the population of printing presses taking off in the world, and hence the number of books and newspapers. This was only about 500 years or 25 generations ago. The black line indicates the beginning of the industrial revolution about 200 years ago or 10 generations ago, the steam engine, railroads, telegraph and proliferation of the next great type of service system entity – the manufacturing businesses that benefited from standard parts, technological advances and scale economies, and required professional managers and engineers. By 1900, just over 100 years ago, or 5 generations ago, 10% of the world's population, or about 200 million people were living in cities and many of those cities had universities or were starting universities.

Finally, just 60 years ago or 3 generations ago, the electronic semiconductor transistor was developed (indicated by the olive colored line on the right), and the information age took off, and many information intensive service activities could now benefit from computers to improve technology (e.g., accounting) and many other areas.

So to recap, cities are one of the oldest and most important type of service system and universities are an important and old type of service system, as well as many types of businesses. Smarter Service Systems = Complex Systems that serve customers better with services such as water, electricity, transportation, education, healthcare, etc.

Based on the systems literature, "systems" can be defined as an "entity which is a coherent whole". This coherence enables a boundary to be drawn around an entity distinguishing the elements that are "inside" from the "outside". Also, the existence of a boundary enables us to identify inputs and outputs that crosses the boundary [14]. All these elements of the system that function together show some level of organization beyond that of the random or weakly related. Therefore, an entity considered as a "whole", has sub-systems and is part of a wider whole [6].

## BOULDING'S SKELETON OF SCIENCE

Boulding [5] in a short essay entitled "General Systems Theory - The Skeleton of Science" motivated the importance of general systems theory for fools like us. Fools like us use highly specialized symbols and language to learn and communicate scientific findings between the Right People. He also indicates that "General Systems Theory' is a name which has come into use to describe a level of theoretical model-building which lies somewhere between the highly generalized constructions of pure mathematics and the specific theories of the specialized disciplines." As Boulding observes the need for general systems theory is accentuated by the present sociological situation in science... the crisis of science today arises because of the increasing difficulty of such profitable talk... The Republic of Learning is breaking up into isolated subcultures... the total growth of knowledge is being slowed down by the loss of relevant communications...

As Boulding points out, these two approaches (general phenomena/ecological and ordered complexity/evolutionary) (**Figure 4**) are complementary rather than competitive approaches. Simon [17] further developed the notion of hierarchical complexity in his work on "sciences of the artificial." Arthur [2] more recently developed a further theory of the nature of technology as ever more complex recombinations of prior technologies, and Auerswald[3] talks about "production recipes" in economics as recombinations of prior recipes, including both technology and rule recombinations. Spohrer, et al [10), 11)]. provide a useful broad brush perspective of the same territory, using a combined ecological and evolutionary view of physical systems, chemical systems, biological systems and service systems. In particular, this latter worked surveyed what scientists know about the origin of phenomena from the Big Bang some 14 billions years ago to the rise of cities some 10 thousand years ago to modern technologies such as the semiconductor transistor (~1947), integrated circuit (~1958), and microprocessor (~1971).

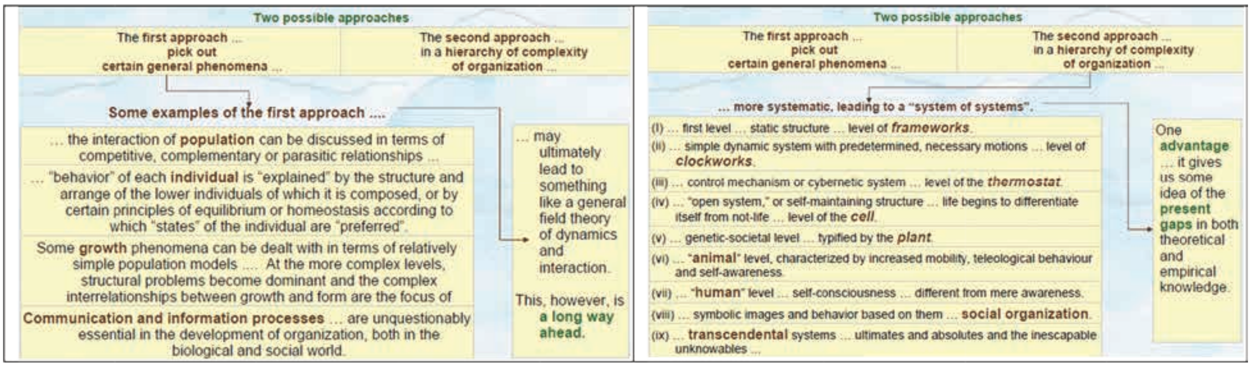


Figure 4. General System Theory : The Skeleton of Science [5)]

## REFRAMING PROGRESS SINCE THE BOULDING'S SKELETON OF SCIENCE

Boulding, as emphasizes the importance of notions such as discovery and innovation, which from a service science perspective relates to knowledge creation and the application of knowledge to create benefits broadly.

From a service science perspective, progress can be thought of in terms of the rights and responsibilities of entities (individuals and institutions). In our human service ecology, value-cocreation depends on trust, and trust depends on rights and responsibilities. Rights are associated with societal benefits and freedoms, and responsibilities are associated with societal constraints (backed up by the threat of loss of rights or access to resources as well as reputation damage, fines, or coercion). Governance mechanisms are a special type of value proposition in the service ecology, and governance mechanisms are one of the twelve fundamental concepts in service science [18)].

When we lose trust in "the system of others," society falls apart and progress slows. Therefore, progress can be seen in terms of rights and responsibility of entities to acquire and use competences (knowledge) for the benefit of themselves and others. This view has the potential to integrate the three major traditions associated with the concept of progress, namely, societal progress (responsibility to next generation's quality of life), scientific progress (rights to share, expand, and accumulate knowledge), and the myth of progress (not a linear scale).

First, consider competence without rights and responsibilities of entities to address the knowledge burden. Competence without comprehension can be seen in both organisms in the natural world and machines in the technological world. Both organisms (evolved) and machines (designed) can do remarkable things, without comprehension of what or how they do what they do.

Next, consider competence with comprehension of what entities are doing, how they are doing it, and the associated rights and responsibilities of using the knowledge. For example, consider the work of a scientist trying to understand bird flu, or a pharmaceutical firm introducing a new drug. Individuals and institutions have rights and responsibilities associated with the use of knowledge.

We also need to think about how we can evolve systems thinking with learning and coevolving. According to Ing [13)] systems thinking need to evolve based on service systems in three ways: (1) from parts and wholes to learning and co-evolving, (2) from social and environmental to resilience of emerged ecologies, (3) from specialized and separate episteme (deduction), techne (abduction) and phronesis (induction) to integrated and holistic approaches.

## Concluding Remarks : Future Directions

As articulated in Spohrer & Maglio [21), 22)], service science is a specialization of systems science that attempts to integrate elements of many other disciplines (associated with the four fundamental types of resources, people, technology, organizations, and shared information). Each disciplinary part contributes to the understanding of the evolution of value-cocreation interactions between complex adaptive entities – service systems - within an ecology of nested, networked entities. It focus on service systems and value co-creation [8), 20)].

We call this perspective the service systems worldview. The service systems worldview can be used to interpret the world that we live in as a world of (1) interacting service systems, (2) connected by value propositions (to cocreate value), (3) with governance mechanisms (to resolve disputes) among the many stakeholder service systems, (4) that collectively form many dynamic, interlocking service networks. Service systems collaborate and compete, explicitly or implicitly, to cocreate and cocapture value. Service systems are knowledge-intensive systems, evolving more sophisticated value propositions to enhance win-win interactions, more sophisticated governance mechanisms to resolve disputes and learn to benefit from measured risk-taking, discovery, and perpetual change, as well as more sophisticated service networks that increase value creation density [15]. Spohrer and Demirkan [20] proposes a systematic new framework for conceptualizing the evolution of value co-creation interactions between complex adaptive entities – service systems - within an ecology of nested, networked entities as a new way to describe the innovation processes of service-producing entities instead of following traditional "bricks-and-mortar product development processes and platforms," and seeks a formal and universal theory – The Abstract-Entity-Interaction-Outcome-Universals (AEIOU) - in which to understand entity, interaction, and outcome patterns of service systems. AEIOU theory defines service separation as customers' absence from service production, which denotes the spatial separations between service production, distribution, consumption and recycling in time and space complexity. Service separation increases customers' perceptions of not only access and benefit conveniences but also performance and psychological risks [19].

This view leads to a new set of OPEN questions for service and systems scientists to answer, about the nature of entities, interactions, outcomes, and their dynamics over time. For example :

- What types of entities are capable of service interactions?
- What types of interactions do service system entities engage in?
- What types of outcomes can result when service system entities interact?
- How do the types of entities and interactions change over time?
- How do the spatial distributions of types of entities change over time?
- How do the hierarchical structure and network relationships of entities change over time?
- How do the knowledge, competencies, resources owned and accessed by the entities change over time?
- How do innovativeness, equity, sustainability, and resiliency interact?

The world is a rich and wonderful place, full of many possibilities for how history might have unfolded differently. Service science with its emphasis on service system entities and value-cocreation interaction can provide perspective for attempting a new definition of what progress is and if there is a speed limit to progress, what that speed limit is.

REFERENCES

1) Ark, B., Broersma, V. L. and Den Hertog, P. : Services Innovation, Performance and Policy : A Review, Research Series No.6, Strategy, Research & International Co-operation Department, Ministry of Economic Affairs, The Hague (2003).
2) Arthur, W. B. : The Nature of Technology : What It Is and How It Evolves. Free Press, New York, NY (2009).
3) Auerswald, P. E. : The Coming Prosperity : How Entrepreneurs Are Transforming The Global Economy, Oxford University Press, Oxford, UK (2012).
4) Begon, M., Townsend, C. R. and Harper, J. L. : Ecology : From Individuals to Ecosystems, Blackwell Publishing, United Kingdom (2006).
5) Boulding, K. E. : General Systems Theory – The Skeleton of Science, Management Science. April, 2(3):197-208 (1956).
6) Checkland, P. B. : Systems Thinking, Systems Practice, John Wiley and Sons, Chichester, England (1981).
7) Demirkan, H. and Goul, M. : Towards the Service Oriented Enterprise Vision : Bridging Industry and Academics, The Communications of the Association for Information Systems, 18(26), pp.546-556 (2006).
8) Demirkan, H. and Spohrer, J. C. : Servitized Enterprises for Distributed Collaborative Commerce, International Journal of Service Science, Management, Engineering and Technology 1(1):68-81 (2010).
9) Demirkan, H., Kauffman, R. J., Vayghan, J. A., Fill, H-G., Karagiannis, D. and Maglio, P. P. : Service-Oriented Technology and Management : Perspectives on Research and Practice for the Coming Decade, The Electronic Commerce Research and Applications Journal, Vol.7, Issue4, pp.356-376 (Jan. 2009).
10) Demirkan, H., Spohrer, J. and Krishna, V. (Eds.) : The Science of Service Systems (in Series : Service Science : Research and Innovations in the Service Economy), Springer Publishing (2011)a.
11) Demirkan, H., Spohrer, J. and Krishna, V. (Eds.) : Service Systems Implementation (in Series : Service Science : Research and Innovations in the Service Economy), Springer Publishing (2011)b.
12) Gustafsson, A. and Johnson, M. D. : Competing in a Service Economy : How to Create Competitive Advantage Through Service Development and Innovation, Wiley/Jossey-Bass, San Francisco, CA (2003).
13) Ing, D. : Rethinking Systems Thinking : Learning and Coevolving with the World, Systems Research and Behavioral Science Syst, Res (2013), Forthcoming.
14) Ng, I. C., Roger M. and Nick, Y. : Outcome-based Contracts as a Driver for Systems Thinking and Service-dominant Logic in Service Science, European Management Journal, 27(6), pp.377–387 (2009).
15) Normann, R. : Reframing Business : When the Map Changes the Landscape, Wiley, Chichester, New Sussex (2001).
16) Smith, R. H. : Ecology Writ Large, Nature 319, 809, 27 (Feb. 1986).
17) Simon, H. A. : The Sciences of the Artificial, 3rd Edition, MIT Press, Cambridge, MA (1996).
18) Spohrer J. C. and Maglio, P. P. : Toward a Science of Service Systems : Value and Symbols, in Handbook of Service Science, Maglio P. P., Kieliszewski, C. A., Spohrer, J. C. (eds.) Springer Publishing, New York City, NY (2010).
19) Spohrer, J., Giuiusa, A., Demirkan, H. and Ing, D. : Service Science : Reframing Progress with Universities, Systems Research and Behavioral Science, forthcoming (2013).
20) Spohrer, J. C. and Demirkan, H. : Understanding Service Systems & Innovations in Time-Space Complexity : The Abstract-Entity-Interaction-Outcome-Universals Theory, working paper, IBM & University of Washington (2013).

21) Spohrer, J. and Maglio, P. P. : Service Science : Toward a Smarter Planet, In Service Engineering, ed, Karwowski & Salvendy, Wiley, New York, NY (2009).
22) Spohrer, J., Maglio, P. P., Bailey, J., and Gruhl, D. : Steps Toward a Science of Service Systems, IEEE Computer, 40, 1, pp.71-78 (Jan. 2007).
23) Sterman, J. D. : Business Dynamics : Systems Thinking and Modeling for a Complex World, Irwin McGraw-Hill, Boston, MA (2000).
24) Vargo, S. L. and Lusch, R. E. : Service-Dominant Logic : Continuing the Evolution, Journal of the Academy of Marketing Science (36:1), pp.1-10 (2008).
25) Wang, S., Ling L. and James, D. J. : Systemic Thinking on Services Science, Management and Engineering : Applications and Challenges in Services Systems Research, IEEE SYSTEMS JOURNAL, 99, pp.1-18 (2013).
26) Weinberg, G. M. : An Introduction to General Systems Thinking, Silver Anniversary Edition, Dorset House Publishing (1975).
27) Wise, R. and Baumgartner, P. : Go Downstream : The New Profit Imperative in Manufacturing, Harvard Bus. Rev., Vol.77, No.5, pp.133–141 (Sep.–Oct. 1999).

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