Chapter 13
Transdisciplinary Science and Technology and Service Systems

Motohisa Funabashi
Japan Advanced Institute of Science and Technology, Japan

ABSTRACT

Systems engineering has a long history with myriads of successful accomplishments. Systems thinking and engineering methodologies are reviewed in this chapter and are reorganized for service systems engineering. The effectiveness and significance of the reorganized methodology is demonstrated in an exemplary problem on service system conceptualization that is widely required to attain a sustainable society. The reorganized systems engineering methodology leads to a new systems science that is emerging (i.e., transdisciplinary science and technology).

INTRODUCTION

Service systems have recently been attracting special interest from policy agencies as well as academia because the GDP of developed countries is more than 70% by service sector. Advances in information and communication technology (ICT) have opened up vast opportunities for e-business. Manufacturing industries are also trying to expand their businesses to service domains based on the idea that the essential needs of their customers have not been focused on their goods but on the functions that their goods have provided.

The Systems, Man, and Cybernetics (SMC) Society of IEEE, a leading academic society in systems science and engineering, declared that their main application domains in the 21st century will include systems for services, for infrastructure and transportation, for environment and energy, and for defense and space (Hippel et al., 2007). As previously mentioned, the growth of e-business and expansion of manufacturing have contributed to the popularization of service sectors but the domain of service systems is not limited to these areas. Infrastructure and transportation systems, environmental and energy systems, and defense and space systems also call for service systems that provide fundamental functions to the respective systems. In this sense, service systems can be seen as foundations of the main application systems of the 21st century.

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Systems engineering has served as the conceptual and technological basis for designing large and complex artifacts since the 1940s. In this sense, the design methodologies of service systems can be obtained from systems engineering; however, the methodologies should be well equipped with new mechanisms such as the management of collaborative creation processes between service providers and customers. It is expected that recent advances in systems engineering might contribute to solving new facets of the design problem. The chapter tries to formulate a framework for designing service systems according to new systems thinking in transdisciplinary science & technology that has been emerging in the 21st century.

The chapter is organized as follows: First an exemplified service system, i.e., a regional energy aggregation service system for the green community, is presented that is sufficiently complex and uncertain to create a concept of the system. Second, a quick overview of the history of systems thinking is presented and an integrated service engineering framework based on systems thinking is proposed with a discussion on the present status of service science and engineering. Then, the proposed framework is applied to the exemplified service systems engineering and future directions to be pursued are discussed. Finally, as scientific and technical foundations toward future directions, transdisiciplinary science & technology is outlined with some preliminary studies that are emerging in the 21st century.

EXEMPLIFIED SERVICE SYSTEM: REGIONAL ENERGY AGGREGATION SERVICE

In 2007, the Intergovernmental Panel on Climate Change (IPCC) produced the 4th Assessment Report (IPCC, 2007): it confirmed that climate change is occurring now, mostly as a result of human activities; it illustrated the impacts of global warming already under way and to be expected in the future, and it described the potential for society to adapt to reduce its vulnerability to climate change; and finally it presented an analysis of costs, policies, and technologies intended to limit the extent of future disruptions to the climate system.

Even though there has been no consolidated agreement by countries throughout the world to reduce the emissions of Green House Gases (GHGs) that are the cause of global warming pointed out by IPCC, a variety of action plans to reduce emissions have been developed and undertaken by respective countries.

The President of the United States, Barack Obama, announced a $3.4 billion investment toward a smart energy grid in October 2009. Germany started the DESERTEC project in 2008 to open the market for renewable energy and interconnection of electricity grids by Europe, the Middle East, and North Africa. The governments of the People's Republic of China (PRC) and the Republic of Singapore signed an agreement in 2007 on developing an eco-city in Tianjin of the PRC and a sustainable urban environment is presently being steadily developed there. In 2010, the Ministry of Economics, Trade and Industry (METI) of Japan released a tentative roadmap on energy life to 2030 renewing a former cabinet's plan. Even though reduced GHG emissions are being discussed, smarter energy use is one of the top priority issues in Japan after the 3.11 Disaster.

Of all the plans to reduce emissions, regional energy aggregation services are the most promising because they pursue local energy production and consumption that can reduce the cost of transmitting energy as well as appeal to people to become more energy-aware. The basic idea behind a regional energy aggregation service is outlined in Figure 1. The aggregation service provider bridges regional energy production and consumption systems and electricity companies that supply energy from outside