

# Introduction to Social Systems Engineering

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# Introduction to Social Systems Engineering

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# Foreword I

With the rise of industrial revolution and scientific management movement, the emphasis on specialized labor division has become one of the significant features in economic and social development. However, problems facing science today are far more complicated than any other time in human history. To deal with the problems requires not only the application of in-depth specialized knowledge, but also the synthesizing of comprehensive knowledge, including social sciences, natural sciences, and systems engineering. *Introduction to Social Systems Engineering* by Mr. Wang Huijiong is a monograph on the theory and methodology of social systems engineering that is based on his long-term theoretical and practical studies in the field and contains significant academic value in China's systems engineering researches.

As a famous engineering expert and economist, Mr. Wang Huijiong has witnessed China's independence and growth, participated in the national construction, and made contributions to China's economic and social prosperity since the reform and opening-up drive. After striving in the field of electrical engineering for over 33 years, Wang has built up thoughts and theories on social systems engineering from his practice in project construction and management. In the 1980s, Wang began to work in the Chinese Academy of Social Sciences (CASS) as a research fellow, and later in the Technological and Economic Research Center of the State Council (one of the predecessors of Development and Research Center of the State Council or DRC) as a research fellow and executive director. He then successfully redirected his research field from project construction and management to social sciences and policy analysis, such as economic growth, industrial planning. Besides, he participated in a number of significant national strategic research projects, from which he has accumulated a wealth of theoretical and practical experience on socio-economic policy studies. Over the last three decades, Wang has been in charge of a series of major research programs. For example, *China in 2000* (led by Ma Hong), in which he worked as a member of the leaders team, won the first prize of National Scientific and Technological Progress Award in 1987. *Integrated Economic Development Policies and Planning*, another grand policy research project, was accomplished through the cooperation with UN Development

Program, in which internationalization, openness, and practicality were highlighted. It focused systematically and profoundly on several major issues in China, including China's industrialization and policy-making, economic system reform, and regional economic development. Its broad range, covering research organization, coordination, and contents, was rarely seen in domestic studies.

In his broad research fields, Mr. Wang Huijiong has conducted long-term and deep practical and theoretical studies on social systems engineering. In 1980, he published *Introduction to Systems Engineering*, systematically concluding his studies on engineering design and management for more than 30 years. After joining CASS and DRC, he applied the research theories and methodologies on systems engineering to social and economic systems studies, continuously enriching and improving the theories and methodologies on systems engineering. In 2015, his *Methodology of Social Systems Engineering* was published, which further facilitates the research on and application of social systems engineering in China. This book written in English is his latest monograph in the field and is an expansion and improvement of his work in 2015. It elaborates the inevitability of social systems engineering progress from the perspective of development history of natural sciences and social sciences, which contains grand theoretical vision and profound historical depth. In the methodology part of social systems engineering, he reviewed and analyzed several crucial kinds of quantitative and qualitative research methods and conducted monographic studies on several key subsystems, which reflected Wang's solid theoretical foundation, rich practical experience, and systematic thinking.

One of the major contribution of the book is to provide a more expansive and comprehensive view for the research on social sciences and public policies by applying theories and methodologies from systems engineering studies. Yet, state and society form a huge and complicated system with a series of economic, social, cultural, scientific and technological issues intertwined with each other. Especially in the following period from now on, human society will be faced with more complicated problems due to the dramatic development and extensive application of information technology. Conducting researches on social systems engineering will help not only to analyze problems and cope with challenges for the community of shared future for mankind in a more comprehensive manner, but also to find more reasonable solutions and policy schemes. Admittedly, professionals are needed in real practice, but the problems facing mankind in production activities and daily livelihoods cannot be solved solely by limited knowledge in one aspect alone. To be specific, the design, construction, and management in engineering area rely not only on natural sciences and expertise in engineering fields, but also on the economic and management knowledge from social sciences. Similarly, reforms and development in economic sector can also be integrated systematically and managed intensively by utilizing concepts and methods from engineering field like planning, designing, testing, executing.

China has made remarkable achievements in economic and social development since the founding of the People's Republic of China, especially since the initiation of the Reform and Opening-up Policy in the late 1970s. As a consequence, more and more countries expect to seek knowledge and wisdom suitable for their own

development from China's development history and experience. As Chinese President Xi Jinping once said, 'The world is so big, and the problems are so many. The international community expects to hear China's voice and see China's plans. China cannot be absent.' To be in line with the requirements of the time, to respond to international concerns and to perform the responsibility as a major power, President Xi Jinping declared at the UN Sustainable Development Summit in September 2015 that China would establish the Center for International Knowledge on Development (CIKD) to study and communicate with other countries on development theories and practices suitable to their respective national conditions. The DRC is a policy research and consultation agency serving the central committee of CPC and the State Council and is also one of the 25 high-end national think tanks in China. The DRC has clearly blueprinted its strategy to build a high-level international think tank and to take conducting international communication and cooperation as one of its key functions. The Chinese government thus granted the DRC to undertake the founding of CIKD based on its functional position and operating characteristics. In March 2017, the Chinese government officially approved the DRC to launch CIKD. In August 2017, President Xi Jinping and UN Secretary-General Antonio Guterres sent congratulatory letters to the official launch of CIKD. In his letter, President Xi Jinping asked CIKD to make positive contributions to researching and exchanging development theories, facilitating international development and cooperation and promoting the implementation of the 2030 Agenda for Sustainable Development. One month later, President Xi Jinping stressed at the Dialogue of Emerging Market and Developing Countries that China would strengthen the cooperation in experience sharing and capability building with the international community through CIKD platform. Therefore, the CIKD has set case studies on China's development as its most important task at the beginning of its official operation. *Introduction to Social Systems Engineering*, written by Mr. Wang Huijiong, is not only a professional output on systems engineering, but also a summary of his participation in China's development and research on national policies, containing rich Chinese elements, experience and wisdom, and will be a good vehicle to tell Chinese stories. Hence, we are pleased to offer the book as one of CIKD's products to international society. Mr. Wang Huijiong is a veteran expert on China's policy researches who worked over 30 years in DRC, so we would like to, taking the opportunity of the book's publication, to extend our sincere gratitude to all senior scholars represented by Mr. Wang for their contributions to China's construction, reform and development undertakings. We also expect more experts and scholars to summarize the theories and practices on China's development and to make positive contributions to international development cooperation and global sustainable development with their counterparts from other countries.

Beijing, China  
October 2017

Li Wei  
President of Development Research Center of the  
State Council

## Foreword II

It is an honor, as well as a pleasure, to write a foreword to this book. An honor, because I regard Prof. Wang Huijiong as one of my teachers about China's economic development, to which both of the book's authors have made important contributions through their research. A pleasure, because my work on China since 1980 has given me the opportunity to know the authors personally and to discover dimensions of their insights and experiences that transcend the technicalities of social science. Without them, what I have done in China would have been both less useful and less enjoyable.

We first met in the early 1980s through the coincidence of two separate but basically similar projects on China's development prospects to the year 2000, which are described and discussed in Sect. 4.3.2 of the book, and both of which benefited from the support of governmental leadership at that time. The authors were working in the Technical-Economic Research Center (TERC) of the State Council with many other Chinese colleagues in many other institutions on a comprehensive study that included both an overall general framework (in which they played key roles) and detailed analyses of individual industries and provinces. I was the deputy chief of a smaller World Bank team led by Edwin Lim that was covering the same range of issues but with more emphasis on international comparisons and lessons from foreign experience.

The Bank team relied heavily on information, advice, and guidance from Chinese colleagues, without which it would have been impossible to connect our knowledge of the rest of the world with Chinese reality in a fruitful way. In this regard, the TERC rendered us a great service by organizing no less than four days of seminars (March 11–14, 1985) to discuss various aspects of our draft report. As I write these words, I have on my desk the notes I made at those seminars and at an 8 March meeting with Mr. Ma Hong, director general of the TERC, accompanied by Prof. Wang Huijiong and another brilliant and articulate old friend, Prof. Li Boxi. One of my responsibilities in the Bank report was for the modeling, and looking back through my notes, I can see how much we learned both from the TERC's comments on our model and from a presentation on the TERC's own model and projections made by a 'young lady,' whom I guess was Prof. Li Shantong.

The TERC report and the World Bank report, though different in many ways, arrived at broadly similar conclusions, and both made useful contributions to China's development to 2000 and beyond by charting the unknown terrain ahead and suggesting ways of navigating through it. The TERC–World Bank seminars also exemplified the way in which close interaction between foreign and Chinese experts added hugely to the productivity, interest, and enjoyment of policy-oriented research on China. Much has changed since those far-off days, with the TERC now merged into the Development Research Center, and China a vastly more prosperous country, but the legacy of the work we did and the friendships we made have endured.

The present book spans almost all areas of scientific knowledge, almost all periods of human history, and almost all parts of the world. Among other things, it relates historical experience in China to experience in the West (Europe and its offshoots), with the purpose of reducing the current asymmetry between China's good knowledge of the West and the West's more limited knowledge of China. The other purpose of the book, as the authors describe it in their preface, is 'to try to fill the gap among natural science, social science and engineering.' Social Systems Engineering (SSE) is a discipline designed for this purpose, and more precisely for combining the insights of different scientific disciplines to improve human well-being, whether at the level of the firm, the locality, the nation, or the world. The book reviews the main theories of SSE and the techniques and models used in its application, especially to planning. It concludes with two chapters that view the progress of China since 1950 through the lens of the long series of five-year plans, whose use has continued, though their methods and content have evolved.

Oxford, UK  
October 2017

Adrian Wood  
Professor Emeritus of International Development  
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# Preface

We are glad to present to you this book *Introduction to Social Systems Engineering* (SSE).

The purpose of this book is two.

The first purpose of this book is to try to fill the gap among natural science, social science, and engineering. It may seem to be a little bit ambitious.

Since the scientific revolution, industrial revolution post the middle part of last millennium, there is rapid progress of science and technology (S&T). Various branches of S&T are emerged to be studied with in-depth. The development of science is characterized by its ever-increasing specialization necessitated by huge amount of data, the complexity of technique within every field. This is also true for various types of engineering; for example, there was no clear distinction between civil engineering and architecture in traditional civil engineering before modern times, but currently, there are branches of civil engineering such as structural engineering, architecture, highway engineering, harboring engineering, coastal engineering. The results of this increasing specialization have caused difficulty of coordination of large industrial projects generally including many different disciplines. It is also detrimental for further development of science and engineering, because the academic study of in-depth and in-breadth are in mutual promotion with each other. Interdisciplinary studies emerged in the early twentieth century. General system theory and systems engineering were established and became popular since mid of the twentieth century.

Both authors of this book are with background of science and engineering and worked in the Development Research Center for policy and planning studies more than thirty years, but Wang had published *An Introduction to Systems Engineering* (in Chinese version) in 1980. We felt deeply that the issues of social science in dealing with planning and public policy are even much more complicated than that of natural science and systems engineering. There are needs to have such new discipline *Social System Engineering* (SSE) to meet the new demand. We had searched the programs of universities globally; there is only University of Tsukuba with a master's program in social systems engineering, and doctoral program in policy and planning sciences. The University of Pennsylvania, which has an

undergraduate program of Networked and SSE, its curriculum is consisted of computer science, economics, systems engineering and sociology. It can be seen that the contents of study of this emerging discipline are only defined basically. We wish to contribute our exploration of this emerging discipline with our perception, knowledge, and working experience.

The second purpose of this book is also derived from our impression in dealing with Western world. We have the impression that the Chinese intellectuals and a part of people know the Western situation relatively better than the knowledge with China of their Western counterpart. This is a natural phenomenon due to the backward state of society, economy, science and technology (S&T) of China before establishment of PRC. Therefore, most Chinese learned Western experience urgently in order to catch up. But China is a large unique country with five thousand years of civilization. There were many philosophers and scholars in the Chinese history, especially in the Spring and Autumn and the Warring State period, who had contributed a lot of valuable knowledge to the mankind, for example, Confucius and Confucianism, Taoism, Legalism.

Currently, China is emerged to be one of the largest nations in economy and trade within a short period of no more than seven decades. As policy researchers, we think it is necessary to share some of our knowledge to global interested readers related to China's cultural system, its socio-economic and S&T development since the First Five-Year Plan up to the present Thirteenth Five-Year Plan as well as some experience of growth of our Center, one of China's national think tanks. We believe that exchange of information to promote a mutual understanding among countries is a pre-requisite toward a harmonious global society. That is our second purpose to present this book.

Then we shall introduce briefly the structure and contents of this book. It is divided into three parts:

Part I is *Emergence of Social Systems Engineering (SSE)* with four chapters and deals with basic theories of SSE and its current growth in some countries.

Chapter 1 is an overview of the whole book.

Chapter 2 presents growth of science around 2500 years and resulted in three trends of science in the early twentieth century, overspecialization, impact of mechanistic view, and neglect of nonphysical science. General systems theory and systems engineering were emerged to respond to these trends. Key concepts of general systems theory and some aspects of systems engineering are summarized to be the theoretical foundation of social systems engineering.

Growth of social science both in China and Western countries is presented in Chap. 3. Based upon purpose of this book, several schools of social studies of ancient China are briefed. Authors of this book believe that their influence to contemporary East Asian Continent is the same as the impact of Greek philosophy to current Western civilization. Development of social science in Western countries is also presented since the Hellenistic period up to present. Three major thoughts effect the development of social science in the twentieth century are analyzed; they are impact of Marxism and others, influences of Freud and growth in parallel of further specialization, and cross-disciplinary approach. Emergence of social

systems theory and method is discussed. Psychology and various aspects related to human behavior and its interaction with environment are discussed. Parsons' theory of social system and his AGIL framework of systems of action are identified to be the other theoretical foundation of SSE.

Chapter 4 presents the development of SSE since the twentieth century. There is a trend of development of SSE in USA, Japan, China, and Europe, etc. Clarification of concepts of design and planning of SSE is presented in relative detail. Three case studies in the nature of social systems engineering are given for illustration. They are: *Nation as large-scale system* by Chestnut, H., two-large-scale research projects done by Development Research Center, *China toward the year 2000* and *Integrated Economic Development Policies and Planning*.

Part II is *Outline of Social Systems Engineering (SSE)* with six chapters.

Chapter 5 is methodology and principle of planning of SSE. Due to the broadness of various disciplines covered by the study of SSE, methodology of qualitative analysis of two important studies is quoted. The first is Hall's Morphology Box for systems engineering; it includes phases, steps, and disciplines which can be applied universally to all types of engineering programs and plans. The second is Warfield's *societal systems*, which focused specifically on planning and public policy, the essential areas of study of SSE. His methodology of  $\Pi$ - $\Sigma$  process and concept of TOTOs<sup>1</sup> the organized conduct of inquiry are introduced. And a concrete policy study project of OECD. *Expo 2000 Forum for the Future* with four successive conferences related to S&T, economy, society, governance from 1997–2000 based on TOTOs is described in detail to illustrate the art of integration of different disciplines, which is also one difficult action 'integration' of Parsons' AGIL framework of systems of actions. Systems engineering logic, a detailed treatment of 'steps' is presented to complement Hall's Morphology Box.

Principle of planning based upon concepts of SSE is also given methodologically. Three frameworks of planning are introduced; they are based on AGIL framework of systems of actions, balanced approach of three subsystems (social, economic, and S&T) of a national system, vertical hierarchy of subsystem (macro, meso, and micro), respectively. Three planning models are also given; they are the system environmental model; the function-structure model, and the process behavioral model. Major concepts of structure of T-21 model are quoted to provide concrete components of function-structure model.

Chapter 6 is methodology of quantitative approach of SSE. Measurement and quantification are two major difficulties in the development of SSE compared to the development of systems engineering in later part of twentieth century. There are improvements of conditions of these two aspects in recent years. Progress of development of social indicators is described in detail. Case studies of preparation of *systems of indicators for sustainable development* by UN and its attached organizations and *framework of preparation of indicators of national competitiveness* by IMD are described. Models are discussed in a broader perspective to

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<sup>1</sup>Note TOTOs is the abbreviation of Task-Oriented Transient Organization.

avoid mathematical determinism. Three decades of experience of policy modeling of DRC is summarized. A case study of DRC-CGE model is presented with the history of its formation, the structure of the model with its various modules, and its application to the analysis of China's Thirteenth Five-Year Plan.

Chapter 7 gives a comprehensive discussion of various types of planning system which is one major aspect of application of SSE. There are debates on planning both in China and other countries due to the failure of central planning system in later period of former USSR and the ideology of economic liberalism. But the rapid growth of Chinese economy is partly due to its continuity and improvement of its Five-Year development planning. EU, Japan, USA, a part of the world, and large enterprises have kept the practice of planning in different types. This chapter starts with a definition of planning and its role and gives the story of a military plan of Qin dynasty to establish a unified empire in ancient China to illustrate the point that planning does exist throughout the human history. Various types of planning are discussed. Evolution of development of modern national planning system in global society is described. Development of planning theories is briefed. The current trend, emergence of Future Studies and Scenario is presented with case study of *Europe 2020* and case study of *Mapping the Global Future Project* of National Intelligence Council of USA. By the meantime, two detail case studies of Medium-Term National Plans of France and India are given. This gives a relatively complete information of long-range scenario planning and medium-term planning.

Chapter 8 deals with Boundary and Environment and Social Change of a Social System. All systems are located in space and time of certain environments and interact with them. The boundary between a physical system and its environment is relatively easier to be identified, but the determination of a boundary line between social system is generally complicated, because it is identified through norms, institutions, and regulations. This chapter has given a general discussion of boundary and environment. A case study of business planning, which illustrates the interaction between an enterprise and its environment-Growth of *Yantian International Container Terminals (YICT)* in Shenzhen, SEZ of China is given. This case study serves for dual purpose; the first is to provide an example of business planning which should also be an aspect of application of SSE; the second is to illustrate the basic view of authors to modify A of Parsons AGIL framework of systems of actions. We have also modified A (adapt) into AA (active adapt) so that there are both changes for the business enterprise and its external environment. Based upon purpose of this book, the formation and change of culture are discussed in detail; especially the dominant influence of Confucianism to China's social system, the basic concepts of Analects are introduced to foreign readers. Finally, one pervasive characteristic of social system,-the social change, is discussed, and the megatrend of contemporary social change, globalization and regionalization, from the perspective of the authors are presented.

Chapter 9 deals with regulation of social system. It seems to be a common sense that the social system needs to be regulated in order to keep order, security, and development of the social system. Public policy, law, regulation, etc., all perform the functions of regulation, and all of them belong to the discipline of public

administration. Therefore, a brief discussion of public administration is given to provide a broad context. Then, a Western legal textbook with unique chapter of policy analysis, the growth of legal system of China since the Spring and Autumn and Warring State period up to Qing dynasty, and also the establishment of modern legal system of China is briefed. A relatively detail discussion of public policy formed the core part of this chapter. Clarification of terminology, history and schools of public policy and policy science both in China and Western countries are summarized. A social system approach of public policy-making process with elements and their relationships to be routinized is described. Two case studies are presented to conclude this chapter. One is applying Analytic Hierarchy Process to project ‘Differentiated Policy to construct the Functional Zones,’ and the other is ‘Industrial Policy of China.’

Chapter 10 deals with global think tanks. There is rapid growth of think tanks since the establishment of first think tank the British Royal United Service Institute (RUSI) in 1831. This growth process was strengthened post-WWII and reached its peak around 1992. This chapter gives a brief discussion of role of think tanks, types of think tanks, its process of development, etc. Relatively detailed case studies are given to several selected think tanks: Brookings Institution, Rand Corporation, International Development Center of Japan. And also case studies of international think tanks such as OECD, the World Bank and its activity in China are described. Think tanks with unique features such as International Center for Economic Growth (ICEG) with network of member communication organization and African Economic Research Consortium (AERC) which is also consisted of networked member organization are also introduced. Finally, development of China’s think tanks, especially case of Development Research Center of the State Council, which both authors of this book are attached is presented to conclude this chapter.

Part III is *Application of Social Systems Engineering* with 2 chapters.

Chapter 11 deals with development of China since its First Five-Year Plan up to Fifth Five-Year Plan. China had no experience of national planning in the period of 1950s and followed the former Soviet model of centralized planning before 1980. *The First Five-Year Plan*, the construction of 156 core projects and the *Outline of the Long-Term Plan of Development of Science and Technology 1955–1967* is described in very detail; these have laid the foundation of China’s planning, industry and development of Science and Technology. Analysis of China’s planning performance (1953–1980) from the perspective of social systems engineering is given in last part of this chapter.

Chapter 12 deals with development of China since the Sixth Five-Year Plan up to present. All planning documents of Five-Year Planning are briefed. It can be seen in the picture how China is in transition from a former centralized planning to an indicative planning system and establishment of the socialist market economy with Chinese characteristics through gradualist approach.

Finally, several features and issues of this book should be clarified.

1. The discipline of social systems engineering is a very new subject with very broad coverage of various concepts. In order to prove our view and certain concept, we generally quote available similar concept of other scholars or studies directly without paraphrase. We think this approach is better to strengthen our concept. Due to the nature of this subject, there is also a part of concepts of others with paraphrase.
2. Based upon the original definition of social system given by Parsons or given by us in chapter one, it should include the political system. And study of social systems engineering should include the study of political system, its function, structure and behavior. But both authors had working experiences only in the policy consultative institution; we have no experience at all in political-administrative position. Therefore, political system is not discussed; it is classified roughly in the social system. And we separate economic, S&T system from the social system to facilitate the discussion of planning and public policy. Because economic system is the foundation of national socio-economic development, while science and technology are the driving force of socio-economic development of all countries.

Based upon above point, we focus more on planning function rather than design in the study of SSE, because planning is generally based on existed political system and power structure., while design will be more detailed and focused more on ideal objective. But there is a general discussion of design and planning in this book.

3. Chapter 8 with the title of ‘Boundary and Environment of the Social System’ is not well focused, because the initial intention of writing this chapter is to study the role of environment and its interaction with the system. But discussion of cultural system which is also a part of social system and very important part of social system is also included in this chapter. It is better to be separated to become an independent chapter, but it is not done due to time constraints.

Both authors of this book acknowledged frankly that our initial background is science and engineering. We get our knowledge of strategic planning, public policy, economics, and sociology through learning and doing in Development Research Center more than 30 years; we have also a lot of chances to learn from our foreign friends in many international conferences and through cooperation of many projects. Our knowledge is very limited; mistakes and errors in this book are unavoidable. All comments and criticism on this book are welcome sincerely. Progress is made through learning from and correction of mistakes! We do believe!

Beijing, China

Huijiong Wang  
Shantong Li

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Huijiong Wang  
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