Systems Science in China

Lei GUO

Institute of Systems Science
Academy of Mathematics and Systems Science(AMSS)
Chinese Academy of Sciences (CAS)

Outline

I. Institute of Systems Science, CAS

II. Systems Engineering Society of China

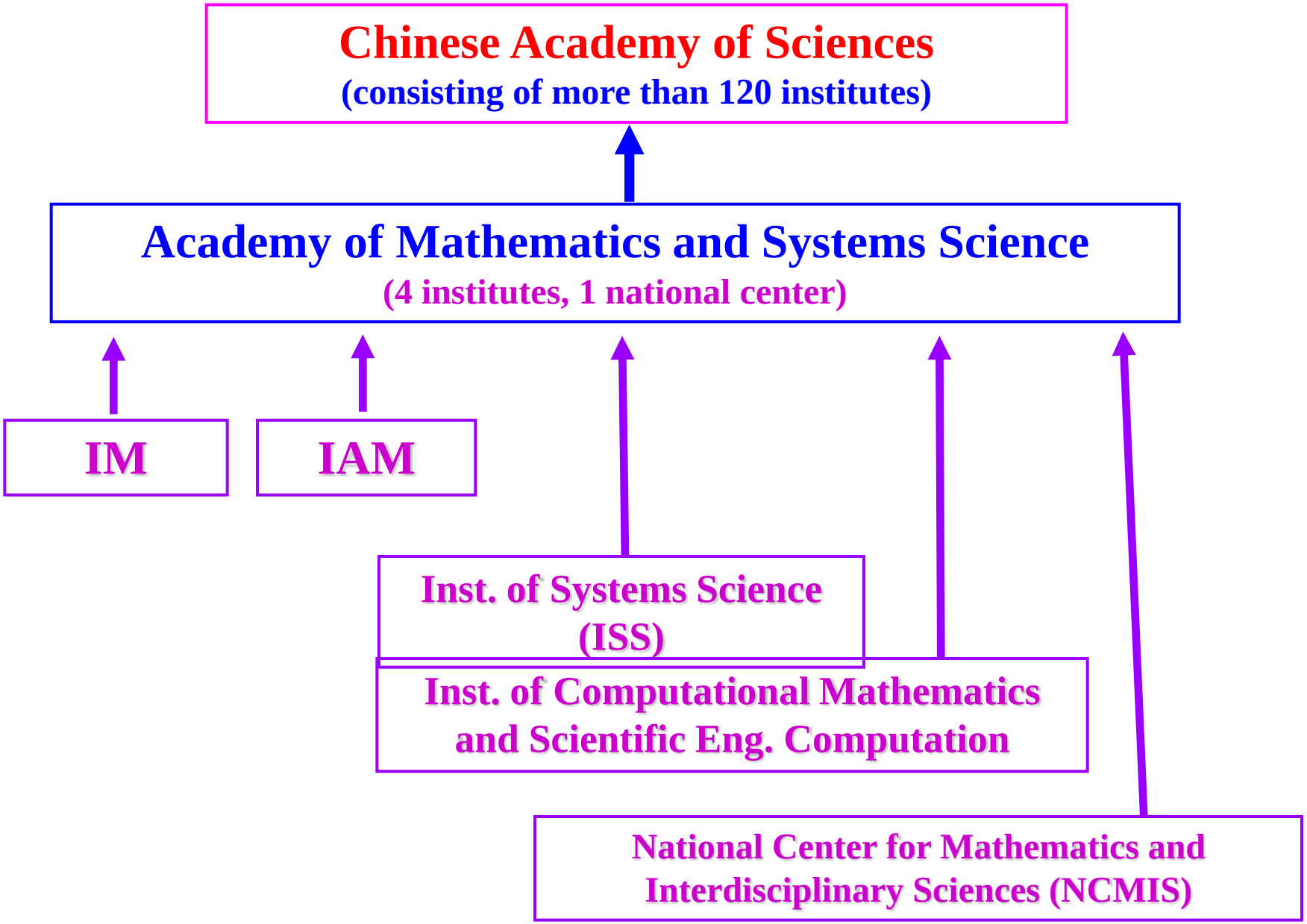
III. A Leading Scientist: Dr.Qian Xuesen

IV . Perspectives and Plans

Institute of Systems Science

Academy of Mathematics and Systems Science

Chinese Academy of Sciences


Chinese Academy of Sciences
(consisting of more than 120 institutes)
Academy of Mathematics and Systems Science
(4 institutes, 1 national center)
IM
IAM
Inst. of Systems Science (ISS)
Inst. of Computational Mathematics and Scientific Eng. Computation
National Center for Mathematics and Interdisciplinary Sciences (NCMIS)

Founding Members of ISS (1979)

KWAN Chao-Chih

Functional Analysis

Control systems

XU Guo-Zhi

Operational Research

Management science

WU Wen-Tsun

Topology

Computer mathematics

Mission of ISS

- **A leading research center in systems science, and related mathematics and interdisciplinary research.**
- **An important consultant center for the government on economic and social development of China.**
- **An educational institution to train high level researchers on systems science.**

Main Research Topics

- **To understand systems**
  - **Structure/property analysis, modeling, inference, identification, prediction, signal processing, reliability, stability, emergence, self-organization, etc.**
- **To control/Regulate systems**
  - **design, reasoning, optimization, adaptation, control, regulation, decision and management, etc.**

Faculty

- 71 research faculties
  - 36 professors
- Over 185 graduate students
- About 30 post-doctoral fellows

Research Divisions

- Key Lab. of Management, Decision, and Information Systems , CAS
- Key Lab. of Systems and Control , CAS
- Key Lab. of Mathematical Mechanization, CAS

- Division of Complex Systems
- Division of Economic Analysis and Forecasting
- Division of Statistic Science
- Division of Pure and Applied Mathematics

Key Lab. of Management, Decision and Information Systems

- Optimization theory and algorithms
- Management science
- Macro-economic analysis and forecasting
- Knowledge science and engineering
- Quality reliability science

Key Lab. of Systems and Control

- Stochastic control systems
- Nonlinear control systems
- Distributed parameter control systems
- Quantum control systems
- Systems biology
- Complex systems and networks
- Multi-agent systems and distributed control
- Modeling, identification and adaptive control
- Boolean control systems
- Advanced control of engineering problems

Key Lab. of Mathematical Mechanization

- Automated reasoning
- Symbolic and hybrid computation
- Geometric computation
- Discrete mathematics
- Coding and cryptography
- Engineering applications:

  Robotics, computer aided design, numerically controlled machine, etc.

Academic Journals of ISS

– Journal of Systems Science and Complexity

– J. Systems Science and Math. Sci. (in Chinese)

– Journal of Control Theory and Applications
(A joint publication with SCUT)

- Theory and Practice of Mathematics (in Chinese)

Societies Affiliated to AMSS

- Systems Engineering Society of China
- Operational Research Society of China
- Chinese Mathematical Society
- Chinese Computational Math Society

Besides,

- Technical Committee on Control Theory of Chinese Association of Automation (CAA), etc

Funding of ISS

- Major funding is from CAS through the Knowledge Innovation Program
  - covering basic personal costs, student costs, and basic facility costs.
- Grants from competitive sources: NSFC, MOST.
  - About 30% of the total budget.
  - Covering research equipments, academic exchange, visitors, etc.

Research Grants (Partial)

National Technology Research and Development Program of China (863 Program)
State Key Development Program for Basic Research of China (973 Program)
Key Project of the Eleventh National Five –Year-Research Program
Foundation for Innovative Research Groups of NSFC
Key Projects of NSFC
Distinguished Young Scholars Foundation of NSFC

Academic Exchanges

- **Each year**
  - (Co)-Organize about 10 international conferences
  - Host more than 100 visitors, mostly from abroad
  - Visit foreign universities or attend international conferences abroad more than 100 times.

Academic exchanges

March, 2003

July, 2013

Statistics on Recent CCCs

Conference	Submissions	Attendees	Dates
27th CCC	2345	700	2008.7.16-18
28th CCC (CDC)	3105	1800	2009.12.16-18
29th CCC	2633	1200	2010.7.29-31
30th CCC	2304	1000	2011.7.22-24
31st CCC	2128	1200	2012.7.25-27
32nd CCC	2809	1500	2013.7.26-28

Consulting Reports

Besides publishing academic research papers, completing practical research projects, and supervising graduate students, etc, each year about 40 Consulting Reports submitted to the state council by ISS.

Example 1: Grain Output Prediction of China

Main results (1981-2013):

- The forecasting lead period achieves more than half a year.
- The forecasting about bumper, average, and poor harvests was correct each year.
- The average error of forecasting is 1.9% , much lower than those of others who use different methods.

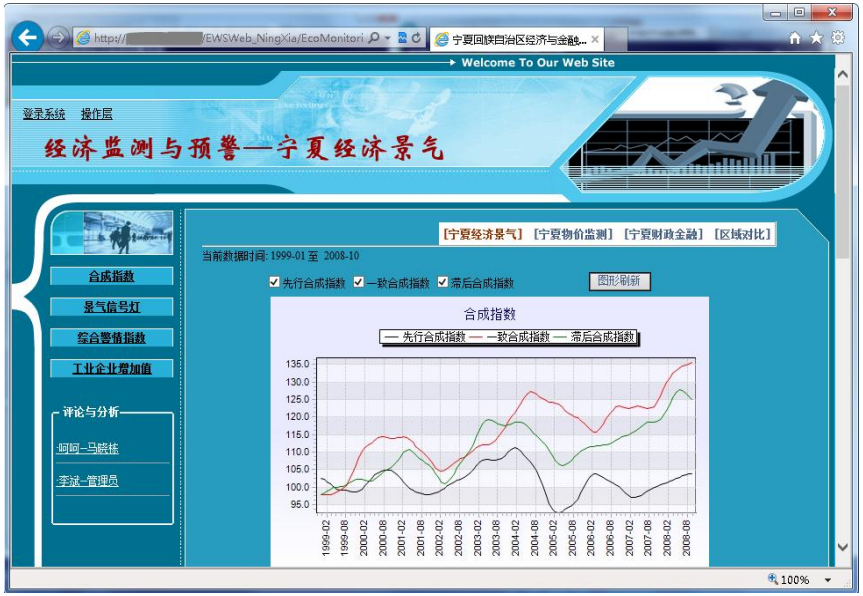
Methods used

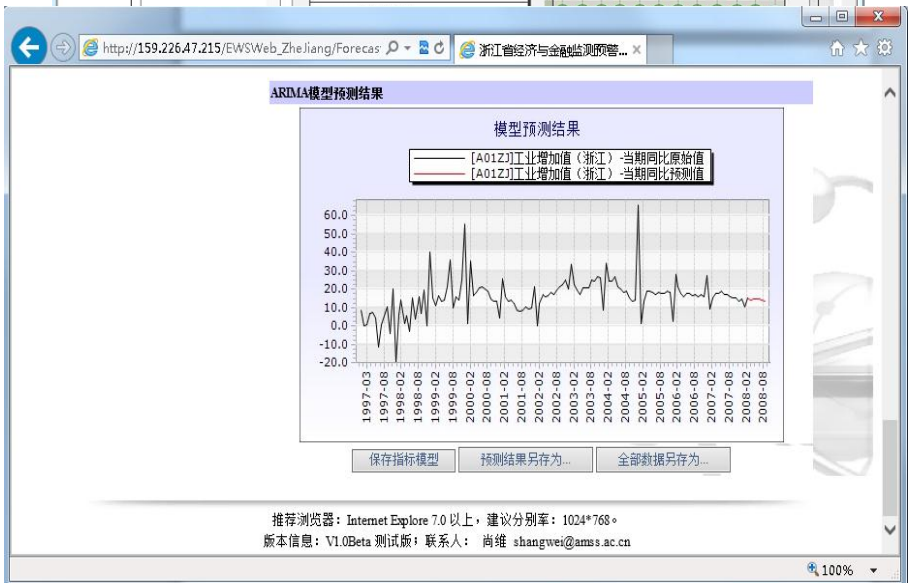
Nonlinear Input Occupied Output (IOO) + Metasynthesis

Example 2: Non-competitive IOO and global value-chain

- China trade structure is special: processing trade around 50%, double-counting in traditional trade statistics and overstating actual trade scale. The value added by processing trade is low.
- The differentiation of processing trade more accurately estimate value-added by different export type. Design non competitive IO model with processing sectors.
- Total domestic value added per unit China's export by the new IO model is 0.591 in 2007. However, by traditional IO model, the result is 0.688, overestimating by 16.4%.

Example 3: Early Warning and Simulation Systems for Macro-economy (China and World)

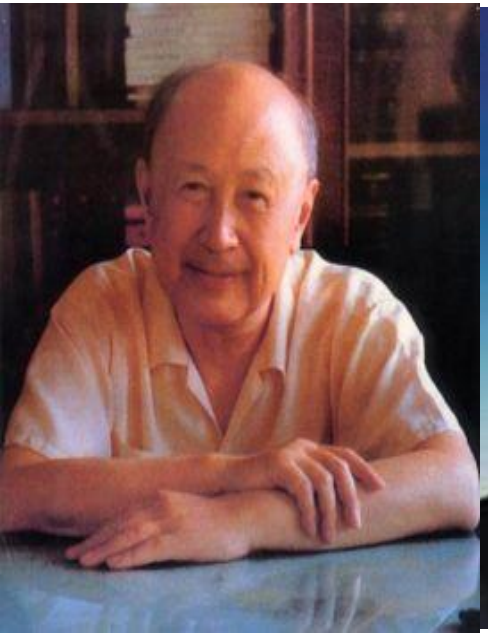




Systems Engineering Society of China(SESC)

SESC

- Founded in 1980, by 21 professors including




- QIAN Xuesen, Honorary President of SESC (1980-2000)
- SONG Jian, Director of the State S&T Commission(1984-1998)
- GUAN Zhaozhi, First President of SESC, First Director of ISS
- XU Guozhi , President of SESC (1985-1995)

Objective

The objective of the SESC is to improve the level of management of the country and to serve the national economic construction and modernization by uniting with the mass of professionals in this filed to develop academic exchange in a purpose to promote and popularize the theories and methods of the Systems Engineering and Systems Science and to extend their applications in various fields.

Systems Engineering Society of China

➢ 18 Sub-societies, including

- Social-Economic Systems Engineering Sub-society
- Agricultural Systems Engineering Sub-society
- Military Systems Engineering Sub-society
- Transportation and Traffic Systems Engineering Sub-society
- Financial Systems Engineering Sub-society
- Education Systems Engineering Sub-society
- Law Systems Engineering Sub-society
- Systems Theory Sub-society
- Systems Dynamics Sub-society

Systems Engineering Society of China

6 Committees, including

- Academic Committee
- International Cooperation Committee
- Publication Committee
- Education and Promotion Committee
- Youth Development Committee
- Applications and Consulting Committee

Systems Engineering Society of China

10 Journals, including

- Journal of Systems Science and Systems Engineering (by Springer-Verlag)
- Systems Engineering: Theory & Practice (in Chinese)
- Journal of Systems Engineering: Theory & Practice (by Elsevier)
- Transportation and Traffic Systems Engineering (in Chinese)
- Journal of Transportation and Traffic Systems Engineering (by Elsevier)
- Journal of Systems Engineering (in Chinese)
- Systems Engineering and Electronics (in Chinese)
- Journal of Systems Engineering and Electronics

Systems Engineering Society of China

26 Provinces Having Systems Engineering Societies, including

- **Beijing**
- **Shanghai**
- **Tianjin**
- **Chongqing**
- **Guangdong**
- **Jiangsu**
- **Liaoning**
- **Hunan**
- **Hubei**
- **Shanxi**

Activities to Promote SS&SE Development

SS&SE Development Programs, including

- Strategic Study for SS&SE Development in 2011-2015
  (Supported by China Association of Science and Technology)

- Survey and Analysis of Disciplines SS&SE in China
  (Supported by Ministry of Education)

- Dictionary, Handbooks of SS&SE
  (Operations Research)

- Textbooks for Undergraduates, Graduate Students
  (4 + 6)

Activities to Promote SS&SE Development

SE Consulting Projects, including

- Low Carbon Economy Development Strategies for China
- Global Value Chain and Global Supply Chain Management
- Reform of the International Financial System and China's Strategies
- Social Safety Early-Warning Systems

Activities to Promote SS&SE Development

Conferences/Workshops/Forums, including

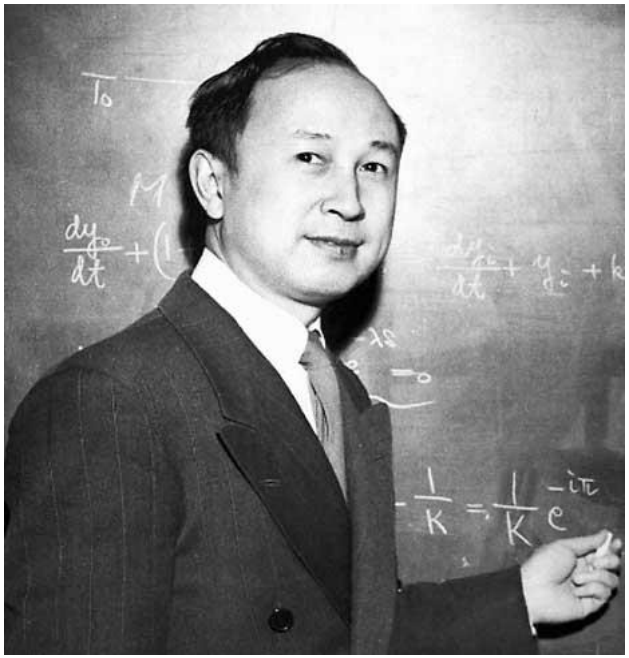
- International Conference of SS&SE (triennially)
  (jointly with IIASA and IFSR, 400 participants)
- National Conference of SS&SE for Young Scientists (bi-annually, jointly with NSFC, 350 participants)

- Each year, SESC also organizes about 10 international conferences, international workshops and international symposiums.

SESC Congress (Biannual)

Since 1980

A Leading Scientist
----- Dr. Qian Xuesen



Qian Xuesen (or H.S.Tsien)

（1911.12.11 ---- 2009.10.31）

- **Widely known as the father of China's missile and space technology programs.**

- **Also, a key and leading scientist for promoting systems science and systems engineering in China.**

Qian Xuesen

Made great contributions in promoting systems science and systems engineering in China in various aspects including research, education, organization and popularization, etc. For example,

- **Book: "Engineering Cybernetics", McGraw-Hill, 1954**
- **Founder and first President of Chinese Association of Automation, 1957**
- **Honorary President of Systems Engineering Society of China (1980--)**
- **Article: "Systems Engineering --- a Technology for Organization and Management" (with G.Z.Xu and S.Y.Wang, 1978)**
- **Organized a series of seminars on systems theory, opened up a Chinese school of complexity Science (1984 --)**
- **Article: "A New Area of Science: Open complex giant systems and methodology"(with R.W.Dai and J.Y.Yu,1990)**
- **Book: "Establishing Systematology" (2001, 2007)**

中国系统工程学会
上海交通大学 编

钱学森系统科学思想文库

创建系统学

（新世纪版）

钱学森 著

上海交通大学出版社

Qian's View on Systems Science

In modern science and technology, there are 11 major branches of science and technology, which include natural science, social science, mathematical sciences, systems science, cognitive science, etc.

Systems science consists of three levels:

- **Applied technology:**

  Systems engineering, control engineering, information engineering, etc.

- **Technological science:**

  Operational research, control theory, information theory, etc.

- **Fundamental theory:**

  Systematology (to be established)

Contributions to Systematology

Qian's concepts and methodology:

- Open complex giant systems;
- From qualitative to quantitative integration;
- Hall for workshop of comprehensive and integrated systems;
- Science and engineering of wisdom in cyberspace.

The Chinese Government named Qian Xuesen an
"Outstanding Scientist of the Nation"
on October 16,1991

Chinese President Hu Jintao (R), visited renowned scientist and founder of China's space technology Qian Xuesen in Beijing, Jan. 19, 2008. (Xinhua Photo)

Hu Jintao said to Qian Xuesen:

"You have made outstanding scientific achievements. I have benefited a lot from your works. I'll give you two examples. One is your systems engineering theory. When I was studying in the Central Party School in the 1980s, your theory really impressed me. Now I still remember that you mentioned when dealing with complicated situation, we must start from an overall consideration and think about all aspects. Currently, we are advocating scientific development, which also fits your theory".

(CCTV News, Jan. 2008)

President Jiang Zemin said at the 14th Party Congress in October1992:

"Establishing and improving a socialist market economy will be a long process, because it is a difficult and complex feat of social systems engineering".

President Xi Jinping said at the Third Plenary Session of the 18th Party Congress in November, 2013:

"Comprehensive deepening of reform is a complex systems engineering ".

Systems Science as a Discipline in China

In 1990, the Degree Committee of the State Council approved systems science as a first-grade-discipline in China, and MS and Ph.D degrees have been awarded in Systems Science since then.

Perspectives and Plans

Some Perspectives

- **Systems science and Engineering could play more important role in the development of economy and society, more efforts should be made.**

- **The interplay between systems science and other branches of science and engineering is beneficial to both, and hence should be enhanced.**

- **International exchanges and collaborations are crucial, and we are looking forward to do more in this aspects, including cooperation with Japanese systems science community.**

“The National Medium- and Long-Term Program for S&T Development “ (2006-2020)

- **Basic Research in Response to Major National Strategic Needs ------ Complex systems, disaster formation, prediction, and control**

  “Research will focus on the relationship between micro-mechanisms and macro-phenomena in engineering projects, nature, and socioeconomic complex systems; mechanism and evolution of structure formation, and relationship between structure and system behavior in a complex system; movement of complex systems and associated system mutation and regulation; relativity between behaviors at different scales in a complex system, and new theory and methodology concerning complex systems.”

Plans for Future Development of SS&SE in China

- More International Cooperation Projects
- More Summer Schools for Young Scientists
- More Training Programs for Governmental Officials
- More Training Programs for Large Companies
- Top Journals and Book Series

Thank You !