Abstract

This paper presents a comparison between Chinese perspectives on systems thinking and ideas from the West, primarily the U.S. and the U.K. In particular we focus on the debate between reductionism and holism which is one of the classical subjects of study in the philosophy of science. Just like the West, China experienced theoretical debate between holism and reductionism which spanned across a broad range of fields such as traditional Chinese medicine and reliability-centered systems engineering. The Chinese developed their own oriental systems methodologies based on the philosophical foundation of ancient oriental philosophy thoughts and dialectic principle, the most distinctive of which include the Meta-synthesis Approach and the Wuli-Shili-Renli approach. In the Western approach to systems thinking there are similar concepts of holistic thinking, synergism, and cause and effect. However, interesting differences exist between China and the West in the role of intuition in decision making. We explore these differences and discuss the implications for applying each approach in different problem solving contexts.

Keywords: Systems Thinking; Systems Approach; Reductionism; Holism
To explain what systems thinking is and how systems thinking works, many researches gave opinions. Ackoff regarded the basic philosophy of systems thinking as doing the right thing (Ackoff, 1974), and established four consequences to think about social systems by classifying systems into three types: mechanical, organismic, and social (Ackoff, 1993). Based on the view of hierarchy of complexity (Boulding, 1956), Jackson indicated there were three kinds of systems thinking applied in management: functionalist, structuralist and interpretive (Jackson, 2009). Considering the four foundations of systems methodology (holistic thinking, operational thinking, systems theories and interactive design) (Gharajedaghi, 2006), five learning disciplines (personal mastery, mental models, shared vision, team learning and systems thinking) (Senge, 1990), thirty systems thinking laws (synergy, gradual process, life-cycle thinking, solution exploration, etc.) (Frank, 2000) and seven critical skills of systems thinking (dynamic, closed-loop, generic, structural, operational, continuum and scientific) (Richmond, 1993), Valerdi presented seven systems thinking competencies to understand systems thinking construct (Valerdi, 2010).

As a matter of fact, systems thinking is a way of people thinking and acting, which have been rooted in systems thinkers’ minds, either westerners or easterners. Currently, systems thinking has closed ties with the basic concepts of systems ideas, such as parts and wholes, system and sub-systems, boundary and environment, emergent properties, hierarchy of systems, communication and control, synergism and effect, etc. (Jackson, 2001; Mingers and White, 2010), and it is usually considered as holism thinking to look things as a whole. But, because of the different philosophical context, culture background and sociopolitical environments between West and East, there are many differences between Chinese and Western systems thinking concepts and approaches. These differences also exist in their problem solving process when they apply systems thinking.

This paper aims to provide a Chinese perspective to systems thinking and systems approaches, and to try to compare the difference between Chinese and Western approaches from the aspects of origins of systems thinking, focus and emphasis, and problem solving processes. To analyze Chinese systems thinking deeply and thoroughly, the reductionism-holism debate in China and their two practices of traditional Chinese medicine and reliability-centered systems engineering were used as an introduction in the paper, and it gave the philosophical foundation of Chinese systems thinking, including ancient oriental philosophical thoughts and dialectical materialism. In our research, the comparison between Chinese and Western approaches was given based on the popular west hard and soft systems approaches and the most broadly accepted Chinese systems approaches: Meta-synthesis Approach (MSA) (Qian et al., 1988; Qian et al., 1990; Qian, 2001; Gu and Tang, 2005; Tang et al., 2005) and the Wu li-Shili-Renli (WSR) approach (Gu and Zhu, 2000; Zhu, 2000).

2. Systems Thinking and Methodologies: A Western Literature Review

2.1. Holism and Systems Theories

Reductionism is the belief that human behavior can be explained by breaking it down into smaller component parts. French mathematician, Rene Descartes (1596-1650), suggested that complex problems could be solved by “Dividing each difficulty into as many parts as is feasible and necessary to resolve it.” In contrast, holism emphasizes the whole rather than the parts. In other words the emphasis is on the idea that “the whole is greater than the sum of its parts”, thereby creating a system that provides value. As two diametrically distinct basic views of the world, reductionism and holism guided the development of nature and social science in many fields, and the theoretical debate between them concerns every area of study in various scientific disciplines.

With the development of operational research (OR) and systems engineering (SE) during and after the second world-war in military fields, systems people focusing in different disciplines are more and more complex and large scale. These issues needed a synthesized approach to cognize and analyze, and the relation between the components and the effect on the whole system could not be ignored. Holism and systems theories were becoming an increasing concern to scientists and engineers. The same situation occurred in biology in the beginning of the last century, which derived general systems theory presented by Bertalanffy in 1950s. Especially with the “crisis in OR” (Ackoff, 1979; Checkland, 1983) in 1970s, which resulted in the development of soft systems/OR and critical systems (Mingers and White, 2010), many systems theories were gradually taking shape. The most representative systems theories include General Systems Theory (Bertalanffy, 1950; Boulding, 1956), Open Systems Theory (Bertalanffy, 1950), Socio-technical Systems Theory (Hill, 1971; Cherns, 1976), Living Systems Theory (Miller, 1978), System
Dynamics (Forrester, 1968), Social Systems Sciences (Ackoff, 1981; Churchman, 1979; Mitroff and Mason, 1981), Soft Systems Methodology (Checkland, 1981; Checkland, 1989), etc. These theories are insightful and useful to the researches and practices in many fields, such as OR, SE, management science (MS) and so on.

2.2. Systems Methodologies

Among the above system theories, many systems approaches and systems methodologies were presented, and various systems thinking based on the systems approaches were built. Systems methodologies are structured ways of thinking, related to different theoretical rationales, focused on improving some real-world problem situations (Jackson, 2001). In other words, systems thinking is a kind of systems methodology which used some systems approaches to cognize and analyze systems, which directs people’s actions to build and reform systems. Checkland and Scholes gave preliminary constitutive rules for generic systems methodologies based on functionalist (hard), interpretive (soft) and radical (emancipatory) (Checkland and Scholes, 1990; Jackson, 2001). In opposition to hard systems approaches such as OR, soft systems thinkers defined their methodologies as soft (Ackoff, 1979; Checkland, 1978). More generally, according whether the problem the approach solved is soft or hard, it usually classifies system methodologies into hard (quantitative) methodology and soft (qualitative) systems methodology.

Hard approaches and methodologies were originally developed for well-defined (hard) system, for example technical/engineering system. The early pioneers of OR methods (Ackoff, 1962; Churchman, 1963), Ackoff and Churchman later adopted the systems thinking label in preference to OR (Jackson, 2009), the same to Cybernetics (Ashby, 1956; Wiener, 1948), Systems Analysis (Gass and Harris, 1996), SE Approach (Hall, 1962) and Systems Dynamics (Forrester, 1968). Among those approaches, some researchers (Lane, 2000; Petkov et al., 2007) considered systems dynamics as not belonging to hard approaches nor soft approaches, but a hard-soft-mixed approach, which is why system dynamics uses hard tools, but is based on soft idea.

In opposition to looking at traditional OR methods as a hard systems approach, many soft systems thinkers aimed to solve ill or unstructured problems (e.g. social system, organization system), and presented a lot of soft systems methodologies/soft OR methods, including Interactive Planning Methodology (Ackoff, 1981), Social Systems Design (Churchman, 1979), Soft Systems Methodology (Checkland, 1981; Checkland, 1989), Strategic Assumption Surfacing and Testing (Mitroff and Mason, 1981), Problem Structuring Methods (Rosenhead and Mingers, 2001), Critical Systems and Multi-methodology (Mingers, 2000).

Table 1 lists a brief comparison between two categories of system approaches. Despite the differences between those approaches, more and more people considered soft systems approaches in the last several decades. The most salient feature of those approaches is for problem structuring (Rosenhead and Mingers, 2001), a basic but very difficult goal and task for system analysts, modelers, strategic planners and decision makers (Gu and Tang, 2005).

<table>
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<th>Hard system approaches</th>
<th>Soft system approach</th>
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<td>Soft/ill-structured problem</td>
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3. Systems Thinking and Methodologies in China

3.1. Philosophy Debate and Practices
3.1.1. Reductionism-Holism Debate

The debate between reductionism and holism is one of classic subjects of study in the philosophy of science, and it had a big impact on the origin of systems thinking. A holism-reductionism debate in China was sponsored by Qian Xuesen (Tsien Hsue-shen) at the end of the last century and continued until the first few years of this century. Qian made remarkable contributions to the missile and space programs of both the United States and China. As a pioneer of system engineering, Qian proposed the scientific framework for Systems Engineering in the 1970s, and established the field of "Systematics" as the link between systems science and scientific philosophy (Omega Alpha Association, 2009). The debate in China led by Qian concerned Chinese academic circles in the various science disciplines, and emerged from a philosophical level to many science and engineering fields. During the debate, using dialectical materialism, Chinese systems thinkers integrated their ancient philosophical thoughts and absorbed modern western scientific thoughts, and presented oriental systems thinking and systems approaches.

3.1.2. Practice of Traditional Chinese Medicine

Traditional Chinese medicine is one of most intense field in the debate between reductionism and holism. For thousands of years, Chinese medicine treatment methods and traditional Chinese medicine have been deeply rooted in Chinese culture. Since the 18th century, with the increasing influence of Western civilization in China, the Chinese medicine theory has been impacted tremendously. Eventually, Western medicine and practices gradually became and continues to be the first choice for the Chinese. When systems thinking and systems science theory come up, people paid more and more attention to traditional Chinese medicine, and it is becoming increasingly popular among Chinese and non-Chinese countries since the late 1950s.

In many people's opinion, Western medicine is microscopic, belonging to reductionism. Its theory foundation is Germ Theory of Disease (Louis Pasteur, 1860's). Western medical theory disciplines include Anatomy, Neurology, Cytology, etc. Its basic treatment methods are medical interview and a physical examination. On the other hand, traditional Chinese medicine is macroscopic which is typical of holism. Its theoretical foundations are Yinyangism (Yin-yang theory) and Five Phases theory. In the Yin-yang theory, everything has two statuses, Yin and Yang. And in the Five Phases theory, there are five elemental qualities, represented by wood, fire, earth, metal, and water. Either Yin and Yang, or five phases, human body's harmony is the treatment foundation of Chinese medicine. By checking the body's synthetic characteristics, especially palpating the pulse and inspecting the tongue, Chinese medicine traces symptoms to patterns of an underlying disharmony.

During the Chinese holism-reductionism debate, a new approach of medicine was presented, which was named integration of traditional Chinese medicine and Western medicine (Chen and Xu, 2003). It did not deny Chinese medicine theory, but also acknowledged the Western medicine theory. The new theory was considered to be the result of systems thinking and systems science theory in China. Nowadays, many Chinese doctors have adopted this theory, especially for incurable diseases, like cancer.

3.1.3. Practice of Reliability-centered Systems Engineering

Traditionally, reliability has been defined as the probability that a product will perform its intended function during a specified period of time under stated conditions. Reliability Engineering is the discipline of reducing and computing the probability of failure of the product/system. Test technology and statistical tools are key approaches of reliability engineering. And it is mainly used for assessing reliability of products/systems. This is a typical holism view: reliability is a property of a product or system that can be measured and observed. In the last half century, all reliability engineers and researchers worked based on this view. But the view has changed in the last decade.

In recent years, a new theory of reliability has attracted many people's interests. It combined POF (Physics of Failure Reliability) theory, and it considered all universal properties of products/systems, such as maintainability, supportability, testability, safety, affordability, producibility, usability, disposability, etc. The Chinese call it Reliability-centered Systems Engineering (RSE). In POF theory, reliability physics mechanisms based on modeling and simulation is key research topic, and is usually used for reliability design and prediction. The new theory uses POF to research the impact factor of product/system reliability and the causes of failure and process of product/system failure on a reductionism view. On the other hand, it considers a product/system as a whole,
considering all of its properties at the same time.

### 3.2. Philosophical Foundation of Chinese Systems Thinking

#### 3.2.1. Ancient Oriental Philosophy

When systems thinking was developed in China, the oriental context, which included philosophy, culture, sociopolitical environments, and economic spheres, constituted its philosophical foundation. Since ancient times, Chinese philosophy was considered as holism which has a belief of harmony. The three major ancient Chinese philosophy thoughts, Confucianism, Taoism and Buddhism (Gu and Zhu, 2000; Zhu, 2000), all emphasized the unity and harmony of different sides of everything. What follows are typical harmony thoughts in Chinese ancient philosophy. For example, unity between man and nature, also named harmony between human and nature, was a primary concept in Chinese traditional culture; harmony between Yin and Yang, indicated everything has two sides, and the two sides relate and their harmony status can explain whether human is health and the situation of a nation, origination developing, etc.; unity of knowledge and practice gave a harmony relation between knowing and doing, and it was integrated into the theory or practice, which was one of basic methodologies of dialectical materialism.

Generally speaking, all of the above Chinese ancient oriental thoughts on holism emphasizes that things cannot be separated. This is why holism was rooted in the thinking way of Chinese. It influenced Chinese systems thinking, although modern science and modern civilization have had an inherent impact on Chinese ancient thoughts.

#### 3.2.2. Dialectical Materialism

Dialectical materialism was derived from Hegelian dialectic, which was presented by a German philosopher, Georg Wilhelm Friedrich Hegel (1770-1831). Nowadays, dialectical materialism is the mainstream philosophy in China, not only in political fields, but also in academic circles. Chinese usually use it in daily life, research, etc. There are two basic principles of dialectical materialism. One is the law of the unity and conflict of opposites, and another one is the law of the passage of quantitative changes into qualitative changes.

As the central concept of dialectics, unity of opposites was suggested by Heraclitus (BC 535-BC 475). It means that everything in the world has two sides or situations, which are opposite to and dependent on each other. This principle can sometimes be applied in scientific research effectively. For example, before Einstein presented wave-particle duality of lights in 1905, many researchers thought lights were waves or particles. So did the debate between reductionism and holism in China. Chinese system thinkers agreed on holism, and at the same time they did not reject reductionism. They considered that systems thinking was a thinking way, which was a unity of reductionism and holism on dialectical view. When the emergence of a system is considered, holism thinking is used. When the hierarchy is researched, reductionism thinking is needed.

![Fig. 1. Unity of Reductionism Thinking and Holism Thinking](image-url)

As another principle of dialectical materialism, the passage of quantitative changes into qualitative changes is a universal principle for dynamics in the world. Any system’s forming process is a quantitative-qualitative-changes (QQC) process. In systems science, it was called emergence. A system is a set of components that interact with each other and serve for an expectation function or a common purpose. A system must be looked at as a whole, and it has many properties that its components never have. In other words, a system isn’t equal to the sum of its parts. The new properties the system has, but its components don’t have, are referred to as emergent properties. Generally speaking, there are two kinds of emergence in the process of system’s quantitative changes into qualitative changes.

One is positive emergence, whose result is system function, which is related to engineering design discipline (such
as Mechanical Engineering, Electrical Engineering, etc.). Another one is negative emergence, whose result is system failure, which is related to reliability engineering discipline. On a quantitative-qualitative-changes view, we can get the hierarchy of a system, which is a system that is composed of many sub-systems, and a sub-system that is composed by other sub-sub-systems, and so on.

![Figure 2. Quantitative-Qualitative-Change Process of System Emergence](image)

### 3.3. Two Systems Methodologies in China

#### 3.3.1. Meta-synthesis Approach

The same time that Western systems thinkers developed soft systems approaches to make up for the limitations of hard systems approaches, Chinese systems thinkers were studying new system approaches based on eastern systems thoughts. Meta-synthesis approach is one of those approaches proposed by a top Chinese system scientist Xuesen Qian to tackle with open complex giant system (OCGS) from the view of systems in the early 1990s (Qian et al., 1988; Qian et al., 1990; Qian, 2001). In Qian’s opinion, OCGS problems are also regarded as ill-structured or wicked problems, and its solving method is also a soft approach. Qian presented a framework to solve it as follows. As the key idea of the approach, Qian’s MSA emphasizes the information and knowledge of humans (experts) in the problem solving process, and it integrates quantitative methods with qualitative knowledge (Gu and Tang, 2005). It had been widely applied in China, from industry to economic fields, from social systems to military systems.

![Figure 3. Qian’s Hall for Workshop on Meta-Synthetic Engineering (expanding on Gu and Tang, 2005)](image)

#### 3.3.2. WSR Approach

Combined Chinese ancient philosophy of harmony, a new *Wuli-Shili-Renli* approach is present which aims to solve soft structure issues like sociotechnical systems, and it has been applied in various fields. In the approach,
sociotechnical systems can be viewed as constituted by \( wu \) (objective existence), \( shi \) (subjective modeling), and \( ren \) (intersubjective human relations) (Gu and Zhu, 2000; Zhu, 2000). Therefore any projects of sociotechnical design/management nature should consider all \( wuli \) (regularities in objective phenomena), \( shili \) (ways of seeing and doing), and \( renli \) (principles underlying human interactions) in a holistic way, although a particular \( li \) may manifest itself as more urgent or crucial than the others at certain stages of conducting projects. The WSR approach got its name from the heading letter of \( wuli \), \( shili \) and \( renli \), which means that the key idea is knowing \( wuli \), sensing \( shili \), caring for \( renli \). Follows are the elements and steps of WSR approach.

![Diagram of WSR Approach](image)

Figure 4. (a) Elements of WSR Approach; (b) Steps of WSR Approach (Gu and Zhu, 2000)

4. Comparison between Western and Chinese Systems Approaches

4.1. Origins of Systems Thinking

To put it simply, the roadmap of Western systems thinking emerged from reductionism to holism, while the Chinese roadmap emerged from holism to reductionism to dialectic unity of the two. It related to the Eastern and Western cultural background and the science development history. This also contributed to the reasons for both systems thinking approaches to have their own advantages and disadvantages. The Western systems thinking approach pays more attention to rules (for example, standard and specification in engineering). Although they act according to the rules, there is no lack of creativity. They are individualistic and lack looking at systems as a whole. Chinese-speaking individuals in general see the big picture and emphasis on collective interests above personal interests. They do everything flexibly, putting the rules aside which are made up by themselves. At the same time, most Chinese lack creativity.

4.2. Focus and Emphasis

**In Western's opinion, systems thinking** is equal to holism thinking, which considers a system as a whole entity. This is why Western systems thinkers put their focus of complex systems on emergent properties. They research more topics on cause, effect and feedback within system components. Chinese look upon systems thinking as a dialectic unity of reductionism and holism. They concern the harmony of the world things. Chinese emphasize on people's initial subjectivity and human roles in problem solving process. It can be seen in MSA and WSR approach. In MSA, expert knowledge plays an important role in decision making. In WSR approach, \( renli \) which relate to inter-subjective human relations is one of the key elements of the approach.

4.3. Problem Solving Process
Western systems thinkers’ problem solving process is model oriented. With both hard systems thinking, and soft systems thinking, it is necessary to build various models, hard model and soft model, to describe the problem context, to analyze and figure out the result, to verify, validate and assess solutions. In order to build an accurate and elegant model, knowing the detail of systems is very important. Ultimately, the problem solving process is a reductionism process. It also accords with Western systems thinking’s origin. Correspondingly, Chinese process is goal-oriented. To reach their goal, the Chinese are very realistic and enriched with wisdom. In most cases, the goal is harmony, which means the solution satisfies most stakeholders. Trade-offs run through the whole decision making process, and this is why humans could play an important role. At the same time, to solve the problem, Chinese systems thinkers research the consistency of systems and the relation between components on a reductionism view, and then focus the emergence properties of whole system on holism view. It is a typical synthesis process.

5. Conclusions

Chinese and Western systems thinking have much in common. They have many same or similar concepts and principles. But, since the origins and philosophy contexts are distinct, especially the harmony-centered east ancient philosophical thoughts is completely different from west which has deep rooted in Chinese systems thinkers, Chinese systems approaches stress more holism thinking and the role of human in the problem solving process. This paper gives an intuitive Chinese perspective to systems thinking and approaches, and attempts to provide more focus on Chinese systems thinking for future discussions.

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