International Journal of Philosophy and Theology
December 2015, Vol. 3, No. 2, pp. 49-63
ISSN: 2333-5750 (Print), 2333-5769 (Online)

Published by American Research Institute for Policy Development
DOI: 10.15640/ijpt.v3n2a6
URL: http://dx.doi.org/10.15640/ijpt.v3n2a6

Borderless Philosophy of Technology: Intercultural Exchange and Spread for Technology between the West and the East

Gui Hong Cao[1]

Abstract

This project aims to investigate related processes, routes, and issues associated with the exchange and spread of the philosophy of technology. Using textual analysis, an examination of historical phases and spatial theory, and comparative research on schools of thought, this study investigates the international exchange and spread of the philosophy of technology. This article analyzes the critical approaches, theories, programs, and contributions of scholar schools, the eastward spread of Western culture as intercultural exchange and spread process, and the theme of technological revolution. This paper further explores the various barriers and reasons for this exchange and reception, thus proposing a global philosophy of technology with an intercultural technology program and an intercultural exchange and reception mode with endogenous and exogenous approaches. The technological development is led by the philosophy of technology and motivated by technological policies. An empirical turn and an ethical turn in the philosophy of technology are conducive to change and eliminate the survival and ecological crisis of nature. This study helps to improve the international communication and the practice of learning from each other about the philosophy of technology. Therefore, it strengthens the internationalization course and a disciplinary progress to achieve success for a great future.

Keywords: Borderless philosophy of technology, Intercultural exchange and spread, Technology, The eastward spread of Western culture, Technological revolution, Global philosophy of technology

1. Introduction

The philosophy of technology is a philosophical field that studies the nature of technology and its social effects. It began in Germany in 1877 (Kapp 1877). After World War II, the philosophy of technology developed in Europe and America, and spread quickly to Asia. Each year witnesses the release of some papers, monographs, and translations of works on major themes of technological ontology, epistemology, methodology, and value. Global dialogs between the West and the East have strengthened the philosophy of technology. However, for various reasons, the communications on the philosophy of technology are still limited by barriers, such as different interests of the society. Technology has national boundaries, whereas the philosophy of technology is borderless. As a newly emerging discipline with a great future (Wu 1999), the philosophy of technology continues to expand rapidly and profoundly, revealing significant functions to guide and monitor the development of technology. Technology matters because

[1] I am finishing my Ph.D. at the Department of Philosophy and the History of Technology, the Royal Institute of Technology (KTH), Sweden. The project has been subsidized by China Scholarship Council (CSC) in China and Royal Institute of Technology (KTH) in Sweden. An earlier version of this paper was presented at the 3rd International Symposium on the History of Technological Exchange between China and Foreign Countries. I sincerely thank the organizer (National University of Defense Technology) and the other participants. I am extremely grateful to Professor Carl Mitcham and Professor Baichun Zhang for insightful discussions. I am indebted to Professor Sven Ove Hansson, Associate Professor Ma Huiduan, Associate Professor Karin Edvardsson Björnberg, and Associate Professor Suzanne Moon for significant guidance.

being human is inseparable from technological development and usage (Nye 2006). The technological matter confronts both success and failure (Ihde 2006). Accordingly, the technological measures must be implemented for better security and efficiency, such as safety design adopted as a cautionary step in a possible technological trap (Editorial 2007). Technological development helps to enhance social welfare (Moon 2007). As advocated in this study, it is not only imperative to understand the technological society, but also important to work toward bringing the favorable reformations in the human society for the pragmatic applications of the philosophy of technology.

Various gaps exist between the reality with restrictive barriers and a great future in the philosophy of technology. Therefore, it is essential to detect the related problems and find solutions. Reversely considered, the following critical issues need to be traced for answers. How does the philosophy of technology exchange and spread in the world? What are the processes, routes, and affairs involved in the exchange and spread of the philosophy of technology? This study aims to examine relevant processes, maps, and issues for the exchange and spread of the philosophy of technology, identify some obstacles and causes, and attempt to find solutions. This paper hopes to enhance the international communications and dialogs, exchange and learn from each other for the philosophy of technology to achieve a great reality.

This article is organized in the following structure by combining theoretical analyses and practical explorations in the society. Following up the specified themes in the introduction, Section 2 presents the methods. Section 3 analyzes the evolution of the philosophy of technology and explores the primary schools of thought. Throughout this article, the term *school* specifies a school of thought in the philosophy of technology. Section 4 examines the process of exchange and spread, highlights the interesting practical topics, discusses the barriers and their causes, and finally offers solution proposals. Finally, section 5 includes the conclusions.

2. Methods

This study applies a variety of methods. First, bibliometric retrievals of the contributions are made to the development of the philosophy of technology in the West and the East. Building on the previous work, this study makes in-depth textual analyses and conducts comparative research, combining historical phases and spatial theory. According to historical developments, the philosophy of technology is classified into four historical stages: prehistory (approximately 427 BC–1876), tradition (1877–1910s), classic (1920s–1980s), and contemporariness (1990s–2010s). Based on geographical and content diversity, the philosophy of technology is exchanged and spread between the West and the East as the first reliable theoretical assumption. This study compares scholar schools to reveal the spread and transfer processes and significant themes. Furthermore, as the second practical hypothesis, the technological revolution is connected with the philosophy of technology and motivated by national policies on technology.

3. Analyses on the Development of the Philosophy of Technology

3.1. The Prehistory: Philosophical Reflection on Technology

The prehistory of the philosophy of technology is viewed as the early philosophical reflection on technology accompanied by technological phenomena and human history. Geographically, the *West* mainly refers to the countries located in the Western and Northern hemispheres. *Logos*, a term from the ancient Greek philosophy and theology, is the source and center of Western philosophy (Zhang 2004). Under the Logos tradition, Western philosophical reflection on technology has been based on rationality. In his *Physics*, Greek philosopher Aristotle thought that technology possesses the capacity to create new objects based on four causes (i.e., material, formal, efficient, and final causes). He distinguished *poiesis* (making) from *praxis* (doing) to emphasize the latter (Mitcham 1980). This article appraises that technological four causes are viewed as a research program in the ancient philosophical reflections on technology to form a traditional craftsman view.

The East includes all the parts of Asia and Africa. The philosophical reflections on technology in the East are mainly influenced by the Chinese Taoism, Japanese Shintoism, Indian Hinduism, Arab Islam, and others. Like Logos is the center of the Western philosophy, Tao is the core of traditional Chinese philosophy, which initiates the ways of heaven, earth, humanity, and rule with Chinese characteristics (Zhang 2004). In terms of ethical attitudes toward technology, Tao emphasizes *wu-wei* (non-action) as the high state of virtue in the *Chuang Tzu* and the *Tao Te Ching* (the ancient Daoist texts). Confucianism underlines humanism as its core including Five Constants (*ren*: humaneness, *yi*: righteousness or justice, *li*: proper rite, *zhi*: knowledge, *xin*: integrity) in the *Four Books and Five Classics* (the authoritative Confucianism books). Both have the ideal of harmony. Daoism is the religion that positively supports scientific and technical development in China and Confucian also promoted the practical development of technics (Needham 1956). The background of the philosophy of technology in the Chinese culture lies in Tao and technique (Wang 2009).

These ancient philosophical reflections on technology in the prehistoric stage have offered valuable thoughts on technology and played a crucial role in influencing the technological development.

3.2. The Traditional Source: Western European German and French Schools

The oldest source and most diverse tradition of the philosophy of technology can be found in Europe, specifically in the German and French schools of Western Europe (Mitcham 1980). It inherited the rational ideology from the European Renaissance between the fourteenth and seventeenth century and was embodied in the technological practice during the Industrial Revolution in the eighteenth century. It analyzed and reflected the ethical rationality and practical perfection of the essence and social significance of technology, based on the approaches of internal existentialism and engineering in Germany to external sociology and theology in France.

The original philosophical theories on technology can be traced in the following three German works on the philosophy of technology. German philosopher of technology Ernst Kapp (1877), the founder of the philosophy of technology, created an organ projection. This article values organ projection as a research program in the German philosophy of technology contributing toward shaping a technology and engineering view. The German engineer Eberhard Zschimmer (1913) explained technology using the Neo-Hegelianism philosophy and regarded technology as material freedom. The German philosopher Friedrich Dessauer (1927) considered the invention to be the most important aspect of technology. This article notes that these initial theories recognized the German school as the originator of the philosophy of technology.

During World Wars I and II, social criticisms of technology had become increasingly severe. After World War II, the philosophy of technology, related to engineering, entered into the organizational stage in Germany and extended to Europe (Mitcham 1994). From the perspectives of existential phenomenology and philosophical hermeneutics, German philosopher Martin Heidegger studies being and time (Heidegger 1927) and inquired technology (Heidegger 1954). Considering the three Kantian critiques of scientific knowing, moral doing, and esthetic feeling, German philosopher Friedrich Dessauer (1956) proposed the fourth kingdom of technology from a critique of technological making. The German philosopher Friedrich Rapp studied the structure of thinking in the technological sciences (Rapp 1974) and an analytical philosophy of technology (Rapp 1978). These keen philosophical explorations on technology in the German Democratic Republic brought a broad philosophical world for technology and a technological kingdom as a dominant position.

In France, French engineer Jacques Lafitte (1932/1972) firstly conducted engineering analysis in industrial production with reflections on the science of machine engineering. Later, French philosopher and engineer Gilbert Simondon (1958) expanded this engineering analysis to examine the mode of existence of technical objects. French philosopher and sociologist Jacques Ellul (1962, 1964, 1980) initiated hard technological determinism in technological society within the technological order and technological system. This article considers the technological system as a research program in the French philosophy of technology to construct a technological world. Later, as influenced by existential phenomenology of Martin Heidegger, the French Bernard Stiegler (1994/1998) studied technology and time. French Jean-Yves Goffi (1988) conducted the studies on the philosophy of technology. These philosophical analyses of technological roles in society have further raised global attentions in the technology-driven society.

3.3. The First Classical Institutionalization: Anglo and American Schools

In contrary to the Western European German and French schools, British and American schools have different history and topics (Mitcham 1980). These schools have explored the philosophy of technology from sociological, historical, cultural, anthropological, and political discussions on technology based on theory and practice.

The American school can be traced back to a sociological study of cultural lag, where culture takes time to catch up with the technological development, thereby causing social disharmonies (Ogburn 1922). This line of thought was then influenced by another work *Technics and Civilization,* written by American historian and philosopher of technology Lewis Mumford (1934) from historical and cultural perspectives, where technology was divided into twofold phases: polytechnics and monotechnics. Mumford (1967, 1970) recommended *Homo Sapiens* instead of common *Homo Faber* to improve the position of human creation from the anthropological viewpoint in his book *The Myth of the Machine*.

The combined foundation of philosophy and engineering was offered by the logical mathematization introduced by British philosophers Alfred North Whitehead and Bertrand Russell in the twentieth century and the logical positivism in British and American philosophies. The conscious discussion on the philosophy of technology by the British and American philosophers was marked with two important issues. First, the Encyclopaedia Britannica Conference on the Technological Order was held in the Center for the Study of Democratic Institutions in Santa Barbara, California in March 1962. Second, in the summer of 1966, a series of papers with the title of "Toward a

Philosophy of Technology" was published in *Technology and Culture* (Mitcham 1980).

The American philosopher Paul T. Durbin edited a group newsletter and an annual series of research papers on the philosophy of technology in 1976 (Carpenter 1978). The Society for Philosophy and Technology was established in 1976. The Western philosophy of technology firstly began institutionalization with the first social publication of *Research in Philosophy & Technology* in 1978 in America, after the philosophy of technology was confirmed as a new and important philosophical discipline at the 16th International Congress of Philosophy in 1978 (Diemer 1983). After hard technological determinism of Jacques Ellul, the American political theorist Langdon Winner (1977, 1980, 1986) launched soft technological determinism based on technical politics. The American philosopher Larry A. Hickman (1990) developed Deweyan pragmatism in technology. By extending phenomenology and hermeneutics of Martin Heidegger, the American philosopher Don Ihde extended postphenomenology in human-technology-world relations (Ihde 1993) and material hermeneutics and studied technoscience (Ihde and Selinger 2003). The American philosopher of technology Carl Mitcham (1994) historically analyzed the philosophy of technology through the engineering and humanities branches and divided technology into object, knowledge, activity, and volition. This article appraises that this classical division of the philosophy of technology is presumed as a research program of engineering-humanities dichotomy in America. This fundamental analytical pragmatism in the American philosophy of technology has established the American school as a research center to lead the world in the field of the philosophy of technology.

3.4. The Spread to Eastern Europe: Soviet Union School

The Eastern Europe-Soviet Union school follows the internal consistency by holding on Marxist philosophy majorly from a political perspective. Based on the Marxist thought, it asserts that the production process is not only the primary human activity, but has a social and historical basis. It focuses on the scientific and technological revolution or the unity of science and technology, which triggered the Second Industrial Revolution in the West (Mitcham 1980).

The term "scientific-technological revolution" was initially suggested by the British Marxist and scientist John Desmond Bernal and American economist Victor Perlo in the early 1950s. The scientific and technological revolution began with the Eastern European criticism of the philosophy of technology in Western Europe. The philosophy of technology experienced a shift from the rejected position considered as a negative pessimism in the 1950s to the accepted position owing to the positive construction after 1965. In 1965, a conference on "Marxist-Leninist Philosophy and the Technological Revolution" in Berlin aimed to present a constructive view of Marxism, inviting the Eastern European philosophers (Mitcham 1980). During the period between 1950 and 1965, the Soviet Union's main discussions on technology concerned questions related to automation and cybernetics. Initially, cybernetics was doubted as a new form of idealism by some Marxist and later this misdoubt was clarified by two papers on cybernetics in 1955. This shift has helped the Soviet Union to understand the scientific and technological revolution in relation to cybernetics and technological transformation (Mitcham 1980). The Russian engineer P. K. Engelmeier (1913) held a technocratic viewpoint from an engineering perspective, especially in the volume four of a series of his works of *Philosophy of Technology*, devoid of an overt recognition of Marxist philosophy. Then this technocratic philosophy of Engelmeier was involved in the general conflict of expert and red between engineers and politicians, as pointed by Kendall Bailes (1974). This article appraises that technological revolution is seen a research program in Soviet Union philosophy of technology with a technocratic view. As discussed in this article, these studies on technological revolution in society made the Soviet Union school an active participant involved in the debate on the philosophy of technology, especially social roles of technological revolution.

3.5. The Spread to the East: Asian Japanese and Chinese Schools

After its initiation in Germany in 1877 and institutionalization in America in 1978, the philosophy of technology began to spread from the West to the East. The Western philosophy of technology has been intentionally or unintentionally exchanged and spread to the East, especially the Marxist philosophy of technology. The Eastern philosophy of technology has been tangibly or intangibly penetrated by the original philosophical reflections on technology. Moreover, the Eastern philosophy of technology has attempted to develop new fields, such as technological theories or new technical methodologies. In Asia, the Japanese and the Chinese schools have developed rapidly with a new expansion in the technological theory and intrinsic cohesion.

The philosophy of technology in the Japanese school is based on the technological theory, which was influenced by the Marxist philosophy before the 1950s and technological innovation after the 1950s. Since the 1930s, Japan has introduced the German philosophy of technology and created its technological theory (Jiang 1986). In 1932, some young Japanese philosophers, scientists, and technologists created a mass academic group of materialistic society to propagandize the Marxist thought. Early researchers studied the philosophy of technology from Marxism. Since

Japanese technology had been stagnated for a long period after the war, the Japanese government promulgated the foreign investment law in 1950 with the goal of actively encouraging the introduction of technology and entering a technological innovation period. Regarding the technological theory, Japanese scholars formulated the existence theorem, content theorem, and structure theorem of technological development, and attributed technological developments from the quantitative to qualitative progress to the phased development mode with partial improvement and principled leap (Li and Jia 2007).

Historically, influenced by the tradition of Taoism and Marxism applied in the dialectics of nature, the Chinese philosophy of technology began developing engineering technology dialectics from a pragmatic perspective. It applied a variety of critical approaches including engineering, sociology, and culture. It grew with the introduction of foreign philosophy of technology including Marxist philosophy of technology and Japanese technological theory. Then, it became relatively independent by building its institutionalization, research program, significant questions, and new theories. In 1985, the Chinese philosophy of technology boomed during the institutionalization process with the following events. "The First China Technology Theory Symposium" was convened at the Chengdu University of Science and Technology, and the Chinese Society for Dialectics of Nature/Philosophy of Nature, Science and Technology formed "the Technology Theory Professional Association" in this symposium in November 1985 (Chen and Chen 2009). Qian Xuesen (1957), the father of China's space program, explored the methodologies of technological sciences from the perspective of technological engineering.

The Chinese scholars participated in intense debates on a research program for establishing the philosophy of technology. The Chinese philosophers Zhang Huaxia and Zhang Zhilin (2001) proposed a research program on the philosophy of technology with the technological epistemology as the center from the perspective of demarcation between science and technology. This research program included the following: (a) technological definition and ontological status, (b) technological epistemological procedure, (c) technological knowledge structure, (d) regular technology and technological revolution, (e) technology and culture, and (f) technological value and technological ethics. It seems that the technological knowledge theory and technological logic are the core of the philosophy of technology. However, the main distinction between science and technology is the difference in values for technology as a practical activity involved in economic area and science as a theoretical exploration (Chen and Yuan 2001). Therefore, Chen Changshu and Yuan Deyu (2001) argued that technological value should be the center for the research program on the philosophy of technology and added six alternative demarcations for the sake of openness. These six demarcations are (i) the demarcation and connection between technology and science; (ii) the demarcation and connection between philosophical turn of technological study and technological turn of philosophical research; (iii) the demarcation and connection between the philosophy of technology and the philosophy of science; (iv) the demarcation and connection between the philosophy of technology and other integrated disciplines related to technical issues (e.g., economic philosophy, technological economy, historical philosophy, sociology of technology, cultural philosophy, technological psychology, and technological esthetics); (v) the demarcation and connection between the engineering philosophy of technology and the humanities philosophy of technology; (vi) the demarcation and connection between basic research and applied research of the philosophy of technology. As held in this article, the former emphasizes technological epistemology as the beginning of the research program of the philosophy of technology, while the latter underlines technological practical value as its ultimate goal. Both can be the center for the research program of the philosophy of technology, but only in the initial and mature developmental stages respectively. This study evaluates that both are termed as a science-technology demarcation program. These philosophical disputations on a science-technology demarcation program on the philosophy of technology promote the extensive development of the Chinese philosophy of technology and contribute toward diversifying and strengthening it worldwide.

Critical questions and new theories on the philosophy of technology have risen in China. Specifically, the Chinese Northeastern School has made great contributions to the research of the philosophy of technology. Chen Changshu (1999) presented that technology changes nature in its entirety to artificial nature and comprehensively studied technological ontology, epistemology, methodology, value, and ecological and humanities critical theories of technology. In order to maintain the vitality, the philosophy of technology needs to have disciplinary features, basic researches, and real values, by the strategies of the base of actual China and the understanding of international dynamic changes (Chen 2001). With respect to the significant issues of the philosophy of technology, there is no position without characteristics (disciplinary features), there is no level without foundation (basic researches), and there is no

future without application (real values) (Chen 2002). Chen (2002) also proposed thirty-five questions on the fundamental studies of the philosophy of technology. These thirty-five questions are divided into six fields: a) the disciplinary position and nature of the philosophy of technology, b) the theoretical significance of the philosophy of technology, c) the nature of technology, d) the relationships between science and technology, e) the values of technology, and f) the development rules of technology. This study proposes that these intellectual explorations deeply inject the clues and provides motivation for the further growth of the philosophy of technology. Tian Pengying (2005) created the philosophy of social technology and explored the nature, method, form, and values of social technology. Hence, the Chinese philosophy of technology has become more extensive in the objects of study including natural technology and social technology. Based on the pragmatic philosophy of Joseph C. Pitt and the analytical philosophy of technology of Friedrich Rapp, Ma Huiduan (2006) constructed the pragmatic analytical philosophy of technology to integrate the choice controversy of the engineering-humanities dichotomy and proposed the responsible technology. Based on the four causes of Aristotle and organ projections of Kapp, Sheng Guorong and Jin Zhongzhe (2007) presented the technological anthropomorphic rule stating that technology develops by simulating, extending, or enhancing human organ for revealing the mode, direction, and paths of technological development based on human evolution and social demands. Yuan Deyu (2008) launched the technological process theory for technological innovation with a dynamic vision. Wang Qian (2009) traced the Taoist tradition of the Chinese philosophy of technology from a cultural perspective. Chen Fa (see Chen and Chen 2009) proposed to adhere to the Chinese Society for Philosophy and Technology as an open academic community center in China and international. The philosophy of engineering rose in the world including China and the West (e.g., Li 2010).

In reality, science and technology are the primary productive forces. The Chinese national leadership is drawn toward technocracy pragmatism. As a developing country, Chinese technological policies include the strategy of invigorating the country through science, technology and education. With the advent of technological transfer application, China has returned to being a manufacturing country. With the gradual developments, China has begun to pursue technological innovation and sustainability. In short, the Chinese philosophy of technology results in technocracy pragmatism in reflections of technological social meaning, for Chinese scholarly and engineering worlds.

As this article points out, these explorations in technological transfer and innovation for localization have resulted in the diversification of the Japanese and Chinese schools.

3.6. The Rise of Contemporariness: Western European Dutch School and Nordic Swedish School

Being a new subject, the philosophy of technology is still in the early stages of growth. The philosophy of technology has not only spread from the West to the East, but also risen in the Western Europe (mainly the Netherlands) and Northern Europe (mainly Sweden).

After the first empirical turn with a social-oriented approach between the 1980s and 1990s in the philosophy of technology, the Western European Dutch school initiated the second empirical turn with an engineering-oriented approach between the 1990s and 2000s (Brey 2010). Moreover, the Dutch school proposed a technological dual (physical-functional) nature program taking into account the technological design and human intentions about the physical structure and social function of technical artifacts (Kroes 2002; Kroes and Meijers 2002). The Twente mode uses the descriptive and normative dimensions (Brey 2008). Influenced by postphenomenology of Don Ihde and combining German phenomenology and American pragmatism, the Dutch philosopher of technology Peter-Paul Verbeek (2005, 2006) presented his technological mediation to analyze the role that technology plays in human-world relations. He also specified to use ethical dimension and empirical approach for reproductive technologies and imaging technologies with the large cultural and social contexts of technology assessment and policymaking. Primarily, the Dutch school conducted researches extending from internal engineering to external sociology in the technological design. It focused on the empirical turn (Kroes and Meijers 2000), engineering design (Kroes 2012; Steen 2014; Vermaas et al. 2008), technological ethics (Brey 2012), engineering ethics (Van den Hoven et al. 2012), and moralizing technology (Verbeek 2011). These novel studies have established the Dutch school as the current pioneer in the philosophy of technology.

The Nordic Swedish school has increased interests in applied ethical research into social-ethical problems surrounding technology in the 2000s and 2010s. This school focused on the classical studies extending from internal technological theory to external sociology in new technology. It concentrated on technical ethics application and technical risk assessment in biotech and artificial intelligence (AI), technological culture, technological sustainability, technological knowledge, technological education, and science-technology relationships (e.g., Cao 2014, 2015; Hansson 2007, 2010, 2013; Palm and Hansson 2006). These fresh studies have made the Swedish school vigorous.

3.7. The Summary

In summary, the Western European schools in Germany and France are superior to others in terms of their profundity and diversity. However, they are inferior to the Anglo and American schools in terms of applying historical knowledge and empirical social science research, and to Eastern European schools for lacking internal synthesis (Mitcham 1980). However, if considered developmentally, the Western European German and French schools neither equal the Asian schools for their intrinsic cohesion, nor rival the Western European Dutch school and the Nordic Swedish school for their smart innovative methods and timely upgrade to the changes. Major schools in the philosophy of technology have relative and important periods with critical issues and research approaches (Table 1). Additionally, Spanish scholars have explored technological reflections in modernity (e.g., Medina and Sanmartín 1989) and Canadian scholars have developed the critical theory of technology to bring social rationality view (e.g., Feenberg 2002). In Africa, the alternative technologies have made progress. The other countries like Argentina, Venezuela, Brazil, and India, have also contributed to the philosophy of technology (Mitcham 1980). However, it is impossible to cover all schools in this historical investigation due to the limitations of languages and sources. The developed countries in the West attach more importance to technological rationality from the critical perspectives of existentialism, theology, and culture. The developing countries in the East pay more attention to technological practices from the pragmatic perspective of sociology. However, both of the schools hold the perspectives of engineering and humanism in the philosophy of technology.

Reflecting the social essence of technology through its natural phenomenon, Marx upgraded the philosophy of technology from the natural transformation theory to the social transformation theory (see, Marx 1906; Marx and Engels 1988). With science in one hand and democracy on the other hand, the social productive practices using technology aims at the advancement of humans from the domain of necessity to the realm of freedom (Marx and Engels 1988). Technology is dually attributed consisting of natural and social properties for human freedom and liberation (Guan 2001). This study argues that natural and social properties of technology ultimately change both nature and society by employing technical artifacts and social technology, for the freedom of human body and spirit liberation in philosophical and technological perspectives.

Table 1. Overview of major schools in the philosophy of technology

School	Space	Time	Approach	Theory	Program	View	Characteristics
A. The Prehistory: Philosophical Reflection on Technology		427 BC–1876	Logos; Tao, Shintoism, Hinduism, Islam	Four causes of technology	A technological four causes program	Craftsman	
B. The Traditional Source: Western European German and French Schools	West	1877–, 1932–	Existentialism, Engineering; Sociology, Theology	Organ projection, phenomenology, technological kingdom; technological determinism	An organ projection program; A technological system program	Technology and engineering	Initiation in 1877; the oldest source and most diverse tradition
C. The First Classical Institutionalization: Anglo and American Schools	West	1960s–	Sociology, History, Culture, Anthropology, Politics	Cultural lag, technical politics, Deweyan pragmatism, postphenomenology	An engineering-humanities dichotomy program	Pragmatism	Institutionalization in 1978 in America; uses historical knowledge and empirical social science research
D. The Spread to Eastern Europe: Soviet Union School	West	1960s–	Politics, Sociology, History, Engineering	Technical revolution	A technological revolution program	Technocracy	Marxism spread; internal integration
E. The Spread to the East: Asian Japanese and Chinese Schools	East	1930s–	Engineering, Sociology, Culture	Technological theory; technological anthropomorphic rule, technological process theory	A science-technology demarcation program	Technocracy pragmatism	Marxism spread; institutionalization in 1985 in China; intrinsic cohesion
F. The Rise of Contemporariness: Western European Dutch School and Nordic Swedish School	West	1990s–	Engineering, Sociology, Design, Ethics	Technological mediation; technological knowledge	A technological dual (physical-functional) nature program	Pragmatism	Empirical turn, ethical turn; smart innovative methods and timely upgrade to changes

4. Results and Discussion

4.1. An Intercultural Exchange and Spread Process: Eastward Spread of Western Culture

The philosophy of technology is exchanged and spread primarily from an intercultural perspective under the framework of technology and society. In the pre-historical period, the philosophies of technology in the West and China had different philosophical traditions. The Western tradition was built on Logos that highlighted rationality while the Chinese foundation was based on Tao with emphasis on practice. Both traditions sought technological perfection in practice. Then, the philosophy of technology was transferred from Western European German and French schools to the British and American schools. Likewise, it spread to the Eastern European Soviet Union school, Asian schools, Western European Dutch school, and Nordic Swedish school. Geographically, it followed a West-East spread route. This study argues that the philosophy of technology classically propagated Western learning to the East during the intercultural exchange and spread process. However, it does not mean that the philosophy of technology is a completed totalizing external force from one school to other schools, from one country to other countries, or from the West to the East. More important issue is the internal needs to develop the philosophy of technology. The imported exchange and spread usually from the outside are selectively perceived, critically reflected, potentially reconstructed, and creatively reacted according to the local demands, and then possibly exported with different values to other places. Such cases include the aforementioned evolutions from the phenomenology to the postphenomenology and from the pragmatic philosophy to the pragmatic analytical philosophy of technology.

Because discrepancies exist in various schools located in disparate spaces with respect to the content, the philosophy of technology has been necessarily and significantly exchanged and spread over time between the East and the West, in response to the first theoretical assumption.

Cultural communication and exchange with various marks of geography and history are inevitable. Moreover, the East-West cultural exchange and dissemination of technology are the mainstream discourses and practical acts of modern technological society. Our common technical living environment with its developmental problems encourages us to learn about the existing theories and methods for better dealing with the technological issues. Therefore, the participation in the cross-cultural research and practice related to the philosophy of technology is a major necessity and cannot be ignored.

Among nations, even across borders, the philosophy of technology has been not only exchanged and perceived intentionally or unintentionally, but also transferred and penetrated tangibly or intangibly. This exchange is quite evident in cases such as the Marxist philosophy of technology and the analytical and pragmatic philosophy of technology. This study argues that technology has borders, such as limited access to certain technologies and patents in some countries, enterprises, and organizations. Economic, political, or military interests are hidden behind technological production or technological innovation, especially in high-tech fields, for instance, biotechnology and nanotechnology. We need to pay the price to overcome these barriers and surpass technological borders. The eastern countries used to adopt the strategy of exchanging the market for technology from the Western countries. However, the feasibility of the rate of return is still in question. Innovation is the effective trump card in technology games, although the suitable strategy depends on its realistic context. However, there are no material interests' conflicts, but an ideal acceptation, opposition, or neutrality associated with the philosophy of technology. The philosophy of technology is exchanged and spread across borders to lead and monitor technological development.

4.2. The Interesting Practical Topic: Technological Revolution

The philosophy of technology has various themes of technological theories and social impacts in its exchange and spread. The interesting practical topic of technology is technological revolution effectively affecting a technological society.

Historically, technological revolution is related to human civilization and social progress. The four ancient civilizations namely Babylon, ancient Egypt, ancient India, and ancient China majorly owe to the rich ancient technological history. The Italian Renaissance beginning in the fourteenth century was the foundation of science and technology based on the Enlightenment ideology. With two scientific revolutions and three times technological revolutions, America has surpassed Europe to become the center for scientific and technological activities in the world (Table 2). Scientific revolutions were primarily involved in astronomy and physics. Technological revolutions included the aspects of the industrial revolution, power revolution, electronic technology revolution, and the IT revolution. Also, the future scientific and technological revolutions are predicted toward the inclusion of regeneration revolution and the space–time revolution (He 2012). Technological futurist Harold Adrian Linstone (2011) predicted that the molecular society consisting of nanotechnology, biotechnology, and materials science would reach the fifth long wave boom in 2024.

Table 2. Comparison of technological revolution in technological society

Society (Linstone 2011)	Time	Technology	Long wave cycle (Linstone 2011)	Scientific Revolution (SR) (He 2012)	Technological Revolution (TR) (He 2012)
The Agricultural Society	8000 BC	Agricultural technology	1st: 1745–1800 (55 years)	1st SR (1543–1687), Italy; 1st SR spread (1688–1859)	2nd TR: Industrial Revolution (18th century) (1698–1825), Britain
The industrial society	1800 CE	Industrial technology	2nd: 1800–1856 (56 years), 3rd: 1856–1916 (60 years), 4th: 1916–1969 (53 years),		3rd TR: Power Revolution (19th century) (1832–1906), Britain
The Information Society	Ca. 1970	Information technology	5th: 1969–2024 (55 years),	4th SR (1900–1926), Germany and America	5th TR: Electronic Technology Revolution (1946–1970), IT Revolution (1970–2020), America
The Molecular Society	Ca. 2025	Biotechnology, Nanotechnology, Material science	6th: Regeneration Revolution (2020–2050) 7th: Space–Time Revolution (2050–2100)		

Since the eighteenth century, technological developments and reforms have rapidly changed the focus from natural science to technological science; also, they have significantly renewed social progress in the world with positive and negative factors. Hence, the philosophy of technology has been formally and accordingly generated to reveal the nature of technology and social effects. In the philosophy of technology, it is noticed that technology develops toward information, ecology, intelligence, and medicalization. This article forecasts that the technological revolutions of the twenty-first century will be a biotech revolution and an AI revolution. Since science has shifted from a natural science orientation to technological science, the technological revolutions in the future will lead to scientific developments. Besides, in contrary to the border limits of technology, the philosophy of technology is borderless. The philosophy of technology reflects and guides technology in the rules of technology and its social impacts. In response to the second practical hypothesis, the technological development is led and supervised by the philosophy of technology, with the stimulation of national policy on technology.

The philosophy of technology has undergone an empirical turn (Achterhuis 2001; Kroes and Meijers 2000) and an applied technology ethical turn (Brey 2010). Accordingly, technology may be considered from two perspectives of empirical practice and ethical rationality. As the result of technological influences, two crises exist in nature: the survival crisis for intrinsic natural loss and ecological crisis for external natural destruction (Li and Jia 2007). As this study argues, the empirical and ethical turns in the philosophy of technology help to alter and eliminate the survival and ecological crisis of nature. By combining and addressing the empirical and ethical applications in a technological society, technological innovation will play an effective role in the twenty-first century. With technological design and innovation in social empirical and ethical applications, the country or countries will become a single technological center or multiple technological centers.

4.3. Barriers and Reasons for Exchange and Reception

The philosophy of technology was confronted with barriers for exchange and reception. Contrary to the

popular philosophy of science with the great past, the philosophy of technology has been ignored in academic and practice circles or even unknown to the common people. The following paragraphs discuss the major reasons for this disregard.

First, there are a number of internal barriers to the exchange and reception of the philosophy of technology. Although there has been gradual advancement, the philosophy of technology is still an undeveloped subject in many fields. For instance, in position, it was in the anthology philosophy named by Elisabeth Ströker (1983), fringe area stated by Joseph C. Pitt (1995), or marginal field called by Friedrich Rapp (1995). It still lacks a systematic theory, accepted theoretical framework, and structural system (Sheng 2008). The philosophy of technology has not essentially clarified the nature of technology and its social impacts. Still there exists a series of philosophical reflections on technology (e.g., technological ontology, epistemology, methodology, and axiology) that is unsettled and confusing. In some cases, the philosophy of technology stayed outside of the boundary of technology with indifferent or adverse postures. Sometimes it is unaware of the various methods to open the black box of technology or it opens the technological box with improper methods. For instance, with a colorful array of social actors, processes, and images, the technological box opened by the social constructivists is still remarkably hollow with neglected technological consequences, irrelevant social groups, disregarded technological origins from the society and culture, and moral and political indifference (Winner 1993). It is high time to de-marginalize the philosophy of technology since technology is the mainstream of philosophy for the human enterprise (Hansson 2012).

Second, besides the internal barriers, external obstacles also exist in the philosophy of technology. There are various viewpoints on the philosophy of technology, mainly from the perspectives of politics, economy, technology, education, philosophy, and culture. In the top level, the politicians view different political natures of the philosophy of technology, for instance, the aforementioned debate about materialism or idealism on automation and cybernetics in the Soviet Union. In the mid-level, the economists or technocrats measure economic or technological benefits from the pragmatic impetus of the philosophy of technology, such as technological revolution and technological innovation. In the bottom level, the educators, philosophers, and cultural communicators notice various values in disciplinary education, philosophical belief, and cultural custom respectively. Most of the times, these diverse views are in conflict with each other while sometimes they are in a compromising state. Systemic exchange and reception management have not yet been proposed as an agenda among the communities of philosophers of technology, technologists, engineers, technical users, and others. The advocacy to improve the critical reflections of technology in student education and public understanding of technological roles in the society will gain momentum, while the trend toward empirical-based and interdisciplinary research will expand and flourish within the philosophy of technology (Michelfelder 2010). This deep insight indicates the necessity and significance of education and propaganda for current extrinsic encumbrances.

4.4. Global Philosophy of Technology

This study proposes a global philosophy of technology with an intercultural technology program and an intercultural exchange and reception mode by endogenous and exogenous approaches. The global philosophy of technology is a global ideal on technology based on the prediction of Mitcham (2014), which states that the philosophy of technology would have a policy turn toward a philosophy of technological policy and a globalization trend to philosophically study the global issues on technology among various countries. An intercultural technology program eliminates the misunderstanding in the technological interaction, such as political and cultural divergences. The nature of intercultural technology is common and pure technology. An intercultural technology program uses an intercultural exchange and reception mode. The mechanism of intercultural exchange and reception of the philosophy of technology includes the approaches and processes of exchange and reception between the propagators and the recipients. The nature of the mechanism is analyzed taking into account the relationships of technology, nature, humans, and society in the process of exchange and reception in an intercultural mode, owing to the spatial theory and content diversity in the philosophy of technology. The intercultural exchange and reception of the philosophy of technology reflect and reveal the identification and reception of various values including sociology, culture, politics, and ethics.

In the endogenous approach, the philosophy of technology must advance from its undeveloped state to a mature status. The following advice potentially increases endogenous returns for the philosophy of technology.

a) With respect to leadership, the academic community centered at the society for philosophy and technology including the West and the East leads the developments of the philosophy of technology in the world. This study advocates the direction of development of the philosophy of technology toward professionalization and diversification in multi-disciplinary cooperation, especially encouraging philosophical-theoretical innovation and methodological application of technology in technological society.

b) With respect to journals, this paper recommends improving in impact factor ranking, open access publication, and research contents diversification dealing with global issues of technology. Wittkower, D. E. and coauthors (2013) also proposed to advance in peer-review, emphasize true open access publication, and increase to publicize and adapt traditional academic research. In terms of attitudes, this article advocates the philosophy of technology to transfer the indifferent or negative attitudes to concerned or positive stances with thoughtful analyses on technology.

c) With respect to the methods, the community of the philosophy of technology is proposed to establish an authoritative and acknowledged systematic theory system from the essential perspectives of philosophy and technology, including technological rules, codes, and roles. It is not limited to considerations only from the external perspectives of sociology, culture, history, theology, and psychology. The philosophy of technology plays a role in leading and monitoring the technological development. In terms of ontology, technology is a creative activity. In terms of epistemology, technology is an objective with structure and function. In terms of methodology, technology is created by design and changed by innovation. In terms of value, the social effect of technology is to serve social progress and benefit human liberation with technological effectiveness and efficiency.

d) Within the intercultural exchange and spread of technological revolution, this study proposes technological revolution to be centered with explorations of technological development rules and technological roles in the society. The explorations on technological revolution require connecting technological innovation and technological ethics with the technological forecast, assessment, and policy. This study recommends countries interested in the philosophy of technology to build their philosophy of technology with unique features and openness to contribute to the localization and diversification in the world. This article suggests that technological nations consider their cases for the developments of domestic technology and international engineering, such as technological innovation or technological transfer in specified technology.

In the exogenous approach, an intercultural exchange and spread system is suggested to be developed and implemented by nations and professional organizations to promote the cohesiveness of the philosophy of technology based on democratic and openness principles. The exchange and spread system for the philosophy of technology are recommended to bring exogenous progress from the major spheres as follows.

a. First, technological schools and engineers' teams are suggested to include technological education about the philosophy of technology as a common knowledge. Essential ideas including technological rules and social impacts, especially in technological design, innovation, and ethics, are suggested to be acknowledged as important knowledge for potential technical users, technologists and engineers as technical makers, and philosophers of technology as experts.

b. Second, technological schools and training organizations are recommended to institute training in technological design and innovation that address the methodologies of basic technological creation and advanced innovation for living and development of both present and future. People learn the ideals of sustainable design, creation, innovation, and basic usage, such as the safe design and usages of IT.

c. Third, a proper technical media structure is suggested to be constructed to publicize the philosophy of technology. The universal technology used for broadcasts, promotions, advertising, and exhibits, are recommended to be set up at the appropriate times, spaces, and projects for increasing the social impacts of technology. For example, professional websites easily and efficiently help to exchange and spread technological thoughts and its social roles. Projects funds for the philosophy of technology offer the channels to attract interests for transferring useful ideas into practical actions, such as speeches on technological ethics and privacy.

d. Fourth, a philosophy of technological policy is suggested to be set up with top-down leadership and assessment alongside bottom-up implementation and monitoring. It may consider relative values including engineering, ethics, and sociology in the connections with technological policy.

e. Fifth, the philosophy of technology is recommended to be exchanged and spread between the West and the East, including not only the spread of Western learning to the East, but also the introduction of Eastern culture to the West. The Eastern philosophy and culture have foundational influences on technology, which helps the Western understanding on the East.

5. Conclusions

In conclusion, by comparatively analyzing the major schools, this study has examined the international exchange and spread of the philosophy of technology. This article has argued the critical approaches, theories, research programs, and achievements in the scholar schools, the eastward spread of Western culture as the transfer process, and the technological revolution as an interesting practical topic. Furthermore, this paper has detected intrinsic and extrinsic obstacles and causes in the exchange and reception process. The borderless philosophy of technology has been exchanged and spread between the West and the East. The philosophy of technology has been rapidly spread, proving to be a powerful function in guiding and monitoring the technological development for social progress and human liberation. Based on the primary views and tactics, this study purposes to establish a global philosophy of technology for developing the international communication and dialog and encourage further exchanges as well as enhance learning. Therefore, it intensifies the internationalization process as a whole to enhance the philosophy of technology toward a discipline from a bright future to a great reality. Theoretically, it enriches the insight of the international development of the philosophy of technology and promotes its exchange process between the West and the East. Practically, it provides references for governmental and educational departments to draft policies on the philosophy of technology and technology.

Bibliography

Published Sources

Achterhuis, Hans, ed. *American Philosophy of Technology: The Empirical Turn*. Bloomington and Indianapolis: Indiana University Press, 2001.

Bailes, Kendall E. "The Politics of Technology: Stalin and Technocratic Thinking Among Soviet Engineers." *The American Historical Review* 79, no. 2 (1974): 445–69.

Brey, Philip. "Anticipating Ethical Issues in Emerging IT." *Ethics and Information Technology* 14, no. 4 (2012): 305–17.

Brey, Philip. "Philosophy of Technology after the Empirical Turn." *Techné: Research in Philosophy and Technology* 14, no. 1 (2010): 36–48.

Brey, Philip. "Technology and Everything of Value." *University of Twente Inaugural Speech Series*, (2008): 1–44.

Cao, Guihong. "Comparison of China-US Engineering Ethics Educations in Sino-Western Philosophies of Technology." *Science and Engineering Ethics*, (2014): 1–27. DOI: 10.1007/s11948-014-9611-3.

Cao, Guihong. "Science-Technology Relationships in Sino-Western Philosophies of Technology: Hints for Innovation, Competitiveness, and Policy." *GSTF Journal of General Philosophy (JPhilo)* 2, no. 1 (2015): 10–26. DOI: 10.5176/2345-7856_2.1.24.

Carpenter, Stanley R. "Developments in the Philosophy of Technology in America." *Technology and Culture* 19, no. 1 (1978): 93–9.

Chen, Changshu. *Chen Changshu Collected Works on the Philosophy of Technology*. Shenyang: Northeastern University Press, 2002.

Chen, Changshu. *Introduction to the Philosophy of Technology*. Beijing: Science Press, 1999.

Chen, Changshu. "Maintain the Vitality of the Philosophy of Technology." *Science, Technology and Dialectics* 18, no. 3 (2001): 43–5.

Chen, Changshu, and Deyu Yuan. "Rethinking of the Research Program of Philosophy of Technology——Discussion with Prof. Zhang Hua-xia & Prof. Zhang Zhi-lin." *Studies in Dialectics of Nature* 17, no. 7 (2001): 39–42.

Chen, Fan, and Jia Chen. "Retrospect and Expectation on Contemporary Philosophy of Technology in China." *Studies in Dialectics of Nature* 25, no. 10 (2009): 56–62.

Dessauer, Friedrich. *Philosophie der Technik: Das Problem der Realisierung* [*Philosophy of Technology: The Problem of its Realization*]. Bonn: Friedrich Cohen, 1927.

Dessauer, Friedrich. *Streit um die Technik*. Frankfurt am Main: Verlag Josef Knecht, 1956.

Diemer, Alwin, ed. *16th World Congress of Philosophy 1978*. Düsseldorf: Congress Organisation, 1983.

Editorial. "Technology Trap." *Nature* 448, (2007): 840.

Ellul, Jacques. "The Technological Order." *Technology and Culture* 3, no. 4 (1962): 394–421.

Ellul, Jacques. *The Technological Society*. New York: Vintage books, 1964.

Ellul, Jacques. *The Technological System*. New York: Continuum, 1980.

Engelmeyer, P. K. *Философиятехники 4: Техницизм*, [*Philosophy of Technology, Vol. 4: Technicism*], Moscow, 1913.

Feenberg, Andrew. *Transforming Technology: A Critical Theory Revisited*. Oxford University Press, 2002.

Goffi, Jean-Yves. *La Philosophie de la Technique*. Paris: Presses Universitaires de France, 1988.

Guan, Xiaogang. "Essence of Technology". *Studies in Dialectics of Nature* 17, no. 12 (2001): 18–22.
Hansson, Sven Ove. "De-Marginalizing the Philosophy of Technology." *Techné: Research in Philosophy and Technology* 16, no. 2 (2012): 89–93.
Hansson, Sven Ove. "Technology and the Notion of Sustainability." *Technology in Society* 32, no. 4 (2010): 274–9.
Hansson, Sven Ove. "What is Technological Knowledge?" In Inga-Britt Skogh and Marc J. de Vries (eds), *Technology Teachers as Researchers*, 17–31. Rotterdam, The Netherlands: Sense Publishers, 2013.
Hansson, Sven Ove. "What is Technological Science?" *Studies in History and Philosophy of Science Part A* 38, no. 3 (2007): 523–7.
He, Chuanqi. *Strategic Opportunities on the Sixth Revolution of Science and Technology*. Beijing: Science Press, 2012.
Heidegger, Martin. *Sein und Zeit* [*Being and Time*]. Tübingen: Niemeyer, 1927.
Heidegger, Martin. *Die frage nach der technik* [*The question concerning technology*]. Vorträge und Aufsätze, (1954): 13–44.
Hickman, Larry A. *John Dewey's Pragmatic Technology*. Indianapolis: Indiana University Press, 1990.
Ihde, Don. *Postphenomenology: Essays in the Postmodern Context*. Evanston, Ill: Northwestern University Press, 1993.
Ihde, Don. "Triumph and Dismal Failure." *Nature* 442, no. 7106 (2006): 984–5.
Ihde, Don, and Evan Selinger. *Chasing Technoscience: Matrix for Materiality*. Indiana University Press, 2003.
Jiang, Zhenhuan. "German Philosophy of Technology and Japanese Technological Theory." *Studies on Dialectics of Nature*, no. 4 (1986): 49–54.
Kapp, Ernst. *Grundlinien einer Philosophie der Technik: Zur Entstehungsgeschichte der Cultur aus neuen Gesichtspunkten* [*Fundamentals of a Philosophy of Technology: The Genesis of Culture from a New Perspective*]. (Braunschweig/Brunswick 1877, Reprint Düsseldorf 1978, Engl. Translation Chicago, 1978), 1877.
Kroes, Peter. "Design Methodology and the Nature of Technical Artefacts." *Design Studies* 23, no. 3 (2002): 287–302.
Kroes, Peter. *Technical Artefacts: Creations of Mind and Matter: A Philosophy of Engineering Design*, vol. 6. New York: Springer, 2012.
Kroes, Peter, and Anthonie Meijers. "The Dual Nature of Technical Artifacts: Presentation of a New Research Programme." *Techné: Research in Philosophy and Technology* 6, no. 2 (2002): 4–8.
Kroes, Peter, and Anthonie Meijers. *The Empirical Turn in the Philosophy of Technology*, vol. 20. Amsterdam: JAI, 2000.
Lafitte, Jacques. *Réflexions sur la Science des Machines* [*Reflections on the Science of Machines*]. Paris: Bloud et Gay, 1932. Reprinted with a new introduction by Jacques Guillerme. Paris: J. Vrin, 1972.
Li, Bocong. "The Rise of Philosophy of Engineering in the East and the West." In: Van de Poel, I., & Goldberg, D. E. (Eds.). *Philosophy and Engineering: An Emerging Agenda* (Vol. 2), (pp. 31–40). Dordrecht: Springer. Springer Science & Business Media, 2010.
Li, Yaqing, and Ga Jia. "The Hundred Years Development of Technology Philosophy." *Scientific Management Research* 25, no. 4 (2007): 32–5.
Linstone, Harold Adrian. "Three Eras of Technology Foresight." *Technovation* 31, no. 2 (2011): 69–76.
Ma, Huiduan. *Pragmatic Analytical Philosophy of Technology*. Shenyang: Northeastern University Press, 2006.
Marx, Karl. *Capital*. New York, N. Y. : Modern Library, 1906.
Marx, Karl, and Fredrick Engels. *The Economic and Philosophic Manuscripts of 1844 and the Communist Manifesto*. Buffalo, NY: Prometheus Books, 1988.
Medina, Manuel, and José Sanmartín. "A New Role for Philosophy and Technology Studies in Spain." *Technology in Society* 11, no. 4 (1989): 447–55.
Michelfelder, Diane P. "The Philosophy of Technology When 'Things Ain't What They Used to Be'." *Techné: Research in Philosophy and Technology* 14, no. 1 (2010): 60–8.
Mitcham, Carl. "Crouching Predictions, Hidden Hopes: The Past and the Future of Philosophy of Technology". *Journal of Engineering Studies* 6, no. 2 (2014): 119−24. Translated by Wang Nan.
Mitcham, Carl. "Philosophy of Technology." In Durbin, P. T. (ed.). *A Guide to the Culture of Science, Technology, and Medicine*, 282–363. New York: Free Press, 1980.
Mitcham, Carl. *Thinking through Technology: The Path between Engineering and Philosophy*. Chicago: University of Chicago Press, 1994.
Moon, Suzanne. *Technology and Ethical Idealism: A History of Development in the Netherlands East Indies* (No. 156). Leiden: CNWS Publications, 2007.

Mumford, Lewis. *Technics and Civilization*. New York: Harcourt Brace, 1934.
Mumford, Lewis. *Technics and Human Development*. Vol. 1 of *The Myth of the Machine*. New York: Harcourt, Brace & World, 1967.
Mumford, Lewis. *The Pentagon of Power*. Vol. 2 of *The Myth of the Machine*. New York: Harcourt, Brace & World, 1970.
Needham, Joseph. *Science and Civilisation in China: Volume 2, History of Scientific Thought*. Cambridge: Cambridge University Press, 1956.
Nye, David E. *Technology Matters: Questions to Live With*. Cambridge, MA: MIT Press, 2006.
Ogburn, William Fielding. *Social Change with Respect to Culture and Original Nature*. New York: B. W. Huebsch, Incorporated, 1922.
Palm, Elin, and Sven Ove Hansson. "The Case for Ethical Technology Assessment (eTA)." *Technological Forecasting and Social Change* 73, no. 5 (2006): 543–58.
Pitt, Joseph C. "On the Philosophy of Technology, Past and Future." *Techné: Research in Philosophy and Technology* 1, no. 1 (1995): 18–22.
Qian, Xuesen. "The Method Issues of Technological Sciences." *Newsletter of Dialectics of Nature*, no. 1 (1957): 34.
Rapp, Friedrich. *Analytische Technikphilosophie*, Freiburg i. Br. / München, Alber 1978 ISBN 3-495-47385-8, engl 1980, span 1981, chin. 1986.
Rapp, Friedrich. *Contributions to a Philosophy of Technology. Studies in the Structure of Thinking in the Technological Sciences*. Dordrecht: Reidel, 1974.
Rapp, Friedrich. "Philosophy of Technology after Twenty Years: A German Perspective." *Techné: Research in Philosophy and Technology* 1, no. 1 (1995): 71–3.
Sheng, Guorong. "Overview the Research Path and Its Evolvement in the Philosophy of Technology in the Occident." *Journal of Dialectics of Nature* 30, no. 5 (2008): 38–43.
Sheng Guorong, and Zhongzhe Jin. The "Anthropomorphic Rule" Phenomenon of the Technological Development ——A Vision of the Philosophy of Technology. *Science & Technology Progress and Policy* 24, no. 4 (2007): 172–76.
Simondon, Gilbert. *Du Mode d'existence des Objects Techniques* [*On the Mode of Existence of Technical Objects*]. Paris: Aubier, 1958.
Steen, Marc. "Upon Opening the Black Box and Finding It Full Exploring the Ethics in Design Practices." *Science, Technology & Human Values* (2014): 1–32. DOI: 10.1177/0162243914547645.
Stiegler, Bernard. *La Technique et le temps: La faute d'Epiméthée* (Vol. 1). Paris, Galilée/Cité des sciences et de l'industrie, 1994.
[Stiegler, Bernard. *Technics and Time: The Fault of Epimetheus* (Vol. 1). Stanford, CA: Stanford University Press, 1998. English version.]
Ströker, Elisabeth. "Philosophy of Technology: Problems of a Philosophical Discipline." In Durbin, Paul T., and Friedrich Rapp, (Eds.), *Philosophy and Technology* (pp. 323–336). Dordrecht: Reidel, 1983.
Tian, Pengying. *Philosophy of Social Technology*. Beijing: People's Publishing House, 2005.
Van den Hoven, Jeroen, Gert-Jan Lokhorst, and Ibo Van de Poel. "Engineering and the Problem of Moral Overload." *Science and Engineering Ethics* 18, no. 1 (2012): 143–55.
Verbeek, Peter-Paul. "Materializing morality design ethics and technological mediation." *Science, Technology & Human Values* 31, no. 3 (2006): 361–80.
Verbeek, Peter-Paul. *Moralizing Technology: Understanding and Designing the Morality of Things*. Chicago and London: University of Chicago Press, 2011.
Verbeek, Peter-Paul. *What Things Do: Philosophical Reflections on Technology, Agency, and Design*. Penn State: Penn State University Press, 2005.
Vermaas, Pieter E., Kroes, Peter, Light, Andrew, and Moore, Steven A. *Philosophy and Design: From Engineering to Architecture*. New York: Springer, 2008.
Wang, Qian. *Between Dao and Technique: Philosophy of Technology against the Background of Chinese Culture*. Beijing: People Press, 2009.
Winner, Langdon. *Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought*. Cambridge, Mass: MIT Press, 1977.
Winner, Langdon. "Do Artifacts Have Politics?" *Daedalus* 109, no. 1 (1980): 121–36.
Winner, Langdon. *The Whale and the Reactor: A Search for Limits in an Age of High Technology*. Chicago: University of Chicago Press, 1986.
Winner, Langdon. "Upon Opening the Black Box and Finding it Empty: Social Constructivism and the Philosophy of

Technology." *Science, Technology, & Human Values* 18, no. 3 (1993): 362–78.
Wittkower, D. E., Evan Selinger, and Lucinda Rush. "Public Philosophy of Technology". *Techné: Research in Philosophy and Technology* 17, no 2 (2013): 179–200.
Wu, Guosheng. "The Philosophy of Technology: A Discipline with a Great Future." *China Reading*, no. 11 (1999): 17.
Yuan, Deyu. *Technology in the Vision of the Process Theory*. Shenyang: Northeastern University Press, 2008.
Zhang, Huaxia, and Zhilin Zhang. "The Research Program of Philosophy of Technology from the Point of View of Demarcation between Science & Technology." *Studies in Dialectics of Nature* 17, no. 2 (2001): 31–6.
Zhang, Tingguo. "'Tao' and 'Logos': The Possibility of Dialogue between Chinese Philosophy and Western Philosophy." *Social Science in China*, no. 1 (2004): 124–8.
Zschimmer, Eberhard. *Philosophie der Technik* [*Philosophy of Technology*]. Berlin: E. S. Mittler, 1913.