The Research-Education Nexus of the Philosophy of Technology: A Research-Education-Industry Roadmap for De-marginalization of the Field

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Abstract

For the philosophy of technology to achieve a bright future, it is necessary to de-marginalize and advance the related research and education. Using qualitative text mining, online surveys, observational studies, discussions and communications, comparison and contrast for research and pedagogy, this paper analyzes the similarities and differences, relationships, and interactions between research and education on this field. As a result, similarities and dissimilarities vary in the research and education on the philosophy of technology. This article initiates an original framework for the interaction of research and education on the philosophy of technology. This paper argues for a sustainable research-education-industry roadmap to de-marginalize and advance the philosophy of technology. Furthermore, this paper proposes three workable approaches of research-led, education-oriented, and application-transformation for endogenous and exogenous growths. Finally, this article advocates shifting the philosophy of technology from the anti-technology tradition to a pro-technology direction by learning by design.

Keywords: Philosophy of technology; Research-education nexus Research-education-industry; De-marginalization; Anti-technology; Pro-technology

1. Introduction

What is the nexus or relationship between the research and education on the philosophy of technology? Where is it located in the higher education? How can the philosophy of technology move ahead in the knowledge society? These are the issues that I attempt to address in this study. The journey of this research starts with an overview of the history of the field of the philosophy of technology.

The philosophy of technology emerged in 1877, when the German philosopher and geographer Ernst Kapp (1877) published *Grundlinien einer Philosophie der Technik*(*Fundamentals of a Philosophy of Technology*) in 1877. Kapp, as the founder of the philosophy of technology, argued that technologies are projections of human organs from the philosophical perspective. For example, axes are the extensions of human hands, and hammers are the expansions of human fists. The materialistic view of technology was influenced by the ideals of Benjamin Franklin's invention and politics (Chaplin, 2006) and Karl Marx's historical materialism (Marx and Engels, 1988). As evident from my current observation research, the philosophy of technology was a result of research stemming from the publication of Kapp's work in 1877 (Kapp, 1877). The philosophy of technology is dedicated to studying the nature of technology and its social impacts in a philosophical field.

As the active background in the United States (US) in 1976 and 1977, a prior planning strategy was implemented including following activities: (a) the establishment of a group newsletter edited by the American philosophy professor Paul T. Durbin; (b) the formalization of a publishing arrangement for an annual series of research papers in the philosophy of technology, also edited by Durbin; (c) the establishment of annual symposia for the philosophy of technology; and (d) the creation of a possible Society for the Study of Philosophy of Technology (Carpenter, 1978). The Society for Philosophy and Technology (SPT) was founded in 1976. The philosophy of technology began the first institutionalization in the US in 1978, with the first society publication of *Research in Philosophy & Technology*, after the confirmation of the field as a new and important philosophical subject at the 16th International Congress of Philosophy in 1978 (Diemer, 1983). Annual book series research in the philosophy of technology was launched in 1978, and*Techné:Research in Philosophy and Technology*, as the official journal of SPT, was firstly published with Durbin as editor in 1995 (http://www.spt.org/).

The philosophy of technology spread to China following the establishment of the People's Republic of China in 1949. The discipline of the philosophy of technology was founded in China in 1982. The field made the second institutionalization in China in 1985 under the auspices of Marxist historical materialism and the dialectics of nature. Two marked events in the field's institutionalization were the First China Technology Theory Symposium at the Chengdu University of Science and Technology, and the Technology Theory Professional Association in this symposium in November 1985 created by the Chinese Society for Dialectics of Nature/Philosophy of Nature, Science and Technology (Chen and Chen, 2009). The related community is the Chinese Society for Philosophy of Technology (CSPT). The *Journal of Dialectics of Nature* was the first journal of Dialectics of Nature in China. The research on the philosophy of technology has made great progress over its nearly one hundred and forty-year history since its emergence in 1877.

In the realm of education, the philosophy of technology has been established as a sub-discipline of philosophy in the US, Canada, the Netherlands, Sweden, China, and others countries. The philosophy of science and the philosophy of technology are both sub-disciplines of philosophy. The US and Canada have begun a few online courses in subjects such as technology and culture, and technology and ethics. The philosophy of technology in the Netherlands has formed academic-education-production collaborative networks in the Three Dutch Technical Universities (3TU): Delft University of Technology, Eindhoven University of Technology, and University of Twente. The 3TU has provided joint study options in five masters of science programs and twenty doctorates of engineering programs. In the research realm,the3TU has established several research centers, covering applied mathematics; integrated design; the built environment; engineering education; ethics and technology; high-tech systems; fluid and solid mechanics; and research on information and communications technology (ICT) (http://www.3tu.nl/en). In China, the field of the philosophy of technology with the characteristics of Marxist philosophy, as a newly emerging subject, has been making great strides in disciplinary norms and vitalities, compared with the more mature field of the philosophy of science (Chen and Cheng, 2014).

Although research and education in the philosophy of technology have made aforementioned achievements, both are in the continuous development. The research on the philosophy of technology, however, is still in the probing stages of onward progress. Lacking a systematic theory system, an acknowledged theoretical framework and structure system, the philosophy of technology is still in the immature status, undergoing an anthology philosophy stated by Elisabeth Ströker (1983), a fringe field called by Joseph C. Pitt (1995), and a marginal field according to Friedrich Rapp (1995), even given its steady advances (Sheng, 2008). The education in the philosophy of technology also is still in the discussing stages of progressional development. These pertinent critics raise the sense of crisis for reflection. Nonetheless, the philosophy of technology is a subject with a great future (Wu, 1999). Systemic pedagogy with classical textbooks is still in the development stages. After significant developments of technical turn (Feenberg, 1995) and empirical turn (Kroes and Meijers, 2000), Brey (2010) instructed three approaches in contemporary philosophy of technology: a society-oriented approach, an engineering-oriented approach, and an applied technology ethics approach. These instructions are mainly for further theory and application from the perspective of academic research. As declared by Hansson (2012), it is the high time to de-marginalize the philosophy of technology for technology as the mainstream of philosophy in human enterprise. This gap between a poor *status quo* and an optimistic far-sighted vision of the philosophy of technology urges action for de-marginalization and enhancement of the field, which is the issue to be addressed in this study.

The key is how to de-marginalize and advance the philosophy of technology in the methods and strategies. This path of study considers investigating the current state of research and education in this field to identify their nexus and find solutions to address this gap. Many studies have contributed to the link between research and teaching, such as in research methods (Neumann, 1996) and the features of the relationship between research and teaching (Neumann, 1996; Smeby, 1998). Individuals have both positive and negative views on the existing literature on the research-teaching nexus (Neumann, 1996). The evidence is inconclusive, and many studies on the research-teaching nexus have suffered from an incomplete conceptualization (Neumann, 1996). Feldman (1987) found only small positive but statistically insignificant associations between academic performance and teaching proficiency. Feldman's analysis drew the extremely tentative conclusion that such positive links were more likely to occur and to be stronger in the humanities and social sciences than in the natural sciences (Neumann, 1996).

As conducted in a nationwide survey of economics faculty in the US in 1992 (Noser et al., 1996), findings indicate a weak research-teaching nexus with a statistically significant but marginal positive relationship at an undergraduate level, and mixed or conflicting results at a graduate level. Moreover, faculty opinions on the relationship between research and teaching seem to be affected by institutional and individual characteristics. As two approaches for research on teaching, *describing* resembles that of the anthropologist studying cultures neutrally, whereas *improving* seems that of the inventor working on a better way to meet a practical need (Gage and Unruh, 1967). This paper, therefore, recommends using both *describing* in philosophical reflections on technology and *improving* for the technological impacts on society. In terms of research-education nexus, few studies specify for some popular subjects, such as economics (Noser et al., 1996) and nurse (Lopes et al., 2014). However, it is a blank for the philosophy of technology, which is worth exploring this interesting and important issue for the development of the philosophy of technology. This project aims to investigate the relationship between research and education on the philosophy of technology. Based on these investigations, this article tries to find a feasible roadmap to de-marginalize and enhance the philosophy of technology both in research and education. From a practical perspective, this study enriches the theories between research and education specifically in the fresh field of the philosophy of technology.

2. Theoretical Framework, Materials, and Methods

The following section shows the sub-questions, theoretical framework, materials and methods in this study.

2.1. Questions and Theoretical Framework

Sub-questions in this research are as follows to move progressively:
(i) What are the similarities and discrepancies between the research and education on the philosophy of technology as a foundation of comparison and contrast to pave theway for their nexus?
(ii) What is the nexus or relationship between the research and education in the field in terms of time, space, and content?
(iii) How do the research and education interact with each other, based on their similarities, discrepancies, and relationship?
(iv) How can the philosophy of technology proceed with a roadmap for the future, based on the research and education?
The performance framework of the relationship of the research and education on the philosophy of technology may be linked as being either parallel or intersecting. This framework is based on the assumption of either separation or unity between the research and education on the philosophy of technology.

2.2.Materials

The materials on the philosophy of technology are mainly collected with the keyword of the philosophy of technology in English or Chinese from the Publish or Perish software, library databases, and professional websites. The basic situations of the research and education in the current higher education on the philosophy of technology are briefly presented with junior and senior levels of research, the learning and teaching of education on the philosophy of technology (Table 1). Taking the available materials in English and Chinese into account, this paper compares and contrasts the research and education on the philosophy of technology in the major English-speaking countries of the West and Chinese-speaking China. China has been making great contributions to the development of the philosophy of technology in the research and education spheres with other countries in the West, including Germany, France, the US, Canada, the Netherlands, and Sweden. Typical representatives are extracted and listed for the research and education on the philosophy of technology in West and China to investigate the nexus between the research and education on the philosophy of technology (Tables 2, 3, 4).

2.3. Methods

We may use a variety of approaches to examine the linkage between teaching and research. Three common approaches are: (A) personal commentaries and analyses; (B) correlations of measures of teaching effectiveness, measured by a combination of student evaluations and research productivity, based predominantly on publication counts; and (C) surveys on academics of their work preferences, time spent on teaching and research activities, and their perceptions of academic rewards (Neumann, 1996). Biddle (1964) offered a seven-variable model to investigate teacher effectiveness, including (a) formative experiences, (b) teacher properties, c) teacher behaviors, (d) immediate effects, (e) long-term consequences, serving as main sequence variables; (f) classroom situations, and (g) school and community contexts serving as contextual variables. The front five variables form a causally linked chain, while the last two contextual variables offer the situations and environments that embed and interact with the variables thus linked (Gage and Unruh, 1967). Biddle's model falls into the category of criterion-of-effectiveness paradigms (Doyle, 1977; Gage, 1963). As found by university faculty in survey data and interviews (Smeby, 1998), among bidirectional positive correlations, research is more important for teaching than vice versa. The interactive characteristics vary between teaching at various levels and between disciplines. The interaction is usually stronger at a graduate level than at an undergraduate level. At the undergraduate level, the relationship is stronger in the humanities and the social sciences than in other fields of learning, whereas there are no such differences at a graduate level.

Based on the above methods underpinned by the interactive theory between research in the senior levels and teaching and the fact of junior and senior levels of research and the learning and teaching of education, this paper specifies to examine the nexus between research and education on the philosophy of technology. Two approaches are (A) personal commentaries and analyses; and (B) the correlations of measures for the productivity of junior research and senior research, the effectiveness of learning and teaching. These evaluations have quantitative and qualitative criteria. The learning measurements include quantitative learning times, test grades, and qualitative examination levels for undergraduate, master, Ph.D., and postdoctoral students. The teaching evaluations contain quantitative teaching periods, numbers of students taught, test scores, and qualitative professional teaching positions for lecturers, assistant professors, associate professors, and professors. The productivities of junior research are measured by quantitative numbers of master and Ph.D. dissertations, and the qualitative quality of published essays under supervisions or peer reviews. The productivities of senior research are assessed by quantitative quantities of papers and books published; project funding amounts; and the impact factors of published journals, citations of publications, academic indexes, and the qualitative impacts of scholarly communities in the philosophy of technology. *H-index* is used to quantitatively measure the productivity and influences of the published works of an individual scholar or a group of scholars in the research. A scholar has index h if the scholar's Np papers have at least h citations each and other (Np − h) papers have no more than h citations each (Hirsch, 2005).

Diverse methods are applied to study the relationship and mutual affection between the research and education on the philosophy of technology. There are basic summaries and inductions between the research and education on the philosophy of technology. Moreover, in-depth text mining is used to qualitatively analyze their similarities and discrepancies by comparison and contrast with the corresponding explanations. Typical representatives of the research and education on the philosophy of technology in the West and China are retrieved with the phrase "the philosophy of technology" (in English or Chinese) for the cites in Publish or Perish software. Through online surveys, the research and education retrievals come from university websites, research organization web pages, and other professional sites. My observational studies include experiences on studying and researching in China and the West. I also discuss and communicate with others who study, teach, or research in the philosophy of technology. These online surveys, observational studies, discussions, and communications on the research and education drive to closely find their interactions. This paper employs comparison and contrast through the space-time distribution of the philosophy of technology in the research and education to intensify the width and depth of these studies.

3.Results

This paper will analyze and discussthe similarities and dissimilarities, relationship and interaction between research and education within the philosophy of technology as follows.

3.1.The Similarities between Research and Education on the Philosophy of Technology

There are many resemblances linking research and education on the philosophy of technology (Table 1). The most important linkage is that the original and central target of both activities is the philosophy of technology. In the philosophy of technology, the research sector utilizes the basic textbooks of education (e.g., Chen, 1999; Mitcham, 1994) as the literature review. The education sector takes advantage of research theories, such as the aforementioned organ projections of Kapp(1877), and the existentialism and phenomenology of Heidegger (1954/2010). Both are similar majorly in the content and method used.

For the content, both research and education involve the *ontology*, *epistemology*, *methodology*, and *axiology* of the philosophy of technology.

a. In the *ontology*, both explore technological definition and technological nature. For instance, Mitcham (1994) classically defined technology as object, knowledge, activity, and volition, and divided the philosophy of technology into engineering and humanities branches. Many follow him in using these definitions and exploration in education courses (e.g., in China) and literature review of research (e.g., Sheng, 2008) in the philosophy of technology.
b. In the *epistemology*, both research and education discuss technological characteristics: the relationship among science, technology, and engineering. Chen (1999) advocated the differences, mediums, and interactions between technology and science for the education. Li (2002) specified engineering among science, technology, and engineering, and recommended the philosophy of engineering for the education and research. For philosophical reflections and educational consequences, de Vries (2003, 2005a) emphasized the nature of technological knowledge (functional nature knowledge, physical nature knowledge, knowledge of the relationship between physical and functional nature, and process knowledge), which differs from scientific knowledge. Hansson (2007) presented technological science to differentiate technology from science in the research.
c. In the *methodology*, both involve technological invention and creation, and design and development. Chen (1999) stressed producing the technical field of an artificial nature by making, processing, controlling, and protection for the education. Kroes (2002, 2012) and others (e.g., Vermaas et al., 2008) underlined creating technical artifacts by design in the research.
d. In the *axiology*, both investigate technological influences on society, typically reflected in “science, technology, and society” (STS) studies. Chen (1999) discussed the dual influences of technological optimism and pessimism on society and the constraints of society on technology for the education. Hansson argued fortechnological risk (Hansson, 2004), technological sustainability (Hansson, 2010), and technological ethics (Palm and Hansson, 2006) in the research. In the research, Cao (2014) proposed professional engineering ethics education to reform engineering social responsibility. Moreover, Cao (2015a) recommends dynamical technological determinism that technological development determines social changes with design and innovation approaches, and effectiveness and efficiency principles.

For the method, both research and education focus on knowledge dissemination of the philosophy of technology. Chen (2002) raised thirty-five questions on the fundamental studies of the philosophy of technology, which were related to six aspects. These six aspects were: 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. Hansson (2013) explored four types of technological knowledge (tacit knowledge, practical knowledge, technological science, and applied science) for technology teachers as researchers. In the literature, both research and education sectors use many popular books (e.g.,Chen, 1999; Heidegger,1954/2010; Mitcham, 1994) and papers (e.g., Chen and Chen, 2009; Hansson, 2007) on the philosophy of technology. In the performance sector, both sides usually use the analyses of materials and texts, comparison and contrast, examples, and discussions.

3.2.The Differences between Research and Education on the Philosophy of Technology

There are also discrepancies to distinguish between research and education on the philosophy of technology from the top status and goal, to the middle content and method, finally to the bottom achievement and assessment (Table 1).

In the status, the research on the philosophy of technology has undergone the institutionalizations in the US and China with different organizations, journals, disciplinary establishment, and websites as mentioned previously. The education on the philosophy of technology has been established as the sub-discipline of philosophy in the US, Canada, the Netherlands, China, and other nations, paralleling the education on the philosophy of science. As an activity, the research on the philosophy of technology is composed of junior and senior levels. The education on the philosophy of technology consists of learning and teaching. Then, the corresponding goal is different as follows. In general, junior research is primary or advanced research on knowledge of the philosophy of technology.

However, senior research usually is profound or innovative thinking on the philosophy of technology (e.g., Chen, 1999; Ellul, 1980;Kapp, 1877; Mitcham, 1994). Nevertheless, excellent original and innovative works sometimes come from the junior research, especially in the doctoral or postdoctoral stages (e.g., Marx, 1841; Winner, 1977). This article analyzes that this kind of excellent junior research may benefit from the newest knowledge absorption and creative innovation. However, some senior research might become rigid due to path dependence, such as old knowledge inflexibility and fixed thinking habits. It, therefore, may be better to cooperate between junior research and senior research to learn from each other for knowledge progress. Learning is to study the fundamental knowledge of the philosophy of technology, whereas teaching is to instruct basic knowledge of the philosophy of technology.

In the object and position, postgraduates and dependent researchers regularly conduct the junior research, including master, Ph.D., postdoctoral students, and young dependent researchers. Supervisors and independent researchers typically implement the senior research, containing assistant professors, associate professors, professors, and senior independent researchers. The students include undergraduate, master, Ph.D., and postdoctoral students. The instructor roles include lecturers, assistant professors, associate professors, and professors. In the model, junior researchers mainly are dependent or coauthors. They complete master or doctoral theses or projects in a short time in schools. Senior researchers may be independent scholars, single authors, or coauthors. They continue to research for a long time in academic communities and organizations (e.g., SPT, CSPT). In general, students learn and finish the courses in classrooms and campuses in a short period, while teachers repeatedly teach or continue new programs of schools and universities over a comparatively long period.

Even when content and methodology converge, there are divergences as follows.

a. In the *ontology*, the research includes technological order (Ellul, 1962), technological autonomy (e.g., Ellul, 1964; Winner, 1977), technological system (Ellul, 1980), and the dual nature of technology with physical structure and social function (Kroes, 2002; Kroes and Meijers, 2002). The education specifies basic technological concepts and terms, and technological knowledge (e.g., Hansson, 2013).
b. In the *epistemology*, the research usually studies novel trends, such as technological science differs from natural sciences in terms of different characteristics (Hansson, 2007), or science-technology relationships framework and implications (Cao, 2015b). The education discusses general and traditional thoughts; for instance, technology as applied science, and the historical schools of the philosophy of technology.
c. In the *methodology*, the research emphasizes technological invention, innovation, and design (e. g., Kroes, 2002, 2012). The education underlines technological production and development (e. g., Chen, 1999).
d. In the *axiology*, the research probes technocracy and liberalism (e.g., Winner, 1977), technical politics (e.g., Winner, 1977, 1980, 1986), the decisive social impact of technology (e.g., Ellul, 1964, 1990; Winner, 1977), technological responsibility (e.g., Ma, 2006), engineering ethics (e.g., Van den Hoven et al., 2012; Zhu, 2010), and technological ethics (e.g., Cao, 2013; Brey, 2012). The education involves general technology and ethics, engineering and ethics (e.g., Li, 2008), and technology and culture (e.g., Wang, 2009). Here, these differences point more to the trends in the research or education for comparison, although some topics or works are collaborative in both research and education, such as engineering ethics, technology, and culture.

In terms of methodology, junior researchers diffuse the classical or latest knowledge of the philosophy of technology, whereas senior researchers spread deep or innovative knowledge. Students absorb and deliver old knowledge, while teachers spread existing knowledge. In the literature, junior researchers use more classical books and fewer peer review papers, while senior researchers take advantage of more peer review papers and fewer classical books. Students read more basic books and fewer papers, whereas teachers read more classical books and fewer papers.

In terms of performance, the research side adopts textual analyses, observational studies, online surveys, survey research, questionnaires, interviews, comparison and contrast studies, case studies, presentations in conferences, and workshops. The education aspect usually employs material analyses, class education, comparison and contrast studies, case studies, lectures and speeches, and seminars and group discussions.

In terms of achievement, junior researchers write master or Ph.D. dissertations, and publish essays on the related issues of the philosophy of technology for graduation. Senior researchers make contributions to papers or book publications, and work on national or international projects. Students learn courses and obtain credits, while teachers teach courses and release credits.

In terms of evaluation, both research and education evaluate the input and output of the philosophy of technology but with different means. Supervisors or peer reviewers usually assess junior researchers in the input of reliable knowledge and the output of innovative knowledge of the philosophy of technology. Peer reviewers or academic organizations evaluate senior researchers primarily in the export of original knowledge of the philosophy of technology. In general, students absorb more and relatively less produce proper understanding knowledge in some topics, while teachers accumulate and deliver right knowledge in the philosophy of technology. Quantitatively, supervisors or peer reviewers assess junior researchers in their master or Ph.D. dissertations, the quantity of published essays, and impact factors of publication journals. Peer reviewers or academic organizations evaluate senior researchers in the quantity of their paper or book publications, project funding amounts, impact factors of publication journals, the number of citations of their publications, and their academic performance index. Teachers assess students in the time that they learn, and test them with abilities and grades; educational leaders or university organizations check teachers in teaching periods, students' scales, examination scores, and the evaluations from students. Qualitatively, supervisors or peer reviewers assess junior researchers from supervisions or peer reviews, whereas peer reviewers or academic organizations inspect senior researchers from the peer reviews or reputations of academic communities. Teachers examine students in corresponding learning levels, whereas educational leaders or school organizations investigate teachers in professional teaching.

3.3. The Relationship between Research and Education on the Philosophy of Technology

Chronologically speaking, the research on the philosophy of technology emerged with Kapp in 1877. First, philosophers, engineers, and technologists do research. Based upon that research, educators bring the education of the philosophy of technology to the world. In China, the philosophy of science and technology was renamed from the dialectics of nature in 1990. The research group on the dialectics of nature was established in the Institute of Philosophy of the Chinese Academy of Sciences in June 1956. Then, the *Journal of Dialectics of Nature* was created in October 1956 (Chen and Chen, 2009). Later, the teaching and research organizations were set up in Chinese universities including Peking University, Renmin University of China, and Northeastern University. By the end of 2008, there were twenty-seven doctoral and over one hundred master programs of the philosophy of science and technology, and over twenty doctoral and master programs in the philosophy of technology. Also, China had trained over one hundred Ph.D. and several hundred master students in the philosophy of technology (Chen and Chen, 2009). With regard to time, the research on the philosophy of technology came earlier than the education on the philosophy of technology.

Spatially speaking, the research on the philosophy of technology has been dispersed alongside the general spread of Western culture. The philosophy of technology began in Germany and France. The first three books on the philosophy of technology were published in German (Dessauer, 1927; Kapp, 1877; Zschimmer, 1913). After World War II, the philosophy of technology spread from Germany to other countries in Europe, as well as to the US. French philosophers and engineers undertook philosophical analyses in technology and engineering (e.g., Lafitte, 1932; Simondon, 1958). The philosophy of technology began the process of institutionalization in the US in 1978 (Cao, 2014). The Soviet Union in Eastern Europe persists in Marxism materialism; Russian philosopher of technology P. K. Engelmeier advocated a technocratic view (Goriunova, 2007). The Polish philosopher Tadeusz Kotarbinski analyzed the philosophy of technology from the perspective of praxeology (Gasparski and Airaksinen, 2011). The philosophy of technology has spread from the West to the East including Japan and China during the eastward spread of Western culture (Cao, 2015c). Moreover, the Chinese philosophy of technology has both similarities and discrepancies in comparison with the Western philosophy of technology in terms of tradition (Cao, 2015d), and the Western philosophy of technology has been critically receipted in China (Cao, 2015e). The philosophy of technology also arose in Sweden and the Netherlands. Following the nineteenth century, the education on the philosophy of technology developed in the US, Canada, the Netherlands, China, and other countries. In general, the interests in local or international projects stimulate the research on the philosophy of technology without limits on locations. National education requirements in local finite places or few international educational exchanging sites, however, drive the education on the philosophy of technology. Although both research and education involve in international topics, the research based on wide literature review in the world tends to be wider than the education. In regard to space, the research on the philosophy of technology is usually wider than the education on the philosophy of technology.

Content-wise, based upon the contributions of previous studies, the research on the philosophy of technology tends to generate original theories, for instance, the organ projections of Kapp (1877) and the technological determinism of Ellul (1964, 1980). Sometimes, the research has recommended innovative strategies, for example, technological policies, and education strategies on the philosophy of technology or engineering and ethics (e.g., Mitcham, 2009). The research also spreads the latest or classical knowledge, such as an introduction from foreign experiences or a review on the philosophy of technology (e.g., Mitcham, 1994). Nonetheless, according to the textbooks or publications, the education on the philosophy of technology tends to deliver old knowledge and disseminate existing knowledge related to technology and philosophy (e.g., the history or the old theories of the philosophy of technology). Classical monographs in the research sphere have often become the textbooks for the education on the philosophy of technology (e.g.,Chen, 1999, 2002; Heidegger,1954/2010; Mitcham, 1994). The research has been updated more quickly and more richly than has the education in the philosophy of technology of humanities. In the content realm, the research on the philosophy of technology tends to be more innovative and deeper than the education on the philosophy of technology.

To a great extent, as this paper argues, the research on the philosophy of technology determines the education on the philosophy of technology in terms of width, innovation, and depth (e.g., Heidegger,1954/2010; Kapp, 1877; Mitcham, 1994). According to my observations, people usually learned the philosophy of technology first, and then taught the field. Alternately, as a universal rule, experienced persons in research studied the territory first, and then taught the domain. However, due to job mobilizations or the training necessities ofnew positions, sometimes teachers from other fields taught the philosophy of technology.

As this article further discusses, the research may be dissociated or connected with the education on the philosophy of technology in theory and in reality, based upon three axes of time, space, and content. The relationship between research and education on the philosophy of technology may be bidirectional and multi-level. According to my observations, in the visible or direct connections of education and research, some students need to learn in order to pass courses on the philosophy of technology and to write theses on the subject for graduation. Some professors both teach the discipline of the philosophy of technology and do research projects on the field. In the invisible or indirect conjunctions of research and education, some lectures of the philosophy of technology borrow the research papers on the philosophy of technology, or some research projects on the philosophy of technology make use of the primary literature or theories from the subject of the philosophy of technology. Sometimes, the research and education on the philosophy of technology have to be separate, for instance, in the sole research project or single lecture. Sometimes, both research and education need to be combined, such as in the supervision of master or doctoral programs. In some cases for social context, however, the research and education on the philosophy of technology are better to be segregated alone (e.g., professional researching or capable teaching) or be integrated together (e.g., comprehensive research and education).

This paper would like to analyze the results of the separation and interaction of the research and education on the philosophy of technology, based on my experiences, observations, and discussions with others engaged in learning, teaching, and researching in the field. In the separation, the research and the education on the philosophy of technology go further by alone like the philosophy of technology walks in a single leg. Nevertheless, for the philosophy of technology with a single leg, the developmental time becomes long, and the evolutionary speed becomes slow. To a certain extent, the evolutional space is confined, and the progressive contents are shallow. For example, if we only read books in the philosophy of technology without any researchable thinking, the textbooks have become faded from our memories after some time. If we have to write research articles on the philosophy of technology, but direct sources for studying are not immediately available, then, it needs to take too much time to look for the first-hand or second-hand sources. It is sometimes not easy for professors to find appropriate literature for teaching and researching. These phenomena may be related to the currently marginal status of the philosophy of technology, unlike the readily available sources in popular economics or engineering.

When research and education collaborate each other, however, the philosophy of technology moves ahead quickly with research and education together, much as a person with two legs walks more easily than someone with only one leg. Then, for the philosophy of technology with two legs, the developmental time becomes short, and the evolutionary rate becomes fast in the same destination. To a great extent, the evolutional space is enlarged, and the progressive contents are deepened. For instance, if we write research assignments after studying, which become faster and easier than we do the research assignments without studying.

Other experienced faculty members, engaged in studying, teaching, and researching in the philosophy of technology, hold that it should be a great way to learn from relevant teaching for researching, or from corresponding researching for teaching. Such as, Norström (2014) recommended that an introduction to the philosophy of technology should be included in every technology teacher-training program for technology teachers to understand a proper framework in technological knowledge.

3.4. The Interaction between Research and Education on the Philosophy of Technology

In the theoretical framework of the interacting theory, the interacting improvement of the philosophy of technology is the result of the stimulation and interaction between research and education on the philosophy of technology, based on their affinities, variances, and relationship.

The interaction between research and education on the philosophy of technology is revealed in the typical representatives list for the research and education on the philosophy of technology (Table 2, 3, 4). Most senior representatives have a Ph.D. background in philosophy, which affords high status in academic and education circles. Senior representatives possess keen insights and substantial knowledge for their further innovative researches and professional teaching. For instance, seventeen presidents of SPT between 1981 and 2014 have respective specialties and innovations in their research areas on the philosophy of technology. Most of them have been both the editors of journals, and professors in teaching the philosophy of technology and supervising master and Ph.D. students to keep the body of knowledge updated and innovative. Educators and researchers believe that high levels of master, Ph.D., and postdoctoral project educations in teaching and learning improve intelligence and insight in the philosophy of technology. These high-level educations, therefore, promote research in depth and innovation, and drive research toward the frontiers of the field. On the contrary, according to my observations, low-level undergraduate educations repeat simple knowledge and make the basic concepts clear. Low-level educations, hence, help the expression and presentation of research on the philosophy of technology, but do not do much to deepen research or to advance the research. The research level is positively correlated to the education level with regard to knowledge depth and breadth in the philosophy of technology. As a result, in this study, the research and education are beneficial to each other in the philosophy of technology. In addition, I observe from my experiences and others performances that the research and education related to foreign affairs or international comparison tend to be more challenged than local research or educations due to information accessibilities and cultural shocks. The former, however, is usually more significant than the latter.

This article further explores a few critical factors that play significant roles in the complex interaction of the research and education of the philosophy of technology, despite the complexity and subtlety of the field. According to my observations and conversations with others in the field, the intermediary elements include the motivations and capabilities of junior and senior researchers, the purposes and effects of the learning and teaching, and the developmental level and supportable resources of this discipline. The motivations and capabilities may sometimes be restricted visibly or invisibly, such as the available resources in financial, cooperative, and human resources. In general, students have to pass examinations, whereas teachers need to teach effectively. The philosophy of technology has grown slowly but surely. For the immense developmental space for the philosophy of technology with a great future (Wu, 1999), we need comparatively consider the supportable resources, such as in the schemes and operations to be discussed as follows.

4. Discussions

The philosophy of technology has made steady achievements, but remains in the exploratory stage of research and education nearly one hundred and forty years after the emergence of the field in 1877. The principal reasons for these shortcomings of a marginal field may be the negative views of technology and a strong tradition of anti-technology. According to interviews in the California public attitudes toward technology (La Porte and Metlay, 1975), political factors including liberalism form the core of potential antitechnology or technological dissent in the awareness of adverse social consequences of technology. “Sometimes Heidegger—and with him, Ellul, Marcuse and even the later Mumford—have sometimes also been characterized as being ‘anti-technology’ or *dystopian*. And, it is certainly true that this set of forefathers did have a tendency to lump all technologies under a single, generalized or transcendentalized ‘Technology’, and to see such Technology as a danger or threat for humankind, (high) culture, or the future.” (Ihde, 2004, p. 123). These anti-technology and dystopian trends may be due to technological alienation.

The anti-technology doctrine has brought a diversification to the philosophy of technology, especially in the ethics and risk analyses of technology for pluralistic values to identify the problems and find possible solutions. It, however, seems to make matters more complicated in regards to both space and time, as culture needs to take time to catch up technological progress, therefore causing social issues and clashes in cultural lag (Ogburn, 1922). A sophisticated philosophy of technology is not like a pure philosophy of science, which goes toward one direction for seeking truth. According to my observations and communications, the philosophy of technology is marginal in quantity known by a small amount and in a marginalized situation in views accepted by a few people, which may be due to an anti-technology tendency in this field.

How then can the philosophy of technology be assured of a better future? The mission is to de-marginalize and advance the philosophy of technology from a discipline with a great future to a subject with a significant fact. For 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). If the philosophy of technology does not have unique educational characteristics, this field will not obtain its place, but covered by other disciplines, or falling behind others, such as the philosophy of science. If there is no classical research theory in this field, then it will be difficult to measure its advances. If application values—such as using technological invention, design, or ethics to improve technological roles in society—are not available, people will lose their interests in this field and will even doubt the necessity of its existence. This paper, thus, further analyzes that education, research, and application should be essential to develop the philosophy of technology. To instantiate the basic philosophical approach to technology, the philosophy of technology needs to come into closer contact with the real world of technology, or at least how that technological world is manifested in the technological discourse (Mitcham, 1994). This article agrees that we should penetrate this technological example-providing approach in the philosophical reflection on technology to open the mysterious black box of technology to see how it works. The history of industrial research laboratories offers a good opportunity of studying the complex relationships between science and technology for science education and technology education (de Vries, 2001). Philosophical reflections on technological nature and its social impacts—for example, technological norms, standards, rules of thumb, technological ethics, and values—have educational consequences in social practices (de Vries, 2005a, 2005b). The philosophy of technology with an understanding of technology helps to conceptualize intellectual approaches to the teaching and learning about technology (Peters, 2006). Teachers help students develop deep understanding in the education (Ritchie, 1998). The trend toward empirically based and interdisciplinary research will continue to expand and flourish, whereas the advocacy of the improvement on critical reflections on technology in student education and public understanding on technological roles in the society will gain momentum within the philosophy of technology (Michelfelder, 2010). Replacing the empty state disappointed by Winner (1993), we can fill the black box of technology with explorations of the ethical applications used in design practices (Steen, 2014). These insights point to the linkage among education, research, and technological application in the philosophy of technology.

Based on aforementioned progressive analyses on the research-education nexus and existing studies on the philosophy of technology, this paper proposes that a sustainable roadmap would be to incorporate the realms of research, education, and industry, with two schemes of theorization and application surrounding technology to amplify social effects (Figure 1). Theorization first puts deep evidence-based research meta-theories and practical methodologies of technological design and innovation from senior and junior researchers into social demand-based teaching and learning. This theorization course brings increased endogenous returns in expanding social visibilities, injecting students' reflections, and improving public understanding of the technological nature and functions in society. Then, the practical evidence decision-based application stage transfers the theory of research and education into industrial productions by technicians and engineers. This application process gains exogenous growth in enhancing technological production, as well as social acceptability of the new technology. For instance, ICT ethics research and education enhance public ethical awareness and pupil moral knowledge on ICT for inner theorization developments. In the further application, privacy design in PayPal account facilitates ordinary people in making the online payment. The management mechanism is to motivate the input-output of the philosophy of technology and to maximize the results of that stimulation on the philosophy of technology. These results include the performance of research theory in practice, expanded educational delivery in public, and extended production of new technologies in society.

The blueprint demands wide-ranging and practical strategies. Since the research principally determines the width, innovation, and depth of the educational system, the research has priority as a leader. The research on the philosophy of technology needs to develop a mainstream theoretical system in the areas of ontology, epistemology, methodology, and axiology. It also needs to launch a set of classical theoretical frameworks and structure systems to become widely acknowledged and accepted. Then, educators of the philosophy of technology absorb the results of the research and deliver it to a new generation for more widespread knowledge dissemination. Finally, the industry applies the knowledge to new technological and engineering products used in society. At the same time, researchers and educators examine and advance the industrial applications of the new technologies. The workable research-education-industry networks capture the benefits of tripartite collaboration: more effective theory and supervision, more helpful and efficient pedagogy, and better production application. This tripartite community consists of experts from the academic, educational, and industrial circles. They create a rich toolbox by cooperation, trust, democracy, openness, monitoring, improvement, social, environmental and economic sustainability, and other effectivenesses that come from working together rather than in isolation.

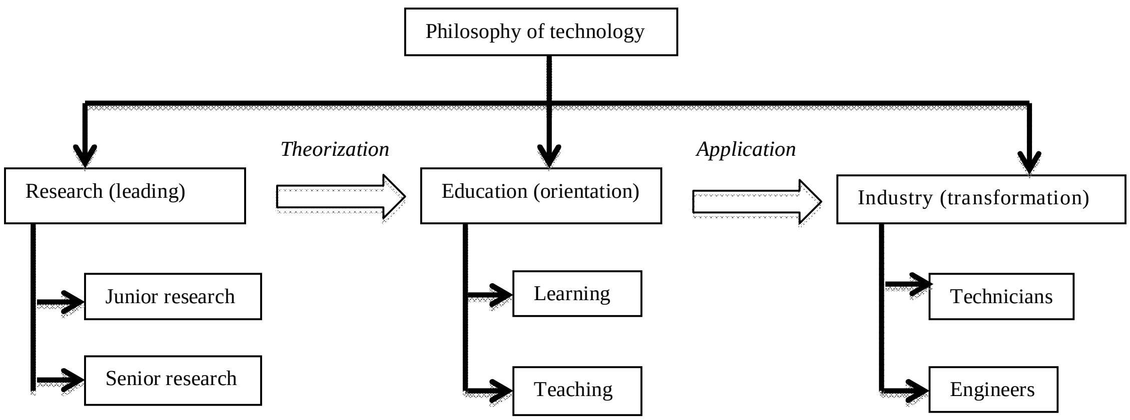

Figure 1: The roadmap frame for research-education-industry for the de-marginalization of the philosophy of technology

For further steps to de-marginalize and enhance the field of the philosophy of technology, this paper recommends three approaches: a research-led approach and an education-oriented approach for endogenous intelligent returns, and an application-transformation approach for exogenous growth in technological productions. These three approaches bring inclusive growths for the junior and senior researcher in research, students and teachers in education, and technicians and engineers in industry. This article advocates that the community in the philosophy of technology including researchers, educators, technicians and engineers should highlight technological policies research, technological education, and technological application to bring the technological world into peoples' daily lives. This paper underlines that the learning by design for technological invention and technological innovation is penetrative through this research-education-industry roadmap for good technological assimilation into society, thus offsetting potential technological alienation.

More specifically, the community in the philosophy of technology applies the design channel in technological innovation research, technological design education, and technological creation applications to connect physical structure and social function. By the transformation of design, therefore, the philosophy of technology turns opponents of new technology into helpful technological problem-solvers as researchers and educators work with them to identify their objections and to find design solution. This article urges the philosophy of technology to shift the anti-technology tradition to a new pro-technology direction, the marginal and marginalized position to the center for the sustainable development of this research-education-industry roadmap.

This study results from theoretical analyses and empirical research from text mining, online surveys, observational studies, discussions, and communications. These results keep the objectivity of observations and the subjectivity of communications. Furthermore, the academic authority from research may bring more influence on educational honor than the impacts from educational achievements on academic reputations.

The academic authority and reputation of the philosophy of technology might not be measured only by academic indexes, which mix the results from the coauthors and the achievements from the philosophy of technology and other fields as normal research phenomena. In addition, like various lengths in human fingers and toes for different functions, the research and education on the philosophy of technology might not be treated in a similar way. The research and education on the philosophy of technology may be mixed together for some topics or by implementers. As this paper would like to point out, the cases and Table 1 for the research and education on the philosophy of technology refer to the tendencies more in the research or education for the purpose of comparison and contrast, not for absolute isolation to be sole research or single education. The junior and senior ones in research, as well as the learning and teaching in education on the philosophy of technology may not be judged by the alike manners due to dynamic knowledge updates and innovations, and spatial and temporal accumulation effects.

5. Conclusions

This study presents the primary development of the philosophy of technology as the exploratory advancements of research and education. As this paper has discussed, the de-marginalization of the philosophy of technology will be achieved first in research, followed by the dissemination of knowledge of the field to the world. Similarities and discrepancies are diverse in the current research and education on the philosophy of technology. As this article has argued, in terms of time, space, and content, the research on the philosophy of technology has been active for a longer time, and is more widespread, more innovative, and deeper than the education on the philosophy of technology. In the relationship of theory and reality, the research can be detached or it can interact with the education on the philosophy of technology based on the three dimensions of time, space, and content.

This paper launches an original interactive framework for the research and education on the philosophy of technology. Moreover, in the knowledge-based and technology-driven society, this article offers a research-education-industry roadmap for the philosophy of technology to de-marginalize the field and to realize its great potential for social good toward a discipline with a significant reality. This paper recommends three approaches with research-led, education-oriented, and application-transformation for endogenous and exogenous developments. This article advocates the philosophy of technology to transfer the established anti-technology tradition into a pro-technology direction with the learning by design to develop sustainably in the future. The next steps are how to establish research-education-industry networks devoted to the philosophy of technology, both locally and internationally.

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Appendices

Table 1: The research and education on the philosophy of technology (PoT)

	Item	**Research on the PoT**		**Education on the PoT**	
1	Status	PoT institutionalization in the US in 1978 and in China in 1985		The sub-discipline of philosophy in the US, Canada, the Netherlands, Sweden, and China	
2	Activity	Junior research	Senior research	Learning	Teaching
3	Goal	Primary or advanced research on knowledge of PoT	Deep or innovative leading on intelligence of PoT	The learning on fundamental knowledge of PoT	The instructing on basic knowledge of PoT
4	Object	Postgraduates, dependent researchers	Supervisors, independent researchers	Students	Instructors
5	Position	Master student	Assistant professor	Undergraduate	Lecturer
		Ph.D. student	Associate professor	Master student	Assistant professor
		Postdoctoral student	Professor	Ph.D. student	Associate professor
		Junior dependent researchers	Senior independent researchers	Postdoctoral student	Professor
6	Content	Expertise in research of PoT		Specificity in education of PoT	
a)	*Ontology*	Technological definition, how to do	Technological autonomy, dual nature of technology	Technological concept and term, technological knowledge	
b)	*Epistemology*	Technological characteristics, science-technology-engineering relationship	Technological science, technological engineering	Technology as applied science, historical schools of PoT	
c)	*Methodology*	Creation, design, and development	Invention, innovation, and patents	Creation, invention, and development	
d)	*Axiology*	Technological influences on society	Technological ethics, engineering ethics code, technocracy and civilization, technical politics	Technology and ethics, engineering and ethics, technology and culture	
7	Model	Dependent or coauthor under guidance	Independent, single author, or coauthor	Learning	Teaching
a)	*Place*	Universities, workshop	Academic communities, organizations (SPT, CSPT)	Campuses, classroom	Schools, campuses, or online
b)	*Feature*	Complete master or doctoral thesis or project in short term	Continue to research in long term	Finish a course in short term	Repeat or continue courses in long term
8	Method	Classical and latest knowledge diffusion	Innovative knowledge publicity	Old knowledge absorption and delivery	Existing knowledge spread
a)	*Literature*	More classical books references, fewer peer review papers references	More peer review papers references, fewer classical books references	More basic book reading, fewer papers reading	More classical book reading, fewer papers reading
b)	*Performance*	Textual analyses		Material analyses	
		Observational research, online survey, survey research, questionnaire, interview		Class education, online education	
		Comparison and contrast		Comparison and contrast	
		Case study		Case study	
		Presentation in conference		Lecture and speech	
		Workshop		Seminar and group discussion	
9	Achievement	Master or Ph.D. dissertation, essays publication, graduation	Paper or book publication, national or international project	Passing course, obtaining credit	Teaching course, releasing credit
10	Assessment	The input of reliable knowledge and the output of innovative knowledge of PoT	The import of reliable knowledge and the export of original knowledge of PoT	More absorption and less delivery of proper knowledge of PoT	Accumulation and delivery of right knowledge of PoT
a)	*Quantitative*	Master or Ph.D. dissertation, essays publication number, impact factor	Paper or book publication quantity, project fund amount, impact factor, citation, academic index	Learning time, test grade	Teaching period, taught students scale, examination score
b)	*Qualitative*	Supervision, peer review	Peer review, the reputation of academic community	Exam level	Professional teaching

Table 2 Typical representatives of the research and education on the PoT (the order by the time) (sources retrieved on January 20, 2016)

Name	Country	Time	Research		Education	
			Junior research (Ph.D. thesis field)	*Senior research (Specified area in PoT)*	*Learning*	*Teaching*
Ernst Kapp	Germany	1808-1896	"De re navali Atheniensium" in 1830 (http://vlp.ur.de/people/data?id=per702)	Organ projections	Ph.D.	A professor
Karl Marx	Germany	1818-1883	"The Difference Between the Democritean and Epicurean Philosophy of Nature" in 1841 (http://www.marxists.org/archive/marx/works/1841/dr-theses/)	Materialism	Ph.D.	Marxism
Martin Heidegger	Germany	1889-1976	"The Doctrine of Judgement in Psychologism" in 1914 (http://www.egs.edu/library/martin-heidegger/biography/)	Existentialism, phenomenology, hermeneutics	Ph.D.	A professor
Jacques Ellul	France	1912-1994	On the Roman mancipium (http://www.christinyou.com/pages/ellul.html)	Hard technological determinism, the technological society, the technological system, technological autonomy	Ph.D.	A professor
Thomas Parke Hughes	US	1923-2014	Ph.D. from the University of Virginia in 1953 (http://en.wikipedia.org/wiki/Thomas_P._Hughes) (http://web.stanford.edu/dept/HPS/hughes.html)	Technological momentum, technological determinism, large technical systems, social construction of technology	Ph.D.	A professor
Friedrich Rapp	Germany	1932-	Philosophy in 1966 (http://ifpp.fk14.tu-dortmund.de/cms/ifpp/de/personen/emeritiert/rapp.html)	Analytical philosophy of technology	Ph.D.	A professor
Don Ihde	US	1934-	On the phenomenology of Paul Ricoeur in 1964 (http://www.stonybrook.edu/commcms/philosophy/people/faculty_pages/ihde.html)(http://www.amazon.com/Hermeneutic-Phenomenology-Philosopher-Paul-Ricoeur/dp/0810106116)	Phenomenology, technics and praxis, technology and the lifeworld, technoscience, material hermeneutics	Ph.D.	A professor
Andrew Feenberg	Canada	1943-	The dialectics of theory and practice in 1972 (http://www.sfu.ca/~andrewf/index.html) (http://www.worldcat.org/title/dialectics-of-theory-and-practice/oclc/17293581)	The democratic transformation of technology	Ph.D.	A professor
Wiebe E. Bijker	The Netherlands	1951-	"The Social Construction of Technology" in 1990 (http://www.maastrichtuniversity.nl/web/Profile/w.bijker.htm)	Social construction of technology, science and technology policy	Ph.D.	A professor
Trevor J. Pinch	UK	1952-	"The Development of Solar-Neutrino Astronomy" in 1982 (http://www.soc.cornell.edu/cvs/pinch.pdf) (http://sts.cornell.edu/people/tjp2.cfm)	Social construction of technology, the sociology of technology	Ph.D.	A professor

Table 3 Typical representatives in the research and education on the PoT (the order by the president of SPT) (.. No available data) (sources retrieved on January 20, 2016)

Name	Nation	Time	Research		Education		President of SPT
			Junior research (Ph.D. thesis field)	*Senior research (Specified area in PoT)*	*Learning*	*Teaching*	
Carl Mitcham	US	1941-	Ph.D. in philosophy at Fordham University in 1988(http://inside.mines.edu/Carl-Mitcham)	Ethics of technology; STS studies; science and technology policy	Ph.D.	A professor	1st (1981)
Alex Michalos	Canada	..	Ph.D.in the philosophy of scienceatUniversity of Chicagoin 1965 (http://www.unbc.ca/political-science/faculty)	Technology assessment, facts and values; philosophical problems of science & technology	Ph.D.	A professor	2nd (1983)
Kristin Shrader-Frechette	US	1944-	Ph.D. in philosophy of science in 1972 and post doctor in biology, economics, and hydrogeology (http://www3.nd.edu/~kshrader/)	Technological risk, technological ethics	Ph.D.	A professor	3rd (1985)
Marx Wartofsky	US	1928–1997	"Denis Diderot and Ludwig Feuerbach: studies in the development of materialist monism" in 1952 (http://www.worldcat.org/title/denis-diderot-and-ludwig-feuerbach-studies-in-the-development-of-materialist-monism/oclc/503173468)	Historical epistemology	Ph.D.	A professor	4th (1987)
Langdon Winner	US	1944-	"Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought" in 1973 (http://homepages.rpi.edu/~winner/)	Social and political issues surrounding modern technological change, technical politics	Ph.D.	A professor	5th (1989)
Joseph C. Pitt	US	1943-	Ph.D. in philosophy at University of Western Ontario in 1972(http://www.phil.vt.edu/Pitt/jpitt.html)	Technological influence on scientific change, technological knowledge	Ph.D.	A professor	6th (1991)
Jose Sanmartin	Spain	..	(http://en.wikipedia.org/wiki/Society_for_Philosophy_and_Technology)(http://www.udel.edu/Philosophy/sites/pd/files/technology2.pdf)	Technology, society, and humanity	Ph.D.	A professor	7th (1993)
Larry A. Hickman	US	1935-	Ph.D., the University of Texas at Austin in 1971 (http://mypage.siu.edu/lhickman/)	John Dewey's pragmatic technology, technological culture	Ph.D.	A professor	8th (1995)
Paul T. Durbin	US	1933-	Ph.D. in philosophy of science in 1966 (http://www.udel.edu/Philosophy/sites/pd/files/pd-cv.pdf)	Technology and responsibility, social philosophy of technology	Ph.D.	A professor	9th (1997)
Deborah G. Johnson	US	1955-	"Legal Responsibility, Legal Liability and the Explanation of Action." in 1976 (http://www.philosophy.ku.edu/programs/graduate/placement.shtml)(http://www.batten.virginia.edu/content/faculty-research/faculty/deborah-nodefieldfacultymiddlename-johnson) (http://www.ancientfaces.com/person/deborah-g-shape-johnson/105692127)	Technology and society, computer ethics, engineering ethics, gender and technology	Ph.D.	A professor	10th (1999)
Andrew Light	US	..	Ph.D. in philosophy in University of California, Riverside in 1996; post doctor in Environmental Risk Assessment in University of Alberta from 1994 to 1997 (http://ippp.gmu.edu/people/light.html)	The social dimensions of emerging technologies	Ph.D.	A professor	11th (2001)
Paul B. Thompson	US	1951-	"The Concept of Risk" in 1980 (http://www.fsl.orst.edu/tgerc/iufro2001/cv/cv-thompson.pdf)	The development of agricultural techno-science	Ph.D.	A professor	12th (2003)
Peter Kroes	The Netherlands	1950-	On philosophical problems concerning the notion of time in modern physical theories in 1982(http://ethicsandtechnology.eu/member/kroes_peter/)	The dual nature of technical artefacts, modelling socio-technical systems	Ph.D.	A professor	13th (2005)
Diane Michelfelder	US	1953-	"On Responding to Heidegger" in 1982 (http://www.macalester.edu/academics/philosophy/facultystaff/dianemichelfelder/)	Ethics of information and computing technologies	Ph.D.	A professor	14th (2007)
Philip Brey	The Netherlands	1966-	On the cognitive turn in epistemology and the philosophy of science in 1995 (http://www.utwente.nl/gw/wijsb/organization/brey/)	Engineering design, bioengineering ethics, computer ethics, sustainable technology	Ph.D.	A professor	15th (2009)

Sven Ove Hansson	Sweden	1951-	Ph.D. "Belief Base Dynamics" in theoretical philosophy in 1991; Ph.D. "Structures of Value" in practical philosophy in 1999 (http://people.kth.se/~soh/)	Technological ethics, technological risk	Ph.D.	A professor	16th (2011)
Peter-Paul Verbeek	The Netherlands	1970-	De daadkracht derdingen: Over techniek, filosofie en vormgeving (Dutch, 2000), "What things do: Philosophical reflections on technology, agency, and design"(English, 2005) (http://www.utwente.nl/gw/wijsb/organization/verbeek/)	Moralizing technology; technological agency and design	Ph.D.	A professor	17th (2013)

Table 4 Typical representatives in the research and education on the PoT (the order by the time in China) (sources retrieved on January 20, 2016)

Name	**Nation**	**Time**	**Research**		**Education**	
			Junior research (Master or Ph.D. thesis field)	*Senior research (Specified area in PoT)*	*Learning*	*Teaching*
Chen Changshu	China	1932-2011	Master in Marxist philosophy in Renmin University of China in 1956 (http://baike.baidu.com/view/307484.htm)	Technical artifact, science-technology relationship, technology and society	Master	A professor
Li Bocong	China	1941-	Master in philosophy in 1981 (http://people.gucas.ac.cn/~libocong)	Philosophy of engineering, engineering ethics	Master	A professor
Liu Dachun	China	1944-	Master in philosophy in Renmin University of China in 1981(http://baike.baidu.com/subview/953431/16250638.htm#viewPageContent)	Discovery and innovation, technological ethics	Master	A professor
Wang Qian	China	1950-	Ph.D. in philosophy in Northeastern University in 2000 (http://gs1.dlut.edu.cn/Supervisor/Front/dsxx/new/Default.aspx?WebPageName=WangQ)	Chinese philosophy of technology, the history of technological thought, technological ethics	Ph.D.	A professor
Chen Fan	China	1954-	Ph.D. in philosophy in Renmin University of China in 1992 (http://www.baike.com/wiki/%E9%99%88%E5%87%A1)	Technological socialization; STS studies; Marxism and technological development	Ph.D.	A professor
Qiao Ruijin	China	1957-	Ph.D. in philosophy (http://baike.baidu.com/view/1379450.htm)	Marxist Philosophy of Technology, technological design	Ph.D.	A professor
Xu Liang	China	1957-	Ph.D. in philosophy in 1996 in Fudan University, post doctor in physics between 1996 and 1998 in University of Science and Technology of China (http://cc.usst.edu.cn/Able.Acc2.Web/Page_TeachersDetail.aspx?ID=78639)	Technological nature, value, development	Ph.D.	A professor
Gao Lianghua	China	1963-	Master in the Department of Social Sciences in Beijing University of Technology in 1988 (http://baike.baidu.com/view/4163204.htm)	Technology in humanist vision, high-tech strategy and management	Master	An associate professor
Ma Huiduan	China	1974-	Ph.D. in the philosophy of technology in Northeastern University in 2004 ("Pragmatic Analytical Philosophy of Technology") (http://www.wfxy.neu.edu.cn/newsnei.php?id=1645&nation=13&clid=301)	Pragmatic and analytical philosophy of technology; technological phenomenology; STS studies	Ph.D.	An associate professor