

Entrepreneur in Academic Research: Interview with Professor Kwang-Hyung Lee

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Abstract This is an interview with Professor Kwang-Hyung Lee, founding Dean of KAIST Moon Soul Graduates School of Future Strategy and founder of the Department of Bio and Brain Engineering of the same university casting two questions about academics. The first question is what pattern is desirable in the evolution of research topics of an academics. While traditional researchers in science and engineering tend to focus on one subject in ever greater depth over time, Professor Lee's research agenda has spanned several new topics by gradually changing the content of the study: from artificial intelligence to bio and brain research, and to creativity development method, further to future study. The second question is about researchers' social responsibility. He has devoted to contributes to industry fields and the nation through academic activities as well as educating several successful business people, founding a new academic department and graduate school of future studies.

Keywords Academic entrepreneur, artificial intelligence, creativity development, social responsibility, future study

I. Introduction

In this interview, we introduce a university professor working the scientific field. He enjoys a good reputation as a computer science professor majoring in artificial intelligence. He has not only educated and trained his students to be global entrepreneurs, but he has also participated in enterprise management. He has established the Department of Bio and Brain Engineering at KAIST (Korea Advanced Institute of Science and Technology) and then established KAIST Moon Soul Graduates School of Future Strategy. In addition, this professor is an outstanding expert in creativity development method. Despite the many accolades he received for his works, it is hard to characterize and

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describe him in one word. That is why we introduce him in this interview section.

The academic is Professor Kwang-Hyung Lee, founding Dean of KAIST Moon Soul Graduates School of Future Strategy and founder of the Department of Bio and Brain Engineering of the same university (<http://www.biosoft.kaist.ac.kr>). Not much information comes out when one do a search about his research performance. This is because, in his early days, his English name, Kwang-Hyung Lee, was misspelled as Lee-Kwang Hyung or Kwang Hyung Lee. Although his name has been incorrectly spelled in his early works, most of his later papers are identified with the correct name, so any search yields the intended results.

Although we have known each other for a long time, I visited Professor Lee's office in December 2016 to conduct this interview. My visit was followed with numerous phone calls and emails to further elaborate on the topics discussed. As for external reputation and appraisal, we mainly referred to Professor Sang-Hyuk Suh, a co-author of this article, who knows him well since his graduate student days in France.

This paper addresses two critical questions. The first question is what pattern is desirable in the evolution of research topics of an academics. While traditional researchers in science and engineering tend to focus on one subject in ever greater depth over time, Professor Lee's research agenda has spanned several new topics by gradually changing the content of the study. The second question is about researchers' social responsibility. While he has been devoted to research per se, Professor Lee always has emphasized social responsibility in the education of his students as well as contributes to industry fields and the nation.

II. Professor Kwang-Hyung Lee

1. History

Professor Kwang-Hyung Lee was born in 1954. He graduated from Seoul National University with a B.S. in Industrial Engineering (1978) and from KAIST with a M.S. in Industrial Engineering (1980). Then, he obtained a doctorate in Computer Science from Lyon 1 – France's Institut National des Sciences Appliquées (INSA). Upon his return to Korea, he became a professor of computer science at KAIST. A scholarship enabled him to complete his doctoral degree in France.

He has presented 122 international papers and around 40 domestic research papers. Most of his early writings were about artificial intelligence, bio-

information, and fuzzy theory. He owns 16 international and Korean patents and developed ten products. As an author, he has published six computer books and five books of essays in Korean, and three books in English. Some of his books in English include:

‘Introduction to System Programming’ (Prentice Hall, 1997); ‘First Course on Fuzzy Theory and Application’ (Springer, 2004) and ‘Three Dimensional Creativity’ (Springer, 2014)

Books in Korean include ‘Future by Science and Technology’ (Ministry of Culture and Tourism, 1993); ‘If I have Computer Company like POSCO’ (Seoul: Sol Publishing, 1995); ‘From Multimedia to Cyberspace’ (Sol Publishing, 1996); ‘Startup Company - I Can Do’ (Seoul: DongA Ilbo, 1997); ‘The 21st Strong Startup Nation’ (Seoul: Kimyoungsa, 2000); ‘Developing Three Dimensional Creativity’ (Seoul: Business Map, 2012) and ‘Future Management by Three Dimensional Forecast’ (Seoul: Sangneung, 2012)

At KAIST, Professor Lee acted as Dean of International Relations (2001-2004), Dean of the College of Interdisciplinary Studies (2004-2006), Chairman of the Bio and Brain Engineering Department (2003-2006), Dean of Academic Affairs (2006-2010), Dean of the Graduate School of Future Strategy (2013-). In academic societies, he was Editor-in-Chief of the Journal of Information Science (1999-2000), Editor-in-Chief of the Journal of Information Processing (2001-2002), President of the Korean Fuzzy and Intelligent System Society (2003) and President of the Korean Society of Bioinformatics (2005-2006). Internationally, he has worked as Associate Editor of the Journal of Uncertainty Analysis and Applications (2006-2013) and Associate Editor of the Journal of Advanced Computational Intelligence (2006-). He is currently President of the Korea Association for Futures Studies (2016-2017).

In 1999, Professor Lee was appointed as an endowed chair professor funded by an enterprise. In the same year, he became the inspiration for an eccentric professor in “KAIST,” an 81-episode TV drama aired on SBS. The series focuses on the lives of KAIST students in electronic engineering and computer science, depicting their studies and affairs. His students at the time found startups and achieved successes in their entrepreneurial endeavors. One of the students who became a successful CEO is Jung-Joo Kim, who accumulated great wealth and became a super-rich in Korea and the world. In the 2016 World’s Billionaires List published by Forbes, Kim ranked the 787th wealthiest person in the world with a net worth of \$2.2 billion dollars (www.forbes.com).

In 2001, Professor Lee presided over the establishment of the Department of Bio and Brain Engineering, initially called Department of Biosystems. His intention was to set up an interdisciplinary department that brings together

various academic fields such as computer science, electronic engineering, bioscience, medical science and nanotechnology. While convergence research is standard practice today, establishing such a new department back in 2001 was a pioneering enterprise. Even at KAIST, the 47-year-old computer science professor was not allowed to establish the Department of Biosystems. Despite sufficient funding donated for this purpose, the creation of the department was rejected by senior professors and university administrators. However, Professor Lee managed to persuade the Minister and Vice-Minister of Ministry of Science and Technology to support the establishment of the department. Eventually, the Department of Biosystems came about once the Minister of Science and Technology persuaded the President of KAIST to move ahead with the project.

The adversity he faced in establishing the Department of Bio and Brain Engineering helped him have a new way of looking at issues. He thought that his university colleagues' opposition to his proposal was rooted in a lack of understanding and knowledge of convergence, and of future academic directions. He thought disagreement was also based on his inability to persuade the skeptics with a good systemic explanation. Since then, he developed an interest in the future: the necessity of systemic prediction of the future, strategy setting and methodology to communicate sympathetically with others. He began conducting seminars on futurology through the provision of futurology courses.

In 2013, Professor Lee led the establishment of KAIST Moon Soul Graduates School of Future Strategy. This time, the university faculty understood better his motivation, study and experience in the creation of the Department of Bio and Brain Engineering a decade ago and they approved the establishment of the graduate school. In addition, the university administration was no longer in a position to oppose the plan since enough funding through donations had been secured. Though, some faculty cast doubt on the rationale for the establishment of the graduate school dealing with humanities and social science at KAIST, a science and engineering university. He pointed out that technology has emerged as a key factor in futures studies because society is highly technology-centered. In this regards, he insisted on the fact that KAIST, as a science and engineering university, will have a significant advantage in futures studies.

Professor Lee served as a member of the advisory committee and worked as a consultant for various organizations such as industries and numerous Korean government departments as well as the National Assembly of Korea. Of note is his industrial experience working as a major decision-maker (independent director for the public interest, audit and Chairman of the reward committee) in Mirae Corporation from 1999 to 2013 after he voluntarily helped this company with technological challenges at no cost in 1998. The funds for

KAIST Moon Soul Graduates School of Future Strategy and Department of Bio and Brain Engineering had been raised from the Chairman of this company, Moon-Soul Chung.

2. Professor Lee's Evaluation

Professor Lee's career is extensive. While a professor with a successful academic track record on artificial intelligence, bioinformatics and fuzzy theory, he also worked as an outstanding startup educator. In addition, he had a wealth of administrative experience at KAIST and consultation services to industries and various government ministries. In particular, his research interests have evolved from artificial intelligence to bio and brain and, going even further, to creativity methods and future strategy. At a glance, it is hard to say whether he is a researcher, a social activist or an entrepreneur.

Regarding his identity, Professor Lee defines himself solely as an academics. He states that all his activities have been based on his artificial intelligence research. So, his study could evolve to bio and brain research through which creativity method has been developed. With his novel creativity method, he explained he could develop future studies. As an educator, he claimed he merely trained his students to view the world from their perspectives. The students with remarkable achievements in business decided to start businesses during they stay at the university. He worked with a student who established a big game company - the student wanted to play computer games with players in foreign countries in real time. Professor Lee pointed out the network was not fast enough to play the game on the Internet at the time. The student, however, replied that it would be possible in ten years' time. He developed Internet games and became a billionaire. Professor Lee said all his social activities devoted to industry and society were the results of the application of his research to the need of society.

III. Achievement and Evaluation

1. Evaluation

In academic circles, Professor Lee is called an innovator or an entrepreneur. Continuing evolution characterizes his research area and he has committed to social responsibility through this evolution. We drew two important questions based on his story gathered in the interview. Firstly, in which pattern should

an academics' research interest evolve? Secondly, what is social responsibility of a researcher?

We threw a basic question to him during the interview. How has he raised fund for his academic transformation? Although the establishment of the Department of Bio and Brain Engineering was rejected, he had secured funds for it when he submitted the proposal. In a science and engineering university, he began to explore the future studies, which is considered as humanities and social science, and he eventually succeeded in setting up KAIST Moon Soul Graduates School of Future Strategy. In the early 2000s, it was hardly possible to establish a new department in KAIST due to the difficulty in getting funding from the government. His answer was simple. If the project is for society and the future rather than for individual interest, any idea can be developed and funds can be raised. Not all researchers with excellent ideas can raise funds, however.

That is why we believe other key factors explain his success. Firstly, we believe that his evolution and performances started from his highly distinguished academic achievement in his early days as a professor. He contributed to the publication of special editions on artificial intelligence in several journals as editor-in-chief or associate editor five times over four years in the early 1990s. He also published academic papers consistently every year in many academic journals, such as *Fuzzy Sets and Systems*, *IEEE Transactions on Fuzzy Systems*, *IEEE Transactions on Cybernetics Machine and Systems*. In the 1990s, he developed new technologies for industries and obtained 16 patents. Along with it, he has filled in various posts in Korea as editor-in-chief and head of academic societies.

The second factor is Professor Lee's commitment to social responsibility. He stated that he could complete doctoral degrees thanks to fellowships and he could pursue his research with the financial support of the government and society. Therefore, he said, teaching students is his imperative duty and he should help wherever his knowledge is needed within society as long as time allows. These thoughts led him to meet the Chairman of Mirae Corporation, Moon-Soul Chung, and helped him resolve technical problems at the Corporation free of charge. It was a newspaper article that brought him in contact with Chairman Chung. Impressed by the newspaper interview of an entrepreneur who emphasizes a corporation's social responsibility, he called the entrepreneur directly and had a meeting where he offered to help the company for no money. When Chairman Chung stepped down as Mirae Corporation president, he appreciated Professor Lee's ethical philosophy committed to responsibility without seeking personal interest. He invited Professor Lee to take a key position in the company management beyond the role of technical advisor. He had been involved in the management of Mirae Corporation until 2013.

Chairman Chung made a donation of one billion won to KAIST in 1999 to support Professor Lee's research as a mark of appreciation. This funding enabled the creation of an endowed chair. Before long, Professor Lee imparted on Chairman Chung a profound conviction of the necessity of convergence of IT and bio. In 2001, Chairman Chung donated 30 billion won to support the establishment of the Department of Bio and Brain Engineering on the condition that the entire funds can be used only for Professor Lee's research. A decade later, in 2012, Professor Lee put forward the idea of the necessity to amalgamate future studies and training to raise competent researchers. Chairman Chung agreed and donated an additional 21.5 billion won for the establishment of a new graduate school of future strategy. This fund has been used exclusively for the creation of KAIST Moon Soul Graduates School of Future Strategy and future research.

The third question raised by Professor Lee's history is why did he decide to help the for-profit corporation at no cost even if he is a person who places a high value on social responsibility? Even in the academic community, it is hard to see anyone working for a company for free as part of a social responsibility agenda. Again, his answer was simple. Any social activity that charges money cannot truly work in social responsibility. Because he has enough funds for research and many students to work together, the provision of necessary expense is sufficient for his work. Social responsibility can be performed in its truest sense only when a researcher works without pursuing an individual benefit. In this regards, he volunteered to help solve Mirae Corporation's technological challenges at no cost in the late of 1990. His philosophy had captured the mind of Chairman Moon Soul Chung who eventually donated research funds to KAIST for him. Since he has helped Mirae Corporation from 1999 with his consistent and unfailing attitude over a decade, Chairman Chung offered financial support to establish the Department of Bio and Brain Engineering. He kept his resolve throughout the establishments of the department and of the graduate school. Even though he was a department founder, he did not take the position of chair and chose the smallest office. Moreover, he sticks to the principle that no research fund can be used for his benefit.

2. Liberalism and Social Service Education

His education reflects his philosophy. He has never compelled his students to study a specific area. So, his laboratory was famous in the student community of KAIST computer science department for the inviting study environment. He also accepted students expelled from another laboratory who could not meet heavy workload.

When he visited Stanford University in 1995, he was exposed to Silicon Valley and the atmosphere where startups are considered important. This experience opened his eyes. He offered his students opportunities to do research in the Silicon Valley by raising funds from two companies there. Returning from the visit, he sent seven students to the Silicon Valley and let them participate in the research of the company one after another, for six months for each student. The students were able to think freely and they transmitted the atmosphere of Silicon Valley back to his Korean office. Because of the rich opportunities, his students could be prepared to start businesses by following their interests.

In the school lab, five businesses were established: Nexon (1996), a game company, Idis (1998), a security device company, Inzen (1998), an internet security company, Hackerslab (2000), an information security company, and Neowiz (2000), a web portal company. Adamssoft (1995), a cyber singer company and Olaworks (2005), a computer vision technology company were established based on the research in the school lab after graduation. Olaworks were acquired by Intel in 2012. Idis, Neowiz and Nexon are currently companies listed in the stock market.

The first company created in the KAIST school lab is Madison, a manufacturer of diagnostic medical devices, founded in 1985 by a doctoral student studying electricity and electronics. Madison had grown to a venture conglomerate until it went bankrupt in 2002 and it has been acquired by Samsung Electronics. The first company created by KAIST graduates is Qnix set up by a computer science graduate in 1981 who had been out of business in 1997 during the Korean economic crisis (Seol, Park and Suh, 2002).

Despite some successful examples of students starting their business, Professor Lee and his students planned business start-ups clandestinely because the KAIST faculty barely had an understanding of startups. Even then, it was still not permitted for students to study an area close to their interest, such as game development. They are to work on research in the assigned study areas of KAIST because they are funded by the people's taxes. So, it was forbidden for a professor to connive with students who wanted to work on their own research. So students kept their work secret until graduation. Some students, surprisingly, started their business in the school lab under other names. They did not utilize the university's startup assistance facility, of course.

For reference, according to '2014 survey report on the performance of startups founded by those from KAIST', startups established by KAIST graduates and companies occupied in KAIST startup center number 1,245, of which 50 have so far gone public. They post 10 trillion won (\$8.7 billion) in annual sales in total. According to the survey result, 929 companies were founded by alumni (Newsis, 2015.7.8). As shown in the startup cases, another

innovation found in Professor Lee is that he set the fresh ground for student startups in the situations when startup establishment was unacknowledged as a function of universities. Also, his student education has drawn a way to make students find their way based on their needs rather than passively accumulate knowledge taught by a professor.

IV. Creativity Education

1. Professor Lee's Three-Dimension Creativity Development

As an artificial intelligence researcher, Professor Lee had experienced adversity when he was turning to another academic field: bio and brain engineering. As described, it was difficult to establish the department because the general opinion at the time was that it is impossible to combine IT and BT. Turning to bio and brain engineering was a tough challenge for him, and it required determination. A Chinese character calligraphy displayed in his room, 必死則生 必生則死, which means 'who has the willingness to die will survive and vice versa,' shows his desperate heart at the time of adversity. Changing his study area to bio and brain engineering, he got interested in creativity development. Then he published some books on creativity. Let's look at his three-dimension creativity development method.

He defines creativity as follows: 'creativity is a power to make me think differently from my former self,' 'a departure from what you are used to is a starting point of creativity' and 'creativity is obtained by a combination of existing facts and different pieces of knowledge, not by the creation of a completely new thing.' Moreover, a genius is defined as a person who thinks in a different way (Lee, 2014). The most important departure point for a researcher to develop creativity is questioning himself or herself, he states. For the self-questioning, a researcher should understand what questions to ask as a first step and then understand how to ask the questions to the researcher himself or herself.

He suggests the three-dimension question method to decide what questions to ask. The three-dimension means time, space and area. The time question means 'think any matter in a different time frame,' and the space question means 'put any subject in a different space.' The area question views the problem in a different academic area. The core of his three-dimension question method is the questioning method based on different time, space and area. A researcher should get into the habit of self-questioning and thus, according to Professor Lee, pleasure and commendation should be given to encourage the self-questioning habit.

His perception of time is clear: “We can expand our thoughts through time traveling.” That is why he suggests order change, speed change and interpretation change to think based on different time frame. His view on space is simple as well. Becoming free from space restriction, perspectives can be liberated. As for space questioning, he suggests shape change, location change, and size change. An area involved is one of the restrictions on free thinking, he states. As thinking skills beyond the border of areas, he suggests function change, material change, and convergence. He also points out that creativity can be strengthened by a simultaneous change of time and space, time and area, and furthermore, space and area. Moreover, creativity, which changes all the three elements, including time, space and area, is also achievable, he says. The most critical factors in creativity are openness, embracement, and convergence. The three-dimension creativity method implies the background of his transition from creativity method lecture to future studies as he stated ‘future is visible on the time axis.’

Three dimensional change for creativity

- Time frame change: order change, speed change and interpretation change
- Space frame change: shape change, location change and size change
- Area frame change: function change, material change, and convergence
- Time and space change, time and area change, space and area change
- Time, space and area change simultaneously

2. Creativity Development Theory

We have reviewed the literature related to creativity method to identify the position of Professor Lee’s creativity method. A large number of academic journals were found on SCOPUS DB when searching for the word ‘creativity.’ While many of the studies were conducted in psychology and psychotherapy, creativity is being addressed frequently in other areas in recent times, such as artificial intelligence, cognitive science and brain research. It can be seen from this that his research is part of a worldwide academic trend. Because too many papers have come up, we narrowed down the search result with an additional keyword: creativity + training. The filtered result produced 372 papers on creativity, which show that creativity training is being referred in almost all academic fields. Medical science accounted for the greatest number of the total papers, 127 followed by psychology (86) and social science (84). Coupled with computer science (52) and artificial intelligence (26) also accounted for a significant volume of the literature.

Numerous books on creativity were found on Google book search. Traditional research is represented by Cohen (1967) while Kaufman and Sternberg (2006) published by Cambridge and Kieth (2012) published by Oxford University Press draw recent research trends. Interestingly, Vartanian, Bristol, and Kaufman (2013) have collected creativity research papers from various point of views in neuroscience and published it as a book at MIT Press. Thus, it can be seen that creativity study in artificial intelligence field is one of the recent worldwide trends.

3. Future Research

KAIST Moon Soul Graduates School of Future Strategy was established in 2012. It is a new graduate school that started to recruit master's degree students in 2013 and doctoral students in 2015. It runs semi-annual Advanced National Future Strategy Program in Sejong city, a new administrative capital city of Korea. Moreover, in Seoul, it runs Advanced Intellectual Property Strategy Program semi-annually. Beginning two years ago, it hosts a Conference on Strategies for National Development every Friday. Until now, the conference has been held around 90 times. The results of the conference have been published as a book named 'National Future Strategy' and the latest third edition was published recently.

V. Discussion

We designed this interview because of the following reasons. Firstly, this interview illustrates a remarkable example of a scientist who evolved his research horizontally, not pursuing it vertically in depth. Secondly, as a researcher, his performances reflect social responsibility. Thirdly, we wanted to find out the source of the power that enabled him to realize his idea in society. We appreciate that he has established a new department and a new graduate school in KAIST in the past, a conservative university in a developing country, although now it no longer is what it used to be.

This paper addresses two critical questions. The first question is which pattern is good for a researcher to evolve his or her research area. While traditional researchers in engineering and science tend to study one subject more in depth over time pursuing so-called vertical study, Professor Lee's research has evolved toward new topics by gradually changing the contents of the study. We leave it to readers to decide whether vertical or horizontal evolution is better.

The second question is about researchers' social responsibility. Researchers on natural science tend to put their concern on academic curiosity while researchers on engineering are inclined to want to see their academic results to be realized and used in society. However, as a computer scientist majoring in artificial intelligence, Professor Lee always made decisions based on social responsibility. As a researcher, he always has helped actively to shape a better future because he thinks that the whole society can fall behind if he does not work for it at present. We leave it to readers and the next generation to evaluate his work regarding the social responsibility.

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