2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
Paper ID #37847

Hybrid engineering: An auto-ethnographic story of hybrid curriculum development, learning, and teaching

Prof. Eunjeong Ma, Pohang University of Science and Technology

Trained in Science and Technology Studies, my teaching and research areas include intersections between technology/engineering and society.

Hybrid pedagogies in the making?: A case study of hybrid engineering discipline and culture

Eunjeong Ma, Pohang University of Science and Technology

Abstract: This is an auto-ethnographic account of encounters with engineering students and engineers at a technical university who has tried to diversify engineering education and practice via the merge between engineering and social science, humanities and arts. In a recent decade, to cultivate future creative innovators/engineers with global competence, the incorporation of non-technical elements such as social sciences, humanities, arts and design into core engineering curricula has never been more emphasized in the Korean national context.

In late 2000s, the South Korean government set priorities in science and technology policy to cultivate global leaders at the university level in the fields of information and communication technologies. The goal was clear to educate the undergraduate and graduate students to lead global markets in such fields rather than catching up with the latest technologies. The government funded two top-notches to establish an engineering program with expectation that convergent, student-oriented learning environment in engineering would generate global IT leaders. In the early 2010s, when a new engineering program opened, it received "doubts," "skepticism," or "envious ridicule" both from inside and outside of the university. However, about a decade later one can say that a paradigm shift has taken place and hybridity has become a new currency in engineering education to prepare for the era of highly intelligent and connected world.

The paper presents a case study of how this sort of experimentally innovative community is formed through collaborative efforts between engineers, industry, the government, and others. As much as innovative forms of pedagogies are needed in engineering education, it has been rough and fiery processes to define, configure, refigure, and reformulate hybrid pedagogies among participating actors. Drawing on about a decade-long years of experience in hybrid forms of teaching and learning environment in an engineering department, the paper follows the trajectory of a contested epistemic and pragmatic space, where the topography of engineering practice and education must be reconfigured and remapped. Combining documentary analysis, participation, and in-depth dialogue with engineers, I provide inside and reflexive accounts of what aspects of engineering have been silenced and highlighted in the process of shaping hybrid pedagogies and engineering by reflecting on and assessing the nature of "hybridity," "innovation," and "design" in engineering education.

Introduction

During the late 2000s, the South Korean government identified the need to prioritize science and technology policy in the university sector, specifically in the area of information and communication technologies, with the aim of developing global leaders. A concerning issue of a "crisis in science and engineering fields" was identified, whereby many young students were disinclined to pursue science and technology careers. In response, the government initiated an effort to attract talented young individuals to these fields. By promoting a more innovative and interdisciplinary approach to engineering education, the South Korean government endeavored to ignite interest in the field and to equip a new generation of accomplished leaders who could make substantial contributions to the global technology industry.

In 2010 and 2011, the government provided funding to two top-tier universities to establish convergent engineering programs. Under the auspices of government sponsorship, these convergent or hybrid engineering programs were made available to both undergraduate and graduate students. These programs were conceived to offer a transdisciplinary and nonorthodox approach to engineering education, with the objective of nurturing global elite leaders capable of spearheading IT (Information Technology)-based innovations on a par with internationally renowned figures, such as Steve Jobs of Apple and Mark Zuckerberg of Facebook.

Upon the inception of these programs, they were met with a range of reactions, including skepticism, doubts, and envious ridicule from internal and external parties. Nevertheless, a decade later, it has become clear that a paradigm shift has taken place, with hybridity having become the norm in engineering education and beyond (Kim 2012; Kim, Choi, and Lee 2021; Lee and Son 2019; Park, Jung, and Ma 2017; Ma 2016). This shift was deemed necessary to prepare students for the highly intelligent and connected world of the future.

The engineering department under examination is often hailed as a model exemplar of hybrid pedagogies. It is tempting to say that hhis achievement attests to the efficacy of convergent or hybrid engineering programs and affirms that these programs can offer students the requisite competencies and knowledge to thrive in the fast-paced and ever-evolving technology industry, on one hand. On the other hand, it seems to underscore the success of the government's initial initiative and reinforces the necessity of investing in science and technology education for the betterment of society.

With two issues in mind, this paper presents a reflective exploration of hybrid engineering education, with a particular focus on the relationship between humanities and social sciences and core engineering subjects. The overarching goal of the engineering education program was to foster creativity, innovation, collaboration, student-centered learning, problem-based learning, and hybrid approaches. This was reflected in the diverse array of faculty members, representing various fields including computer engineering, biomedical engineering, electrical and electronic engineering, humanities and social sciences, industrial engineering, and business administration.

Since its inception, the new engineering department's identity has been a contentious issue, particularly in relation to existing engineering disciplines and in relation to humanities and social sciences as core engineering contents. This challenge is reflected in the development of engineering curricula, where the central issue is how to embody and demonstrate creativity and hybridity through the integration of humanities, entrepreneurship, social sciences, and art (HESA). The goal of this paper is to explore the nature of hybridity in hybrid engineering education and its implications in a broader context.

Research methods and data collection

Research site: The university

The university is a prestigious, research-focused engineering institution located in a major industrial city, often compared to Carnegie Mellon University for its forward-looking approach to building collaborative and mutually beneficial relationships with the city. The student body consists of approximately 2,500 undergraduate and graduate students. Traditionally, 300 students were admitted each year without declared majors, with students selecting their majors at the end of their first academic year.

In 2012, with support from both the government and industry, a hybrid engineering program was established, admitting 20 undergraduate and 20 graduate students. While the newly formed department was structured and organized in accordance with university guidelines, it was given autonomy to operate independently with regards to admission criteria, graduation requirements, exchange programs with international universities, curriculum design, and other areas. In essence, the department was permitted to experiment innovative sorts of engineering education to a greater degree, so long as the experimentation was characterized by creative or innovative convergence or hybridity.

Research methods and data collection

In cooperation with a select group of engineers, humanists, and social scientists, I have been intimately involved in the formation of hybrid engineering curricula. Influenced by autoethnography (Ellis, Adams, & Bochner 2011), I believe that my position as an educator and researcher within the department confers a unique opportunity to navigate the intricate strata and challenges associated with hybrid engineering education. The use of autoethnographic memoirs allows for the incorporation of personal experiences and reflections to attain a more profound comprehension of the topic while simultaneously upholding the degree of critical distance to analyze and interpret findings. I partly draw on personal experience, memories, interactions, and reflections combining observation and unstructured interviews with the students, researchers, administrative staff, and faculty members of the related departments. I interviewed both undergraduate and graduate students and faculty members about the nature and directions of hybridity in engineering education. For faculty members, we have conversed over teaching pedagogies and philosophies along with occasional conversation about collaborative research. Data drawn from interviews and observation is complemented with policy reports, newspapers, academic literature review, and annual reports generated by the department. Through this research, I hope to elucidate the multifarious and intricate nature of hybrid engineering education and contribute to the ongoing discourse concerning the innovative and hybrid approach to engineering education and studies.

Hybridity as an innovation tool

"Imagination is not to be divorced from the facts: it is a way of illuminating the facts" (Whitehead 1929). "It's technology married with liberal arts, married with the humanities, that yields us the results that make our heart sing" (Jobs 2011). The most circulated phrases among the members of the department and beyond in the nation around that time was "humanistic imagination" that can lead to technological innovations. Steve Jobs' intersection of technology and liberal arts were popular to be adopted by policy makers and academics. Though Alfred Whitehead's notion on imagination was not directly cited, imaginative capacity was highly desired to apply to technology and engineering.

The department's establishment should be in the context of national Information and Communication Technology (ICT) human resources development policy that started after the economic crisis in the late 1990s. When the South Korea governments mobilized the technological and scientific capacities for the development of national economy, it looked to so-called Western countries as a reference point to emulate. And the governments had heavily relied on human resources trained in Western countries, in particular the United States, who served as the main engine of production and dissemination of advanced scientific knowledge and technology (Choi 1999). ICT fields from infrastructure to human resources were a focus of development policy for the future (Ko and Kang 2014). Viewing that the IT infrastructure, the industry, and human resources had had a tremendous success in terms of quantitative expansion, in 2010 the government launched a project to cultivate "IT Elites" or "IT Talents" at the undergraduate and graduate levels. It was a 10-year-long educational program aimed at cultivating global leaders in ICT, with a focus on IT convergence and creativity. To get ahead in the fields of IT in global markets, the government identified artificial intelligence, intelligent robotics, u-health, nanomaterials and the like as the fields to be hauled. An ostensible goal of the project was to create "Korean version of MIT Media Lab" in terms of research environment (KEA 2010). To put the project into implementation, the Ministry of Knowledge and Economy (MKE) oversaw setting up a 10 year-long roadmap, selecting the university to carry out the project, and auditing and overseeing the university chosen.

> The aim of this project is to develop creative and skilled researchers who will lead the way in developing new technologies and finding solutions to the challenges faced in

> building future societies. The focus will be on utilizing Information and Communication Technology (ICT) in novel and unconventional ways that go beyond traditional methods and conventional thinking (MKE 2011a).

To be more specific, the government agency defined this project as an effort to achieve ICT convergence while prioritizing the development of highly skilled professionals in this field. In order to create a Korean style Media Lab, the Ministry envisioned an open system as the solution for promoting innovative education. The concept of an open system in education was closely tied to promoting innovative and disruptive teaching and learning methodologies that broke away from traditional and conventional approaches. At the time when the department was established with government sponsorship, representatives from policy and research institutes for science and technology advocated for the fusion of science/technology and humanities/social sciences as disruptive methods to lead to transformative innovations (Choi 2009; Kim et al. 2007; Song 2010; Song, Sung and Chang 2011). As a result, the following principles were emphasized: multidisciplinary education and research, apprenticeship-style educational approaches that move away from traditional lecture-based learning, research and practice-based learning built upon mentor-mentee relationships, and student-centered programs (KEA 2010).

In both 2010 and 2011, the Ministry selected two prestigious universities to establish convergent engineering programs (MKE 2011a). Since then, due to government policies and funding opportunities, it has become a trend for universities to create new departments or graduate schools with titles such as "convergence," "fusion," or "interplays" (Kim 2018).

Engineering curricula: Imagining and institutionalizing hybridity

What teaching principles and methods should and could be adopted to stand for and amplify creativity and convergence? Steve Jobs was an iconic figure that should and could be cultivated via innovative engineering education, according to policy administrators and makers. Led by select faculty members of Electrical and Electronic Engineering, the members of the department mobilized from a diverse range of disciplines shared “creative convergence” or “hybridity” as a cornerstone of the newly founded departmental identity. They made collective efforts to imagine and realize student-oriented innovative teaching and learning environments that should be differentiated from traditional modes of learning. A consensus among the members of the department was reached about hybridity: infusion of non-technical contents represented by humanities, social sciences, art, business into technical contents. Those engineering faculty members who joined the engineering program did not know how to refer to people with intellectual backgrounds in non-engineering. For the sake of convenience, the majority with engineering backgrounds adopted IT (information technology) vs non-IT people.[1] At the beginning more than 30 faculty members with diverse engineering backgrounds joined the program, while less than 5 members were recruited from humanities, entrepreneurship, social sciences, and arts (HESA).

The curricular design principle was based on the integration of subjects, termed as non-IT subjects, into core engineering subjects. The idea was very much like appropriating usable/applicable dimensions of humanities as if they would lend imaginative power to engineering capacity. About one third of mandatory courses were composed of non-IT subjects, whose teaching and learning models were project-based studios. Though attempts were made to hybridize between non-technical and technical subjects, there was a palpably

[1] I am using actors’ category. From the very beginning, there was a problem with how people perceived and categorized others with different intellectual backgrounds. This was particularly evident in the division between engineering and humanities and social sciences, described as a division between two cultures by Snow in 1959.

deep-rooted epistemic and ontological wall between the two. In other words, for the faculty members with engineering backgrounds, hybridity or convergence meant to have HESA contents, whose nature should be differentiated from conventional humanities and social sciences as one faculty member emphatically mentioned “To cultivate creative engineers we need humanities, social sciences, arts. But not in the sense of traditional, discipline bound literature, history, and philosophy” (*mun sa cheol* in Korean, personal conversation with electrical engineer in 2015). All engineering faculty members I met shared the similar view about HESA subjects: desperately needed. However, the need was conditional in that faculty members with engineering backgrounds believed that such subjects should be subservient to technical subjects. That is, they believed that HESA subjects should help engineering students to cultivate imaginative power that could lead to technological innovations.

Being outnumbered, people including me in charge of HESA subjects found daunting to reinvent engineering education with our input. People standing for HESA tried to voice that hybridity meant to merge HESA subjects and conventional engineering subjects at equal measure. In the process, the members found that it was indeed challenging to create a hybrid engineering project without falling into binary loop. We did not have terms to refer to the other and the new one to be created; thus, we kept repeating “for the sake of better terminologies,” “for the sake of time saving,” and returning to the binary loop: technical vs. non-technical, IT vs. non-IT. Whenever it occurred, those with engineering backgrounds turned to HESA people saying that “you are word makers. Propose better terminologies.”

As to the issue over how to best put the curricular change into practice with different understandings and interests among members, one of the hotly and fiercely debated issues was architectural design of the departmental building and spatial arrangements of classrooms. Designing spatial composition and arrangements of classroom was predicated on the assumption that teaching philosophy, teaching methods and practices were innovative, disruptive to a certain degree for that matter. Like Shaping suggests, the architectural design and spatial arrangements embody social and political relations. And we also intended to equip disciplinary identity by building a symbolic space to represent and further bond hybridity, creativity, and convergence.

> “The physical and the symbolic siting of experimental work was a way of bounding and disciplining the community of practitioners, it was a way of policing experimental discourse, and it was a way of publicly warranting that the knowledge produced in such places was reliable and authentic.” (Shapin 1988, p. 373-4)

The government funding agency made it clear that a new building should embody and express creativity and open innovation from every angle, and came down to C^5 representative of “cultivating, creative, collaborative, convergence center.” Out of efforts that were tried to make the physical site to become interactional trading zones among all participating members, I would list the following three representative actions.

1) Smart classrooms: tablet personal computers were distributed to the faculty members, encouraging them to use the device to make interactions between the instructor and students more interactive and dynamic. A member of the engineering faculty praised the tablet because it allowed him to visualize his explanation effectively. Using the device, he was able to communicate with his students more intimately since he no longer needed to turn his back to write on the board. (which happened while using the board on the wall). Large TV monitors were installed in the classrooms with the expectation that tablet PCs would be connected to these screens instead of projectors. Additionally, there were high-speed wireless internet connections available.

2) Flexible classrooms and open labs: designing the classroom not to be fixated on a particular physical space in order to give the feeling that the classroom was not physically

confined, but instead flexible and expandable. The classrooms were designed based on the concept of "open space," which integrates and implements the idea of having no borders between walls and boards. For instance, desks were movable so that they could be combined and separated depending on the type of lectures, class activities, and the size of the class.

3) Problem or project-based and student-oriented learning: all courses were designed to focus on the students, their motivations, and intellectual growth. Instructors acted as mentors or advisors, rather than assuming authoritative roles, and students were encouraged to identify problems and find solutions.

Concluding remarks: Engineers as sociotechnical designers

A major goal of the hybrid curriculum was to cultivate elite engineers who could lead in the ICT-related fields and promote an innovative and entrepreneurial engineering culture that went beyond existing disciplinary boundaries. As prospective professional engineers, the following qualifications were emphasized to equip with: an intellectual mobility, self-motivation, leadership, and openness that can actively and aggressively (to a greater degree) incorporate knowledge and skills that go beyond established disciplinary territories. These ideals were reflected in the number of mandatory credits needed to complete for graduation, which included humanities and social sciences as core engineering subjects. Employing project- and problem-based learning, students were encouraged to integrate design-thinking and an entrepreneurial mindset.

As noticed and emphasized (Bashir, Hahn, and Makela 2019) in the US context, I would like to point out that it is too important to emphasize to have like-minded communities of practice that support faculty-driven innovative teaching methods. At the departmental level, all departmental members including teaching and research faculty, administrative staff, researchers, and students supported innovative curricula and teaching and learning methods and prided over the newly implemented curricular changes. For those who did not agree with faculty-driven innovation in engineering education tended to leave the department, as quoted saying “I have no idea of what this department is doing, no identity, no teaching, etc.” For the first few years, there were occasionally students who quitted the program, with fiery complaints against innovative teaching methods.

Although the reference point to a newly created program was the Silicon Valley’s innovation culture, it has been an ongoing battle over “discipline-identity” or “no-discipline-identity.” The issue was partly translated into the localization of how to shape and build Silicon Valley’s competitive innovation culture in the Korean context. The most invoked rhetoric was to set up a representative Korean exemplar differentiated from the US model. However, as experience has accumulated and more graduates are produced, it turns out that most students tend to align their engineering identity with existing disciplines, which is reflected in the fact that they choose double majors in Electrical Engineering, Computer Science and Engineering. Hybridity, achieved at the curricular level, is still at peril at the student level, let alone at the faculty level.

I cautiously conclude that hybridity, in circulation among members of the department and beyond and meant differently depending on the individual, may have acquired the status of boundary object (Star and Griesmer 1989) in a loose sense, as the ideal idea (however differently imagined) is the glue to hold people with diverse interests and backgrounds. Similarly, the practice of building hybrid curricula, which is still evolving in reflection of changes in the university and in technology policy, seems to have served as trading zones (Galison 1999) via which people have been managing to cooperate and coordinate differences.

References

Choi, Hyaeweol. (1999). “Shifting Human Resources in South Korean Science and Technology.” *Comparative Education Review* 43(2): 212–32.

Choi, Yeongoo. (2009). The fusion and exchanges among science/technology, humanities/social Sciences, and culture/arts. Science & Technology Policy 175: 40-45.

Ellis, C., Adams, T. E., & Bochner, A. P. (2011). Autoethnography: An Overview. *Historical Social Research / Historische Sozialforschung*, *36*(4 (138)), 273–290.

Galison, Peter. (1999). "Trading zone: Coordinating action and belief." In The Science Studies Reader, edited by Mario Biagioli, 137-160.

Jobs, Steve. (2011). "Steve Jobs Apple's DNA = Technology + Liberal Arts." https://youtu.be/AZeOhnTuq2I.

Kim, Jeong Hyo. (2012). Exploring the Possibility of Interdisciplinary Education for Convergence Education in Knowledge-based Society. *Korean Journal of Culture and Arts Education Studies* 7(1): 175-200.

Kim, Mi Sung, Choi, Myung Sook, and Lee, Sung Ha. (2021). An analysis of domestic research trends on university convergence education: focusing on academic papers published in registered journals from 2011 to 2020. *The Korean Journal of Educational Methodology Studies* 33(1): 77-99.

Kim, Hwan Seok, et al. (2007). A proposal to bridge and extend the link between science/technology and humanities/social sciences. Korean Association of Science and Technology Studies.

Kim, Donyoon. (2018). Pretention to get funding…163 convergence departments at the university in disappearance. The Korea Economic Daily, June 19. https://www.hankyung.com/society/article/2018061919711. Accessed July 10, 2019.

Lee, Huiyong, Seo Mingyu, and Kim Jaedeuk. (2015). A study on the strategies to vitalize the fusion between humanities/social sciences and arts vitalization at the university level in South Korea. Munhak Kwa Eoneo Hakhoi 25-41.

Lee Yedana & Son Seung-hyun. (2019). Exploring Knowledge Convergence through Project-Based Learning integrated Curriculum in University Liberal Arts Education. *Journal of Education & Culture* 25(1): 155-177.

Ko, Sangwon and Kang Hayeon. (2014). 2013 Modularization of Korea's Development Experience: ICT Human Resources Development Policy. Korea Development Institute (KDI).

KEA (Korean Electronics Association). (2010). A project to cultivate IT talents. Journal of Korean Electronics, June: 16-21.

Ma, Eunjeong. (2016). Designing Engineering: Hybridizing Imagination and Technical Knowledge. *The Korean Society of Science & Art* 24: 185-97.

MKE (Ministry of Knowledge and Economy). (2011a). A project to cultivate IT talents that will lead the age of convergence in full swing—The opening of a Korean style MIT Media Lab at Yonsei University. March 23. Press release. Ministry of Knowledge and Economy.

MKE (Ministry of Knowledge and Economy). (2011b). A consortium of POSTECH-SUNY Korea elected as the 2011 IT talents project. November 07. Press release. Ministry of Knowledge and Economy.

Naiman, Linda. 2019. The European Business Review, Design Thinking as a Strategy for Innovation, May 20. https://www.europeanbusinessreview.com/design-thinking-as-a-strategy-for-innovation/.

Park, Ju An, Jung, Sung Jun, and Ma, Eunjeong. (2017). A study on multidisciplinary and convergent research using the case of 3D bioprinting. *The Korean Society of Science & Art* 30: 151-61.

Shapin, Steven. 1988. The House of Experiment in Seventeenth-Century England. *Isis*, *79*(3), 373–404.

Snow, C.P. (1959). Two Cultures and Scientific Revolution. Cambridge University Press.

Song, Wichin. (2010). The policy agendas and need to fuse 'science/technology and humanities/social sciences'. STEPI Insight 47: 1-22.

Song, Wichin, Sung Jieun, and Chang Youngbae. (2011). A proposal to fuse science/technology with humanities/social sciences to solve social problems. Science and Technology Policy Institute, pp. 1-164.

Star, S. L., and J. Griesemer. 1989. Institutional ecology, 'Translations', and Bound ary objects: Amateurs and professionals on Berkeley's museum of vertebrate zoology. Social Studies of Science 19: 387-420.

Whitehead, N. Alfred. (1929). The Aims of Higher Education.