Education for Innovation in Japan & the US: Challenges & Approaches in the University Setting

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Introduction: Overview of Education for Innovation

The ability to innovate is an essential part of being human; mankind has survived throughout history by adapting to or anticipating change through the creation and discovery of new tools and the development of new products and services that aim to improve the human condition. Not surprisingly, educational content that aims to improve human capabilities for innovation has long been part of university curricula across a broad range of disciplines that range from product design, engineering, and engineering management to law (intellectual property), new business development, psychology (creativity and problem solving), and even art.

The aggregation of such content into university programs that focus on innovation, however, is a relatively recent phenomenon that has emerged out of the context of programs on entrepreneurship, design thinking, and management of technology. As with those fields, innovation curricula are intrinsically interdisciplinary and typically include experiential educational activities (active learning) as well as traditional teaching. A model of the various elements of innovation education is shown in *Chart 1*.

The model in *Chart 1* recognizes that innovation not only includes the initial stages of "creativity" and "product/process design" but that it also includes the institutional context in which an individual or group takes a new idea to the real world ("entrepreneurship" or "intrapreneurship") and the strategic "management" of existing and potential new ideas (e.g. their association with a revenue model) so as to maximize their positive impact, typically in terms of business results or competitiveness. Nevertheless, most innovation education programs focus on the "creativity" and "innovation" stages of the process. One widely employed approach to "creativity" and "innovation" is design thinking, which is modeled in *Chart 2*.

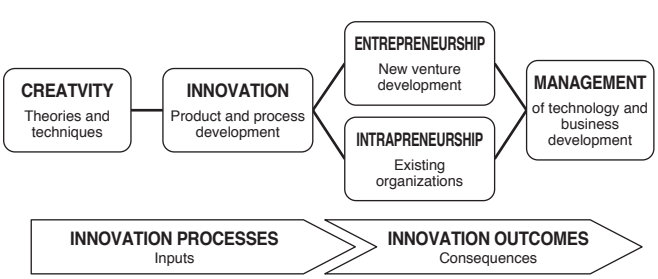
Chart 2 shows the model for design thinking in use at Stanford University's "d.school" and similar institutes. This model focuses on the innovator and on market feedback; the institutional context in which a new idea is prototyped and tested is not included. Institutional context is often addressed by separate university programs that study innovation systems (e.g. university-industry-government interactions aimed at enhancing the innovation capabilities of an economy) or entrepreneurial ecosystems.

History of Education for Innovation in US

Elements of the innovation education model shown in *Chart 1* have a long history in university programs. Programs in product design began to proliferate in the US in the 1940s and 1950s with the recognition of industrial design as a profession. For example, Stanford University created an interdisciplinary program in design

CHART 1

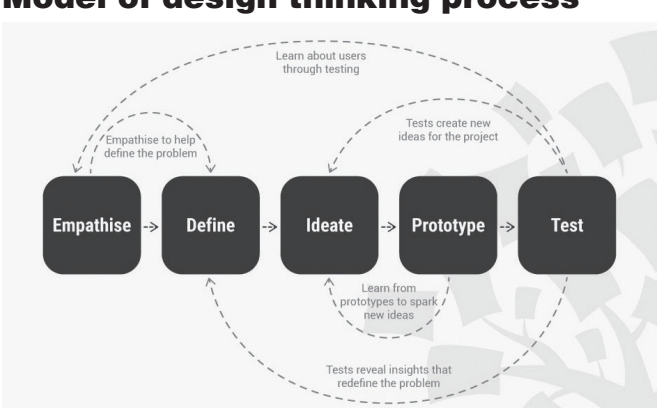
Duval-Couetil & Dyrenfurth innovation education continuum framework



Source: Nathalie Duval-Couetil and Michael Dyrenfurth, "Teaching Students to Be Innovators: Examining Competencies and Approaches Across Disciplines", International Journal of Innovation Science, Sept. 2012, vol. 4, No. 3, p. 147

CHART 2

Model of design thinking process



Source: Teo Yu Siang and Interaction Design Foundation, "Five Stages in the Design Thinking Process" <https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process>

jointly between the Department of Mechanical Engineering and the Art Department in 1958 that granted degrees in both departments. Such early programs received much influence from the German Bauhaus practical art school movement of the early 20th century.

The incorporation of elements such as industrial design into broader innovation education curricula in the US, however, owes much to two more recent trends in US university education. The first trend was the creation of educational programs in management of technology (MOT) in the early 1990s. Many MOT programs received their impetus from widespread interest in Japanese success with new technology commercialization in the 1980s. In 1991, the US government launched a major grant program, the US-Japan Industry and Technology Management Training Program, which led to the establishment of centers for Japan-related MOT education in more than 13 large US universities by 1994. Also in 1991, the first Portland International Conference on Management of Engineering and Technology (PICMET) was held. By 1992, the University of Miami had spearheaded the creation of an academic society, the International Association for Management of Technology. MOT programs at American universities presented opportunities for cooperative creation and delivery of curriculum content between engineering schools and business schools, often with direct participation by industry practitioners, and so they provided tools and connections for these disciplines and groups to cooperate in studying and teaching about innovation itself. MOT education also provided a precedent for the inclusion in curricula of innovation as a strategic tool for business competitiveness. In some cases, those MOT programs evolved into programs whose primary focus can be described as institutional and systemic aspects of innovation, e.g. the US-Asia Technology Management Center at Stanford University.

A second trend with direct historical links to the creation of innovation education programs in the US was the proliferation of educational programs in entrepreneurship from the mid-1990s. Academic programs in entrepreneurship go back at least as far as 1971, when the University of Southern California launched an entrepreneurship concentration in its MBA program (Donald Kuratko, 2005, "The emergence of entrepreneurship education: development, trends, and challenges" in *Entrepreneurship Theory and Practice*, vol. 29, pp. 577-598). Kuratko notes that around 300 universities were offering courses in entrepreneurship and small business in the 1980s. By 2005, Kuratko counted more than 2,200 courses in entrepreneurship at over 1,600 universities, with more than 100 centers that focused on entrepreneurship.

The spread of entrepreneurship programs in the 1990s was stimulated by widespread awareness of the success and impact of startup companies in the US that had been founded by young entrepreneurs and that comprised a distinctive element of economic ecosystems such as the Silicon Valley. For example, while courses on entrepreneurship can be found at Stanford from the 1980s and early 1990s, organized programs in entrepreneurship there began with the formation of the Stanford Technology Ventures Program in the School of Engineering in 1994 and the Center for Entrepreneurial Studies in the Graduate School of Business in 1996. George Deeb ("Out with MBAs — in with Masters in Entrepreneurship", *Forbes*, Oct. 16, 2013) notes that 10 of the top 25 graduate programs in entrepreneurship, and 17 of the 25 undergraduate programs in that field, were first offered since 1993.

As studies of entrepreneurship grappled with theoretical distinctions between Silicon Valley-style high-growth startups and traditional SMEs, they naturally came to include in their areas of focus the innovation processes whose outputs were realized through startup company creation. Around the same time, in the years following the dot-com crash of 2001, innovation came to be widely recognized as a key to US economic resilience and growth. In 2005, a roundtable of 15 prominent US industry associations and business organizations publicly expressed concern that the US was falling behind in its capacity for technology innovation and created the Tapping America's Potential (TAP) coalition to advocate for renewed attention to US competitiveness and America's capacity to innovate (Tapping America's Potential — The Education for Innovation Initiative, "Gaining Momentum, Losing Ground" *Progress Report 2008* <http://businessroundtable.org/sites/default/files/2008_TAP_Progress_Report.pdf>). Following a two-year study, the National Science Board (NSB) presented a report in 2010 to the US Congress and President Barack Obama that advocated efforts to develop innovators in STEM fields who could implement creative ideas in practice through new products, services, or processes ("Preparing the next generation of STEM innovators: identifying and developing our nation's human capital", NSB, May 5, 2010).

Innovation education programs began to appear in the midst of these policy discussions. The University of Colorado, Colorado Springs, launched a trademarked Bachelor of Innovation degree in Fall 2007 that it claims was the first of its kind (Julie Kliegman, "How one college built an innovative degree program … in innovation", *The Week*, June 10, 2016). From 2011, the National Science Foundation (NSF) funded and launched "Innovation Corps" (I-Corps) programs at several multi-university "nodes" across the US. Based on the approach in a course *The Lean LaunchPad* by Professor Steve Blank at Stanford, the NSF I-Corps program prepares scientists and engineers to extend their focus beyond the university laboratory, and aims to accelerate the commercialization of NSF-funded, basic-research projects. In the five years since its inception, around 3,000

scientists and engineers at 217 universities have participated in NSF I-Corps programs ("I-Corps data summary, FY 2011-2016"). In 2015, the National Institutes of Health launched its own I-Corps program, as well.

A direct connection between new innovation education programs and earlier entrepreneurship education could be seen when the NSF awarded the Stanford Technology Ventures Program along with the nonprofit organization VentureWell (formerly the National Collegiate Inventors and Innovators Alliance) a five-year, $10 million grant in 2011 to establish the National Center for Engineering Pathways to Innovation ("EpiCenter"). The EpiCenter program served as a national hub for the development of innovation education programs for undergraduate engineering students.

Distinctive Features of Innovation Education at US Universities

The approach by EpiCenter reflects a distinctive characteristic of innovation education programs in the US: it aimed at fostering innovation education from bottom-up, student-driven initiatives as well as from top-down, faculty development and institutional change initiatives. In its University Innovation Fellows program, EpiCenter trained students to analyze their campus innovation and entrepreneurship ecosystems and to create educational opportunities for their peers. During the EpiCenter grant, the program trained 607 students at 143 institutions. In 2015-16, student Innovation Fellows delivered more than 269 extracurricular events, 239 extracurricular programs, and 169 academic offerings at their institutions. At the same time, in the Pathways to Innovation program, EpiCenter personnel worked with faculty teams from 50 universities to analyze their campus assets and strategically integrate innovation and entrepreneurship into their curricula. The Pathways teams worked on more than 400 projects designed to implement sustained changes to the undergraduate experience. The resulting programs engaged about 30,000 undergraduate engineering students at participating universities, as well as undergraduate and graduate students from other disciplines. Nine of the participating universities in the Pathways program became I-Corps sites.

A second distinctive feature of innovation education programs at US universities is their emphasis on experiential activities, as well as traditional classroom education. Most programs engage students in one or more of the following: problem-definition and ideation in design thinking workshops, rapid development of startup company business plans and market research in "bootcamps", the pitching of new ideas to potential investors in role play or in business plan competitions, and corporate sector innovation through internships in companies. Students who participated in such experiential activities reported a significant increase in their self-confidence in regard to overall entrepreneurial ability and their readiness to start a business (Nathalie Duval-Couetil, Angela Shartrand, and Teri Reed, "The Role of Entrepreneurship Program Models and Experiential Activities on Engineering Student Outcomes", *Advances in Engineering Education*, vol. 5, Winter 2016, pp. 1-27).

US programs in innovation education typically involve participation by industry practitioners as well as academic experts, not only as mentors and judges for experiential activities but often as instructors in traditional classroom settings. While there has been considerable concern in the university community about the increasing percentage of contingent and adjunct faculty in the professoriate as a cost-cutting measure, the direct participation of venture capitalists, successful entrepreneurs and inventors, and industrial designers in innovation education has provided US university programs with face validity as well as primary source perspectives on practical applications of innovation theory. Practitioners also bring in a realistic sense of the time pressures involved in innovation, design, and decision-making in corporate settings.

US innovation education programs also benefit from close university-industry ties through long-established licensing and commercialization activities. Licensing of university technologies in the US, which goes back to the early 20th century and received major impetus from the Bayh-Dole Act of 1980, contributes to a general awareness of the importance of innovation among faculty and students, especially in STEM fields, and it provides exposure to real-world cases of ideation, entrepreneurship, and intellectual property management. At present, industry partners are often involved in sponsoring prizes and supplying judges for university business plan competitions, and in supplying guest lecturers with case studies of innovation.

University-affiliated business incubators and accelerators likewise encourage interest in innovation, as well as provide practical examples for students. For example, in January 2017 the State of California provided a one-time funding package of $22 million across the 10 campuses of the University of California for incubators that would "accelerate innovation and entrepreneurship". By Nov. 30, 2017, that funding had supported more than 500 new startups and existing companies, helped launch at least 47 new products, and enabled companies to attract $3.7 million in additional investments (<https://www.universityofcalifornia.edu/press-room/ab-2664-innovation-funds-supported-hundreds-startups-dozens-product-launches-2017>).

Education for Innovation in Japan

Innovation education in Japan has evolved more recently than in the US, and it has similar roots in entrepreneurship and management of technology programs at Japanese universities. Nevertheless, innovation education in Japan represents an independent approach that is integrated with international sources outside as well as inside the US, and that is in the process of optimizing itself to the structure, dynamics, and needs of the Japanese economy.

As in the US, curricula for product design served as a precursor of some aspects of innovation education in Japan. Such programs appear to have arisen more recently than in the US. Although design has long been recognized as an important industrial capability in Japan (as evidenced by the creation of a national laboratory for industrial design in 1928; see <https://www.jidp.or.jp/en/about/history/hdpj>), Virginia Prostel states in *The Substance of Style* (New York: Harper Collins, 2003) that there were no university-based design schools in Japan, South Korea, or Singapore in 1970. She notes that by the early 2000s, there were 23 design schools in those countries.

Entrepreneurship education in Japan likewise represents a newer development than in the US, at least in part because universities had been relatively isolated from the entrepreneurial ecosystem of the country. Accordingly, government policy has played a big role in the development of curricula for entrepreneurship and innovation, first through university system reform. Since the collapse of Japan's economic bubble around 1991, the Japanese government has promulgated a steady stream of laws and measures aimed at enabling and encouraging universities to innovate through technology commercialization and new business creation. Three laws have had especially notable impact. The Technology Licensing Organization (TLO) Law (1998) allowed universities to create technology transfer offices and receive licensing revenue. The National University Incorporation Law (2003) gave the national universities legal status that was independent from the government; the law stipulated that the universities should put more effort into commercializing research, and the new system ensured greater financial independence through subsequent yearly reductions in operating subsidies. And the Industrial Competitiveness Enhancement Act (2013) allowed national universities to own stock in businesses and engage directly in venture capital investment.

The University of Tokyo provides a robust example of how universities in Japan developed ecosystems for entrepreneurship education in the context of such reforms. It established an Office of Science Entrepreneurship and Enterprise Development (SEED) under a new Division of University Corporate Relations (DUCR) in 2004. SEED is now known as the University of Tokyo Innovation and Entrepreneurship Office. It became the educational center of a tripartite cooperative framework with the university's technology licensing office (CASTI) and its dedicated venture capital firm UTEC. Under SEED, the university began an entrepreneurship education program, namely The University of Tokyo Entrepreneur Dojo (training school) from FY 2005. The Dojo provides classes to 150-250 students and organizes a business plan competition each year. Of the more than 1,800 students who had completed the program by 2013, about 70-80 graduates were involved with newly created entrepreneurial ventures. SEED also led the establishment of a mentor network in close cooperation with the University of Tokyo Alumni Office (Shigeo Kagami, "Innovation and University Entrepreneurship: Challenges Facing Japan Today" in Sothea Oum, Patarapong Intarakumnerd, George Abonyi, and Shigeo Kagami, eds., *Innovation, Technology Transfers, Finance, and Internationalization of SMEs' Trade and Investment*, ERIA Research Project Report FY2013, No. 14, pp. 97-121).

A survey by Tsukuba University of 527 public and private universities in Japan in 2003 found that 44 had established entrepreneurship education programs (a ratio of 8.3%) and 236 (44.8%) had introduced lectures on entrepreneurship training (Teruo Shinato, Katsuyuki Kamei, and Léo-Paul Dana, "Entrepreneurship Education in Japanese Uuniversities — How Do We Train for Risk Taking in a Culture of Risk Adverseness?" *International Journal of Entrepreneurship and Small Business*, 2013, vol. 20, No. 2, pp. 184-204). Shinato, Kamei, and Dana further cite a survey of 22 leading entrepreneurship education programs in Japan by Daiwa Research Institute in 2006 as finding that the programs fell into three types *(Chart 3)*. This finding also explains the link in Japan between MOT content and entrepreneurship programs.

Entrepreneurship education in Japan recently received further stimulus from the EDGE grant program (Enhancing the Development of Global Entrepreneurs) of the Ministry of Education, Culture, Sports, Science and Technology (MEXT). EDGE provided funding from 2014 to 2016 for entrepreneurship programs at 13 universities and multi-university centers. The goals of the EDGE program resemble those of the NSF I-Corps: to provide students with the skills and knowledge they will need to become innovators and entrepreneurs. The EDGE-NEXT program will continue to provide funding in new grants from 2017 to 2022.

As with many programs in the US, the scope of the EDGE program includes elements that fall under "creativity" and "innovation processes" as well as the "entrepreneurship" block in the model for innovation education shown in *Chart 1*. Accordingly, EDGE program centers include university organizations with a focus on innovation

CHART 3

Types of university entrepreneurship education programs in Japan

Type A: **MBA courses (52%), whose aims are to train students in management and foster skills necessary for founding a business.**

Type B: **MOT (management of technology) courses (20%), whose aim is to provide students of technology with management skills.**

Type C: **Career education courses for undergraduate students (28%), as general education, even for students who have no intention to set up an enterprise.**

Source: Shinato, Kamei, and Dana, 2013

rather than entrepreneurship in the narrow sense.

Programs with a specific focus on innovation appear to have emerged in Japan in the mid-late 2000s. For example, the University of Tokyo launched an "i.school" in 2009 under its Center for Knowledge Structuring (CKS), itself established in June 2007. The improvement of innovation capabilities was included as an aspect of the applied technology development that formed the main focus of CKS, which also served as a platform for joint research projects with companies in information technology, nanotechnology, and related technical areas. The University of Tokyo i.school subsequently led an interdisciplinary team that included the Division of University Corporate Relations and the School of Medicine in establishing the EDGE program center at the University of Tokyo. In 2017, however, the i.school spun out of the university and became an independent nonprofit organization; this development allows it to expand its offerings to students at other universities and already-employed persons.

In 2012, representatives of a number of Japanese universities that had developed content related to innovation education established the Academic Society for Innovation Education. Founding partners included the University of Tokyo (i.school), Keio University (the Graduate School of System Design), Kyoto University (Design School), Tokyo Institute of Technology, Kyushu University (the Graduate School of Art Engineering and the Robert Huang Entrepreneurship Center), and Tohoku University (Sendai School of Design). This academic society now includes over 950 individual members who are involved with innovation activities at Japanese universities and nonprofits.

Characteristics & Challenges for Innovation Education in Japan

Japanese universities have approached innovation education with a highly international outlook as well as with industry participation. For example, the University of Tokyo i.school partnered with design groups at major universities and industrial design firms in the United Kingdom, Finland, S. Korea, and India, as well as the US, in developing and delivering its programs. Accordingly, the theoretical underpinnings of innovation education in Japan reflect the worldwide state of the art. Moreover, Japanese university innovation education programs are incorporating many of the experiential activities found elsewhere. An exception, however, is the relative absence of student-led programs and student participation in curriculum formation.

It must also be noted that the environment of actual innovation activities at universities is still less well established in Japan than in the US. Although growing rapidly, licensing and startup company creation by Japanese universities is a recent phenomenon that may provide less clear evidence of which approaches represent best practices. This situation means that university-based innovation education in Japan lacks both content and stimulus that are easier to find in the US.

Moreover, large Japanese companies have not yet opened their strategic planning processes to the influence of bottom-up innovation or open innovation with startup companies; instead, companies tend only to select innovation items that already match their existing strategic roadmap. This pattern limits industry's capability to benefit from the new voices of young innovators who have been trained at the university.

Finally, both in Japan and in the US, university-based innovation education tends not to address the organizational learning and change management challenges that accompany a robust innovation system. For example, few if any programs consider the challenge of deciding when to abandon an existing product or service. Instead, the university programs are still primarily oriented to developing individual capabilities to create new innovations. The field still has a long way to grow. JS

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