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Hajime Ito and Jun Kurihara[1]

A Discourse on the New *Kai'entai*: A Scenario for a Revitalized Japan

「新『海援隊』論」

1. The Fall and Decline of "*Mono-zukuri* (Craftsmanship)" Japan?

The year 2010 will mark a historic moment for Japan's economy. Japan's gross domestic product (GDP) that has been the second largest after the United States' since 1967 is expected to be overtaken by China's. Japan should applaud China's spectacular rise on the ground that East Asia has become a *bona fide* node of global economic networks along with North America and West Europe. While China's manufacturing sector has been called the "factory of the world," Japan's manufacturing sector has taken pride in being the "mother factory of the world." The "mother factory of the world" means that Japan's manufacturing sector provides local factories around the world with prototype products that could be sophisticated according to local preferences and regulations in major markets including North America, Asia, and Europe.[2] Under these circumstances, the Japanese people like to call Japan a country of "*mono-zukuri* (craftsmanship/artisanship)."[3]

This essay examines the long-term sustainability of Japan's status as the "mother factory of the world." The authors are concerned about the future of Japan's "mother factory" status. In the globalization age, Japan's technologies, however sophisticated and suitable exclusively for Japan's domestic demand, might not necessarily be incorporated or embedded into products and services in the global marketplace. Without global cooperation, Japan might run the risk of developing unwittingly what have been already developed outside Japan and of wasting precious resources through dual investment. Or without global cooperation, Japan might also run the risk of going too far without being appreciated in the global marketplace and of losing opportunities to reap the fruits of Japan's research and development (R&D) investment at earlier stages.

In the meantime, young Chinese researchers are studying at top U.S. universities and communicating, through these universities' global networks, with their counterparts all around the world. In sharp contrast, Japanese researchers tend to remain within Japanese soil. They are also reluctant to study at U.S. universities. To make matters worse, they cannot communicate with their foreign counterparts in English. As a result, few Japanese scholars participate in global

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1 Hajime Ito is President of Japan External Trade Organization (JETRO) New York (Hajime_Ito@jetro.go.jp). Jun Kurihara is a Senior Fellow, Harvard Kennedy School (HKS). He also serves as a Research Director of the Canon Institute for Global Studies (CIGS) and a liaison officer of the Research Institute of Economy, Trade and Industry (RIETI) (Jun_Kurihara@hks.harvard.edu). The views expressed in this essay are those of the authors and do not necessarily reflect those of JETRO, HKS, CIGS, or RIETI.

2 See, for example, Junjiro Shintaku and Tomofumi Amano, "Emerging Market Strategy of Japanese Firms: Reshaping the Strategies in the Growing Markets," Paper prepared for the 8th Northeast Asia Management and Economics Joint Conference, October 14-17, 2009, Government of Japan (including Ministry of Economy, Trade and Industry (METI)), *Seizo Kiban Hakusho*/*Mono-zukuri Hakusho* (『製造基盤白書』/『ものづくり白書』), June 2007, p. 63, and Jos Benders and Masaya Morita, "Changes in Toyota Motors' Operations Management," *International Journal of Production Research*, Vol. 42, No. 3 (February 2004), pp. 433-444.

3 For example, Toyota, Japan's largest manufacturer, produced 7,234 thousands automobiles worldwide in 2009, out of which its domestic production is only 3,543 thousands (47.7% of Toyota's total production) according to Toyota Motor Corporation's press release, January 25, 2010, see http://www2.toyota.co.jp/en/news/10/01/ 0125.html.

networks where leading scholars, irrespective of their nationalities, cooperate to expand new frontiers of science and technology. If these trends continue, the "mother factory," now located on Japanese soil, might move somewhere else.

Based on these observations, the authors advocate a formation of the new *Kai'entai*. The original *Kai'entai* was a trading company established at the time of Japan's national crisis in 1865 by *ronins* (masterless *samurais*) spearheaded by an internationally minded revolutionary named Ryoma Sakamoto. The main purposes of the *Kai'entai* were to amass those who, regardless of their original affiliations throughout Japan, had interest in overseas affairs with personal aspirations, and introduce foreign products and practices into then segregated Japan.[4] Heisei-era's Japan needs, like Japan just prior to the Meiji Restoration, a group comprising individuals of high caliber who are interested in foreign affairs and try to combine their skills and knowledge with those of their foreign counterparts.[5] Accordingly, this essay examines first the current condition surrounding Japan's manufacturing sector and then argues the globalization of R&D as well as the segregated condition of Japan's research capabilities. The essay concludes the need of the establishment of the new *Kai'entai* to revitalize Japan by connecting Japan's domestic resources with demand and resources located outside Japan.

2. Current Condition of "*Mono-zukuri* (Craftsmanship)" Japan

2.1. China's expanding manufacturing base and a "manufacturing conundrum" in industrial countries

Japan is now enjoying its status as the "mother factories of the world." The share of Japan's manufacturing production, however, has fallen gradually over long years (See Table 1). This trend can be easily understood because Japan's manufacturers have relocated their production factories toward outside Japan to get geographical vicinity to local markets to respond quickly to geographically specific market needs.

Table 1. Shares in the World's Manufacturing Sector (value-added at constant 2000 market prices, %)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Japan	20.8	19.6	18.9	18.8	18.0	17.5	17.7	17.8	17.7	17.5	17.1	16.8	14.7	16.5
U.S.	26.9	27.6	28.1	28.0	27.0	27.2	26.7	26.7	26.3	25.8	25.0	23.9	23.5	23.4
China	5.9	6.4	6.7	7.0	7.7	8.4	9.3	9.5	10.1	10.9	12.1	13.3	15.4	15.2
Europe	24.7	25.0	24.6	24.3	24.9	24.2	23.5	22.8	22.3	22.1	21.9	21.7	20.6	21.0

Note: The figures for 2009 and later are OECD estimates.
Source: Statistics shown in Figure 1.2. in the Organisation for Economic Co-operation and Development (OECD), *OECD Country Survey of China*, February 2010, p. 24.

In the mean time, China's manufacturing sector has grown rapidly. In 1997, China's manufacturing production accounted for a meager 5.9% in the world. In 2009, however, its share has risen to 15.4% surpassing Japan's. While Japan's manufacturing sector was hit hard by the so-called 2008 Lehman Shock, its Chinese counterpart demonstrated its resilience primarily because of buoyant domestic markets supported by massive government spending and speculative real estate investment. China's rapidly changing economic landscape has provided its manufacturing sector with enormous opportunities; in addition to exports, massive infrastructure development, aggressive production facility

[4] See, for example, Marius B. Jansen, *Sakamoto Ryoma and the Meiji Restoration*, Princeton, NJ: Princeton University Press, 1961, p. 267.

[5] Heisei is the current era name in Japan. Modern Japan has an era name during the reign of an Emperor. For example, Meiji is the era name during the reign of Emperor Meiji (Mutsuhito) (1867-1912), and the period during the reign of Emperor Showa (Hirohito) (1926-1989) is called the Showa era.

building. Furthermore rapid urbanization throughout China have proliferated opportunities for manufacturing activities. Accordingly, China's steel production has soared recently, having made its Japanese and American counterparts look dwarfed in the steel-making community (See Table 2).[6]

Table 2. Shares in the World's Steel Production (%)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Japan	13.1	12.0	11.9	12.6	12.1	11.9	11.4	10.5	9.8	9.3	8.9	9.0
U.S.	12.3	12.7	12.3	12.0	10.6	10.1	9.7	9.3	8.3	7.9	7.3	6.9
China	13.6	14.7	15.7	15.0	17.7	20.2	22.9	26.2	31.0	33.8	36.4	37.9
Europe	24.3	24.6	23.1	22.8	22.0	20.8	19.8	18.9	17.1	16.5	15.6	14.9

Source: Statistics shown in Figure 1.2. in the Organisation for Economic Co-operation and Development (OECD), *OECD Country Survey of China*, February 2010, p. 24.

In the meantime, advanced industrial countries have suffered a "manufacturing conundrum," as Nobel laureate economist Joseph E. Stigliz argues.[7] He notes:

> Manufacturing has long represented the pinnacle of a particular stage of development, the way for developing countries to leave traditional agrarian societies. Jobs in the sector traditionally have been well paid and provided the backbone of the twentieth-century middle-class societies of Europe and North America. Over recent decades, successes in increasing productivity have meant that even as the sector grows, employment has decreased, and this pattern is likely to continue.[8]

2.2. Japan's manufacturing with its focus on High-tech fields

While all advanced industrial countries suffer the "manufacturing conundrum," Japan still has a breathing time to galvanize Japanese younger generations to bolster Japan's international competitiveness. As Table 3 shows, Japan's high-tech companies have their will and ability to devote their resources to R&D. On the other hand, China is currently busy catching up rapidly and it's still left behind in many sectors where high-tech companies both in Japan and in the West are prevailing.[9]

Table 3. R&D Activities of Japan, the United States, China, and Europe (%)

	Macro Data (2007) (% of GDP)	Industry Data		
		High-tech companies	Medium-tech companies	Low-tech companies
OECD Average	2.3	30.2	10.1	0.6
Japan	3.4	29.2	14.6	0.6
U.S.	2.7	38.3	10.3	0.7
China	1.5	3.9	2.7	0.7
Europe	1.8	24.3	8.4	0.4

Source: Statistics shown in Organisation for Economic Co-operation and Development (OECD)'s *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, p. 27, and in *OECD Country Survey of China*, February 2010, p. 26.

Buoyant R&D activities would enhance productivity growth and promote technology exports to other countries.

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6 Some observers, however, claim that China's steel makers should improve their product quality. See, for example, Karen Fisher-Vanden and Rebecca Terry, "Is Technology Acquisition Enough to Improve China's Product Quality?" *Economics of Innovation and New Technology*, Vol. 18, No.1 (January 2009), pp. 21-38.

7 Joseph E. Stiglitz, *Freefall: America, Free Markets, and the Sinking of the World Economy*, New York, NY: W.W. Norton, 2010, p. 190.

8 *Ibid*.

9 As for difficulties facing China's high-tech companies, see, for example, Ming Gu and Edison Tse, "Building Innovative Organizations in China: The 'execution+' Organization," *Asia Pacific Journal of Management*, Vol. 27, No. 1 (March 2010), pp. 25-53.

Thanks to accumulated efforts over the past years, the United States and the United Kingdom have enjoyed a surplus in the technology balance of payments. Japan has also improved its balance of payments and currently registers a surplus accounting for 0.34% of GDP as of 2006 (See Table 4).

Table 4. Technology Balance of Payments (2007, % of GDP)

	Japan	U.S.	U.K.	France	Germany	Sweden	Austria	Canada	Switzerland
%	0.34	0.42	0.60	0.11	0.04	1.23	0.95	0.13	-1.02

Note: France's figure is for 2003.
Source: Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, p. 119.

Regarding the technology balance of payments as a percentage of GDP, Japan ranks 5th after Sweden, Austria, United Kingdom, United States, and Denmark among OECD countries.[10] Given the high level of R&D efforts in Japan, Japan's technology balance of payments is expected to play a significant role in stabilizing its economic growth. At the same time, the *modus operandi* in R&D efforts—cooperation between the academic and business communities, government support, and international strategic technology alliances—is now under scrutiny to improve efficiency of R&D activities.[11]

Tables 5 and 6 show major countries' share of patents filed under the Patent Co-operation Treaty (PCT) in the fields of the environmental and life science technologies. The tables show that Japan's R&D efforts in these fields have produced fruitful results. In the environmental field, as Table 5 shows, especially in the solid waste management, Japan ranks first regarding its share of patents filed. In the fields of air pollution control (APC), water pollution control (WPC), and renewable energy, Japan ranks second behind only the United States.

Table 5. Top 10 Countries in Environmental Technologies Patents Filed under PCT (2004-2006, %)

	Air Pollution Control		Water Pollution Control		Solid Waste Management		Renewable Energy	
	Countries	%	Countries	%	Countries	%	Countries	%
1	U.S.	26.02	U.S.	22.52	**Japan**	19.37	U.S.	19.63
2	**Japan**	23.92	**Japan**	18.44	U.S.	17.83	**Japan**	18.74
3	Germany	18.79	Germany	9.56	Germany	8.26	Germany	11.91
4	France	6.44	Australia	5.01	U.K.	5.84	U.K.	4.93
5	U.K.	4.02	U.K.	4.38	South Korea	4.90	Spain	4.41
6	Sweden	2.54	France	3.97	Italy	4.46	Denmark	4.15
7	South Korea	2.22	South Korea	3.71	Australia	3.92	China	4.03
8	Canada	2.13	China	3.62	France	3.75	Australia	3.28
9	Italy	1.77	Canada	3.40	Canada	3.31	Canada	2.95
10	China	1.35	Netherlands	2.09	China	3.26	France	2.86

Source: Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, p. 53.

Japan demonstrates its technological competitiveness in the life science field as well (See Table 6). Japan ranks second just only behind the United States in the fields of medical technology, pharmaceuticals and biotechnology, setting aside the arguments if possession of a larger number of patents filed is a meaningful indicator of

10 Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, p. 119

11 See, for example, Government of Japan, Ministry of Education, Culture, Sports, Science and Technology (MEXT), *White Paper on Science and Technology 2009* (『科学技術白書』), Tokyo, June 2009, Part I Chapter 3.

competitiveness or performance of an industry.[12]

Table 6. Top 10 Countries in Life Science Technologies Patents Filed under PCT (2004-2006, %)

	Medical Technology		Pharmaceuticals		Biotechonoloy (2006 only)	
	Countries	%	Countries	%	Countries	%
1	U.S.	48.49	U.S.	42.06	U.S.	43.50
2	**Japan**	10.53	**Japan**	10.99	**Japan**	11.63
3	Germany	7.69	Germany	7.53	Germany	6.74
4	U.K.	4.25	U.K.	5.86	U.K.	4.43
5	France	2.73	France	3.94	France	3.69
6	Israel	2.69	Canada	3.21	Canada	3.04
7	Sweden	2.20	India	2.46	South Korea	2.84
8	Netherlands	2.16	Italy	2.25	Netherlands	2.81
9	Switzerland	2.11	China	2.11	Australia	2.00
10	Australia	2.07	Switzerland	1.94	China	1.85

Source: Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, pp. 61 and 67.

The OECD's *Science, Technology and Industry Scoreboard 2009* also tells us that in the nanotechnology field Japan ranks second just behind the United States. These statistics give us an impression that the future of Japan's manufacturing sector is bright and its current status as the "mother factory of the world" with a spirit of "*mono-zukuri* (craftsmanship/artisanship)" will last for a long time.

2.3. Japan's technological superiority: Does it last long?

In order to examine the long-term viability of Japan's technological competitive edge, the authors pay attention to the current frontline of various science fields. Innovation is a result of long-time accumulation of knowledge and experience including patent filing and paper/patent citation.[13]

The OECD's *Science, Technology and Industry Scoreboard 2009* provides a guidance to identify new areas of science by co-citation analysis. Co-citation is a form of citation in which a set of papers is simultaneously cited by other papers. By clustering oft-cited papers, this analytical approach can identify "research fronts" and "research area," as well as "core papers or core articles" that are oft-cited by other papers in a research front or area.[14]

According to this co-citation analysis, the previous image that Japan is one of the leading countries in advanced technological fields completely disappears (See Tables 7 and 8). Table 7 shows that Japan ranks 13th in the field of

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[12] For example, a recent study regarding Japan's pharmaceutical industry shows that the number of patents filed is rather negatively related to corporate performance, see Jörg C. Mahlich, "Patents and Performance in the Japanese Pharmaceutical Industry: An Institution-Based View," *Asia Pacific Journal of Management*, Vol. 27, No. 1 (March 2010), pp. 99-113. Ryuhei Wakasugi and Harue Wakasugi identify the culprit of problematic R&D activity in Japan's pharmaceutical industry as Japan's national legal and regulatory framework. As for detailed arguments, see Ryuhei Wakasugi and Harue Wakasugi, "The Effects of Regulation on Japan's Pharmaceutical Research and Development," *The Japanese Economy*, Vol. 35, No. 4 (Winter 2008/2009), pp. 107-132.

[13] See, for example, Adam B. Jaffe and Manuel Trajtenberg, *Patents, Citations, and Innovations: A Window on the Knowledge Economy*, Cambridge, MA: MIT Press, 2002, Ajay Agrawal and Rebecca Henderson, "Putting Patents in Context: Exploring Knowledge Transfer from MIT," *Management Science*, Vol.48, No.1 (January 2002), pp. 44-60, and Andrea Mina, "The Emergence of New Knowledge, Market Evolution and the Dynamics of Micro-Innovation System," *Economics of Innovation and New Technology*, Vol. 18, No. 5 (July 2009), pp. 447-466.

[14] As for detailed arguments, see Masatsura Igami and Ayaka Saka, "Capturing the Evolving Nature of Science, the Development of New Scientific Indicators and the Mapping of Science," STI Working Paper 2007/1, Paris: Organisation for Co-operation and Development (OECD), February 2007. See also Roberto Fontana, "Mapping Technological Trajectories as Patent Citation Networks. An Application to Data Communication Standards," *Economics of Innovation and New Technology*, Vol. 18, No. 4 (June 2009), pp. 311-336.

climate change. In the fields of air and chemical pollutants, Japan ranks 12th. Japan ranks 14th in the field of biodiversity. As noted earlier, Japan ranks second in patent filling in the field of air pollution control as Table 5 shows. It means that while Japan possesses a dominant position in patent filing in the climate change field, it has not played a leading role in providing core articles.

Table 7. Top 14 Countries in Core Articles in Environmental Science (2001-2006, % of entire core articles in all fields)

	Climate Change		Air and Chemical Pollutants		Biodiversity	
	Countries	%	Countries	%	Countries	%
1	U.S.	2.23	U.S.	2.40	Denmark	2.46
2	U.K.	2.19	Sweden	2.25	U.K.	2.44
3	Switzerland	2.14	Switzerland	2.01	Switzerland	2.37
4	Netherlands	1.91	Netherlands	1.81	Netherlands	2.17
5	Sweden	1.81	U.K.	1.79	U.S.	2.09
6	Canada	1.78	Canada	1.58	Belgium	1.88
7	Australia	1.59	Australia	1.16	Sweden	1.83
8	Belgium	1.39	Germany	1.00	Australia	1.73
9	Germany	1.14	France	0.82	Canada	1.65
10	France	1.11	Italy	0.59	Germany	1.34
11	Spain	0.79	Spain	0.55	France	1.07
12	Italy	0.64	**Japan**	0.46	Spain	0.83
13	**Japan**	0.23	China	0.18	Italy	0.57
14	China	0.15	n.a.	n.a.	**Japan**	0.26

Source: Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, p. 53.

This staggering contrast between Table 5 showing the rankings of patent filing and Table 7 showing the rankings of core articles makes us excogitate the future of Japan's technological preeminence. The Japanese cases present a sharp contrast to those of the United States, the United Kingdom and Canada.[15] The United States has many patents filed as well as leading researchers who write core articles. The United Kingdom and Canada have fewer patents filed but more core articles than Japan does. It is understandably very difficult to connect directly the result of patents filed with the contribution to core articles in a specific field.[16] However, Ajay Agrawal of the University of Toronto and Rebecca Henderson of the Harvard Business School (HBS) conclude based on the data regarding knowledge transfer from MIT that "patent counts are not useful measures of the overall output of new knowledge," and propose that paper count is a "reasonable measure" of output of new knowledge.[17] They also argue that paper citations have a significant impact on patent counts. If citation of core articles have influence over patent counts as Agrawal and Henderson argue, the future of Japan's patent filing might look bleak and gloomy.

The same pattern can be observed in the life science field. Table 8 shows that in any subfields of life science—genomics, regenerative medicine, and plant science research—Japan's rankings are not so appealing, i.e., 13th, 12th, and 15th respectively. These rankings are alarming compared to Japan's rankings in Table 6. As in the field of

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15 As for Japan's R&D efforts, suffice it to refer to the seminal work of Ikujiro Nonaka and Hirotaka Takeuchi, *The Knowledge-creating Company: How Japanese Companies Create Dynamic Innovation*, Oxford: Oxford University Press, 1995.

16 As for recent studies on a relationship patents and academic papers, see, for example, Brent Goldfarb, Gerald Marschke, and Amy Smith, "Scholarship and Inventive Activity in the University: Complements or Substitutes?" *Economics of Innovation and New Technology*, Vol. 18, No. 8 (November 2009), 743-756.

17 Agrawal and Henderson, *op. cit*., p. 59.

climate change, in the life science field, Japanese scholars' role to provide core articles is very limited compared with its American and European counterparts.

Table 8. Top 15 Countries in Core Articles in Life Science (2001-2006, % of entire core articles in all fields)

	Genomics		Regenerative Medicine		Plant Science Research	
	Countries	%	Countries	%	Countries	%
1	U.S.	2.46	U.S.	2.48	U.S.	2.24
2	Switzerland	2.12	Switzerland	2.09	Switzerland	2.23
3	U.K.	1.85	Netherlands	1.61	Denmark	2.04
4	Netherlands	1.75	Sweden	1.58	U.K.	1.76
5	Belgium	1.54	U.K.	1.56	Netherlands	1.60
6	Sweden	1.46	Belgium	1.51	Belgium	1.60
7	Germany	1.22	Germany	1.26	Sweden	1.58
8	Canada	1.20	Canada	1.19	Canada	1.31
9	Australia	1.02	France	0.94	Germany	1.26
10	France	0.93	Australia	0.92	Australia	1.07
11	Italy	0.82	Italy	0.82	France	1.05
12	Spain	0.68	**Japan**	0.59	Spain	0.80
13	**Japan**	0.49	Spain	0.52	Italy	0.75
14	n.a.	n.a.	n.a.	n.a.	India	0.55
15	n.a.	n.a.	n.a.	n.a.	**Japan**	0.51

Source: Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, p. 69.

Based on the abovementioned observations, that authors conclude that Japan today should rethink how new knowledge is being created. In this connection, Andrea Mina, a Senior Research Fellow at the Centre for Business Research of the University of Cambridge, says:

> The process through which new technologies emerge and develop over time is the outcome of *complex interaction between heterogeneous agents* (italics added) differing their incentives, behaviours, and competence bases. The engine of innovation processes is the creativity of scientists, engineers, and entrepreneurs. This is chanelled and gradually institutionalised in innovation systems as a result of the growth of communities of practitioners driven by the localised search for solutions to scientific, technological, and market problems.[18]

Japan should take to heart that *complex interaction between heterogeneous agents* play an important role in the creation of new knowledge. When Japan was at the stage of developmental catching-up between the end of World War II and the 1970s, its homogeneous value systems and its homogeneous behavioral patterns served quite successfully.[19] However, today's Japan has already reached at its matured stage. Furthermore, Japan is now living in the globalization age. Japan should pay attention to a constellation of heterogeneous, if small, intellectual communities that can communicate freely and frequently with their foreign counterparts. Accordingly, the authors pay attention to the process of technology frontier formation by focusing on the interplay among leading researchers differing their affiliations, incentives, behaviors, and competence.

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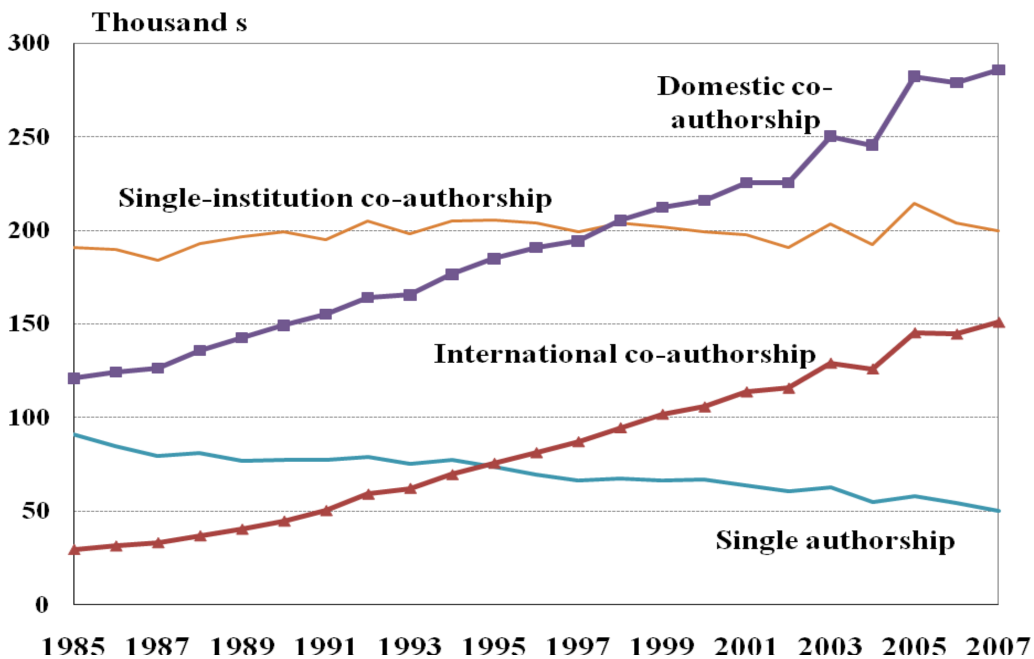
[18] Mina, *op. cit.*, p. 449.

[19] See, for example, Ezra F. Vogel, *Japan as Number One: Lessons for America*, Cambridge, MA: Harvard University Press, 1979.

3. Globalization of Research Activities

In this relentlessly globalizing world, only one thing we can safely say is that we are living in the age of cross-border networking. Figure 1 shows an undeniable long-term trend in academic article authorship. This figure shows a sharp rise in co-authorship both domestically and internationally, and both individually and institutionally.

Figure 1. Global Trends in the Co-operation in Science (1985-2007)



Source: Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, p. 115.

Rapid progress in information and communication technology (ICT) and extensive development of cross-border transportation networks have brought about a freer, cheaper, and frequent flow of information as well as people and materials. These phenomena have lowered geographical barriers and raised the possibility of global interdisciplinary R&D activities. Under these circumstances, international cooperation in R&D activities has rapidly advanced. They have also brought about an increasing number of international co-authorship by taking full advantage of division of intellectual labor.[20] According to OECD, in 2007, about 21.9% of scientific articles are written under co-authorship, and the figure is three times higher than in 1985 (6.7%).[21]

Given a rich history of theological studies dating back to the Middle Ages and its geographical proximity, Europe has a higher share of international co-authorship by international standards (See Table 9).The United States is

[20] Recently scholars at INSEAD and the HBS show that cooperation can reduce the probability of very poor outcomes and simultaneously increase the probability of extremely successful outcomes. See Jasjit Singh and Lee Fleming, "Lone Inventors as Sources of Breakthroughs: Myth or Reality?" *Management Science*, Vol. 56, No. 1 (January 2010), pp. 41-56.

[21] Organization for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, Paris, p. 14.

following the steps of Europeans, while their Japanese and Chinese remain left behind with the level of around 24%.

Table 9. Share of International Co-authored Scientific Articles (2007, % of total articles in each country)

	Japan	U.S.	France	Germany	U.K.	Canada	Italy	Russia	China
%	24.5	30.1	52.6	50.6	49.2	45.3	44.0	38.9	24.3

Source: Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, p. 115.

3.1. Intellectual agglomeration measured by patent filing through international cooperation in Europe

As noted earlier, *complex interaction between heterogeneous agents* is the vital factor to expand new frontiers in science and technology. For this reason, despite rapid advancement of ICT and extensive development of transportation networks, geography still matters. Silicon Valley in the United States and the so-called China's Silicon Valley Zhongguancun (中关村) suggest that complex intellectual interaction require agglomeration of intellectual activities.[22]

Incidentally, top 10 regions in the world, measured by the share of patents filed cooperatively with foreign co-inventors in recent years, are all located in Europe (See Table 10). These European regions, in the age of the globalization and the Internet, have exploited various opportunities for global interdisciplinary R&D activities and achieved resultantly internationally cooperative patent filing.[23]

Table 10. Top 10 Regions by Share of Patents filed in Cooperation with Foreign Inventors (2004-2006)

	Region	Country	Share of international cooperation (Share of patents filed with foreign co-inventors)
1	Haut-Rhin (FRA)	France	80.0
2	Graubünden (CHE)	Switzerland	72.9
3	Hochrhein-Bodensee (DEU)	Germany	58.6
4	Basel-Landschaft (CHE)	Switzerland	57.4
5	Bruxelles-Cap./Brussels Hoofdstedlijk (BEL)	Belgium	54.6
6	Prov. Liège (BEL)	Belgium	52.3
7	Prov. Vlaams Brabant (BEL)	Belgium	50.0
8	Bas-Rhin (FRA)	France	48.3
9	Limburg (NLD)	Netherlands	48.1
10	Prov. Antwerpen (BEL)	Belgium	43.8

Source: Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, p. 113.

For example, Haut-Rhin, a département (France's administrative unit) in Alsace whose borders face both Germany and Switzerland, is Peugeot's hometown and one of the richest regions in France. Graubünden is Switzerland's sovereign state called canton whose borders facing Liechtenstein to the north, Austria to the north and east, and Italy to the south and southeast, while Hochrhein-Bodensee is a German-Switzerland region that borders Austria.

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[22] MIT and Harvard scholars empirically find that transportation costs for goods, people, and ideas are important for industrial agglomeration. See Glenn D. Ellison, Edward L. Glaeser, and William R. Kerr, "What Causes Industry Agglomeration?: Evidence from Coagglomeration Patters," Discussion Paper No. 2133, Cambridge MA: Harvard Institute of Economic Research, April 2007.

[23] As for inter-firm cooperative innovation activity in Europe, see, for example, Laura Abramoyaskya, *et al.*, "Understanding Co-operative Innovative Activity: Evidence from Four European Countries," *Economics of Innovation and New Technology*, Vol. 18, No. 3 (April 2009), pp. 243-265.

In this connection, European institutions of higher learning have a huge number of foreign doctoral students (See Table 11). In Switzerland, foreign students account for 44.2% of the total number of doctoral students. The comparable figures for the United Kingdom and Belgium are 42.7% and 31.0% respectively, while Japan's is 16.8%.

Table 11. Number and Share of Foreign Doctoral Students (2006, persons and % of total doctoral students)

	Japan	U.S.	Switzerland	U.K.	Canada	France	Belgium	Australia	Austria	Spain
Number	12,074	92,026	7,646	38,447	7,440	28,486	1,535	7,704	2,532	6,550
Share (%)	16.8	26.3	44.2	42.7	38.3	35.8	31.0	20.9	20.9	19.2

Note: France's number of foreign students is for 2005 and America's share of foreign students is for 2001.
Source: Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, p. 127.

3.2. Intellectual agglomeration measured by filing through international cooperation in America and in Japan

When it comes to the number of patent filing though international cooperation, as Table 12 shows, regions in the United States appear as leading areas (e.g., New York-Newark-Bridgeport, San Jose-San Francisco-Oakland, and Boston-Worcester-Manchester).

Table 12. Top 20 Regions by Number of Patents filed in Cooperation with Foreign Inventors (2004-2006)

	Region	Country	Patents filed with foreign inventors (A)	Total patents filed (B)	Share of international cooperation (A)/(B) (%)
1	New York-Newark-Bridgeport (USA)	United States	2,096	14,636	14.3
2	San Jose-San Francisco-Oakland (USA)	United States	1,958	17,780	11.0
3	Boston-Worcester-Manchester (USA)	United States	1,314	10,842	12.1
4	Graubünden (CHE)	Switzerland	1,104	1,515	72.9
5	Hochrhein-Bodensee (DEU)	Germany	828	1,413	58.6
6	Los Angeles-Long Beach-Riverside (USA)	United States	767	8,158	9.4
7	Philadelphia-Camden-Vineland (USA)	United States	691	5,221	13.2
8	Houston-Baytown-Huntsville (USA)	United States	654	3,780	17.3
9	San Diego-Carlsbad-San Marcos (USA)	United States	651	6,193	10.5
10	Haut-Rhin (FRA)	France	640	800	80.0
11	Detroit-Warren-Flint (USA)	United States	634	4,068	15.6
12	München (DEU)	Germany	623	4,317	14.4
13	Stockholms län (SWE)	Sweden	603	2,691	22.4
14	Chicago-Naperville-Michigan City (USA)	United States	598	6,156	9.7
15	**Tokyo (JPN)**	**Japan**	**597**	**20,177**	**3.0**
16	Rhein-Main (DEU)	Germany	553	2,513	22.0
17	Shanghai (CHN)	China	488	1,514	32.2
18	Raleigh-Durham-Cary (USA)	United States	472	2,849	16.6
19	Düsseldorf (DEU)	Germany	465	2,667	17.4
20	Washington-Baltimore-Northern Virginia (USA)	United States	463	4,051	11.4

Source: Organisation for Economic Co-operation and Development (OECD), *OECD Science, Technology and Industry Scoreboard 2009*, December 2009, p. 113.

Table 12 evidently shows Japan's unique characteristics. Among the top 20 regions in the world, only Tokyo is listed as a prominent area of intellectual agglomeration; Tokyo has the largest number of total patents filed among the top 20 regions (20,177). At the same time, Tokyo's rate of international cooperative patent filing is the lowest (3.0%).

4. A Constellation of Innovative Regions in the United States, and Japan's Serious Problems

Despite the current unfavorable economic situation, U.S. cities still attract people, money, and information from around the world. Talented people, irrespective of their nationalities, study at U.S. institutions of higher learning and create cooperatively new ideas and products. Clayton M. Christiansen of the HBS says that "The United States . . . has continued to be a magnet for the best talent in the world."[24] Each of leading U.S. regions in Table 12 has prominent U.S. universities. Joseph E. Stiglitz says that "No other sector in the [U.S.] economy has had a greater market share of global leaders; U.S. universities have attracted the best talent from around the world, many of whom stay to make America their home."[25]

The region of New York-Newark-Bridgeport has Columbia University, while San Jose-San Francisco-Oakland, Stanford University and the University of California at Berkeley. The Boston-Worcester-Manchester region has Harvard University and the Massachusetts Institute of Technology (MIT), while Los Angeles-Long Beach-Riverside, the California Institute of Technology (Caltech) and Philadelphia-Camden-Vineland, the University of Pennsylvania to name a few. This agglomeration of talented people produces international cooperative patent filing as well as core articles.[26] In the meantime, the number of Japanese students at U.S. universities has been dramatically decreased. For example, Table 12 shows the number of students registered at the University of California at Berkeley. In 2004, the earliest year when statistics were published by the university, Japan ranked 5th after China, South Korea, India, and Canada. But in 2009, Japan ranked 10th despite a slight increase in the number of graduate students. Furthermore, only Japan shows a decrease in the number of students among major countries listed in the table.

Table 12. Foreign Students Registered at University of California at Berkeley

	Total		Undergraduate		Graduate	
	2004	2009	2004	2009	2004	2009
Total	2,699	3,419	870	391	1,818	2,331
Japan	**139**	**84**	**75**	**0**	**64**	**71**
South Korea	279	612	85	32	194	351
China	420	513	46	17	374	250
India	228	299	38	24	190	221
Canada	177	240	50	25	127	184
Taiwan	100	145	18	3	82	63
Hong Kong	95	102	15	7	65	90
United Kingdom	91	97	2	0	70	78
Singapore	85	91	53	11	32	76
France	64	90	9	21	55	69
Germany	71	78	24	27	47	51

Note: In this table, the numbers of exchange students are not shown.
Source: University of Berkeley (International Office).

Berkeley is not an exceptional case. As Table 13 shows, the similar phenomena are taking place at MIT. In 1999, Japan ranked 5th after China, Canada, India, South Korea. Japan ranks, however, in 10 years later, 9th falling behind

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[24] Clayton M. Christiansen, Michael B. Horn, and Curtis W. Johnson, *Disrupting Class: How Disruptive Innovation Will Change the Way the World Learns*, New York, NY: McGraw Hill, 2008, p. 6. Christiansen, however, warns that the U.S. has become less attractive for the best talent by referring to *The Economist*'s article, "American Idiocracy: Why the Immigration System Needs Urgent Fixing," March 24, 2007, p. 40.

[25] Stiglitz, *op. cit.*, p. 194.

[26] As for the role of agglomeration in innovation and diffusion of knowledge and information, see, for example, William R Kerr, "Breakthrough Inventions and Migrating Clusters of Innovation," *Journal of Urban Economics*. Vol. 67, No. 1 (January 2010), pp. 46-60, and Paul Ormerod and Bridget Rosewell, "Innovation, Diffusion and Agglomeration, *Economics of Innovation and New Technology*, Vol. 18, No. 7 (October, 2009), pp. 695-706. As for university-industry spillover, see, for example, Richard Jensen, *et al*., "University-Industry Spillovers, Government Funding, and Industrial Consulting," NBER Working Paper No. 15732, Cambridge, MA, February 2010.

Germany, Singapore, France, and Taiwan as well as the major 4 countries (China, China, India and South Korea).

The authors are concerned about this astonishing decrease in Japanese students at the Institute. MIT has been and will be, as everybody admits, one of the best birthplaces of tomorrow's manufactured goods and services. Many of MIT students will develop innovative products and services in the not-so-distance future. In the age of globalization and the Internet, the paucity of Japanese students at MIT prognosticates that Japan's *mono-zukuri* (craftsmanship) might be left behind and a new style of 21st century craftsmanship might emerge from somewhere (China or India, perhaps?) out of global networks developed by MIT scholars and graduates.

Table 13. Foreign Students Registered at MIT

	Total		Undergraduate		Graduate	
	1999	2009	1999	2009	1999	2009
Total	2,386	3,150	355	391	2,031	2,331
Japan	**117**	**81**	**8**	**0**	**109**	**71**
China	259	452	3	32	256	351
South Korea	142	288	4	17	138	250
India	148	263	13	24	135	221
Canada	192	216	22	25	170	184
Germany	64	113	5	3	59	63
Singapore	80	101	15	7	65	90
France	72	99	2	0	70	78
Taiwan	56	94	4	11	52	76

Note: In this table, the numbers of special and exchange/visiting students are not shown.
Source: Massachusetts Institute of Technology (MIT) (International Students Office).

Harvard University is also exhibiting the same pattern. In 1995, Japan ranked second only behind Canada. Since then the number of students registered has gradually decreased (See Table 14).

Table 14. Foreign Students Registered at Harvard University

	1991	1995	1996	2000	2001	2005	2006	2007	2008	2009
Japan	**179**	**181**	**179**	**158**	**162**	**135**	**130**	**127**	**107**	**101**
Canada	348	362	375	434	464	481	471	489	531	538
China	220	175	178	270	318	378	403	400	421	463
South Korea	137	124	159	213	212	244	269	297	305	314
India	98	101	104	104	120	189	193	216	225	235
United Kingdom	149	135	127	158	156	177	194	201	209	227
Germany	105	102	107	120	118	159	149	158	159	159
Singapore	34	34	43	56	61	75	71	66	89	114
Taiwan	138	138	135	102	81	113	113	117	100	99
Turkey	16	31	39	75	64	71	80	90	96	96
Israel	52	52	48	72	71	71	81	77	86	85
Mexico	57	93	94	101	95	78	98	83	76	79
France	65	58	59	74	67	76	82	81	84	77

Note: Japan's peak year was 1994 with 191 students.
Source: Harvard University (Harvard International Office (HIO)).

At Harvard like other American universities, the number of Japanese undergraduate students is extremely small, only 5 students in 2009 (See, Table 15 on the next page). This is partly because Japan has excellent universities spearheaded by the University of Tokyo, Kyoto, Keio and Waseda Universities to name a few.

Yet in Japanese universities, there is a grave problem. English courses are not sufficient enough to make students have a high command of English, the *lingua franca* for the academic and business communities in the world. Furthermore, English language proficiency is a *sine qua non* to conduct verbal communications with foreign scholars. For these reasons, the authors are concerned about the deficiency of Japanese undergraduate students at U.S. universities. There should be substantial improvement in English courses at Japanese universities. Or otherwise, Japan should immediately increase the number of undergraduate students studying abroad.

Table 15. Foreign Students Registered at Harvard University (2009)

	Total	College	Graduate School of Arts and Science	Business School (HBS)	Kennedy School (HKS)	Law School (HLS)	Others
Total	4,131	666	1,358	608	404	308	787
Japan	**101**	**5**	**31**	**11**	**16**	**9**	**29**
Canada	538	144	138	66	16	56	118
China	463	36	248	42	22	22	93
South Korea	314	42	117	9	24	14	108
India	235	20	51	80	30	8	46
United Kingdom	227	54	71	45	20	14	23
Germany	159	14	77	28	24	8	8
Singapore	114	22	42	11	9	7	23
Taiwan	99	2	48	1	1	7	40
Turkey	96	13	47	15	14	3	4
Israel	85	11	33	8	12	15	6
Mexico	79	4	23	18	16	3	15
France	77	7	24	24	8	6	8

Source: Harvard University (Harvard International Office (HIO)).

A survey conducted by the Japanese government incidentally underscores this phenomenon of the deficiency of Japanese students.[27] Table 17 shows the number of scholars belonging to Japan's institutions of higher learning who visited foreign countries. While the number of scholars who experienced short-period visits shows a gradual rise as a trend, the number of scholars who stayed overseas for 30 days and longer has decreased dramatically from 7,586 persons in 1999 to 4,163 persons in 2006.

Table 17. Number of Japanese Scholars Who Visited Foreign Institutions of Higher Learning (Persons)

	'99/H11	'00/H12	'01/H13	'02/H14	'03/H15	'04/H16	'05/H17	'06/H18
Total	94,217	112,372	103,204	115,838	112,022	124,961	137,407	136,751
Visit for 30 days and longer	7,586	7,674	6,943	6,515	5,877	5,385	4,725	4,163
To North America	2,960	2,920	2,745	2,670	2,235	1,895	1,602	1,413
To Europe	3,182	3,067	2,772	2,493	2,336	2,219	1,893	1,629
To Asia	764	915	773	722	700	749	658	598
(Short stay less than 30 days)	86,631	104,698	96,261	109,323	106,145	119,576	132,682	132,588

Note: In this table, the numbers of special students and exchange/visiting scholars are not shown.
Source: Government of Japan, Ministry of Education, Culture, Sports, Science and Technology (MEXT), *Survey of Current Condition of International Exchange for Fiscal Year 2006* (In Japanese, 『平成 18 年度国際交流上補強調査』), March 2009.

Especially, the number of scholars who went to North America and stayed for 30 days and longer has decreased

[27] Government of Japan, Ministry of Education, Culture, Sports, Science and Technology (MEXT), *Survey of Current Condition of International Exchange for Fiscal Year 2006* (In Japanese, 『平成 18 年度国際交流上補強調査』), March 2009.

from 2,960 in 1999 to 1,413 in 2006. As long as Japan's academic community is concerned, the authors have come to confirm a reverse trend of globalization since there's no such countervailing trend that Japan is becoming a magnet of foreign scholars (See Table 18). At the same time, it is very difficult to appreciate an increase in the number of scholars who go abroad for a short period. When those scholars are experienced in communicating with their foreign counterparts and their visits serve as participation in international academic gatherings, there would be no problem. However, when a majority of those scholars are inexperienced and limited English proficient, academic achievements through their visits abroad would be quite limited.

Table 18 shows the number of foreign scholars who visited Japanese institutions of higher learning. Compare to the number of Japanese scholars who visited abroad, it shows a gradual, if not impressive, increase. The total number of foreign scholars with a long-term stay (30 days and longer) in Japan in 1999 was 10,856. The figure for 2006 was 12,518. Asian scholars have been the largest contributor to this increase. However, a closer look at the recent development reveals that the figures for long-stay scholars have decreased since 2004. The authors understand that even within Japan, opportunities for exchange of views between Japanese and foreign scholars are becoming limited.

Table 18. Number of Foreign Scholars Who Visited Japanese Institutions of Higher Learning (Persons)

	'99/H11	'00/H12	'01/H13	'02/H14	'03/H15	'04/H16	'05/H17	'06/H18
Total	22,078	29,586	30,067	30,130	31,924	31,391	34,938	35,083
Visit for 30 days and longer	10,856	13,878	13,030	12,524	12,821	13,307	13,223	12,518
From North America	1,393	1,810	1,671	1,542	1,661	1,732	1,619	1,413
From Europe	2,425	3,152	3,018	2,678	2,731	2,983	2,920	2,619
From Asia	6,086	7,676	7,142	7,131	7,230	7,363	7,475	7,219
(Short stay less than 30 days)	11,222	15,708	17,037	17,606	19,103	18,084	21,715	22,565

Note: In this table, the numbers of special students and exchange/visiting scholars are not shown.
Source: Government of Japan, Ministry of Education, Culture, Sports, Science and Technology (MEXT), *Survey of Current Condition of International Exchange for Fiscal Year 2006* (In Japanese, 『平成 18 年度国際交流上補強調査』), March 2009.

5. Conclusions: Toward a Formation of the New *Kai'en Tai*.

In the globalization age, Japan needs a novel innovation system. The system should comprise individuals of high caliber those who have excellent international communication capabilities as well as personal aspirations irrespective of their original affiliations. In this connection, Mina says that innovation systems "grew out of networks of personal interactions and the development and recombination of personal knowledge. The creative individuals' commitments clustered around a tight but open—and to a great extent of self-organised—micro-community."[28]

Amidst economic difficulties, today's Japan can hardly have the luxury to possess a grandiose system that has communication capabilities. For this reason, size does not matter, but does quality especially with a high command of English. Some Japanese claim language does not matter, but quality. This may be right in various cases including sports, culinary arts, mathematics, and other arts and sciences that do not need the frequent use of verbal communications. Nonetheless, a tight but open, and self-organized micro-community needs a high command of today's *lingua franca* (in most cases, English). Even in the natural science and engineering fields, a government survey shows that scholars who

[28] Mina, *op. cit*., 462.

have experience living abroad can produce more papers in English and provide younger colleagues with more advice than those who have no experience living abroad.[29] Table 19 shows the number of papers in English submitted in the past 3 years by Japanese scholars. Apparently those who have experience living abroad produce more English papers than those who have not lived abroad. Given the decreasing number of Japanese scholars who have experience living abroad, Japan should strategically choose scholars of high caliber and let them actively communicate with their foreign counterparts. Otherwise Japan's R&D might be isolated from the rest of the world and left behind.

Table 19. Number of Papers in English Submitted in the Past 3 Years

Academic Fields	Difference in experience living overseas	Age Groups				
		Total	25-34	35-44	45-54	55-64
Average	With no overseas experience	7.0	4.5	6.3	8.6	12.3
	With overseas experience	**10.4**	**8.6**	**7.8**	**12.3**	**15.3**
Engineering	With no overseas experience	6.4	4.7	6.6	7.1	6.4
	With overseas experience	**11.6**	**8.6**	**14.9**	**18.2**	**11.6**
Medical science	With no overseas experience	8.0	4.1	6.3	10.6	10.6
	With overseas experience	**10.4**	**7.8**	**7.3**	**11.3**	**17.4**
Natural science	With no overseas experience	8.5	5.3	8.2	10.3	11.1
	With overseas experience	**10.7**	**11.1**	**9.1**	**14.3**	**10.7**
Agricultural engineering	With no overseas experience	4.1	3.7	3.9	4.2	5.3
	With overseas experience	**9.4**	**6.9**	**6.3**	**10.6**	**15.5**

Source: Government of Japan, Ministry of Education, Culture, Sports, Science and Technology (MEXT), *A Survey about Mobility of Researchers and Diversity of Research Organization* (『科学技術人材に関する調査』), March 2009, pp. 24 and 2-107-108.

In the globalization age, Japan's R&D is at risk as it faced the nation's crisis before the Meiji Restoration. Like public-minded *samurais* who established the *Kei'entai*, the authors consider the need of a new *Kai'entai*, hoping that Japan's aspiring youth could join the formation of the new *Kai'entai* to revitalize Japan's R&D activities. The new *Kai'entai* has two purposes. First, it establishes a freer and more frequent flow of information between Japan and the rest of the world. Such information flow is (1) adjusted aptly for the timing and the interval, (2) not susceptible to geographical barriers, (3) focusing on two-way communications with diversified and interdisciplinary perspectives, (4), with a strong sense of esprit de corps as a micro-community. Second, it provides opportunities for younger Japanese to learn the *modus operandi* to survive a globalized and highly competitive R&D community outside Japan.

The destiny of the original *Kai'entai* was short-lived, existing only between 1865 and 1868. Its charismatic leader, Ryoma Sakamoto, was assassinated in December 1867 by incorrigibly isolationist *samurais*. The *Kai'entai*, without torchbearers, was later disbanded. However, out of the *Kai'entai*'s members there ermerged a *ronin* named Yataro Iwasaki who later became the founder of the conglomerate Mitsubishi Group, and a *samurai* named Munemitsu Mutsu who later became a prominent foreign minister who struggled for Japan to rescind discriminatory treaties with colonial powers of the West spearheaded by the United Kingdom. Like its predecessor, the new *Kai'entai* might face enormous challenges in the future. Nonetheless, the authors hope some members of the new *Kai'entai* can soon develop a new form of Japan's innovation system.

[29] Government of Japan, Ministry of Education, Culture, Sports, Science and Technology (MEXT), *A Survey about Mobility of Researchers and Diversity of Research Organization* (『科学技術人材に関する調査』), March 2009, pp. 5, 23, 24, and 2-107-108.