Forum Report 011

Technological Development in Contemporary Japan: Possibilities and Challenges

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Governance of Nuclear and Space Technologies in Post-War Japan

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Technology has many implications for society, so a wide range of actors are involved in technology governance. Scientists and engineers play a major role—both as individuals and as members of research institutes. Companies are also significant in introducing technology to society. Various domestic government ministries and agencies are also involved, while foreign governments are major players in cases involving technology transfer.

Technology development entails an increase in various wider risks and benefits. Technology governance thus requires risk assessment and risk management by various segments of society. These involve wrestling both with uncertainty and with distributive questions about how risks and benefits can and should be allocated. On the other hand, technology governance also requires innovation governance, to facilitate research and development (R&D) by scientists and engineers, and investment by the parties that fund them. Mobilizing and implementing new technologies require understanding the push and pull factors that shape innovation and technology demand.

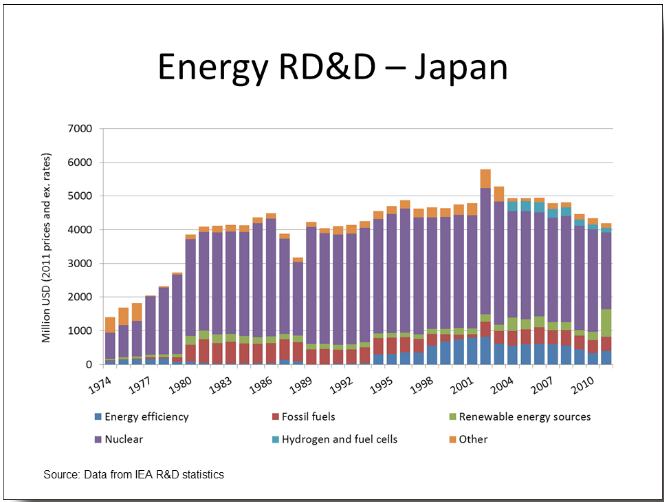
The governance of nuclear technology and space technology in Japan after World War II are instructive. The analysis here focuses in part on the structure and the implications of the 'dual' governance system in each field.

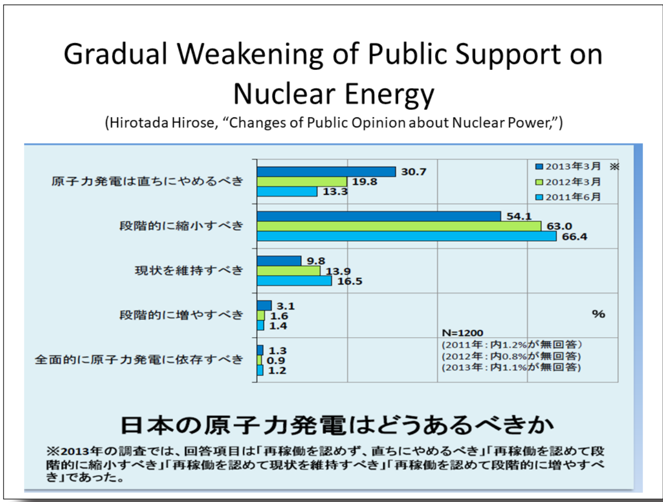
Historically, with nuclear technology, there has been a tension between those who emphasize R&D, especially with respect to fuel reprocessing and fast breeder technology, and those focused on the use of transferred light water reactor technology. The first group includes the Science and Technology Agency (STA), the Japan Atomic Energy Agency (JAEA), and the Power Reactor and Nuclear Fuel Development Corporation (PNC). The PNC was merged into the JAEA in 2005. The second includes the utilities and the Ministry of International Trade and Industry (MITI, now the Ministry of Economy, Trade and Industry [METI]).

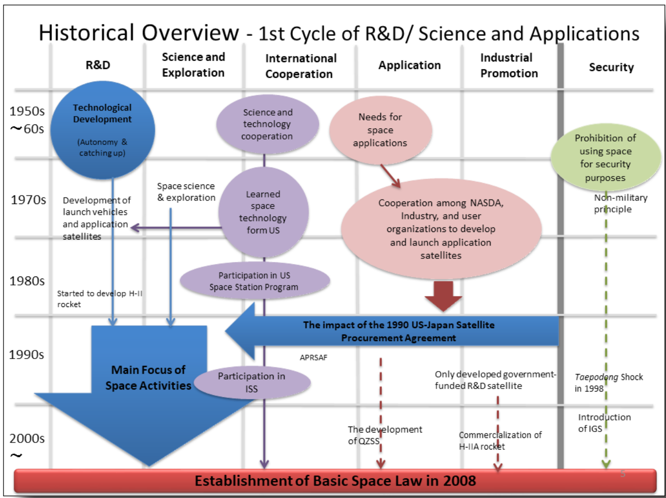
Tensions in the nuclear regulatory regime played out over three major periods. The first period lasted from 1957–1978 and was characterised by executive control. During this time, the prime minister had authority over nuclear business licensing. Approving commercial reactors sometimes required the involvement of competent ministers as well. In practice, these actors closely followed the opinions of the Atomic Energy Commission of Japan, which was chaired by the Director-General of the Science and Technology Agency.

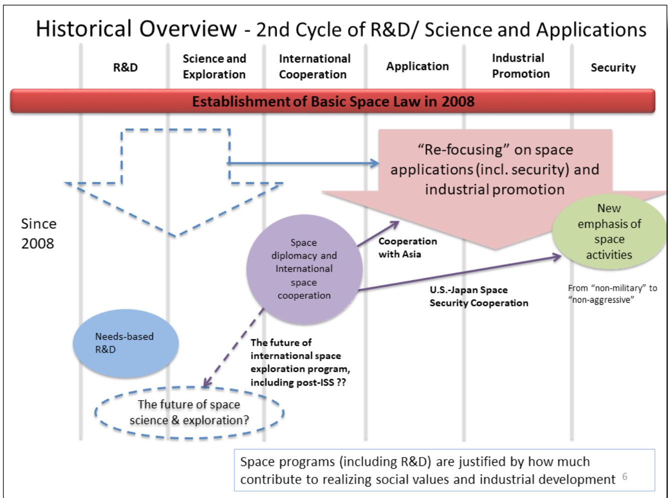
The second period, from 1978–1999, emerged following the 1974 radiation leak from the Mutsu—a nuclear-powered ship. This was a period of decentralization in which governmental agencies held responsibility for both promoting and regulating the industry. The Nuclear Safety Commission—an independent advisory committee—became responsible for both reviewing regulation by other agencies and for engaging the public.

The third period, from 1999 onwards, saw the weakening of the dual system and stronger regulation following an









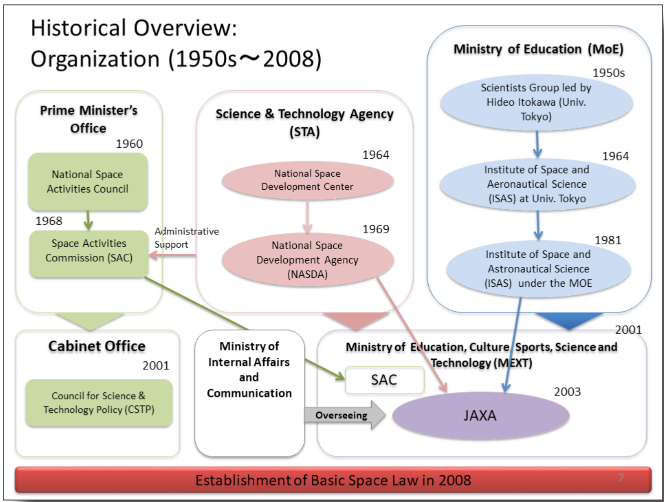
accident involving a nuclear fuel production company. The Nuclear and Industrial Safety Agency (NISA) was established in 2001 as a quasi-independent organization under METI. NISA was highly regulated, but the International Atomic Agency was somewhat skeptical of NISA's true independence.

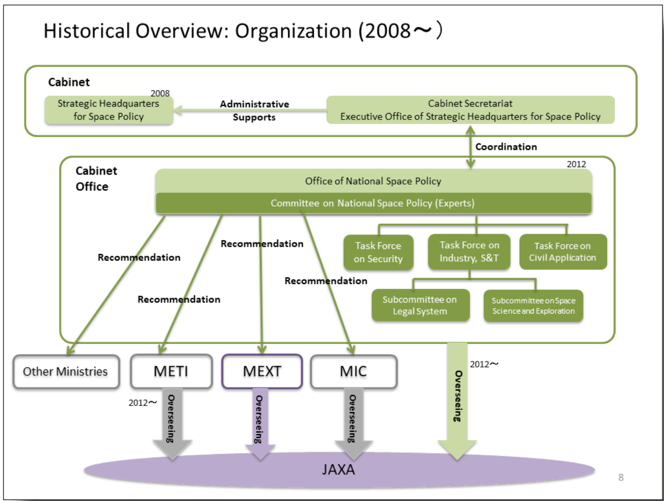
This period also saw incremental change in scientific understanding of, and policy on, earthquakes and tsunamis. One cause of the 2011 Fukushima accident was the failure of the nuclear community to communicate across disciplines and to integrate new knowledge sufficiently from the earthquake and tsunami research communities. For example, tsunami researchers had come to understand that tsunami predictions involved a greater degree of uncertainty than previously thought, including in the Fukushima area, but these findings were not effectively transmitted to the nuclear community. One core lesson is that regulating complex technology systems requires sensitivity to trends across a broad range of knowledge areas.

Another issue was that accident management remained decentralized and was viewed as something that operators would do on a voluntary basis, rather than a strict legal requirement. With this self-regulatory approach, probabilistic safety assessments largely ignored the risks of external events, including earthquakes. While the operators and power companies did take some voluntary measures, without greater government involvement, these actions were insufficient.

After Fukushima, government and non-governmental actors launched a number of investigatory processes. The Diet eventually approved a new Nuclear Regulation Authority in 2013 in response to previous regulatory failures and NISA's conflicting duty to both promote and regulate the industry. However, it is clear that formal independence is not enough: regulatory agencies require capacity, both for effectiveness and for public trust. One key dimension relates to staffing: regulatory agencies need risk managers with an interdisciplinary orientation. This is particularly true in technological domains—such as nuclear power—where there can be interactions between natural disasters, technological accidents, and other risks. It remains to be seen who will staff the Nuclear Regulation Authority in the future.

With space technology, there has been tension between parties emphasizing scientific research, such as the Ministry of Education (MOE) and the Institute of Space and Aeronautical Science (ISAS), and those emphasizing technology use, such as the Science and Technology Agency (STA) and





the National Space Development Agency (NASDA). NASDA and ISAS were merged into the Japan Aerospace Exploration Agency (JAXA) in 2003.

Japan's space sector has also involved several phases. The 1950s saw the beginning of space activities based in Japan with several rockets. In the 1960s, space policymaking was led in part by the Prime Minister's Office. Two separate organizations were also set up, establishing the dual system. ISAS focused on scientific and technical issues, satellite launches, and other scientific missions; NASDA focused on the application of space-based technology to communications, broadcasting, weather monitoring, and other social needs. NASDA also cooperated closely with industry and users of space-based technology, and worked to introduce technology from the United States to Japan.

In the 1990s, the changing post-Cold War security environment and growing threats from North Korea increased the need for space-based monitoring. At the same time, the United States began to criticize the Japanese government's protection of its space industry, in particular in terms of satellite procurement. This led to the opening up of the government market to international bids for non-R&D satellite agreements.

The second cycle began in the 2000s. Under the dual system, space technology research and application had been somewhat divided between ISAS and NASDA, respectively. This system began to weaken following a series of administrative reforms—in particular, the merging of ISAS and NASDA into JAXA. Japan launched its first two Information Gathering Satellites in 2003, undermining strict historical interpretations of 'peaceful' space activities.

In 2008, the Basic Space Law laid out the objectives of Japan's space activities. These included improving the lives of Japanese citizens; strengthening national security; ensuring international peace, cooperation, and diplomacy; advancing scientific research; and fostering socioeconomic development. This signaled an ongoing shift, wherein the application of space-based technology came to receive greater emphasis than it had historically. Japan's Basic Plans on Space Policy, set out in 2009, 2013, and 2015, have placed growing importance on security and industrial applications for space research and technology.

The Basic Space Law also kicked off discussions on building a broader legal framework under a Space Activities Act and a Satellite Remote Sensing Act, which were submitted in 2016. The former is meant to ensure compliance with international treaties and agreements in the face of increasing commercial activities, protect public safety, and promote the space industry. The latter is meant to promote the use of remote sensing data, promote private sector activities, and safeguard security interests.

As has been the case with the nuclear sector, Japan's evolving space regulatory framework involves balancing regulation with industry promotion. As we have seen with the nuclear sector, getting this balance right through an appropriate institutional framework can be critical for fostering public trust and effective risk management.

Independent and effective regulatory power must be preserved in the context of increasing privatization, growing commercial activities, and wider applicability of space-based technologies. However, determining who should provide regulatory resources—and how—remains an open question. Should the government play this role through ministries and the Cabinet Office, or should JAXA take the lead? How should risks, benefits, and accountability be distributed? These will remain urgent and open questions as nuclear and space-based technologies continue to develop.

Following the presentation, the first commenter asked what risks need to be managed in space governance.

Prof. Shiroyama responded that the risks include space debris, satellite crashes, space weather, and the systemic and knock-on risks associated with damages to space-based communications infrastructure. Addressing these risks involves both technical and coordination challenges. There has been more interest in space weather in Europe than in Japan.

The same commenter observed that we have seen an energetic regulatory effort with respect to nuclear risk, but not as much with respect to space. What drives this difference? Is it the relative magnitude of the downside risks? With nuclear, the downside risks are huge and very costly. With space, they would appear to be little more than nuisances. Does the relative lack of coherent state-sponsored efforts to promote innovation and regulation in space reflect a sense that the risks are less serious and less costly than with nuclear?

Prof. Shiroyama suggested that it is also worth thinking about why particular downside risks are accepted. In Japan, historically, downside nuclear risks have been accepted in part because of the need for energy security. With nuclear technology, governments tend to provide a regulatory and insurance framework to allow for private industry to make investments. This framework is more flexible in Japan than elsewhere, but it also offers less stability and predictability to private industry. If governments do not get the framework right, it is possible to introduce moral hazards or stymie investment.

The next commenter asked whether the governance frameworks that Prof. Shiroyama described still work in the 21st century in the face of new risks—for example, related to cybersecurity—and given the speed of development, the speed of applicability, and the scale of investment outside government R&D frameworks. Elon Musk's disruptive leadership offers one such example. Are the established state-led governance frameworks capable of helping us in the future, or are we looking at the last gasp of post-war regulation? If so, do we have a new system that can deal with 21st century risks—for example, related to cybersecurity and the possible democratization of gene-editing technology through tools such as CRISPR?

Prof. Shiroyama responded that this varies on a case-by-case basis. There is a growing portfolio of governance structures, and their relative strengths will depend on the benefits, risks, and governance challenges associated with the technology area in question. For example, we can think about whether a state-oriented or industry-oriented governance structure is appropriate. Where self-governance is prominent, there is often a role for professional ethics codes and education standards. In some industries, the private sector actively pushes for government regulation, because they understand it is necessary to secure a stable business and investment environment.

States have traditionally played a leading role in governing both nuclear technology and space, but in other industries, such as shipping, much of the governance workload has been handled by industry— for example, through insurance schemes and classification societies. Even with nuclear governance, much depends on the private sector. For example, nuclear operators collaborate to share incident data, grade safety among utilities, and determine insurance rates.

The structure of an industry is an important variable as well. In the biotech sector, a lot of activity happens at a relatively small, distributed scale—at the laboratory or firm level. The nuclear industry, on the other hand, is relatively integrated.

Following up, the same commentator asked how traditional governance mindsets fit with where we are headed—for example, with the democratization of certain kinds of technology. How can we regulate outsiders? If someone wants to get into nuclear power, we can regulate that. It seems much harder to deal with someone who wants to create a cryptocurrency that turns global finance on its head.

Prof. Shiroyama responded that while there is a growing emphasis on professional ethics and community-based regulation, this is easier said than done. There is no question that there is much work to do to respond to emerging technology trends.

The next commenter asked for clarification on the timing of the fazing out of the dual system in the nuclear case. Prof. Shiroyama responded that there were already changes taking place in the 1970s and 1980s, but that the overall trend has been incremental and continuous. Even now, we are still dependent on a weakened dual system.

The same commenter then asked about accountability. When disasters happen, the costs may fall disproportionately on certain communities. How do we integrate governance structures with accountability issues, especially with regard to uneven distributions of risks and benefits?

Prof. Shiroyama responded that one key aspect of accountability is the relationship between experts and governing bodies. While independence is important for risk management bodies, we should resist the idea that risk allocations can be neutral just because they are 'scientific.' Risk management inevitably involves politics, owing to the necessarily uneven distribution of risks and benefits associated with a particular technology policy. Accountability should thus incorporate this understanding alongside the perspectives of the numerous stakeholders involved.

Next, Prof. Shiroyama was asked whether there is anything unique in the way that the tensions between innovation and regulation, and between risks and benefits, are framed in Japanese public discourse. Are there differences between different media outlets?

Prof. Shiroyama responded that while it is true that different media outlets emphasize risks and benefits differently, this does not seem to be unique to Japan. It is also worth mentioning that it is not just risks that can be underestimated—benefits can be underestimated as well. Further, there is sometimes a tendency to forget the relationship between risks and innovation. Assessing and responding to risks requires risk-taking innovation and research, but this understanding is sometimes left out of the conversation.

The next commenter asked how much of a role should the government play in shaping research priorities, for example through funding arrangements.

Prof. Shiroyama responded that academic fragmentation is a fundamental issue, and interdisciplinary communication is very important both for innovation and regulation. Different academic communities often do not have the chance to engage with one another. To the extent that the government can encourage more collaboration, this is a good thing. However, there is a need to balance research directed toward specific public purposes with the need for research autonomy.

A final question turned to the role of the Ministry of Defense (MOD) in space policy. One difference between nuclear and space policy seems to be the degree of public scrutiny they receive. Nuclear power has been politically contentious, where space policy is still under the ambit of experts. However, there have been radical changes to Japanese space policy since 2008, with a much larger share of the budget going to the MOD. Space policy was supposed to be entirely about civilian use, but the emphasis has changed. However, this process remains insulated from public scrutiny. People seem to have only a vague but positive view of space policy. In China, the government controls nearly all aspects of space policy. In Japan, the Ministry of Defense is very quiet in the budget process with regard to space policy. Is this process healthy?

Prof. Shiroyama responded that the space community would like to promote the industry and the use of its technologies, but they cannot find enough private demand. One response has been to look to the government, including the MOD. Some in the space industry are still very nervous about this, especially because of the traditional commitment to peace. From the MOD's perspective, there are concerns that if they invest money in space, they will be forced to cut the budget somewhere else.

Prof. Shiroyama made a final observation that there are different cultures at work in the space and nuclear communities, partly because of their different histories and experiences. The space community tends to be more frank, open, and straightforward. The nuclear industry has had a series of accidents and has been subject to much more public scrutiny.

Innovation: 'Japan Inc.' in the 21st Century

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University of Saskatchewan

Since the 1960s, Japan has been among the world's most commercially innovative countries. Japanese companies such as Toyota, Honda, and Mitsubishi dominated efficient automobile design and production. Sony, Panasonic, and Toshiba pioneered consumer digital products and created global brands. Dozens of lesser-known tech firms supported the rise and stability of Japan's economy. The country is also widely known for innovations such as high-quality production, 'just-in-time' manufacturing, world-leading commercial electronics, extensive use of robots, solar power, and LED lighting. These initiatives, marked by intensive collaboration between government and businesses, transformed Japan into one of the world's most successful economies, both in terms of overall productivity and personal incomes.

Despite these strengths, Japan's rate of economic growth slowed dramatically in the 1990s and has only averaged about 1.5 percent per year since 2000 (not including the dire 2008–2009 financial crisis). While economic growth is not the only indicator of a healthy economy and society, national governments do need to deliver opportunities for advancement in life. One of the most important national and international challenges for governments in the 21st century is to develop and sustain policies that promote economic innovation, scientific and technological development, international competitiveness, and environmental sustainability, in almost equal measure.

Japan started earlier and has done more than most countries to build its 21st century future as a science and technology-based economy. In the 1980s, concerns about Japanese manufacturing moving overseas spurred the government to invest in new potential economic sectors. Japan proclaimed itself a Science and Technology nation and passed its first Science and Technology Basic Plan in 1995; the 5th such five-year plan was adopted in April 2016. Through these plans, Japan has worked to build the foundations of a science and technology-based economy, including advanced education, appropriate infrastructure, and business-research collaboration.

Indeed, technological development is the backbone of much of the country's plans for 21st century economic competitiveness. Japan is investing heavily in high risk/high reward areas such as space-based solar panels, nanotechnology, hydrogen energy, and robotic technologies that have the potential to sustain commercial well-being. If the country can reproduce its earlier successes in these new sectors, Japan could experience a new era of economic success in globally disruptive and unsettling times. However, these expensive and risky investments are far from guaranteed. Japan also runs the risk of suffering from the 'Galapagos Effect'—the development of products and services that only succeed in the home market.

Until relatively recently, conventional wisdom held that investing in advanced education, basic research, and commercialization would lead to jobs and prosperity. However, it is not clear whether this 'innovation equation' is working as anticipated. Innovation has undermined many job categories—starting in manufacturing and processing, and increasingly in professional areas. Facing confusing and challenging trends, from rural depopulation and aging societies to climate change, automation, and wealth inequality, governments around the world believe the new, high-tech, innovation-driven economy is necessary and unstoppable. However, it is not clear whether it will provide enough jobs to replace those that are lost.

Furthermore, there is no consensus or set of rules for how to build an innovation economy or the 'economy of the future.' Innovation requires a combination of government policies, legal standards, business ability, creativity, inventiveness, consumer openness, tolerance for failure, and good old-fashioned luck. While conventional wisdom says that market forces foster innovation, the government's insulation from such forces has historically made it a successful innovator. Although there are technology areas that seem to require a strong government hand, it is difficult for governments to know when, where, and how much to invest—and when to stop.

The 'Japan Inc.' model, bringing the government and companies close together, has been one such imperfect but successful approach to innovation. Moving forward, however, it is not clear to what degree Japan can succeed in the international innovation competition; whether past successes predict future leadership; how best to foster innovation and commercialization; and how innovation can improve quality of life in Japan and around the world.

As Japan looks towards the future, it is worth asking what sectors might thrive, especially with a little help. Japan's companies are major players in a number of important traditional and emerging sectors.

In 2016, Japan was the third-largest vehicle-producing country in the world. Japanese auto manufacturers lead in the production of electric, hybrid, and fuel cell vehicles, in part due to government-led R&D, infrastructure support, purchasing support, and long-term-strategies. There are now more electric vehicle stations in Japan than there are gas stations, for example, providing the infrastructural backbone required for the electric vehicle industry to thrive. The Japanese government has also been funding a national strategy to support the commercialization of fuel cells. With its vision of a 'Hydrogen Society,' Japan aims to become the world's first mass market for fuel cell technologies.

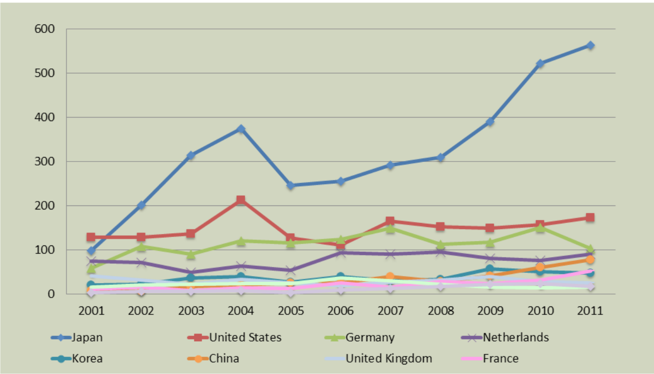
Japan also leads in the development, production, and use of robots, although other countries are eager to catch up. Facing a labour shortage, small and medium enterprises offer a growing source of demand for industrial robots. There are also many other types of robots in development or use, including for concierge services, disaster relief, and security. With Japan's aging society, Japanese companies are actively developing technologies to improve the lives of Japan's senior citizens and their caregivers, including robotic exoskeletons that allow the wearer to lift substantially more weight, robotic pets to provide stimulation and companionship, and smart appliances that allow remote healthcare monitoring. The prime minister recently spoke at the launch of an industry-led 'robotic revolution' initiative that seeks to spread robotics from factories to every corner of society, seamlessly fitting into the places where people live and work.

Japan also has a large, vibrant, and profitable digital content sector that focuses on the commercial distribution of digitized material. While media and public attention tends to focus more on technology than content, the worldwide content sector is now substantially larger than the international movie industry and includes everything from video games and animation to big data applications, e-learning, and financial technology. However, despite considerable government support, relatively little Japanese content makes its way overseas.

Japanese companies have long been active in the development and commercialization of green and efficient technologies as well, and Japan continues to invest heavily on these fronts. The 'Top Runner Program,' for example, looks for the most efficient commercially available model of an appliance and makes that the standard that the industry should achieve. This program, which now covers 31 product categories, fosters innovation by continually raising the efficiency bar.

Japan is also investing in a vision of 'smart' cities that use smart grids, energy management systems, distributed renew-

ENERGY-EFFICIENCY BUILDING AND LIGHTING PATENT APPLICATIONS BY COUNTRY, 2001-2011. PATENT APPLICATIONS, PATENT COOPERATION TREATY



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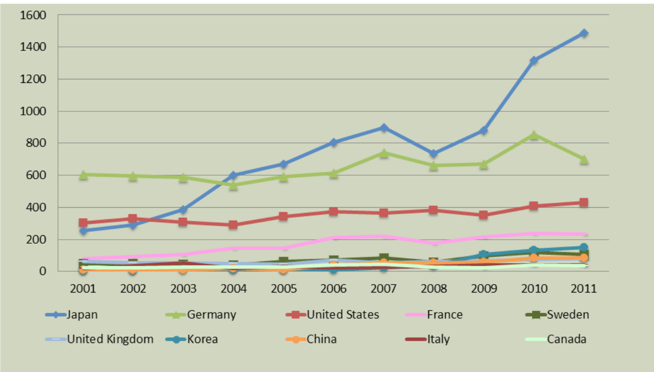
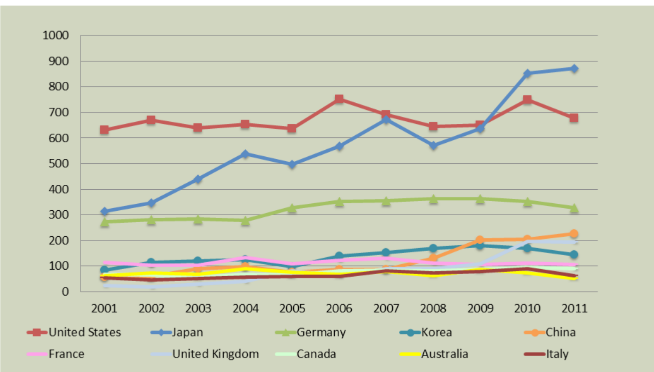


GENERAL WASTE MANAGEMENT PATENT APPLICATIONS BY COUNTRY, 2001-2011.



able energy sources, and information and communication technology to foster high-efficiency, environmentally-friendly communities. With decentralized energy production, such communities can be more resilient in the face of disaster. This planning approach brings together a lot of areas where Japanese companies have expertise, including electric vehicles, construction, batteries, and intelligent transportation. Smart cities not only revitalize local and regional economies; they also showcase new technology to the world. Japan is a global leader in patenting green technologies. With substantial investments, Japan is positioning itself to be a smart infrastructure exporter in an era when climate change and energy scarcity make community resilience ever more essential.

There are also some 'moon shot' efforts worth mentioning. The Japan Aerospace Exploration Agency has been seriously studying space-based solar power generation since 1998, with some 130 researchers working on the project. Together with Kyoto University, they have a technology roadmap that leads to the development of a 1-gigawatt space-based solar power station by 2040. Similarly, the Shimizu Corporation, a Japanese construction firm, recently proposed a plan to build a belt of solar cells around the moon's equator. The company claims that its 'Luna Ring' concept could meet the entire planet's energy needs by using lasers or microwaves to beam electricity back to power stations on Earth.

The 5th Science and Technology Plan's focus ties many of these efforts together with its vision of the 'Super Smart Society'—one that is 'capable of providing the necessary goods and services to those who need them at the required time and in just the right amount.' This ambitious vision seeks to leverage new supercomputer developments, cyber security technology, the Internet of Things, big data analytics, artificial intelligence (AI), high-efficiency products, and next-generation sensing and monitoring technologies to allow people to enjoy customized goods and services, personalized healthcare, localized energy systems, and more resilient communities. While these technologies are converging in many countries, Japan hopes to leverage its strengths to build a 'Super Smart Society' before anybody else.

Looking ahead, Japan enjoys strengths in a variety of high-technology industries, due in part to large public investments in high risk/high reward areas that the private sector is unlikely to fund on its own. With deep experience in convening business, government, and academia, Japan has also enjoyed success in commercializing new technologies. Forward-looking government policy, long-term business planning, high quality standards and consumer expectations, and national support for 'big science' experimentation make Japan well-placed to focus on driving social change and responding effectively to emerging demographic, environmental, and economic issues.

However, there are significant challenges ahead for Japan's continued innovation and technology leadership. Japan faces increasing international competition, a rapidly aging population, high levels of government debt, high energy costs, labour shortages, and the ever-present risk of the Galapagos Effect.

Surveying this evolving landscape, it is worth remembering that the innovation race is a marathon, not a sprint: early successes do not ensure long-term dominance in an era of constant global innovation and disruption. Japan is well placed to succeed, and the Japan Inc. model still resonates widely. The core challenge will be to leverage innovation and disruption to connect new technology with economic development, environmental sustainability, and community well-being.

Following the presentation, the first commenter asked Prof. Holroyd why her research focused on particular technology sectors.

Prof. Holroyd responded that North American audiences rarely read positive things about Japan, and there is value in deepening awareness of the areas where Japan is showing clear leadership.

The next commenter asked how we should think about the relationship between economic growth, science, technology, and innovation. Are Japan's technology successes being offset by other challenges related to economic stagnation and demographic aging?

Prof. Holroyd responded that it is hard to point to a developed country anywhere that is 'doing well'—i.e. that has high growth rates and no problems. On the other hand, we seem always to be expecting more. The questions raised in the Suntory Foundation's Reexamining Japan in Global Context 'Zero-Growth Economy' forum seem very compelling in this respect. There may be a point at which we do not need any more 'stuff'—but that is a hard case for governments to make.

The next commenter observed that every previous stage of technological development has been accompanied by downsides. What are the downsides of the 'super smart society'?

Prof. Holroyd responded that concerns include privacy, data governance, and job dislocation: it is not clear what jobs might be available for those whose skills and labour are displaced by AI, automation, and efficiency gains.

Another commenter pointed out that some countries have already experienced jobless recoveries, while Japan has protected its middle class. It may even be Japan's good fortune to experience its demographic collapse just in time for automation and AI to displace jobs. On the other hand, we are seeing political risks in places such as North America and Europe. There is a sense of career paranoia—people do not know what jobs are going to be there in a few years.

The next commenter asked about the Galapagos Effect. Why is Japan going it alone on so many areas of emerging tech, rather than actively seeking international partners?

Prof. Holroyd responded that Japan does seek to collaborate in many cases—for example, with respect to nuclear fusion and with certain space programs. There are also different degrees of collaboration. In pursuing the hydrogen society, the super smart society, and smart grids, for instance, there is some international testing and knowledge exchange. However, language and culture play a role as well.

Another commenter expanded on this idea, pointing out that immigration policy also influences the Galapagos Effect. While the government has been introducing programs to allow highly-qualified researchers to relocate from abroad, very few English-speaking scientists seem interested in settling in Japan. Similarly, very few Japanese scientists move abroad. While it is easier to globalize universities, it is difficult for foreigners to settle in Japan to work for Japanese tech companies. Overall, Japanese researchers seem satisfied with the status quo, but this constrains international collaboration.

Another commenter pointed out that the Galapagos Effect is usually framed negatively. However, it may have benefits for Japan and the world. In the face of disruptive challenges, it may be worthwhile to have different technology systems and approaches rather than a single global standard.

Next, Prof. Holroyd was asked why Japan does not seem to have national champions—industries or large firms that are favoured by government policy to advance national interests.

Prof. Holroyd responded that there are many more Japanese companies, both large and small, compared to a country such as Canada. Some championing does happen, but it is less vital.

Next, Prof. Holroyd was asked about disruption and international competition. A lot of Japanese consumer electronic companies have disappeared, for example, or shrunk almost to irrelevance. Can the Japanese auto industry survive coming disruptions?

Prof. Holroyd offered two responses. First, it is not clear that hydrogen cars will make it. As we move increasingly to car-sharing and autonomous vehicles, the demand for cars will drop. This poses challenges for a hydrogen economy. Second, a lot of innovation comes from the supply chain. Small and medium enterprises will therefore play a major role in determining the future of the auto industry.

Another commenter pointed out that real innovation sometimes comes from unexpected areas, or from research that is not problem-solving oriented. This presents a challenge when the emphasis is on tackling societal challenges. Scientific and technical communities have sometimes been forced to frame their work somewhat arbitrarily around societal issues. However, this focus can be too narrow. Education, immigration, and labour market reform may be important for scientific and technology planning, but it not always easy to connect these dots in a purposeful way.

Prof. Holroyd suggested that even if things do not turn out exactly the way the government plans, having some kind of goal or direction is a good thing. This is not common, for example, in Canada. However, it is important to also plan for continuity, and this requires monitoring for progress. This is a particular challenge with Japan's five-year science and technology plans.

The next commenter asked about education. What is the relationship between advanced education, innovation, and competition? Can we draw lessons from other countries in terms of this relationship?

Prof. Holroyd responded that there can be differences between how people think innovation works and how it actually does work. In Canada, close to 50 percent of students go on to higher education, mostly to university. However, many of them are not necessarily well suited to, or interested in, an academic environment. Canada does a poor job of channeling people into vocational programs. This is a problem in Japan as well. Many people are going to university, but they are not graduating with the kinds of skills they believe they are graduating with. This presents a major challenge in a context of technological disruption and job displacement. What do we do with people who want a good job and a good life, but for whom there are no jobs, or whose skills are inadequate for the jobs available?

Another commenter suggested that while we do not need everyone to be scientists, engineers, or social scientists, we do need a basic level of literacy for a cohesive and productive society. The West has done a great job of giving away its advantage. It has populated the developing world's university systems with well-trained people, and has lost its own edge. This is to a large extent a result of under-investment in elementary and high school education. Students should not have to attend university and take on large amounts of debt to acquire basic skills in science, math, reading, writing, and speaking.

The next commenter returned to the difficulty of identifying the 'innovation equation.' Some technology proposals do not seem to include serious thinking about social science and policy questions, or even economic feasibility. This suggests that economic incentives do not drive all innovation; dreaming is important, too. Our dreams about the future help us to explain and contextualize the present. Japan's problem may be that Japanese people are not good at dreaming. They are very pessimistic about their future, but also go on with life as though everything is normal. How can Japanese people learn to dream?

Prof. Holroyd replied that dissatisfaction is a big driver of innovation. This may be part of the human condition; it is hard to point to a country that is truly happy with the status quo, whether globally or at home. South Korea, for example, is a very unhappy country, despite its enormous success. It is also a big challenge when people feel unable to participate in society. Things look good in Canada, but the political situation could change quickly in the face of uncertainty around economic disruption, security, and immigration.

A final commenter suggested that there are many reasons to be optimistic. While we must plan for emerging challenges, our efforts should also be inspired by blue-sky dreams about the future we want. We have not seen a well-articulated vision of the net positive and synergistic effects of some emerging technologies, or of the social policies they might make possible. Some communities have begun talking about the importance of design thinking in engineering, and greater collaboration between scientific and creative communities. This may be a good place to start.

Reexamining Japan in Global Context

Technological Development in Contemporary Japan: Possibilities and Challenges

Saturday, May 20, 2017, Suntory Foundation, Osaka, Japan

Keynote Speakers

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- Captain Keizo KITAGAWA, *Japanese Maritime Self-Defense Forces Command and Staff College*
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Hideaki Shiroyama is Professor of Public Administration at the Policy Alternatives Research Institute, where he was formerly director; at the Graduate School of Public Policy, where he was formerly dean; and at the Graduate Schools for Law and Politics, University of Tokyo. His research focuses on international administration, science, technology and public policy, and public policy processes. His publications include *Transformation of Political Space and Policy Innovation 1: Political Theory of Policy Innovation* (University of Tokyo Press, 2008), *The Structure of International Aid Administration* (University of Tokyo Press, 2007), *Governance of Science and Technology* (Toshindo, 2007), 'The Harmonization of Automobile Environmental Standards between Japan, the United States and Europe' *Pacific Review* 20:3, 'Administrative Reorganization and Public Sector Reform in Japan,' in *The Public Sector in Transition: East Asia and the European Union Compared* (Nomos, 2007), and 'Technology Innovation and Diffusion for Environmental Protection,' in *Energy Market Restructuring and the Environment* (University Press of America, 2002). He also served as the chairman of the Planning Committee of New Initiatives for Humanities and Social Sciences Program at the Japan Society for the Promotion of Science (2003–2008); as President of the PI forum, a non-profit organization for consensus building in Japan (2006–2008); and as a member of various government advisory councils on higher education, nuclear safety, food safety, fire protection, climate mitigation, and industrial policy.

Carin Holroyd is President of the Japan Studies Association of Canada and Associate Professor, Department of Political Studies, University of Saskatchewan. She earned an M.Sc. in Japanese Business from Chaminade University of Hawaii and Sophia University of Japan, and a Ph.D. in Political Science from the University of Waikato in New Zealand. She has taught at universities in New Zealand, Japan, and Canada. Carin has written extensively on issues related to government policy on Japanese trade and commercial innovation. Her first book in this field, Japan and the Internet Revolution (with Ken Coates; Palgrave Macmillan, 2003), explored the emergence of the Internet as an economic and social force in Japan. This was followed by Innovation Nation: Japanese Science and Technology in the 21st Century (with Ken Coates; Palgrave Macmillan, 2007), a detailed study of the evolution of Japanese innovation strategies. Dr. Holroyd's work then focused on the emergence of digital media as a commercial force, leading to two comparative studies, Digital Media in East Asia: National Innovation and the Transformation of a Region (with Ken Coates; Cambria, 2012), and The Global Digital Economy (with Ken Coates; Cambria, 2015). Her latest book is Green Japan: Environmental Technologies, Innovation Policy and the Pursuit of Green Growth (University of Toronto Press, 2017), which looks at the commercialization of environmental technologies and the importance of this sector to medium-term Japanese government economic targets.

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