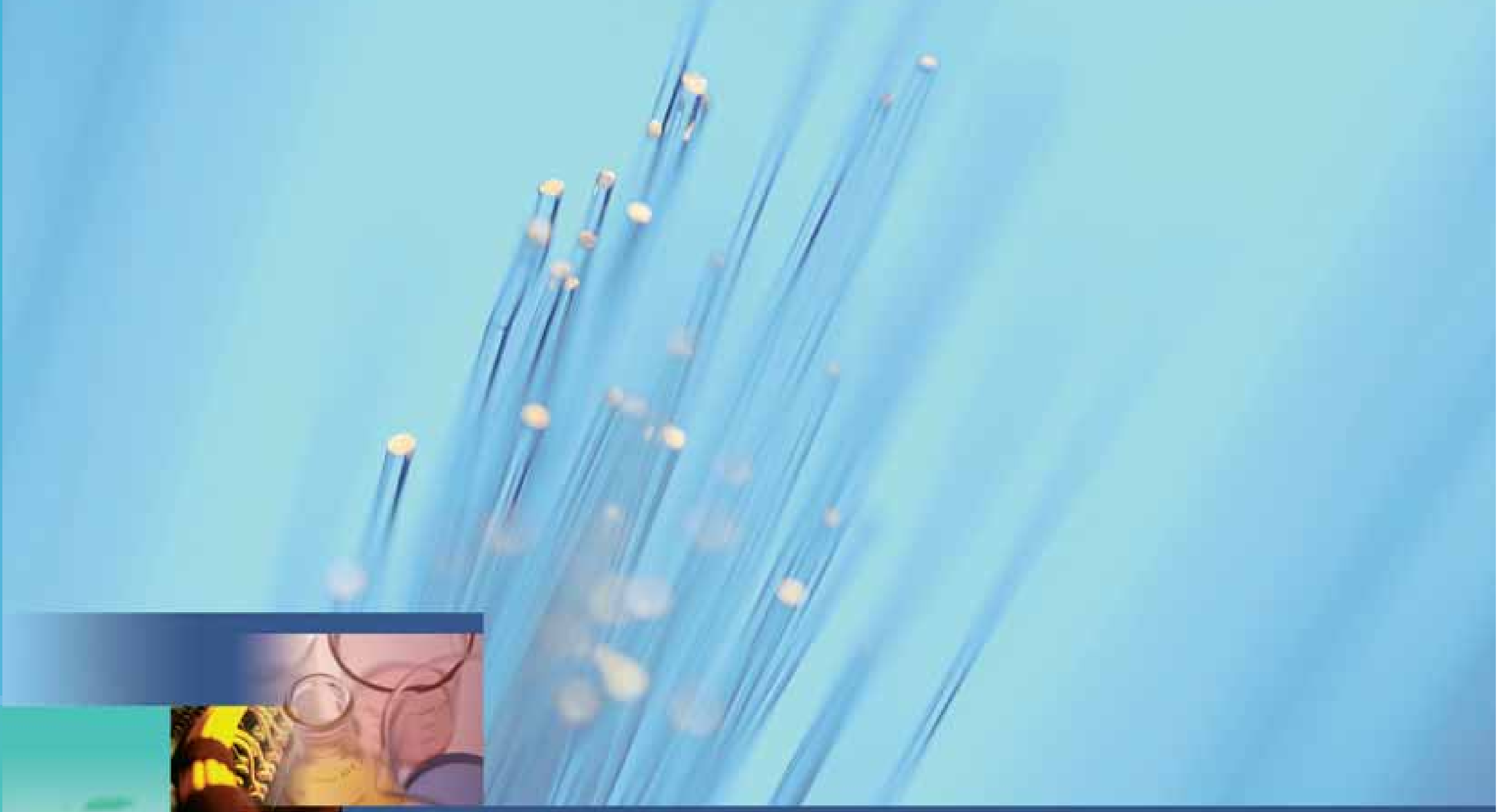

TECHNOLOGY TRANSFER, INTELLECTUAL PROPERTY AND EFFECTIVE UNIVERSITY-INDUSTRY PARTNERSHIPS

The Experience of China, India, Japan, Philippines, the Republic of Korea, Singapore and Thailand

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* The views expressed in this study are those of the authors and do not necessarily represent those of WIPO.
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PREFACE

I am pleased to present this study on *Technology Transfer, Intellectual Property Rights and University-Industry Partnerships: The Experience of China, India, Japan, Philippines, the Republic of Korea, Singapore and Thailand.*

Universities worldwide play a leading role in advancing the frontiers of science and technology. In recent years, a key concern for policy-makers has been how to ensure that the wealth of knowledge generated within universities can be transferred to industry so that society in general, and local businesses in particular, can benefit from university scientific and technological expertise. The realization that important research results would not reach society as a result of bottlenecks in the commercialization of university research results led to increasing interest in finding the most adequate frameworks to promote university-industry partnerships for the transfer of technology.

Intellectual property rights have been identified in many countries as a mechanism that provides the necessary incentives for the commercialization of university research results. Data from a number of Asian countries show a marked increase in the number of patent applications filed by universities. National governments have enacted policies to promote university-industry technology transfer, and various Asian universities have adopted formal intellectual property policies and established technology transfer offices to manage their intellectual property rights. The time, therefore, seemed ripe for embarking on an analysis of university-industry partnerships for technology transfer in Asia, with a view to identifying some of the lessons that may be learned for the future.

I would like to express my gratitude to all the researchers who have contributed to this endeavor. I hope that the study proves to be an effective tool in understanding recent developments in Asia, and will provide useful insights to policy-makers engaged in finding the most effective ways to promote the development of university-industry partnerships.

Kamil Idris
Director General,
WIPO
2007

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PART 1: OVERVIEW OF TECHNOLOGY TRANSFER, INTELLECTUAL PROPERTY RIGHTS AND EFFECTIVE UNIVERSITY-INDUSTRY PARTNERSHIPS IN CHINA, INDIA, JAPAN, PHILIPPINES, THE REPUBLIC OF KOREA, SINGAPORE AND THAILAND

Risaburo Nezu[1]

1. Introduction

This study examines and evaluates the recent progress made in seven Asian countries (China, India, Japan, Philippines, the Republic of Korea, Singapore and Thailand) towards more effective and mutually reinforcing relations between universities and industries in the field of scientific and technological research and proposes a checklist for action to make these relationships even more effective from the broad perspective of the national economy. In particular, it highlights the mechanisms adopted by these Asian countries for technology transfer and pays particular attention to the use of the intellectual property system as an instrument for technology transfer from university to industry. While economic and historical situations are different across Asian countries and no simple solution can be found that is universally applicable throughout the region, it is the hope of the participants in this project that this document will provide some useful lessons and insights, and will thus be helpful to policy-makers who are concerned with evaluating the effectiveness of university-industry relations in their respective countries and identifying ways to improve them.

This overview chapter draws largely from the national studies commissioned by WIPO[2] as well as from the discussions held at the WIPO Roundtable on Development of University-Industry Partnerships for the Promotion of Innovation and the Transfer of Technology that took place on 26 and 27 April, 2005, in Tokyo. At the Roundtable, it was found that in many countries, transfer of technology involves not only universities, but also government-funded laboratories. This paper, however, focuses on the transfer of technology from universities, since universities have special challenges and institutional problems that may not be of direct relevance to national research institutions.

University-industry partnerships in the field of science and technology are complex and may develop through a large number of mechanisms. These may range from more informal mechanisms, which include publication of research results, employee mobility or informal exchanges between scientists to more formal contractual mechanisms in which longer-term relationships are established. This publication will deal primarily with the latter type of mechanisms, i.e. situations in which universities (or their staff) and industries enter into formal relations in the field of scientific and technological research and development. Such relations may imply the transfer of technology developed within universities, consultancies and transfer of know-how, collaborative research projects, sponsored research or other similar arrangements.

The protection and licensing of intellectual property rights is here identified as one possible mechanism for the transfer of technology that has increasingly been the focus of attention of policymakers. Patenting by universities has been increasing steadily throughout the Asian countries (see Table 1) and it is now timely to review performance so far and identify areas in which further work is required to ensure that the expected results are achieved. While one of the key areas of focus of this paper is the use of the intellectual property system by universities, it is important to ensure that countries and institutions that choose to promote the protection of IP by universities, and particularly the use of the patent system, do not do so at the expense of other mechanisms for transfer of technology, including informal mechanisms that

1. The views expressed in this chapter are those of the author and do not necessarily represent those of WIPO
2. Each national study is published on the WIPO website (*http://www.wipo.int/uipc/en/partnership/*)

may be particularly suited to certain fields of technology or certain types of technological knowledge. In addition, the paper highlights measures to avoid and manage conflicts of interest in order to ensure that the drive to encourage patenting and university-industry cooperation does not negatively affect the universities' capacity to perform their core functions and mandate in the field of education and research, but rather helps to re-enforce it and enhance its effectiveness.

2. Historical and Cultural Settings for University-Industry (U-I) Collaboration

Relations between universities and industry are very much subject to the historical and cultural background of individual countries. In every country, universities operate under a different set of rules, practices and constraints. With some exceptions, most Asian countries have been isolated from global trade in the manufacturing and service sectors until three decades ago. Over the past three decades many Asian nations chose to participate in global competition and began to reap more benefits from the efficient use of their knowledge. The size, levels of economic development and resources devoted to research and development (R&D) by the Asian countries that were the focus of this project are significantly different. Japanese per capita income exceeds US$35,000, while those of four other countries included in this study are less than one tenth of that. The resources devoted to R&D, both financial and human, exhibit an even wider difference. China is undoubtedly the largest nation in the world, while Singapore is one of the smallest (see Table 2). In addition to historical and cultural differences, these differences in the economic realities in which individual countries are placed present divergent contexts for university-industry relations. However, regardless of these differing contexts, over the last twenty years, Asian governments have been giving increasing attention to the effectiveness of their national innovation systems, in particular the relationships between universities and industry.

Japan

In spite of its overwhelming success in the process of industrialization throughout the post-war period, Japan, by the late 1990s, was obliged to fundamentally transform its university-industry relationships. In Japan, many good universities are traditionally State-owned and have thus been shielded from the pressures of the private sector. As a result, they have shown little interest in working with business. Particularly after 1945, they harbored strong anti-business sentiment, believing that large business had been responsible for driving Japan into the painful Pacific War. Against this background, it was rare for such State-owned universities to offer services to businesses in order to help them to resolve technical problems. Universities believed that they must be allowed to pursue truth, free from the interests of external agencies such as government and business.

It was only as late as the 1990s that Japanese society became serious about establishing mutually supportive relations between the two communities. The direct cause of this change was the heavy loss of competitiveness by Japanese firms to the United States in such key sectors as information technology and biotechnology. Korea, and then China, countries that were industrializing at accelerating speeds, were posing new threats to Japanese industry. The response to these new challenges was to upgrade industrial structures and raise the competitiveness of Japanese industry. Companies began to show increasing interest in utilizing the knowledge of universities rather than doing all of their research on their own. Under the pressure of global competition, utilizing the most advanced knowledge developed by universities in a speedy fashion became a matter of the highest priority for Japan. On the part of universities, there have been increasing indications that Japanese universities are falling behind foreign universities in their levels of academic research because they have not interacted with industries, which employ equally competent scientists. At the same time, there is still a strong sense of cautiousness, often legitimate, that universities should not give way to the pressure to contribute to commercial gains at the expense of its academic and educational missions. Many Japanese universities are considering and reviewing their policies to find the right balance.

China

China has emerged from a completely different historical background. Its university-industry partnerships began as early as the 1950s. From the start of the Communist regime, universities were called upon to make full contributions toward the increase of production in China, as the Chinese economy was deemed to be in a state of “shortage.” Transfer of knowledge from universities was conducted without explicit rules with respect to intellectual property. It was only after the major policy change that took place during the 80s that China became more focused on the productivity of the economy and thus began to mobilize academic and scientific resources to achieve economic ends. The Decision on the Reform of Scientific and Technological Systems by the Central Committee of the Chinese Communist Party in 1985 marked this turning point in Chinese science and technology policy. This decision allowed universities to make their own decisions, based on the market situation, in organizing R&D programs and transferring technologies. In addition, the decision made it possible to provide incentives through “more pay for more work.” The role of the government changed from direct intervention and control to guidance and oversight, setting laws and regulations under which universities could decide on their own course of action.

Republic of Korea

The Republic of Korea presents another developmental model. To narrow the gap quickly with Japan and other industrialized countries, Korea began to recognize the importance of closer working relations between universities and businesses. The industrial sectors of strategic importance to Korea changed quickly from labor-intensive products to more high tech machinery and information sectors. In the recent past, a number of laws were introduced and amended to make way for a broader range of collaboration between universities and business. Four laws were of particular importance to facilitating U-I partnership: the Science-Technology Basic Law, the Technology Transfer Promotion Law, Patent Law and the Law for Industrial Education Promotion and Collaboration Boost. Seeing that Korea’s innovation system was based upon the catch-up model, the World Bank and the Organisation for Economic Co-operation and Development (OECD) advised Korea to redirect its strategy toward long-term basic research and to open up its innovation system to foreign participation. Strengthening the U-I relationship is thought to be the right step towards achieving this end.

Singapore

The case of Singapore is different from any other Asian country. Having its origin as an *entrepot*, it has been open to international competition since its independence. By the 1990s, the country had already reached a high level of industrial development and its industrial strategy of utilizing cheap labor was no longer feasible. The need to move to an innovation-driven economy was felt earlier than in its neighboring countries. Being the only two full-fledged universities up to the turn of the century, the National University of Singapore (NUS) and Nanyang Technological University (NTU) have had a strong tradition of collaborating with industry. Their graduates continue to find employment readily in the diverse manufacturing and service sectors. The culture of interaction with industry has been developed through a range of activities including internships, research collaboration, technology licensing, adjunct appointments and industry participation in consultative committees of academic departments.

Philippines

In the Philippines a large proportion of economic activity is in the agricultural sector, which mainly serves its domestic market. Collaboration between university and industry is new and not yet widespread. A very small proportion of universities have strong R&D units that enable U-I collaboration. An in-depth study commissioned by a government agency acknowledges that several problem areas existed with respect to research activities in Filipino universities, including administrative processes, lack of full time researchers and other resource shortages. What is noteworthy about the Philippines is that many of the firms operating in the country are subsidiaries of foreign firms or joint ventures. They generally lack confidence in the local laboratories and prefer to rely on technology supply from their parent companies, which lack knowledge on the research undertaken within Filipino universities. Nevertheless, during the past decade, there have been cases of industry contacting local research institutions and universities to resolve their technical problems. This was made possible partly as a result of the increasing expertise built up through the Engineering and Science Education Program (ESEP) and also brought about by the economic difficulty the country was experiencing. Science Parks were also recently established in the UP Diliman, Quezon City and UP Los Banos, Laguna in order to encourage close collaboration with industry.

India

After independence in 1947, Indian science and technology policy was integrated into the fabric of the planned economy. A series of five-year plans set out the basic national strategies for economic growth and industrial development. Over the last ten years however, India moved gradually from a planned and closed economy to a more open and deregulated one, with new challenges being set forth for universities and industries. Presently, India is in the process of implementing its 10^{th} five-year plan. In the area of science and technology (S&T), the country is being steered by the S&T policy of 2003. It is only in recent years that Indian industry has really started collaborative programs with universities. Indian success in the software sector is remarkable. The market share for India in the global IT service business is now 4.4%. Major global IT companies have outsourced some part of their operations to India and have established R&D centers there as well. Indian IT engineers are working in many industrialized countries and contributing to the advancement of information technology. A few world-famous universities like Indian Institute of Technology have made this success possible. But overall, few Indian industries are supporting research projects within universities. Most of the collaboration is in the form of consultancies, which typically do not involve large-scale projects. On the other hand, according to the survey questionnaire conducted by P. Ganguli in the Indian national study,[3] Indian universities are not fully aware of the importance of intellectual property rights (IPRs) and lack the resources to manage them. Both sides need to reach out if U-I collaboration is to flourish.

Thailand

In Thailand economic growth in the last decade has been remarkable, with a brief interruption at the time of the Asian financial crisis of 1997. Owing to a high level of foreign investment in the manufacturing sector, in particular, automobile and electronics machinery, Thailand is already a global hub for the production of parts and components in these industries. But Thailand's indigenous private sector is not very active in pursuing research. Only very large firms have their own laboratories. U-I collaboration has a limited history and there is still limited experience. There is no overarching framework underpinning such collaboration. Its regime for managing intellectual property rights is also rather new. The first law for protecting intellectual property, which covered only patents, was enacted in 1979. This was followed by another law of 1991 and an amendment of 2000 that covered trademarks. Protection of copyright came in 1994. However, the Thai government is fully aware of the potential benefit of U-I collaboration, as is evidenced by its National Social and Economic Plan No. 9, which stresses the importance of transforming the national structure for production, trade and services. The Ministry of Finance allows registered firms, including public and private firms, universities and research institutions, to deduct up to 200% of R&D expenditures from taxable incomes.

In spite of these differences in historical backgrounds and stages of economic development, the recent wave of globalization in the national economies of East Asia has given rise to a common concern across the region. That is, how to ensure sustained economic growth in the increasingly competitive global market and how to take full advantage of the opportunities provided by the advent of the knowledge-based economy. Information technology has offered an unprecedented opportunity for developing countries to narrow the gaps with developed countries over a short space of time. The Republic of Korea, Singapore, China and India are among those that are successfully seizing such opportunities and, at least in some sectors, are rising up to the forefront of global competition. The classical model of economic development, as illustrated by the so-called flying-geese model, may no longer be valid. In a knowledge-based economy, some countries are able to make leapfrog jumps to the most advanced stage of development. China, for example, is today the largest user of third generation mobile phones, even though ten years ago, most people did not even use landline telephones. The Philippines is another country that today uses mobile telephone extensively for personal and industrial uses, but it does not have a past record of IT equipment producers. The Republic of Korea is the most advanced user of broadband

3. Ganguli, P., *Development of University-Industry Partnerships for the Promotion of Innovation and Transfer of Technology: India*

Internet, but it never produced mainframe computers. India is the biggest supplier of outsourcing IT service for the United States and other OECD countries, but India has not had an effect of similar magnitude in other industrial sectors.

The primary reason for such a jump in the process of economic development is that we are now living in a time of global business activity and the knowledge economy. Capital, which was once the major constraint to growth, is now mobile on a global scale. Natural resources can be shipped to anywhere they can be used in the most efficient way. What really matters is the knowledge that enables a company to differentiate itself and generate competitive advantage. The advent of digital technology and biotechnology in the '90s has amply demonstrated the way in which the nature of competition today differs from the earlier paradigm. A high number of new information technologies originated from academic circles and venture businesses rather than from the laboratories of large firms. An increased call for returns on investments and reduced time to market added to the pressures on firms to use output from R&D that takes place outside their own walls. All of these forces came together to create increasing incentives for firms to work with universities for research and development.

From the perspective of the universities, there is a growing interest to join forces with the private sector, as universities are being called upon to make tangible contributions to society. In many economies, governments are coming under strain in allocating limited resources to divergent requirements such as providing for the aging population, combating environmental degradation, and maintaining education and social welfare. The university is no longer a sacrosanct investment, free from the critical evaluation of cost effectiveness. The increasing realization of the role of innovation as a catalyst for economic growth, has put pressure on governments to ensure that efforts are made to enhance the economic and social impact of public R&D investments. Experiences from a number of successful clusters show that innovation systems work best when there is active interaction between various agents, ranging from companies to government support structures, business associations, research centers and universities. Universities are, therefore, increasingly expected to contribute to economic welfare and, particularly in countries where a substantive portion of overall investments in R&D is made in the public sector, it is increasingly important to ensure that investments in R&D are helping to enhance the technological development of the domestic industry which is under heavy pressure from global competition. The idea that useful research results may remain unused on laboratory shelves if a pro-active policy to transfer such results to industry is not undertaken has been at the back of the minds of many policy-makers.

In countries such as Japan and the Republic of Korea, where the private sector invests heavily in R&D, working with industry is a very attractive option for universities, as business laboratories tend to be better funded and better equipped. The level and quality of their research is as high as those of universities. In addition, students tend to prefer universities that have close working relations with industry, since such universities offer opportunities for finding good jobs after graduation.

But being detached from the world of business, universities are not always aware of how best to mobilize their academic knowledge. Traditionally, university scientists have attached far greater importance to writing academic papers and having them published in leading scientific journals than to transferring technology to the private sector or applying for patent protection. Low awareness in applying for Intellectual Proparty Rights (IPRs) is also a problem of culture and mindset, although today faculty members increasingly have more positive attitudes towards applying for patents and establishing relations with business.

State-owned universities in Japan are a very good case for illustrating the new expectations placed on universities and their role in society. As of April 2004, their legal status has been changed to independent administrative agencies. While they now have greater leeway over the management of their own affairs, including partnerships with the business community, they are held accountable for ensuring efficient operations and making proper contributions to society. One good way for the university to render service to society is to make their scientific and engineering knowledge available to businesses and to work with them to commercialize such knowledge. This can be achieved effectively when there are proper incentives for universities to do so. At the same time, in the industrialized economies, universities may find that researchers and research facilities in the private sector are of high caliber and are helpful to their purposes. Thus, interest in reaching out to the other is growing on both sides.

As for intellectual property rights, these are increasingly perceived as a useful mechanism, providing all stakeholders with the necessary incentives, for transferring technology to industry. The experience of the United States has been examined carefully throughout the world. US industry lost its leadership position largely to Japan during the '80s, but revived since the middle of the '90s. During the '80s, the US introduced many measures to facilitate the commercial use of scientific knowledge that was in the hands of universities. The Bayh-Dole Act of 1980 was the best-known piece of legislation for that purpose. The Act permitted universities to retain intellectual property ownership over any new knowledge that resulted from publicly-funded research activities and, where possible, to commercialize that knowledge through licensing to industry or to start-up companies. According to a study conducted by the Association of University Technology Managers (AUTM), 260,000 jobs and US$40 billion of economic activity was created in the US as a result. There have been many other measures of equal importance taken to facilitate U-I collaboration. Though there is some debate about to what extent the pro-patent policy in the US facilitated the commercial use of inventions by universities, it is without question that university inventions gave rise to many ventures and added to the technological advantages of the US firms in the biotechnology and information technology sectors.

Unlike mechanical engineering and information technology, in biotechnology, scientific discovery is directly used for producing drugs and diagnostic substances. Most of the patents are filed by academic institutions and small ventures rather than by large pharmaceutical firms. The distance between the university laboratory and the market is very short. Accordingly, there is higher chance of success for spin-offs. The emergence of this new US model and its overwhelming success story in the biotech sector urged other nations to reinvigorate their own university-industry relations. The report from the US Council on Competitiveness (1998) states, "The nation that fosters an infrastructure of linkages among and between firms, universities and government gains competitive advantage through quicker information diffusion and product deployment." Taking a look at the developments taking place in many countries in Asia and the rest of the world, it is generally correct to conclude that the subject of relations between science and business communities has gained importance throughout the 1990s to become one of today's priority issues for policy-makers worldwide.

3. U-I Relationships: Facts and Figures

To examine the deepening relations between industry and the academic community in a quantitative way and to make an international comparison is by no means an easy task. A good indicator is the so-called "science link," namely the number of academic papers cited in the patent applications filed at the US Patent and Trademark Office. This science link indicator shows a clear upward trend in all industrialized countries, and at the same time significant gaps among these countries as well. In the US for example, the number of academic papers cited per patent application was less than 0.5 in 1985, but went up to a level of 3.0 in 1998. On the other hand, the same figures for Japan were 0.2 and 0.6 respectively, showing a substantial gap between Japan and the US in the strength of U-I linkages (Table 3a). US industries draw much more heavily from academic research when they file patent applications. Other industrialized countries come between Japan and the US. The Republic of Korea represents a unique and remarkable case in the sense that in spite of a high level of R&D spending relative to GDP (2.5%), its science linkage is the lowest among the OECD member countries. This confirms that Korea has the potential to reap huge benefits through strengthened U-I collaboration.

By discipline, biotechnology shows a remarkably high degree of science linkage, followed by organic chemistry (Table 3b). An average patent application in the biotechnology field draws from more than twenty scientific papers. The high level of science linkage in the US is explained by its strong presence in this sector. This indicates that commercial success in this sector cannot be achieved without having strong scientific research in the university or public laboratory. This is exactly why countries find it difficult to narrow the gap with the US. By contrast, computing is the area with the lowest level of scientific linkage. The Computer industry, particularly its manufacturing part, is a sector where engineering skill, as opposed to scientific knowledge, is the key input to produce patentable knowledge. This may be the reason why many Asian countries could catch up with the American and the Japanese leaders.

China

In China, universities have been given considerable freedom to engage in profit seeking businesses. Such university-run enterprises can be either scientific/engineering businesses or non-scientific business such as shops. The number of scientific university-run enterprises is around 2,000, employing 238,000 workers, of whom 78,000 are scientific researchers. The sales income from university-run scientific enterprises increased from RMB 18.5 to 45.2 trillion. Technology transfer and licensing from universities is also on the rise. The number of patent transfers, for example, went up from 298 in 1999 to 532 in 2002. During the same period, technology transfers also increased from about 4000 to 5600. In addition to technology transfers, contractual research, consultancy and enterprise incubation are widely seen as a means for university researchers to work with private businesses. During the three-year period between 2000 and the end of 2002, 326 establishments were created in cooperation with Chinese or foreign enterprises. What is remarkable about the funding of scientific research in Chinese universities is the high proportion of funding from private companies, a total of 40%. This points to a very high level of readiness on the part of Chinese businesses to pursue U-I collaboration.

The World Bank's Report of 2001 on "China and the Knowledge Economy" confirms that Beijing University and Tsingbua University created more than sixty spin-offs each in high tech areas. Some are already listed on the Chinese stock market and generating profits and royalties. This is very much due to strong incentives such as allowing researchers to keep at least 50% of the earnings from commercialized technologies. There are differing views on this distinctive feature of the Chinese innovation system. Some argue that this is essential for pushing the knowledge economy in China. Others argue that universities are not set up for making a profit and they must first fulfill their roles as generators of knowledge for the common good. The Chinese Ministry of Education has recently begun to look into the current state of U-I collaboration in order to ensure the right balance.

University spin-offs or university-spawned ventures are one widely recognized way of commercializing the results of university-conducted research. This is particularly common in such fields as information technology and life sciences. Such spin-offs include: i) firms founded by public sector researchers, including staff, professors and post-doctorate students, ii) start-ups with licensed public sector technologies, and iii) firms in which a public institution has an equity investment. Spin-offs are an entrepreneurial and risk-taking method of exploiting knowledge developed by public laboratories for commercial benefit. The effectiveness of this method is particularly noticeable in such sectors as biotechnology where a new discovery is often directly usable without having to go through the many stages from basic research to commercial application. There is much debate as to whether spin-off companies, with all the risks involved in setting up a new company and the high mortality rate for start-ups, are the most efficient way of getting university technologies to market if compared to licensing to existing firms. Preliminary evidence would suggest that particularly in the case of disruptive or very innovative technologies spin-offs may be the best way of ensuring that a given technology is commercialized. In addition, spin-offs are sometimes used as a mechanism to ensure that university technology is commercialized by domestic companies that can benefit the local economy.

Japan

In Japan, the number of university-spawned ventures has been looked at as a key indicator for measuring the overall effectiveness of U-I collaboration. The Minister for Economy Trade and Industry (METI) proposed that one thousand such ventures be created by the end of March 2005. When it was announced, in 2002, it was seen to be too ambitious. But it turned out that over 1,000 university spin-offs were created, overshooting the publicly announced goal (see Table 4). The biggest contributor to this achievement was Tokyo University, which spawned 64 spin-offs, followed by Waseda and Osaka University. Most of the universities on the list were big and prestigious ones. The policy focus is now moving from spawning as many start-ups as possible to bringing them to the stage of initial public offering (IPOs). It is the intention of the Japanese government to shift the policy emphasis on such ventures from quantitative expansion to qualitative improvements. This will be a management issue, as well as a technology issue. After all, the number of spin-offs from national university laboratories is small compared to the total number of technology led start-ups in the entire economy. The mere number of spin-offs from universities is, at best, a rough measurement of the effectiveness of U-I collaboration.

There is other evidence of the growing interest of Japanese universities in protecting their inventions by filing patents as a means for transferring technology. The Japanese universities filed 1,335 patents in 2002, a substantial increase from the 76 patents in 1996. But there are some negative indicators that reveal weakness in Japan. Japanese companies spend more than two times as much money on collaboration with foreign universities as they do on collaboration with universities at home. In high-technology fields such as IT and biotechnology, the gap widens to ten times. Why does this happen? Because in the view of Japanese business, Japanese universities are much less responsive to the needs of business, slow to act and less experienced in managing IPRs. While the current progress is encouraging, Japanese U-I relations still have a number of problems to overcome.

Republic of Korea

In the Republic of Korea, in the year 2003, 133 cases of technology transfer were reported from 19 Korean private universities. This represents a significant increase, up from 102 in 2002 and 58 in 2001. Parallel to this, the income for these universities from technology transfers more than tripled, from 0.473 billion Won in 2001 to 1.913 billion Won in 2003 (see Table 5). Patent applications by national universities seem to have increased drastically as well. This began after the establishment of the Industry University Cooperation Foundation (IUCF), which is responsible for the management of IPRs at each university. Seoul National University and Kyungpook National University obtained 260 and 36 patents respectively just in 2004. Prior to the set up of IUCF, Korean universities were inactive in protecting their inventions. Up until May 2001, only 44 patents were filed by the Korean national universities.

Singapore

In Singapore, universities have been collaborating intensely with industry since the government initiated the Research and Development Assistance Scheme (RDAS) in 1981. This was a grant scheme aimed at stimulating R&D in the form of U-I collaboration. A full-fledged technology transfer operation began in 1992, when the Industry and Technology Relations Office (INTRO) of the National University of Singapore (NUS) was formed to handle research collaboration, IP management and technology transfer within NUS. Up to the present, INTRO facilitated the filing of more than 700 patents, 166 of which have been granted. 84 licensing agreements have been concluded to generate revenues of US$1.44 million and equity in lieu of royalties reaching US$4.85 million. In 2002, 136 research collaboration agreements were signed with external parties amounting to a total project value of US$42.5 million, or about 15% of the NUS annual research budget.

Philippines

In contrast to Singapore, in the Philippines, university-industry partnerships in science and technology have been limited. But there are several specific examples of U-I collaboration reported in the national study (see WIPO website). They indicate that the contents of the agreements between universities and industry are very different depending on individual cases. Some are with local companies and others are with foreign companies. Other than the University of Philippines, most Filipino universities do not have a separate unit in charge of managing intellectual property rights. One reason for weak U-I relations is the strong presence of foreign businesses among potential partners for university collaboration which tend to rely on R&D and IP transferred from their parent companies. This may risk complicating U-I relations and making collaboration more difficult.

R&D resources in the Philippines are also relatively modest both in terms of expenditure and number of researchers, but concrete examples of U-I collaboration can now be seen, as a statutory framework for IPR protection gets adopted by major universities. Since 1991, the University of the Philippines, Los Banos has been granted six patents and has filed an additional ten patent applications that are still at the patent office. The University of Santo Tomas is negotiating its first licensing agreement with a pharmaceutical company. Ateneo University has also entered into an agreement with a private company for research and development projects with both parties contributing financial and other resources. The other universities are also moving towards entering into arrangements with either Filipino or foreign multinational companies.

India

Indian academic institutions became aware of the importance of protecting and disseminating their knowledge through patents rather recently and the trend seems to be continuing. In 1995, only 35 applications were filed, but it rose to 96 in 2001 and 79 in 2002. Out of the more than 300 Indian universities, the number of academic institutions that filed patent applications during the last four years was in the range of 22 to 29 per year (a total of 62 over the four-year period), and this was still too small compared with the high number of educational institutions in India that engage in R&D activities (see Table 6). In contrast to this modest progress, the performance of the Council of Scientific and Industrial Research (CSIR) has been outstanding. The number of patents filed and granted doubled or tripled every year after 2001. This is a result of an aggressive and systematic IPR policy as well as the benefit of 39 networked laboratories. This points to the importance of attitudes and policies taken by individual research organizations in advancing the protection of inventions.

Thailand

Thailand's expenditure on R&D is modest compared to its GDP, which is growing at a remarkable pace. In 2003, only 0.18% of GDP was spent on R&D. This low level of resource allocation for R&D is reflected in the small number of patents granted to universities. Between 1995 and 2004, a total of 139 patents have been granted to them, with two universities Kasetsart University and King Mongkut's University, accounting for more than 60% (see Table 7). Patents granted to all universities showed some increase in the late 90s, but has been going down again over the last four years. Patents granted to U-I collaboration have been very rare. Only six cases have been recorded since 1995.

As has been observed in the preceding sections, U-I collaboration is progressing in all Asian countries, albeit at different speeds and with different momentum. But universities and companies are running into new issues and challenges that had not been anticipated until they had embarked upon this process of collaboration. Such issues will be examined in the following sections.

4. National Policy Framework for U-I Collaboration

For the Asian countries that participated in this project,[4] development and expansion of U-I relationships during the last decade has been a result of goal-oriented and deliberate public policy efforts. The areas of focus have included: defining the legal status of universities and their professors, relaxing or removing regulations that prevented faculty members from working with companies, developing policies on intellectual property rights, establishing technology transfer offices, creating funding schemes, and ensuring adequate financial resources for research and development activities at universities. There now seems to be some consensus in Asian countries, both developed and developing, that universities and public laboratories should make greater contributions to countries' overall economic growth and competitiveness. While universities, industries, and publicly-funded research institutions should be allowed to develop working relations with each other through their own initiative, governments also have a responsibility to establish laws and practices that would give proper incentives towards collaborative research activities. At the same time, we must be careful not to forget the importance of long-term scientific goals and educational responsibility. Universities should not cave in to the pressure to generate quick commercial outcomes.

In all of the Asian countries that participated in this project, some type of policy framework, underpinned by laws and government regulations, has been put in place over the last two decades. Ideally, the policy framework should serve three purposes: first, to state publicly the intention of the government with respect to the direction universities and industry should take; second, to lay down legal rules for the conduct of universities and industry, for example in relation to the management of IPRs; and third, to secure financial resources and incentives to facilitate collaboration. Not all countries have policy frameworks that serve all three purposes. In certain countries, the legal status of universities needed to be

4. Each national study is published on the WIPO website (*http://www.wipo.int/uipc/en/partnership/*)

redefined by new laws so that they could operate as independent and responsible entities. In others, there was no need for new legislation. In some countries, governments are taking pro-active measures to boost U-I collaboration, while in other countries they play more backseat roles, allowing universities and industries to determine their own courses of action. The legal frameworks are very different among the Asian countries that participated in this project.[5] In some countries, laws are written to spell out technical details. In other countries, they provide only basic guidelines, leaving all technicalities to ministry directives, circulars, and notices. In addition to the legal framework, some countries draw up basic plans and goals for U-I collaboration with a view to setting forth future directions and accelerating the trend. Such basic plans are meant to be reviewed and if necessary, modified regularly to take into account the progress to date.

In the past, universities in different countries had had different degrees of autonomy to engage in contractual collaboration with the private sector. In Japan and Korea, State-owned universities were treated as part of the government and were not allowed to operate as independent entities. Because of this unique legal arrangement, they had no legal status, and did not have the capacity to write a contract or own patents. This is particularly important because top universities in most Asian countries are often State-run. Such State-funded universities normally did not have a legal status, which would allow them to claim ownership over the results of their research activities, employ researchers, write contracts with private companies and take on legal obligations if necessary. Rather, they were deemed part of the government itself and were obliged to follow a meticulous process to obtain permission to work with the private sector. Professors were government employees and because of this, they were not allowed to work outside the university. In order to pave the way for more operational and efficient U-I relations, specific actions have been taken in these two countries.

Republic of Korea

In Korea, for example, several different laws collectively form the basis for U-I partnerships and technology transfers. Among them are science and technology basic laws and patent laws, but the legislation of direct relevance is the Technology Transfer Promotion Law (2000). Prior to this law, national and public universities did not have the status of a legal person and therefore could not claim patent rights. The rationale behind this rule was that the results of publicly funded research should belong to the public domain, not to the organization that developed them. This had been a major obstacle for universities with respect to conducting research in areas of commercial interest.

Article 16 of the technology transfer promotion law reversed this statute in order to enable publicly funded universities to work with businesses and use their technologies and knowledge for commercial purposes. Under the new arrangement, researchers in national universities have been allowed to not only work with the private sector, but also take a slice of the earnings in the event that the project generated revenues. As of 2001, a significant gap was observed between publicly-funded universities and private universities in the proportions of research funds coming from the private sector. In the case of the former, 14.7% came from the private sector while, in the latter case, it was 32.3%. Whether the low level of exposure for national universities to corporate funding is good or not is debatable. Maybe it is because national universities do not need to rely on private sector funding that their proportions are so low. But without a doubt, national universities are less experienced in doing joint research with the private sector and part of the reason for this is the restrictive nature of the legal status of professors. Whether the new Law for Industry Education Promotion and Industry University Cooperation Boost of 2003, coupled with the monetary incentives, will bring about dramatic changes in the attitudes of the national universities is yet to be seen. But the initial signs indicate that this change in the legal framework will affect patenting activities considerably.

Japan

Japan's development is very similar to that of Korea's. The law Promoting Technology Transfers from Academia of 1996 was the first in a line of legislative attempts to facilitate technology transfers. It was followed by a second law, the Industrial Revitalizing Law of 1999, which established a legal structure similar to that created in the Bayh-Dole Act in the

5. Each national study is published on the WIPO website (*http://www.wipo.int/uipc/en/partnership/*)

US. However, the most important law, a law to alter the legal status of national universities from a government institution to an independent administrative entity, took effect in April of 2004. The purpose of this law goes well beyond facilitating U-I collaboration. It aims to render the Japanese national universities more responsive to the changing needs of society by giving them more freedom of conduct on the one hand, but, at the same time, making them more accountable for creating value in Japanese society. One area where visible change is expected is U-I collaboration. By giving universities an independent legal status, this new arrangement enables them to own the technologies and inventions that they develop. Researchers and faculty members in the national universities are no longer bound by the regulations applicable to government employees. This change, coupled with other reforms that the Japanese national universities have undergone recently, has very much altered the attitude and mindsets of the university researchers with respect to collaboration with the private sector. For example, the rapid increase in spin-offs from university laboratories is largely due to the relaxation of the old regulations prohibiting faculty members of state-owned universities from working outside the campus.

China

Concerning the legal status of public universities, other countries in the region did not face similar restrictions. In the Philippines, state-owned universities are autonomous and allowed to act like a corporation, even though they are financially supported by the government. China has a very different situation. The Law of Corporation of the People's Republic of China (1994) stipulates that the legal person of an enterprise, institution or citizen is authorized to establish a corporation according to the law. Because universities are institutional legal persons under this law, it is possible for the university to make investments and establish a corporation with its own capital. In addition, the law stipulates that technology, patented or not, can be regarded as capital. This set of stipulations paves the way for universities to act independently and commercialize their technologies through enterprise incubation, or by holding equity stakes in private companies. In the year 2000, there were 5,451 university-run companies. While most of them were not research-based, the science-related companies accounted for 2.3% of the total sales in the high-tech sector in the rapidly growing Chinese economy. This is a very high number compared with other Asian countries. Such university-conducted business activities are concentrated heavily in the top five provinces.

In the late 1990s, China took a series of more specific actions to push ahead with U-I collaboration. The Central Committee of the Communist Party decided in 1999 that bilateral and multilateral mechanisms for collaboration should be created in the form of mutual part-time jobs and training. Quite a high number of regulations were adopted by both the central and provincial governments in the years 1997, 1998, and 1999 in order to boost technical innovation and U-I partnerships. Among them are two laws setting out the supplementary details of the rights and obligations of, as well as the contracts for, the parties involved in technology development, transfer and commercialization. The measures put forth in Several Opinions on Bringing into Full Play the Scientific and Technological Innovation Role of the University by the Ministry of Education (2002) are directly oriented toward U-I partnerships. This government decision states as objectives: "To promote universities to form technology transfer offices; to encourage universities to disseminate the use of technologies developed in various forms such as through patent licensing, technology transfer…" As a result of this decision, Chinese universities are able to make regulations aimed at encouraging inventions and technology transfer. Faculty members and students are encouraged and supported in their efforts to build or take part in venture businesses as part-time work.

Setting up the legal framework for universities is important in promoting U-I collaboration. What is of equal importance, however, is that Asian governments express their political will to bring about more active exploitation of knowledge developed by universities. In Japan, the Republic of Korea and India,[6] such political will has been incorporated into "basic plans" of some kind, which lay down long-term priorities and funding policies. While the processes established in these plans are not identical, it is important to note that U-I relations have been given renewed emphasis in all of the countries.

6. Each national study is published on the WIPO website (*http://www.wipo.int/uipc/en/partnership/*)

Japan

In Japan, formal U-I collaboration dates back to 1983, when joint research projects with the private sector were first approved, but it is more recently that U-I collaboration has been given full recognition as a major policy direction in the Japanese science and technology policy. The Basic Plan for Science and Technology, adopted by the Cabinet in 1996 stressed the importance of promoting collaboration between universities and business. During the few years that followed, several important decisions were made at the intergovernmental level, including the Japanese version of the Bayh-Dole Act of 1999 and the Basic Law for IPRs of 2002. Pursuant to the Basic Law for Science and Technology, the Science and Technology Council draws up a "Basic Plan for Science and Technology" every five years. The latest one, published in 2001, recommended that the Japanese government spend 24 trillion yen over the next five-year period on public research and development. It also stressed the importance of strategically allocating resources in basic fields to the organizations that can conduct world-class research.

Philippines

The Government of the Philippines is also beginning to play an active role in advancing U-I collaboration. Its latest National Science and Technology Plan (NSTP) of 2002 stresses the importance of linkages between university, industry and government. The Plan has been formulated by close consultations among government, industry, academia, and interested non-governmental organizations. It sets out the science and technology (S&T) vision and defines the goals to be achieved over the short, medium and long term. These goals should be achieved through collaborative S&T programs that utilize cost sharing, information sharing, and best practices. The Plan also attaches importance to the transfer and/or adoption of technology formulating the Technology Innovation and Commercialization (TECHNOCOM) and Small Enterprise Technology Upgrading (SET-UP) Programs. Details of this plan have been released through a series of government memoranda and administrative orders between 2002 and 2004. In addition, a Venture Financing Program is also being put in place in order to accelerate the commercialization of new technologies by providing funding. In response to these actions by the government, universities are beginning collaboration in practical fields like training and consulting, the type of services that are most needed. The Philippines Council for Industry and Energy Research Development, Philippines Council for Health Research and Development, Philippines Council for Advance S&T Research and Development, Philippines Council for Agriculture and Resource Research and Development of the Department of Science and Technology are helping universities to establish viable academia-industry linkages. Recently in the Philippines under the Magna Carta for Scientists and Technologists, researchers are allowed to work in private industries under certain conditions. This is meant to broaden and deepen U-I collaboration, but so far, only a few universities have made efforts to set up these links.

The purpose of these basic plans is not just to make a political statement. Far more important is that they set out long-term goals and priorities. Goals set out in the basic plan will be useful as a basis upon which to evaluate progress. Setting priorities is of course not an easy exercise, as it affects the allocation of limited resources to R&D. Furthermore, scientists and engineers naturally advocate the fields which they are in. The same holds true for government ministries such as the Ministry of Education, Science and Technology and the Ministry of Economy, Trade and Industry. They all compete for greater proportions of the available resources. While situations are not identical among the countries, many national experts who participated in the Roundtable in Tokyo expressed their concern that university researchers and industry managers are becoming confused by numerous ministries and agencies that have begun their own programs. Basic plans should provide overall guidelines on how to distribute resources in a way that would minimize potential conflicts.

In determining priorities and the allocation of resources, Asian governments adopt a combination of top-down and bottom up approaches, with both of them having advantages and weaknesses. In many instances, discussions start with mid-level management officials and gradually move up to more senior officials. This is inevitable since senior politicians normally do not have a sufficient understanding of the potentials and the implications of advanced technologies. This bottom-up approach, namely leaving the resource allocation decisions largely to government and research managers would be a better approach for preserving long-term consistency, but may fail to ensure adequate resources for emerging technologies. Top-down approaches would be more suitable at times when there is an urgent need for a priority shift, though this approach also jeopardizes the stable research environment and the long-term commitment of researchers. According to a study by the OECD, compared with the United States, European countries and Japan are far slower in shifting research funds from mature fields, such as material science, nuclear physics and mechanical engineering to biotechnology and health. A recently published report by the Ministry of Economy, Trade and Industry of Japan also confirms that, in response to the rapid advances in the field of life sciences, the number of students in the United States in the field of biotechnology increased 70% from 1991 to 2000. Meanwhile, the number of students in Japan remained unchanged. Whenever there is a need to expand resources for some emerging area at the expense of another declining area, a high level of leadership is required.

Top-down decision-making enables governments to rapidly move resources to new areas and to thus to meet the demand for new research. In 2004, in response to the sudden onset of SARS, the deadly bird flu, some Asian governments decided to strengthen their research on infectious disease and public health. Thirty years ago, in order to deal with the oil crises, the Japanese government decided to give the top priority to the development of energy technologies. In retrospect, this timely response strengthened the industrial competitiveness of Japan and laid down the foundation for prosperity in the 1980s and afterwards. In order to ensure that the national innovation system stays relevant and responsive to the ever-changing needs of the nation, it is important that political leaders oversee the effectiveness of the entire system, including the U-I collaboration. Drawing up a basic plan offers a good opportunity for stakeholders to design such a system.

Republic of Korea

Unlike other Asian countries, Korea[7] develops its basic plan regularly. Pursuant to the Science Technology Basic Law, the Minister of Science and Technology is required to make an executive plan every year. The Chief of Central Administrative Organization and the Chief of Local Bodies are to make and implement the yearly plan in accordance with the Basic Law. The government has placed the National Science Technology Committee, and the Local Science Technology Advancement Council under these two Chiefs. The law states that the Korean government should set up mid- and long-term policy goals and directions for science and technology development in order to achieve the objectives of the law most efficiently. It also states that the basic law should include measures for spreading technology transfer and promoting the utilization of research. As is clear from this, the Basic Law sets out the objectives of technology transfer and industrial utilization. The Basic Law also requires the government to regularly collect indexes and statistics, predict trends and evaluate the effectiveness of its policies and that the spreading of technology transfer and the promotion of research utilization, should be included in the basic plan. This is important because reliable statistics are the basis for an objective assessment of a policy's effectiveness.

India

In India, science and technology policy is determined by the general direction set out in Science Policy 2003 and its implementation plan. The responsibility of administering S&T policy is spread out over many government ministries and their departments, each one of which has jurisdiction over a particular field, such as environment, agriculture, health, information technology and water. The Department of S&T in the Ministry of S&T is the central body that deals with the promotion of S&T. But, apart from this department, the Department of Scientific & Industrial Research (DSIR) was created in 1985, with a mandate to oversee indigenous technology promotion, development and transfer. DSIR is also responsible for coordinating the activities of the Council of Scientific and Industrial Research (CSIR) and two public enterprises, namely National Research Development Corporation (NRDC) and Central Electronics Limited (CEL). The NRDC provides consulting service to academia and industry for the protection of their IPRs and the transfer of technologies. This function of the NRDC is central to supporting and facilitating effective industry-academia collaboration that result in the commercialization of technologies.

Overall, there have been different approaches in terms of government involvement in shaping a national policy framework to advance U-I collaboration. While Japan, Korea and China made a deliberate policy effort to lay down such a framework to accelerate U-I collaboration, other countries followed more autonomous processes of learning through experience.

7. Each national study is published on the WIPO website (*http://www.wipo.int/uipc/en/partnership/*)

For the countries that fall in the first category, these frameworks consist of two parts. As a first part, Asian governments have introduced the necessary laws, ministry directives, notices, and guidelines. This is meant to establish stable rules to regulate government and university conduct. Such legal measures were taken for the most part in the second half of the 90s, reflecting the growing need for U-I collaboration. The second part of the national policy framework, of an evolving rather than fixed nature, takes the form of basic plans and sets forth certain goals and targets to be achieved within a given timeframe. Unlike legal frameworks, these are reviewed and revised periodically. In many instances, basic plans are a part of broader strategies for economic development, not just independent plans for U-I collaboration. In either case, the basic plan ought to express the political commitment of the government and the direction that the government wants universities and industries to follow. The priority for funding different areas of scientific research is usually set in the plan.

Singapore

Singapore represents a second category. It went through a different process. The system for protecting IP and other economic properties was developed according to civil laws and other rules governing business practice and contracts that were already in place. These formed the basis for shaping the U-I relations, rather than the government's initiatives. This is largely due to the historical fact that, by the time other Asian countries became aware of the importance of U-I collaboration, the country had already ample experience of managing such collaboration.

While historical processes differ among Asian countries, it is now a fact that all Asian countries take strong interest in advancing U-I collaboration. Different ministries are involved in implementing the laws and the plans. Often, the ministry in charge of S&T tends to have a different perspective and different priorities from the ministry in charge of education, or the ministry in charge of commerce and industry. Thus, there are many instances in which ministries and departments compete with each other for greater authority and influence and often run similar programs that overlap. If too many organizations related to U-I collaboration and technology transfer are established, the system cannot be supported efficiently. In certain countries, there is a need to streamline and reduce complexities. U-I collaboration is still in the making in Asian nations. The existence of multiple government support programs runs the risk of creating confusion on the part of universities and firms that intend to use such schemes of support. Moreover, the fragmentation of the entire system tends to result in inefficiencies and greater management costs. Strong leadership needs to be taken at a high policy level to address this question. A process of trial and error will have to occur before effective mechanisms can be developed. In the meantime, however, Asian countries can learn from the experience of other countries.

5. Framework for Managing Intellectual Property Rights in U-I Collaboration

Universities across the world are confronted by the very delicate question of how to ensure that any research results that are developed within the university can best serve the public interest. Publishing results and putting them in the public domain is one option which, however, not always works in terms of resulting in the commercialization of the technology. Patenting research results has emerged as an interesting option in recent years and is thought to be a useful mechanism to create the necessary incentives among researchers, universities and businesses to commercialize research results developed by universities, particularly in some fields of technology. While publishing continues to be important, not least for the career advancement of researchers, the experience of many countries is showing that patenting and publishing are not incompatible, particularly in universities that have a well-managed technology transfer office that can assist researchers in the process. Even if commercial gains are not always the goal for universities, and licensing of patented technology is unlikely to solve the funding problem of universities, patenting may be advisable as a means to ensure that technology is transferred and businesses are willing to invest what is required to take the technology to market.

Being members of the World Trade Organization (WTO), and more specifically, its Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs), all of the Asian countries that participated in this project[8] have well defined systems

8. Each national study is published on the WIPO website (*http://www.wipo.int/uipc/en/partnership/*)

to protect the economic value of innovations. In recent years, most countries updated their intellectual property legislation to comply with international requirements under the TRIPs agreement. Experience with the use of the system is varied among Asian nations, but on the whole, the use of the IP system by universities is very recent and only some universities have managed to professionalize their IP management activities. In many cases, universities still lack an internal IP policy and a unit in charge of managing IP assets.

China

In China, both before and after its accession to the WTO, several important laws were put into effect regarding the protection of IPRs and the legal framework has been laid down for vibrant U-I partnerships. While general principles are stated in a set of laws, including the Law for the Promotion of Transformation of Scientific and Technological Achievements of 1996, the details for managing IPRs in the context of U-I collaboration are left for universities to work out. Today, many universities have publicly stated IP rules that deal with ownership of inventions and procedures and requirements for disclosure. Individual university researchers are asked to report necessary information to universities by filling out disclosure forms for IP protection. The rules, in addition, request that researchers provide background information about the creative points of the invention and the details of the contract with industry. Based on this information, University IP Management Offices make a judgment on the patentability of the inventions.

India

In the last few years, India has amended and enhanced its IPR legislation to be in full compliance with the TRIPS Agreement of the WTO. But it should be noted that, unlike Korea or Japan, India does not have any specific law, like the Bayh-Dole Act of the United States, that dictates the ownership of the inventions that arise from publicly funded R&D. Different ministries, departments and funding agencies have different policies. For example, the department of S&T issued general guidelines regarding the ownership of IPRs that resulted from DST funding. This guideline leaves the question of ownership to the contract made between the inventor and the enterprise. On the other hand, inventions from projects funded by the Department of Ocean Development can be owned entirely by the institutions. Guidelines from other government departments are yet to be formulated, as their IPR Policies are still being made. Generally speaking, the concept of IPR policy in Indian academic institutions is still incipient with only a small number of institutions announcing their policies. Most universities just deal with IPR on a case by case basis.

Thailand

U-I relationships have evolved in a very informal way in Thailand. In many instances, relations started when an engineer in a private business ran into a technical problem and sought help from the university he/she graduated from. On other occasions, owners or company executives were friends of university faculty members. They invited university researchers to do part-time jobs as corporate advisors and consultants. Conversely, it often happens that company engineers have part-time jobs as teachers at universities. In Thailand, this type of personal relation is the first step toward developing U-I collaboration. The collaboration takes on a wide variety of forms, but consulting is the most widely observed modality.

The Thai government is supportive of this collaboration. It guides and encourages the industrial and business sectors to work together with universities in efforts to develop and utilize intellectual property. But, there is no publicly stated rule as to how they should share the outcome of such research collaboration; neither are there any regulations on royalties, disclosure of information, or reporting requirements. It is largely up to the bilateral deals between the parties involved. Funding passes through faculty members, not university business offices. Consequently, universities may not be able to keep track of what is happening. There is no formal approval or reporting mechanism. Very few universities in Thailand have their own offices for licensing and technology transfer to the business sector. It is left to individual faculty members. In short, in Thailand, U-I collaboration has been very much “connection based.”

Efforts are currently underway in Thailand to lay down a more formal basis for U-I collaboration, at least at the level of individual institutions. Several factors are under examination including the structure of the proposed project, the location, the management of the project, the types of IP to be expected from the collaboration, the ownership and the potential users of the outcome, and the possibility of spin-off or other forms of technology transfer and licensing. A concrete example of just such an IP policy was published recently by Mahidol University. Its IP policies and regulations are winning recognition from other universities as a model to be followed.

Republic of Korea

In Korea, under the Technology Transfer Promotion Law of 2001, units can be created within the university to take responsibility for technology transfer. They are responsible for managing and licensing university patents and deal with the whole process from drawing up a research contract to supporting the start-up of the business. But one piece of legislation cannot ensure a comprehensive solution. According to Hwa-Cho Yi: "unlike the United States, universities do not, for the most part, have technology transfer experts."[9] As a matter of fact, it is more as if they are managing government R&D business than dealing with technology transfer. The financial conditions of organizations in charge of technology transfer are becoming an acute issue as it is not easy for universities to operate them profitably. The licensing income of universities is very small compared to their entire budgets. In most cases, it is only one to two percent. According to Hwa-Cho Yi, even though professors apply for patents in the name of the school, they do not always pay separate royalties to the university. Some universities have regulations that make professors who founded businesses donate to universities in accordance with the financial success of the company; but instances of this are very rare. This shows some of the difficulties universities face in implementing the rules on this issue. It points to the need for looking into the actual implementation of general rules in addition to examining the rules themselves.

Japan

As the result of a set of laws that were introduced in the late 1990s, Japanese universities are now capable of owning IPRs for inventions developed at their universities. Some of them have established internal patent policies to deal with IPRs. Faculty members are required to report inventions to the university. The university evaluates their patentability and commercial value and then decides whether or not to file an application. If the invention is patented, universities compensate the faculty member who made the invention according to the rules of the university. If the university licenses the patent to a private company and receives royalties, the university should reimburse part of the royalty revenues to the faculty member. How much should be paid is again dependent on the internal rules of individual universities.

Republic of Korea

As collaborative relations between universities and industries deepen, the distinction separating their different activities becomes less identifiable. As in other countries, Korean universities are expected to carry out duties that could be thought to be conflicting: education, basic research, and profit-oriented research. In order to enhance the accountability of universities, there is a need for adequate information and transparency with respect to U-I collaboration. This is all the more true since it involves the financial resources collected from taxpayers. In Korean legislation there is no specific provision about reporting. Accordingly, there are insufficient reporting requirements on the management of IPRs. There is no reporting requirement on inventions under the sphere of business influence. There is no punishment in case of negligence of the existing reporting requirements. In the case of the Seoul National University, a total of 1,666 patent applications were filed by its faculty members between 1982 and 2000, but only 11 of them were reported to the University. Other Korean universities, however, show a much higher rate of reporting.

Throughout the seven countries in this study, information regarding technology transfer is incomplete and inadequate for the purpose of monitoring and evaluation. There is no established procedure and rules as to what should be reported, in which ways, at what time and to whom. On the other hand, if inventions are reported to the universities and the ownership remains with the university, then the universities must decide on whether or not to apply for patents, how long to maintain them, and make any arrangements for licensing them to industry. With respect to whether to provide exclusive

9. Yi, H., *Development of University-Industry Partnerships for the Promotion of Innovation and Transfer of Technology: The Republic of Korea*

or non-exclusive licenses, Asian universities in general tend to prefer non-exclusive licensing, reflecting their conviction that their inventions made in universities should be accessible to anyone wishing to use them. This may run into conflict with the private companies that wish to utilize the inventions exclusively. This is even more so in the case of risky start-ups or spin-offs or sectors in which significant investments are required to take research results to market.

In spite of the limited experience of Asian countries and the deficiencies of the systems in governing U-I relations, there is a clear tendency in all of the countries towards promoting the transfer of publicly funded research results from universities or public research laboratories to the private sector. But countries differ when it comes to the ownership of inventions developed within universities. On the issue of who should retain ownership of an invention – whether those who conducted the research (the researchers), the institutions they work for, the government or the funding agency – the debate continues. The US model, established by the Bayh-Dole Act of 1980, allows the institution performing the publicly funded research, namely the universities, to file patent applications on the research results and to grant licenses to third parties. While this model has spread to many industrialized countries, a few countries like Finland and Italy grant ownership to the inventors. Globally, this issue of how to allocate ownership is a subject of on-going debate and Asian countries should keep an eye on how this debate develops, and should stand ready to review their country policies in accordance with the global trend.

Ownership and distribution of proceeds generated from the technology are two different things. While ownership may be in the hands of the university, university IP policies generally state how revenues are to be distributed among all stakeholders. This issue is generally left to individual institutions and within a single country, different schemes are adopted. In Singapore, the National University of Singapore (NUS) divides net profits (net of costs up to 15% of income) as follows: 50% to inventor(s), 30% to the department and 20% to the university. On the other hand, at the Nanyang Technical University, royalties are split with 75% going to the inventor and the balance going to the university for the first US$500,000, with a decreasing proportion going to the inventor as the royalties increase. Mahidol University of Thailand has more or less the same allocation system as NUS: 50% of the net income goes to the inventor, 30% to the University, and the last 20% is evenly split between faculty and the department. In Korea, KAIST pays 70% of the execution fees to the inventor. Seoul National University has a slightly different policy. In the case of small projects that generate less than 20 million Won in income, 100% of the revenues go to the inventor. As the project gets bigger, this ratio goes down to 60%.

In the Philippines, according to the Implementing Rules and Regulation of the Magna Carta for Scientists, Engineers, Researchers and other Science and Technology Personnel in Government (Republic Act 8439), a researcher normally takes 40% and the government institution takes the balance. However, recently, an MOA was entered into in one university in which the revenue-sharing was 40% for the inventor, 40% for the funding agency and 20% for the University of Philippines. In the De La Salle University, the policy is that the inventor/creator will not get less than 20% nor more than 80% of the net revenues. From this, it can be noticed that the system of remuneration is not fixed at the moment, but is at the stage of development. In China, income generated from U-I collaboration is distributed with 50-80% going to the R&D team, the university taking 10-25% and the Department taking 10-25%.

Sharing of revenues is very common across countries and institutions and increasingly seen as a way to provide incentives not only to individual researchers but also to the groups of people and the institutions that contribute to the IPR in one way or another. In practice, this may seem a good option rather than assigning ownership to the researcher, since putting all the responsibility for the management of IPRs, including disclosure and ownership protection, on one single researcher would discourage the researcher and reduce the likelihood of filing patents. On the other hand, it should not be forgotten that many Asian universities and their technology transfer offices (hereafter shortened as TTOs, although in certain countries the same types of institutions are known under different names) are under increasingly heavy financial stress because of the cost of filing patent applications and paying maintenance fees.

Internationally, there are several different views with respect to the allocation of ownership and income that results from commercializing inventions. One line of argument is, of course, that the royalties should go entirely to the owner of the

IPR. The other thought is to split royalties evenly amongst inventor, laboratory or department, and the university. Between these two extremes, there are many different variations and they are often determined on a case-by-case basis, even when there is a broad yardstick. The situation in Asia explained above is a testimony to this.

While the issue of ownership of IP may be clearly determined by national policy in cases in which research results are obtained entirely with public funds, the situation becomes more complex in cases in which universities engage in collaborative or sponsored research, i.e. when a company contributes financially or otherwise to research conducted in a university. Worldwide, different countries and institutions approach the issue of ownership in such contexts differently. While there are cases in which the university owns the research results or inventions regardless of the contribution made by the industrial partner, there are also universities that leave the matter to be defined in individual contract negotiations with the industrial partner or attribute ownership on the basis of the contributions made by each side. The issue of ownership will go hand in hand with decisions on whether the commercial partner would obtain an exclusive or non-exclusive license to commercialize the invention, whether it would have to pay royalties, whether it would be allowed to license or sublicense the technology to others and similar arrangements.

While flexibility and room for individual negotiation may be welcome, Asian universities should look closely at developments in this field and consider the advantages of developing policies (or model agreements) in this respect that would provide the basis for negotiations with commercial partners. Lack of clarity and diversity in national and international guidelines on these issues can be a barrier to the commercialization of inventions as it increases the transaction cost of negotiating the terms of collaboration and also increases the risks involved. Clarity and transparency will become very urgent if U-I collaboration is to develop across national borders. As a matter of principle, there is no strong argument against having different rules for different universities in a country, or different countries having different rules. But, there may be confusion if disparate policies are adopted by hundreds of universities and research institutions. This may already be happening. Japanese IT companies, for example, are concluding research contracts with Chinese Universities to develop advanced software. Conversely, Japanese universities, like Kyoto University are setting up TLO in China and other Asian countries to form research alliances with the local companies. In light of growing international collaboration across Asia, a case can be made for more consistent rules in IPR management that can apply at least on an Asia-wide scale. Without such transparent rules, if the terms are left entirely to individual negotiations, disputes tend to arise, or the expectations of parties may be hard to reconcile during negotiations.

6. Administrative and Organizational Setup for the Management of U-I Collaboration and Role of TTOs/TLOs

The need for universities to adopt clear policies for protecting and managing IPRs is increasingly realized by Asian universities. Without a strong IPR policy, that provides clear rules and guidelines for the commercial exploitation of IP generated within the university, establishes ownership criteria and rules for income-sharing and defines responsibilities and obligations of all stakeholders, it will be difficult for universities to move forward in this field in a systematic manner. In some cases, problems arise from inadequate implementation of rules rather than the absence of rules. But on the whole, without clear guidelines and procedures, there is a risk of conflict between the different parties as the outcomes may not meet expectations. In some of the Asian countries analyzed in the national studies, only few universities have formally adopted an IP policy, although in some cases, policies are currently being discussed or have been submitted to the relevant internal bodies for adoption.

A problem researchers or scientists often face is that of their lack of expertise in filing patent applications and negotiating agreements with industry. This raises a fundamental issue for all Asian countries and points to the strategic importance for universities to have a strong and effective office devoted to managing technology transfer staffed with legal and technical experts.

Recently, many Asian universities moved towards establishing an office within or outside the universities to deal with the complex task of managing IPRs and transferring technologies developed in their laboratories. They were mostly emulations of the Technology Licensing Offices (TLOs) or TTOs of US universities. In most of the Asian universities that conduct research, offices of this kind have been set up, although in some cases they are not called TLOs or TTOs. In certain countries where technology transfer from universities is rare, tasks related to technology transfer are handled by a general administration office. But Asian universities are increasingly recognizing that the transfer of technology calls for a high level of expertise, a firm knowledge of technology and the way universities function, and also familiarity with the legal aspects of IPRs. The functions of all TTOs are not identical. In some cases, they only deal with the management of IPRs. In others, TTOs also market their technologies and search for companies that would sponsor university projects. Some TTOs are regarded as profit centers and are expected to be self-supporting, while others are heavily subsidized by the universities or even by the government. In either case, it is widely recognized that having a TTO as a central body to handle all issues relating to the transfer of technology is that it makes possible to professionalize technology transfer activities and enhance the bargaining power of the universities. It would be practically next to impossible for individual researchers to deal with all the necessary work.

Japan

Japan has gone through a radical transformation in managing IPRs at universities. In 1977, it was agreed as a matter of general principle that IPRs that resulted from national universities research should belong to the individual researchers. But it was too burdensome for individual researchers to file patent applications or undergo the other processes necessary to claim and use IPRs. An alternative approach was to create an independent organization within or outside the universities that would be able to hold ownership of the IPRs and encourage their commercial utilization. In 1998, under the leadership of the Japanese Ministry of International Trade and Industry (MITI, renamed METI in 2001), the Diet passed the Law to Facilitate the Transfer of Technology from Universities. As a result, TTOs have been created one after another in the universities. At the end of 2004, 39 TTOs were in operation. While most private universities, being legal entities in their own right, established TTOs within the university, national universities, which did not have such an independent legal status, created TTOs outside the university, which thus operated as independent bodies.

In 2003, the Ministry of Education, Science and Technology (MEXT) moved in to instruct universities on how to establish an additional IP headquarters within the university. While the functions of this new office were not exactly the same as TTOs, there was a considerable overlap between the two. At present, many universities are managing to avoid redundancy by sharing the work of TTOs and IP headquarters, though it is likely that in due course they will merge together into one single office dealing with all matters related to technology transfer. As of June 2004, there are 119 IPR related offices in Japanese universities, either TTOs or IP headquarters. About half of them are at national universities. In addition, 174 other universities, national, private and public, are considering setting up such an office.

Up until April 2004, inventions made at the universities were reported to the invention committees, which were set up in each university. The committee decided whether the invention should belong to the government or the individual inventors. Universities could not claim ownership because they did not have the legal status needed to do so. As a matter of principle, any inventions based on research funded by special budget arrangements or research made possible by the use of large-scale facilities that were owned by the government had to be handed over to the government and treated as a part of the national assets. The fact was, however, that in most universities, invention committees were seldom called because the procedures were so cumbersome. In general, university researchers wanted to pass their invention to the private companies that worked with them. In rare cases, inventions were transferred to the government, which was obligated to follow a competitive bidding process. Due to this restriction, very few inventions were actually licensed.

After April 2004, national universities in Japan could claim ownership of inventions made in their laboratories. In other words, if a university decides that an invention deserves to have patent protection sought for it, such a filing is now done by the university through its TTO or the IP headquarter. While expectation is high for TTOs and IP headquarters, it is unrealistic to expect that the establishment of TTOs will make a dramatic difference within a short space of time. The total amount of royalties collected by all TTOs in Japan is 0.55 billion yen, while in the US, TTOs have generated a total of one billion dollars, about 200 times as much as Japan. Being in a fledgling state, the TTOs and IP headquarters of universities are not yet able to effectively communicate with industry in one voice. In the long run, however, they will face the difficult question of how to generate a stable flow of revenue to cover the cost of filing and maintaining patents. Currently, they are subsidized by the government budget, but such subsidies are expected to terminate within a five years time, which will be fiscal year 2006. It is not clear how TTOs and IP headquarters will keep financially afloat once the five year period ends. In addition to the financial issues, Japanese TTOs and headquarters are lacking in experienced staff members who are capable of handling the complex issues relating to technology transfers. METI recently announced that it intends to train and educate about 100 technology transfer specialists by supporting human resource development programs in high performing TTOs. In addition, a report from METI, released in February 2005, proposes that an independent body will be set up to evaluate the performance of TTOs by way of a ranking system and to identify those with exemplary performance, so that other TTOs can learn from them.

Singapore

According to a study done by the OECD and the World Bank, Singapore is ranked at the top for its IP protection and research collaboration between university and industry (Korea and the Knowledge-based Economy, 2000). Singapore's success can be attributed to several factors including its long-standing use of English as a working language, which facilitated adoption of good practice and streamlining of processes. The actual handling of the technology transfer is left to the universities. The National University of Singapore (NUS) established a TTO in 1992 that is called the Industry and Technology Relations Office (INTRO). While technology transfer through licensing is the most direct approach, NUS employs a variety of approaches to publicize the availability of technologies that they have at hand. It sends technologies selectively to companies for evaluation and places these on its "technology offer database" on the Internet. Companies thus approached are given opportunities to evaluate the technologies. If they are interested in exploiting the technology, they can submit a business plan for negotiation with INTRO. Companies often seek exclusive licensing, but NUS grants such exclusive licensing judiciously and only when companies are able to be specific on the field of use and geographical application of the technology. INTRO also conducts licensing negotiations. (Statistics on invention disclosures, patents filed by and granted to universities in Singapore are provided in Table 8).

China

In China, the first TTOs emerged in 1999 at the East China University of Science and Technology and at Xi'an Jiotong University. In September 2001, the Ministry of Economy and Trade and the Ministry of Education recognized six TTOs at six different universities. They were set up not as a part of the university but as national technology transfer centers. Subsequently, more TTOs have been established by universities. At present, 30 TTOs are in operation in China. In addition to TTOs, university science parks and incubators are also playing important roles in transferring technologies from universities to industry. Currently, there are more than 70 university science parks recognized by the government, with 459 enterprises having been created in such science parks. University incubators have also given birth to many enterprises. 2778 enterprises have been established in these facilities.

Republic of Korea

In Korea, until the turn of the century, the technology transfer situation at national universities looked somewhat disorganized, with a variety of institutions for Industry-University (the common phrase in Korea) collaboration institutions coming into play, each one of which was backed up by some government ministry. As a result, overall efficiency was lost. The situation improved when the Law for Industry Education Promotion and Industry University Cooperation Boost was amended to pave the way for the establishment of the Industry University Cooperation Foundation (IUCF). IUCF has its own judicial division and can accordingly acquire IPRs. This is Korea's version of the TTO. One IUCF is set up in each university. The IUCF negotiates a contract with the industry, maintains the IPRs, and takes actions to promote technology transfers. At present, however, it is still unclear how work is to be distributed between the IUCFs and the other entities that existed prior to the creation of the IUCFs. But without a doubt, the number of patents filed by some leading national universities showed a dramatic increase in 2004. Private universities have their Technology Transfer Centers, and they are more active in working with the private sector. The Small Business Administration, in particular, is helping the transfer of technologies to small and medium-sized businesses.

Like other countries, Korea has problems in staffing the IUCF with competent experts. They generally lack specific experience in handling legal contracts and financial arrangements. They are often sent from outside organizations under temporary contracts. This makes it difficult to create and expand the human resources needed by TTOs in the long run.

Philippines

In the Philippines, it was in 1985 that the first TTO was formally created with corresponding policies at the University of the Philippines. However, in May 30, 2004, an improved version of the policy was approved by the UP Board of Regents. The approval is in principle, as consultations have to be done with the different campuses of the UP Systems and the faculty members. This is an ongoing activity, thus implementation is in moratorium. On the other hand, the De La Salle University has its policy on IPR since 1995. The implementation is handled by the IPR committee. This policy is applicable for all the members of the System.

Thailand

In Thailand, it has been proposed that the U-I Partnership Office have the authority and responsibility for managing IP assets. If this proposal is put into practice, the U-I Partnership Office will play the role of facilitating the transfer of technology from university to industry. In light of the present circumstances in Thailand, an organization to establish standard procedures and practices needs be set up regardless of whether it will be called a TTO or a partnership office. This can be done in conjunction with the new legislation regarding U-I partnerships. In most Thai universities, there are IP asset offices of some form with different names. In some cases, however, they are only a part of the main business office. U-I collaboration is usually placed under the supervision of a university business office. This may prove to be inadequate, since, as evidenced by the experience of other Asian countries, technology transfer requires the development of specific professional skills for procurement, financing and administrative work as well as technical/scientific and legal skills.

It should be noted that more recently, Mahidol university of Thailand developed and published its IP regulations, which spells out rules for: the ownership of patents and copyrights, requirements and procedures for disclosure, rules for income distribution of patents and copyrights, and other rights and obligations for the parties involved. The university's Applied and Technological Service Center is in charge of IP management. In light of the absence of such offices in other universities, it is perhaps the first TTO in Thailand; and as such, it may set an example for others.

In light of the scarcity of experts in this area, it seems to make a lot of sense for Asian experts and experts-to-be to meet regularly and exchange experiences. In some Asian countries, private law firms are moving in to provide professional services for a few, but from a public policy viewpoint, they are rather poor substitutes for TTOs since only large and wealthy firms are able to pay for such services.

While TTOs are being created in an increasing number of Asian universities, they have another common problem, other than human resources. That is, how to finance the cost of operation and staffing. According to a recent study done by APRU (Association of Pacific Rim Universities), while 9 out of 10 prestigious universities in North America have TTOs whose income is adequate to cover their costs, only 22% of first-rate Asian universities can say the same. The reason is obvious. Due to their youth, the number of technology transfers has been too few to make the operation of the TTOs self-sustaining. In the United States, it is believed that many TTOs are operating as profit centers, and that about 90% of their revenue come from biotechnology and life science fields. TTOs of less well-known universities are not making profits either. This should not lead us to conclude that TTOs have limited chances of success. The external benefit of technology transfer should go well beyond the income collected by TTOs. The performance of TTOs should not be judged purely by their profits. If the objective is to achieve the commercialization of university research results and ensure that the innovative capacity of industries is enhanced as a result of cooperation with universities, measures that reflect this should be devised. However, if TTOs are not to be self-financed, it will be important to ensure that they can benefit from adequate funding to conduct their activities.

In the case of Japan, 90% of Japanese TTOs are not profitable without government support. In fiscal year 2002, Japanese TTOs as a whole filed 1,335 patent applications domestically and 284 with foreign patent offices. The royalty revenue was 410 million yen. This number is expected to rise over the next few years.

In many Asian universities, the functions of TTOs go well beyond merely patent management. Instead of waiting for university researchers and industry people to knock at their doors, they are often expected to be more proactive in marketing the technology, finding potential partners, and securing funds. This calls for multi-faceted talent, which is of course very short in supply. To deal with this, some Japanese experts are considering a kind of "super TTO," which reaches out beyond university boundaries and combines several TTOs in the region. There are already a few such examples. The alternative approach is to outsource some functions to outside law firms and patent offices. Conversely, recruiting new staff from outside on a fixed term with the assurance that they can go back to their original places when the term expires is yet another option for a TTO. In either case, it remains the case that Asian countries are sorely lacking experienced human resources in this field. In light of the increasing litigation brought to courts and the complex mechanisms for dispute resolution, the work to be done by TTOs call for more and more advanced knowledge. Only a handful of universities have people that are qualified to do this. To secure them, TTOs must be financially ready to offer the right incentives. Very few experts with such talent would be willing to work out of an altruistic motivation for a sustained period.

When a TTO is in operation, at the very least, its financial statements as well as some key indicators that permit outsiders to evaluate the effectiveness of U-I collaboration should be publicized. This should include information about types, numbers, and themes of cooperation and output. On the other hand, it is in the interest of no one to create excessively burdensome and bureaucratic reporting requirements and procedures. The right balance can be found through the exchange of experience across countries and organizations

7. Funding Schemes

Asian governments place a high priority on ensuring adequate levels of funding for the activities of universities and public research institutions. Such research activities create a pool of knowledge and inventions, a resource that can be tapped for the purpose of U-I collaboration. In addition, there have been new types of funding in recent years, such as support for incubation facilities, science parks, and soft loans. In some countries, tax incentives have been adopted to encourage companies to utilize technologies developed by universities. In general, Asian universities have been given increasing amounts of funds for their research programs in the scientific and engineering fields.

China

Chinese universities have been particularly successful in receiving funds: one billion Yuan in 1999 to 2.2 billion in 2002. About half of the funds came from the government and the other half from enterprises and institutions. In addition to general funding, there were several other schemes. One of them was the Industry-University Research Institute Combined Development Engineering Project Plan that was implemented between 1992 and 2003. Any project that was brought about through an agreement between a university and an industry and that conformed to the industrial policy of the government could be listed on the Project Plan. Once listed, these projects were eligible for non-reimbursable support from the government. There was another category, category B project plan, which was approved by the Ministry of Science and Technology. The applicants were required to guarantee that the leadership of the project came from the business sector. Once approved, the project was also eligible for non-reimbursable support. This project had to be of a scale of no less than RMB 50 million and was allowed to receive up to 10% of the matched fund. Such support could take the form of lump-sum grants, interest free loans, or stock equity participation by the government. In addition to the direct support for U-I collaboration, the Chinese national and local governments moved to set up Enterprise Technical Centers and State Engineering and Technical Research Centers. Up to now there are more than 1300 Enterprise Technical Centers across the country. Quite a few of them are supported by universities. State Engineering and Technical Research Centers have been explicitly created by an initiative led by the Ministry of Science and Technology to improve the production enterprises of China and contribute to the growth of the Chinese economy. In 2002, they collaborated with 1,878 enterprises and 521 universities and colleges. University Science Parks and Incubators have proved to be an effective vehicle for U-I collaboration.

India

In India, most of the R&D funding comes from government ministries. In the year 2001-2, universities accounted for 51% of the total projects in number, but only about 28% in terms of funding. The national laboratories spend 38% of the total funding. It is possible that universities undertake more basic research, which is less expensive, while national labs conduct research at more advanced stages, which tends to be more expensive. Like many other Asian countries, engineering and life sciences (biotechnology and medical sciences) are the two biggest fields for national research funding. In addition to general funding, some government departments, such as the Department of Scientific and Industrial Research administer specific programs for collaboration with the private sector at various stages of development. Among them, the University Grant Commission (UGC) provides seed funds on condition that the outcome is patented.

Japan

The Japanese government also stresses the strategic importance of life sciences, information technology, nano-technology, environmental and material sciences. Energy, which was high on the priority list three decades ago, is not there any longer. In the fiscal year 2000, more than 90% of government funding went to public universities and national laboratories, with the balance being distributed among private universities and companies. In spite of the increasing pressure to cut expenditure from the national budget, which relies on debt for more than 40% of its revenue, the Japanese government has remained determined to secure an increasing amount for R&D. The government stresses the importance of distributing the funds through a competitive process, where researchers both in public and private laboratories are invited to make research proposals. The current Basic Plan for Science and Technology, while encouraging U-I collaboration, also puts a strong stress on the use of university inventions to create small businesses and university spawned venture businesses. It is expected this new policy will invigorate research communities and give opportunities for young and innovative companies that are less connected to existing research institutions.

The Japanese business community is now paying more attention to U-I collaboration. Traditionally, large Japanese companies made donations to individual university professors, mainly for the purpose of keeping working relations and soliciting informal consultancy, but most importantly to recruit good students that are under the supervision of the university professors. Today, Japanese companies are moving toward more formal working relations based on contracts in exchange for financial support. Japan has a special incentive to support university spawned ventures. The revival of the US industry in 1990s had been largely achieved through thousands of high-tech ventures and start-ups. In Japan, however, entrepreneurial activities by ventures and start-ups have been at the lowest level among the OECD countries. Japanese universities have begun to place a particular emphasis on creating new start-ups by utilizing the technologies developed by the university. The initiation of a "risk-taking venture capital" by the University of Tokyo and Tohoku University are concrete examples of this movement.

Republic of Korea

Korea and Japan are the two OECD countries where public funding accounts for the smallest percentage of total research funding. They are 26.3% and 26.6% respectively. Generally, this figure is above 30% or even 40% for many of the industrialized economies. Korea has learned that it must strengthen its basic research, which now accounts for only 13.7%. Because the country has already reached a high level of technology, it will become more and more difficult for the country to continue to import technologies from abroad. Government funding is evenly split between national/public universities and private universities, but private universities take more funding from the private sector, reflecting their greater willingness to work with the industry.

The funding mechanism in Korea looks complex. There are numerous institutions that funnel research funds from the government to individual research laboratories. Apart from the Research Foundation which supports pure basic research, and therefore has little to do with collaboration with industry, the Korean Science and Engineering Foundation (KOSEF) administers several different programs such as Basic Research Grants, Center for Excellence, Special Research Materials Bank and Fellowship, whose entire funding amounts to 297 billion won (nearly US$250 million). The Foundation selects projects at universities with a view to supporting the activities of university researchers who are engaged in international cooperation and U-I collaboration. In addition, the Ministry of Commerce, Industry and Energy covers part of the project costs that are deemed necessary to improve the competitiveness of Korean industry. The Ministry runs several programs including Industry Innovation Technology Development, Parts & Material Technology Development projects, Regional Specialized Business Development Business, International Development Business, Clean Production Technology Development Business, and Small and Medium Business Administration. In some cases, part of the funding must be returned if the project turns out to be a success and profits are realized by the companies that participated in the collaborative projects.

Philippines

The R&D funds for the public universities in the Philippines largely comes from the government budget. While 3.61% of the national budget is allocated for research by universities and colleges, universities depend on the private sector for additional funding. Due to the severe fiscal constraints that the government is facing, the total expenditure on R&D in the Philippines saw only a marginal increase during the last few years from 4 billion Pesos in 1996 to 4.5 billion in 2002. In addition to the funds distributed by the Commission of Higher Education (CHED), Filipino universities have one more source of funding, the Department of Science and Technology (DOST). The Department extends grants to the research institutions with projects that meet the goals and standards set forth in the National S&T Priorities Plan. The Department recently started a new program known as Technology Innovation for Commercialization. This is meant to be a technology transfer program that seeks to identify key technological breakthroughs with excellent commercial potential. The university and industry can jointly request financial support from DOST. Aside from grants by different DOST Councils, the Technology Application and Promotion Institute of DOST is extending financial assistance for patent and utility model applications. Some vertical departments run programs to fund research projects in their respective areas, such as agriculture, environment and natural resources, health, industry & energy, and advanced science. Thus, universities can obtain research funds from different ministries, depending on the nature and field of their projects. Universities are encouraged to patent their research outcome and the cost of filing is usually covered by the general funding for the project. The Congress and the Budget Office evaluate those projects that are funded by government agencies with respect to their progress and achievements. Because the evaluators are mostly non-technical staff members, these R&D projects are often not fully appreciated.

Singapore

In Singapore, in addition to general funding for research activities at universities, myriad government incentives aimed at forging collaboration with industry have evolved since the early 80s. Today, schemes are available to cover activities across the entire business cycle, from research to IP protection, support for commercialization, start-ups, business development, investment, tax incentives, and venture developments. The history of government support for U-I collaboration dates back to as early as 1981, when the Research and Development Assistance Scheme (RDAS) was introduced. The program has now been broadened significantly with new and enhanced schemes to address different sectors and levels of needs. These special industry technology upgrading and R&D programs are responsibilities shouldered by the Enterprise Development Board (EDB), and the Agency for Science, Technology and Research (A*STAR). Both EDB and A*STAR are the major sources of government funding. EDB provides R&D grants for companies through a variety of grant schemes. EDB places a special emphasis on supporting start-ups. To support start-ups, it runs a special program, called Startup Enterprise Development Scheme (SEEDS). This scheme offers equity matching funds for early stage startups. So far some 100 companies have successfully obtained SEED funding. The National University of Singapore (NUS) has its own complementary but modest venture support fund to assist start-ups.

In general terms, small and medium enterprises (SMEs) face important limitation in doing R&D and are in dire need of technical support from outside. Their needs are not always in the most advanced scientific fields but rather at more mundane and practical levels. All Asian governments place importance on transferring technology to SMEs. In China, SMEs have access to a special government fund. The fund was formed in 1999 with an initial annual endowment of one billion RMBs. The level of funding ranged between RMB 0.5 and 1 billion with a priority being given to U-I partnership projects with IPRs of their own. This fund offers not only straightforward grants but also low interest loans and capital injections.

Republic of Korea

The Korean Small-Medium Business Administration runs a program to support joint research between universities and SMEs. The program, named Small & Medium Business Technology Innovation Development, supports consortiums consisting of university or research organizations and SMEs with matching funds. SMEs that encounter specific technical problems can form a consortium if more than seven of them agree to participate and if they can identify a university or public research institute that could help them resolve their technical problems. If such a consortium is organized, the technology development funds are made available to fund the work of the consortium. 50% of the funding comes from the central government and 25% from local governments. The remaining 25% is to be covered by the participating SMEs. In the Philippines, a great proportion of U-I collaboration is taking place in the fields of agriculture, food processing, electronic and computer programs. Presumably, this is due to the high dependency on the agricultural sector of the country and the strong need from local agricultural communities. SMEs are the driving force in these sectors. In addition, DOST is supporting SMEs in the fields of energy, manufacturing, and health/medicine in their efforts to acquire technology from universities and utilize it. In Singapore, the financial support for patent filings and the support for technology capability upgrading are in fact utilized mostly by SMEs.

Thailand

In Thailand, universities are expected to do more in the area of training workers in SMEs. Some private SMEs have contracts with universities for part time training, which sometimes even takes place during weekends. Since 2004, the Ministry of Industry has taken a new initiative to create 50,000 new SMEs through incubation joint product developments with universities. Universities take on the role of sending new graduates to work in such projects and training workers and retired people who want to become owners of a business. Those new SMEs are in such fields as auto parts, fashion, IT, food processing, and tourism. The “One Tambon (region), One Product” campaign is underway at the provincial level. This is a government policy to boost the best product of each tambon in the national and, if possible, global market. Universities have been requested by the central government to assist local SMEs in their efforts to achieve this goal.

As noted above in this section, the seven Asian countries in this study have a variety of funding mechanisms for U-I collaboration. A few observations can be made that are common to all or most of the countries. First, in general, there are too many programs administered by too many government ministries. While, in theory, each one of the support schemes has its own goals and rationale, the fact is that there is the risk of duplication. From the perspectives of the university and industry, there are many sources of funds that they can tap. Each one of them calls for a different application and different paper work. Such fragmentation of the funding scheme may result in overall inefficiency. Second, while such funding programs aim to support research activities, the cost of administrative work associated with research is not always taken into full account. Such administrative costs include marketing of technology, negotiation with companies, patent filing and the cost of maintaining offices. In certain cases they are subsidized by governments, but in most cases, they must be covered by a general research fund. Third, it is important to ensure that public funds be allocated and spent under clear and transparent rules. While most funds are available on an equitable basis, often new comers find it difficult to have full access to such programs. No funding program should be monopolized by an existing vested interest. Fourthly, the risk of creating excessively cumbersome procedures must be borne in mind. The burden of complying with rules and preparing documents for the evaluation of project progress and outcome is a matter that needs to be looked at. Lastly, it must be noted that the question of funding is linked to the question of ownership. Normally, in addition to their overall general budget, universities receive funds from many government agencies and the private sector. This can cause problems when these funding bodies have different IP management rules. Asian countries should start examinations of individual IP ownership policies of different funding agencies with a view to avoiding unnecessary conflicts and eliminating discrepancies that may make U-I collaboration impossible.

8. Training Personnel for U-I collaboration

Some Asian universities suffer greatly from the lack of trained individuals who are capable of handling the complex and multidisciplinary work associated with U-I collaboration. The need for personnel with a good deal of business expertise who can handle the administrative and business work associated with U-I collaboration and technology transfers is becoming increasingly acute. Such personnel should have both an understanding of science and engineering and knowledge of the law, particularly concerning the management of IPRs. These individuals must also understand how two different communities, the academic and the business, operate.

Singapore

Singapore is one of the first countries to become aware of the importance of developing this type of human resources. Asian universities in other countries are now running programs to train young engineering and science students, but the programs are far too inadequate.

India

In India, a general course on technology transfer is being taught at management schools, but as students do not have adequate engineering background, it tends to fall short of expectations.

(Philippines)

The Philippines has become more and more aware of the importance of highly trained manpower. It established the Engineering and Science Education program (ESEP) with the World Bank and the OECD fund with a view to training and upgrading workers to the graduate level, including the teachers in the elementary and high schools. One of the major activities that were initiated is the offering of the first Management of Technology (MOT) graduate course at the University of Philippine-Technology Management Center since 1994.

Japan

In Japan, the Ministry of Economy, Trade and Industry (METI) began an initiative in 2002 to install management of technology (MOT) education into some universities at the post graduate level. This is a major departure from the long-standing tradition of the Japanese society, which attaches such a high value to on the job training (OJT).

China

Some natural science universities in China have degree programs on management of IP. In addition to formal courses at universities, there are many seminars, symposia and workshops for a short duration provided by private consulting firms and industry associations. One problem is that those who should take such courses, the middle level managers with ten or more years of working experience, are too busy to leave their jobs for an extended period of time. The maximum time duration would probably be two to three weeks.

The other problem is who should pay for such training. As far as staff in TTOs are concerned, they must be paid out of the general budget. There is usually no specific budget set aside for training human resources. At the present, they count on the voluntary support of business for sending personnel experienced in IP, often free of cost.

While need for formal education is not to be questioned, much of the learning must take place through actual practice. A classroom lecture is not seen to be as effective as case studies. Negotiating technology transfer contracts and marketing new inventions are next to impossible to teach except by using actual cases. Growing litigation and court cases that involve the management of IPRs points to the enormous complexity of using new technologies for commercial purposes, hence the difficulty of conducting training in this field. It must be recognized that as technology becomes an ever more important determinant of commercial success, the risk of mishandling technology transfer will continue to rise. Managers in TTOs and university laboratories handling specific cases must be equipped with professional expertise. A question remains whether or not such personnel should have an engineering background, business background or, as is often the case in the US, law background. In Asian universities, the division between natural sciences and social science still remains very deep.

These seven Asian countries[10] are dealing with the issues arising from U-I collaboration largely within their national contexts. Situations are so diverse that policy-makers are less inclined to look at foreign countries. However, while institutional arrangements differ from country to country, business activities are becoming increasingly global. The flow of trade and investment is growing dramatically among Asian countries. This implies that sooner or later, such flows will be accompanied by the flow of people. The movement of people is the best way to transfer technology. Asian countries should prepare themselves for a new era in which the movement of researchers and business people will force national governments to ensure more compatibility in the way national innovation systems operate. One particular issue of importance is increasing the mobility of researchers. New ideas can be better generated when there is a great deal of interaction and contact between scientists and engineers of different laboratories. Such interaction can be greater if researchers feel free to move from one laboratory to the other. Conversely, a low rate of mobility remains a major obstacle to improving U-I linkages in Asian countries. Take Japan as an example, where life long employment is still very much the dominant practice in the government sector, which includes State-funded universities. Only 20% of engineers change jobs more than once in their career, and job changes between the public and private sectors are even less frequent. A sharp contrast to this is the United States, where engineers change jobs every four years on average. But Japan is not an exception. In many European research laboratories, the situation looks more like Japan than the US. In 1997, Japan introduced a fixed term employment system at universities and national research institutions to facilitate greater mobility. On the flipside, however, increasing mobility tends to raise the likelihood of conflicts of interest in employees that switch between rival organizations.

Mobility for engineers and scientists cannot be discussed in isolation from the overall conditions of the labor market. Employment practices, wage systems, and pension portability are among the issues that need to be considered if U-I collaboration is to move ahead. In Japan, since the year 2000, professors of national universities have been allowed to act as board members of TTOs, and are allowed to participate in commercial activities outside of their regular work hours. While legal barriers are diminishing, it is still unclear to what extent non-legal, less formal barriers exist. For example, how their career prospects within universities will be affected as a result of their participation in joint research with industry is not known. At the present moment, it is all left to individual universities. Their overall human resource management rules are still in the stage of discussion. In addition to scientists and engineers, research assistants are of equal importance to the efficient conduct of research.

Recruiting foreign researchers is yet another challenge for many Asian universities and research organizations. As the world moves to a knowledge-based economy, there is even fiercer competition to recruit good talent on a global scale. It is generally well known that the success of US universities and private sector laboratories is partly due to the high recruitment levels of Asian scientists. Research institutions that confine themselves to a local labor market will find themselves at a severe disadvantage. Without a doubt, the English language is one factor that accounts for the advantage of the US, but there are many other reasons that need to be carefully thought about. The general rigidity that dominates national labor markets and employment practices are far more important barriers to attracting good scientist from abroad.

Insufficient rewards for commercially valuable innovations are yet another deterrent. Early in 2004, an interesting court ruling was handed down by a Japanese court. The court ordered a Japanese company that allegedly made millions of dollars of profit by commercializing LEDs (blue light emitting lasers) to pay 20 billion yen to the scientist who had invented

10. Each national study is published on the WIPO website (*http://www.wipo.int/uipc/en/partnership/*)

it. The company had only given a 20 thousand yen reward to the scientist. But early in 2005, the Tokyo District Court ordered a mediation at 0.6 billion yen. While this case is not directly relevant to U-I collaboration, it does reveal the lack of knowledge on the importance of appropriate incentives and rewards. If there are no clear rules on rewards and incentives, more and more trouble will arise as U-I relations begin to deepen.

9. University Mandates and Mechanisms for Managing Conflicts of Interest

The call for more U-I collaboration is well grounded amid the trends towards intensifying global competition and the drive towards a knowledge-based economy. But these changes should not take place at the expense of the fundamental mission of universities. It remains that universities must pursue several different goals that may mutually conflict. Universities must still fulfill their primary mission to teach students, and this goal cannot be compromised under any circumstance. While university professors are given greater freedom to work with the private sector than before, it is not to suggest that there should be no separation between their academic activities and their commercial ones. There is a real risk of running into a conflict of interest. In general such a conflict is defined as a situation in which a public obligation competes with a financial interest. Also research priorities may be skewed towards applied research that tends to produce immediate financial benefit. More generally, university researchers find their intellectual freedom inhibited and their attention may be distracted from the university's essential functions of teaching and basic research.

The situation is different among the Asian countries in this study on this particular issue. In Japan and China, this is a contentious issue and is being carefully looked over by the government ministries. In Thailand and the Philippines, the potential risk is well recognized but has not become a weighty issue. Other specific issues have also cropped up in relation to the conflict of interest. Confidentiality is of particular concern in some Asian countries since a joint project may hamper the free flow of knowledge between those researchers who are involved in joint research with a private company and those who are not. Use of students as workers is another specific issue that is widely recognized by Asian experts.

The first major conflict of interest occurs in regard to time allocation of university researchers between academic and educational responsibility and commercial interest. It is generally agreed in Asian universities that, if university researchers intend to take on commercial responsibility, they should at least notify the university of such intention and obtain approval. In order to be able to deal with such requests for approval, universities must have certain rules. A university researcher should take a leave or a sabbatical or at least make a separation in schedule, so that there is always a line separating the two activities. Such leaves should be taken in a manner that would not disrupt the educational duties of the university or the other research activities of the professor. One example in this connection is the 20% rule, which is widely observed in US universities. Under this rule, faculty members are allowed to spend up to 20%, in other words, one day in one week, outside the university. The National University of Singapore (NUS) has more or less the same guideline of 52 days per year to be spent on consulting activities or for faculty's engagement in a non-executive capacity in a start-up company. But in general, few Asian countries have clear policies in place.

In addition to proper time management, there is also a need for managing the economic gains that may arise. This is likely to occur when a university researcher holds some stake in a business that utilizes the knowledge of the university. A successful start-up may bring about millions of dollars of profit for a single researcher. But, if U-I collaboration leads to a situation where university researchers make a fortune by using the knowledge of the university and its facilities, there may arise sentiments of unfairness, disappointment or even opposition to U-I collaboration. In order to avoid a situation like this, there must be clear rules for them to follow. Whether or not a university researcher can be a corporate director, executive or non-executive, is a moot point. If, yes, under which conditions should they be allowed to do so? While this can be left to individual universities, it will be in the interest of all universities and businesses to have basic guidelines agreed in advance.

It remains questionable whether there is a set of rules that could be applicable to all universities in one country, let alone in all countries. The contributions from the representative national experts of this project indicate that there is no one-size-fits-all solution. Individual universities should develop their own rules. Such rules should be made public so that outsiders can understand how the universities govern themselves. But when pecuniary interests are involved, disclosure and transparency is of utmost importance. An internal body should be put in place to provide advice for individual cases.

Although not all Asian countries are equally aware of conflict of interest issues, practical problems present themselves in a variety of ways. In 2004, a Japanese university researcher participated in a university startup project by investing in its equity. While nothing was illegal about his conduct, a newspaper picked up the news and wrote a story in a manner to create suspicion. The faculty of the university was obliged to issue a statement that it does not approve of its faculty member holding equity. Although universities, businesses, and governments are enthusiastic about U-I collaboration, the general public may not be quite ready to accept university professors who devote part of their time to a commercial undertaking. The Ministry of Education and Ministry of Economy Trade and Industry conducted a study on this and drew up some guidelines. These guidelines conclude that, with the explicit agreement of the university, a researcher at a national university can become a non-executive board member of a company to which technology of the university is transferred. He can work for the company outside the official working hours, provided that an adequate report is presented on his financial interest in the project.

In theory, if a university researcher gets involved in a collaborative project on which confidentiality is agreed, it may well happen that he cannot talk about the project even with his colleagues in the same faculty. University students may not be able to write their thesis in the same scientific field. But such a strict interpretation of the rules would stifle the free research environment of a university and would thus be counterproductive. There is a need for a more practical approach. There can be other difficult cases, such as transferring a technology developed by a university researcher to a firm in which one of his relatives works. Generally speaking, it is hard to draw distinctions between an invention by a university and the one that has been produced through the collaboration of the university with industry. A common sense approach based on a country's particular environment may be the only guide in such cases.

While not all Asian universities have concrete guidelines for avoiding conflicts of interest, some have taken concrete actions. The National University of Singapore identifies a number of potential situations that are likely to arise. They are (i) misusing students by hiring them as cheap labor, (ii) transmitting privileged information that is not generally available to the company, (iii) undertaking or changing the orientation of research to serve the needs of the company, (iv) using university resources for company activities, (v) purchasing equipment from the company in which the researcher has an interest, (vi) funding by the company of a project related to the licensed technology. In addition to these, NUS regards consulting, equity ownership, royalty interest and family ties as potential areas for conflict. For each one of these situations, NUS provides certain policy and guidelines to minimize the risks.

TABLES AND GRAPHS

TABLE 1 – NUMBER OF PATENT APPLICATIONS FILED BY UNIVERSITIES BY YEAR

	YEAR									
	1995	1996	1997	1998	1999	2000	2001	2002	2003	% growth rate 1995-2003
Japan		76	145	235	273	618	1145	1335	1679	+2109%**
China	692	705	654	879	1052	2010	2684	4677		+576%***
Korea	133	141	204	327	480	627	711	957	1692	+1172%
Singapore	49	64	65	92	119	160	130	134	180	+267%
*Thailand	4	1	7	16	15	16	35	29	16	+300%
India	35	29	38	50	62	78	96	79		+126%***
****Philippines		3	0	0	0	1	3	14	9	

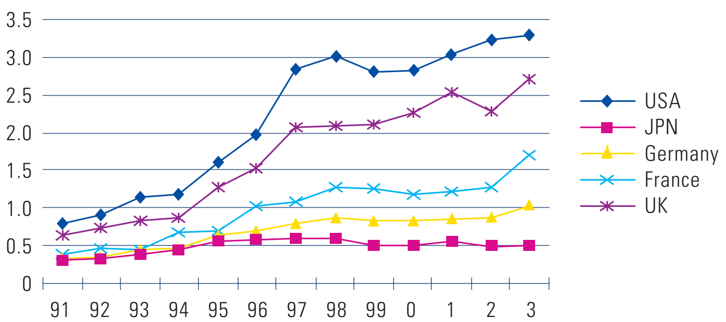
* Patents granted
**% growth from 1996 to 2003
***% growth from 1995 to 2002
**** Data applies only to the University of the Philippines. According to Tansinsin, L., *Development of University-Industry Partnerships for the Promotion of Innovation and Transfer of Technology: The Philippines*, for the period 1995-2004, 11 patents were granted to universities while 32 patents and 5 utility models are pending registration.
Source: National studies and national IP offices

TABLE 2 – KEY R&D INDICATORS FOR ASIAN COUNTRIES

	Income per Capita (US$)	Total Expenditure on R&D (US millions)	R&D/GDP (%)	Total R&D personnel (1000 persons)	Number of scientific articles
India	570	3,743	0.85	308	9,217
Singapore	22,000	1,901	2.2	22	1,653
Thailand	2,380	328	0.26	32	470
Philippines	970	51	0.078	16	164
China	1090	15,558	1.2	1,035	11,675
Korea	12,700	13,849	2.5	190	6,675
Japan	36,400	127,923	3.1	892	47,826

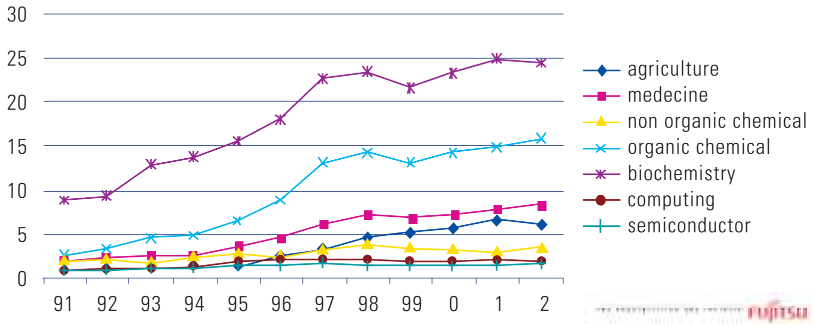
Source: Income per capita (2003) – International Financial statistics
Others (2002)—IMD World Competitiveness Yearbook 2004

TABLE 3A – SCIENCE LINKAGE BY COUNTRY



Source: OECD

Table 3b – Science linkage by sector



Source: OECD

Table 4 – Number of university-based start-up companies in Japan according to two surveys

	1997	1998	1999	2000	2001	2002	2003
MEXT Survey	22	33	62	127	152	159	179
METI Survey	32	53	86	142	165	190	194

MEXT: Ministry of Education, Science and Technology
METI: Ministry of Economy, Trade and Industry
Source: Nishio, K., *Development of University-Industry Partnerships for the Promotion of Innovation and Transfer of Technology: Japan*

Table 5 – Technology transfer of 19 private universities in the Republic of Korea

	2001	2002	2004
No. of technology transfers	58	102	133
Income from technology transfer	473 million won	983 million won	1,913 million won

Source: Yi, H., *Development of University-Industry Partnerships for the Promotion of Innovation and Transfer of Technology: Republic of Korea.*

Table 6 – Patent applications filed by Indian top 10 patenting academic institutions (1999-2002)

No.	Name of the institute	No. of patent applicants
1.	IITs filling at Kolkata Office (includes application from IIT Kharagpur & Gawahati)	75
2.	IISc Bangalore	40
3.	IITs filling at Delhi Office (includes applications from IIT Delhi, Kanpur & Roorkee)	31
4.	University of Delhi	29
5.	IIT Mumbai	22
6.	IIT Chennai	14
7.	AIIMS, New Delhi	14
8.	Goa University	4
9.	Mahatma Gandhi University, Kottayam	4
10.	G B Pant University of Agricullture & Technology, Patanagar	4

Source: Ganguli, P., *Development of University-Industry Partnerships for the Promotion of Innovation and Transfer of Technology India.*

Table 7 – Patents granted to Thai universities from 1995 to 2004 by university

University	Number of patents
Kasetsart University	49
King Mongkut's University of Technology Thonburi	36
Chulalongkorn University	19
Mahidol University	15
Chiang Mai University	5
Prince of Songkla University	4
Suranaree University of Technology	3
King Mongkut's Institute of Technology Ladkrabang	2
Rajabhat Institute	2
Rajamangala Institute of Technology	2
King Mongkut's Institute of Technology North Bangkok	1
Ubon Rajathanee University	1

Source: Krisnachida, N., *Development of University-Industry Partnerships for the Promotion of Innovation and Transfer of Technology: Thailand*

Table 8 – Patents and invention disclosures by Singapore universities

	1995	1996	1997	1998	1999	2000	2001	2002	2003	Summary of 10 years
Invention disclosures	35	53	82	82	97	156	143	131	177	1030
No. of patents filed	49	64	65	92	119	160	130	134	180	1052
No. of patents granted	12	15	18	26	14	28	25	37	40	229

Source: Chou, S.K., *Development of University-Industry Partnerships for the Promotion of Innovation and Transfer of Technology: Singapore*

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PART 2: DEVELOPING INTELLECTUAL PROPERTY FRAMEWORKS TO FACILITATE UNIVERSITY-INDUSTRY TECHNOLOGY TRANSFER

A CHECKLIST OF POSSIBLE ACTIONS

The development of frameworks at the national and institutional levels that facilitate and encourage university-industry partnerships, particularly in the field of technology transfer, is a complex matter for which there cannot be a one-size-fits-all approach. Historical, economic, cultural and political circumstances will affect the policy choices available in each context and influence their outcome and success in implementation. Nevertheless, the experience of the countries that participated in this WIPO study, as well as lessons learnt from the experience of other countries, provide the basis for developing a general checklist of possible measures that governments and institutions may wish to consider.

Encouraging technology transfer from universities to the private sector has been identified in many countries as a desirable goal, not only to enhance the competitiveness of the private sector through access to innovative research results but also to ensure that university R&D results are made available to society through their commercialization. While technology transfer may also result in additional revenues for the university, it should be noted that income from technology transfer generally amounts to a very small percentage of universities' investments in R&D and is generally not the primary objective. The focus will generally be on the benefits for society arising from the commercialization of university research results.

Intellectual property (IP) rights have become a widely used tool in many countries to promote university-industry partnerships as they can provide the necessary incentives to facilitate an effective transfer of technology. A key challenge for governments and institutions is to adequately support the technology transfer process through various mechanisms, including the use of IP rights, while not losing sight of, and reinforcing, the educational and research mission of universities. The objective of the following checklist is to provide policy-makers, both at the national and institutional levels, a set of general measures that may be useful while developing policies for enhancing university-industry partnerships through the use of intellectual property rights. The focus is on how to create the appropriate climate for the management of IP rights, particularly patents, by universities and their effective transfer to industry.

The checklist is meant as an illustrative non-exhaustive set of measures[12] that address three key areas of policy-making, namely:

I. NATIONAL POLICY ON INTELLECTUAL PROPERTY AND UNIVERSITY-INDUSTRY TECHNOLOGY TRANSFER
II. UNIVERSITY POLICY ON INTELLECTUAL PROPERTY AND TECHNOLOGY TRANSFER
III. INSTITUTIONAL SET-UP AND PRACTICAL ASPECTS FOR TECHNOLOGY TRANSFER FROM UNIVERSITIES TO INDUSTRY

I. National Policy on Intellectual Property and University-Industry Technology Transfer

1. **Efficient intellectual property system.** A pre-requisite for any national policy framework that aims to facilitate the transfer of technology from universities to industry via the use of intellectual property rights is the existence of an effective intellectual property system, comprising modern legislation in the field of patents, trademarks, copyright, industrial designs and trade secrets; an intellectual property office in charge of examining and registering/granting IP rights; and the availability of qualified IP professionals (e.g. attorneys, agents, licensing professionals, etc.) who are in a position to assist universities throughout the patent life-cycle, including, in particular, the application process, the negotiation of licenses over patented technology and the settlement of disputes over IP rights.

12. Measures are not listed in order of priority and the importance of each measure will depend on the specific context.

2. **University legal status.** For universities to be in a position to own and manage intellectual property rights and to transfer technology to industry for commercialization, it is essential that they have the necessary legal status to do so. Experience from a number of countries has shown that lengthy bureaucratic procedures requiring state-owned universities to consult government committees or similar bodies prior to each patent application and/or contract negotiation, as a result of a lack of legal autonomy to conduct such activities independently, may become strong disincentives and a major obstacle to IP protection and technology transfer.

3. **Clear and transparent legislation on IP ownership.** Clear and transparent rules covering the ownership of any intellectual property rights developed within public universities or funded with public resources are critical. Different countries have legislated on this matter in different ways, ranging from provisions in patent legislation or in employment legislation to specific legislation dealing with university IP and technology transfer. In addition, government research funding agencies may also have rules that are specific to any research conducted with such funding. Regardless of the manner in which the issue is addressed, there is a strong case to be made in favor of having a nation-wide policy that clearly establishes issues of ownership of IP rights developed by university researchers with public funds. This not only provides clear and predictable rules of the game for all stakeholders but also facilitates joint research between different institutions.

   Different countries have adopted different approaches on whether the university, the researcher, the State or the funding agency will be considered the owner of IP rights over publicly-funded research in universities. In recent years there has been a clear trend towards ownership by the university (although there are often exceptions, for example, for inventions made by researchers on their own time using their own equipment, or for inventions developed within the framework of a collaborative or sponsored research agreement; more on collaborative or sponsored research under point II.7 below). Some of the main reasons for assigning ownership to the universities, as opposed to the State, the funding agency or individual researchers, include:

   – Ownership by the university and management of IP rights by the institution facilitates the professionalization of technology transfer activities and enables researchers to focus on their core research skills;
   – It creates the necessary incentive for the university to support and promote the transfer of technology;
   – Costs of patenting are too high for the individual researcher to fund (particularly if patenting abroad);
   – There are generally many researchers involved in any research project, which would lead to fragmentation of ownership and possible problems for transfer and commercialization if technology was owned by researchers; and
   – It may generate additional income for the university.

4. **Research funding agencies.** In a number of countries, research-funding agencies actively promote the patenting of research results, where appropriate, and in some cases include funding for the protection of research results as part of the funding package. In addition, research-funding agencies sometimes may request researchers to conduct a prior art search using patent databases prior to funding a project. This provides a higher degree of assurance that funding is not channeled to research which has already taken place elsewhere. With respect to the policies on IP ownership of funding agencies, these should be in line with national policy, as inconsistencies between the rules of different funding agencies could complicate matters and result in conflicts over ownership when research is funded from more than one source. Lack of clarity over ownership is generally perceived by industry as a strong disincentive to becoming involved in commercialization.

5. **Safeguarding the public interest.** The ultimate goal of policies and legislation in this field is generally to facilitate the transfer of technology to industry in order to ensure its commercialization for the benefit of the public interest. With this in mind, and considering that university research is generally publicly-funded, policies often contain provisions to ensure that certain public interests are safeguarded. For example, in some countries, universities have a specified time during which they may exercise their ownership, otherwise title is transferred to the gov-

ernment or funding agency. Moreover, in some countries, the government reserves for itself a royalty-free license to practice, or have practiced on its behalf, any publicly-funded invention in exceptional circumstances (also called "march-in rights"). In addition, national policy may require or encourage licensing to local industry or SMEs or require domestic manufacturing of products developed from publicly-funded IP in order to ensure that the local economy benefits from the licensed technology. This, however, should take into consideration that it may limit licensing options. Other measures that relate to the safeguard of public interests may be taken while negotiating licensing agreements and will be dealt with in point III.6, below.

6. **Development of skilled human resources.** Managing technology transfer activities from universities to industry requires skilled human resources and interdisciplinary teams with legal, business, scientific and licensing expertise. Lack of qualified human resources for such tasks is one of the greatest bottlenecks to technology transfer identified in a number of countries, including the countries that participated in this study. Initiatives to train the required human resources should not be perceived as the exclusive responsibility of individual institutions as efforts may be made at the national level to establish, promote or fund training programs geared towards the development of the necessary skills.

7. **Patent funds and/or fee discounts.** A number of countries worldwide have launched initiatives to establish funds that universities and other public research organizations (PROs) may apply for in order to obtain financial support for patenting domestically and, in some cases, internationally. National funds for university patenting may be considered a useful mechanism for promoting the use of the patent system particularly where it is considered that financial constraints are one of the main reasons for under-utilization of the system, resulting in limited commercialization of university technology. Such funds, where they are established, should take into account the entire costs of patent protection (i.e. official filing fees, costs for hiring an expert to conduct a prior art search and/or to draft the patent application, official maintenance fees, and translation costs if funding will include support for patenting abroad). An alternative that has been implemented in many countries is offering discounts or exemptions from official filing and maintenance fees to universities and PROs. While this may also prove to be a good incentive, it is important to recall that official filing fees represent only one of the costs faced by applicants, and generally not the most costly one.

8. **Guidelines and Codes of Practice.** Some governments or research funding agencies have issued guidelines, codes of practice or a set of principles to supplement laws or provide guidance to institutions on the exploitation of IP rights. The aim of such guidelines is generally to ensure that universities have access to information on best practices in the identification, protection and management of IP rights.

9. **Programs to support the establishment of technology transfer offices.** In a number of countries, programs have been introduced to support the establishment of technology transfer offices. TTOs are broadly defined as bodies that are in charge of managing the transfer of technology to industry and are often in charge of managing a university's IP assets (more on TTOs under III.7). Experience shows that only a few technology transfer offices manage to become self-funded, and even when they do, start-up funds are generally required for a number of years. In some countries, governments support the establishment of technology transfer offices by means of financial and/or technical assistance. National IP offices, in particular, are often called upon to provide technical support to technology transfer offices, particularly in the early phases.

10. **Strengthening education on IP.** The need to strengthen IP education within universities is also important, not only among law and business students but also among scientists and engineers so that researchers become acquainted with how the intellectual property system works. Spreading the use of patent databases by science students as a source of technological information is a key measure for enhancing their knowledge of latest technological developments and bringing scientists closer to the intellectual property system.

11. **Grace period.** The publication of research results prior to filing a patent application may compromise their patentability, as a subsequent patent application would no longer meet the novelty requirement. This is often perceived to be a problem for university researchers who are under pressure to publish their research results. As a result, some countries have patent laws providing for a grace period, i.e., a period following the disclosure of an invention, during which the invention's patentability is not compromised as a result of the disclosure. This is thought to be a useful mechanism to facilitate patenting by researchers in universities and PROs. In countries where a grace period exists, researchers may publish their research results and subsequently submit their patent application within a specified timeframe (generally 6 months or a year). Detractors of the grace period, however, argue that grace periods increase legal uncertainty. Countries' legislations differ significantly on this issue and grace periods exist in different forms in some countries (e.g. US, Japan, Russia and China) but do not exist in others (e.g. countries that are members of the European Patent Convention). An important practical point for universities is that patents may be denied to applicants who have relied on the grace period provisions in their own countries when they apply in countries where such provisions do not exist.

12. **Framework for the establishment of spin-offs.** The creation of companies based on university research (spin-offs) is considered an important avenue for commercialization of new technology particularly when the nature of the technology is such that no current player in a particular market would be willing to take the risk of taking a given invention to market. National policies may have to address issues that may arise in relation to the establishment of university spin-off companies. For instance, it may be necessary to determine whether State-owned universities are entitled to own equity over spin-off companies and whether, and in which circumstances, university researchers may participate in private enterprises (more on this below under Section II). In recent years, there has been much debate in some countries over the most suitable commercialization route, taking into consideration that licensing is less resource-intensive for universities than the creation of spin-offs and universities often lack the business expertise to support the creation of start-ups. On the other hand, some have argued the importance of promoting the development of new technology-based start ups based on university technology due to the impact they can have on the local economy. National policy-makers may have to consider these issues particularly if public funds will be devoted to supporting the creation of spin-offs (see below).

13. **Seed funding for spin-offs and start-ups.** Given the financial risks involved in the establishment of start-up companies and university spin-offs, it is often difficult to find the necessary seed funding in financial markets. In some countries, governments have established competitive funding mechanisms to which start-up companies may apply to obtain venture funding. The existence of such funding mechanisms, particularly for the establishment of new technology-based firms based on university protected technology, can have an impact on the likelihood of such enterprises developing and surviving beyond the start-up phase.

II. University Policy on Intellectual Property and Technology Transfer

1. **Clear and transparent IP policy.** A crucial first step for any university intending to build partnerships with the private sector for the transfer of protected inventions is to have a clear and transparent IP policy that is formally approved by the university authorities and available for consultation by researchers and external partners. In many cases, IP policies are the result of a participatory process involving all the main stakeholders within the institution. University IP policies generally cover all IP rights, in particular patents and copyright, but may also regulate the transfer of know-how. The IP policy should be a dynamic document that can be reviewed as necessary, providing clarity on a number of issues. Some of the main objectives of an internal IP policy are to:

– Provide rules and guidelines for the commercial exploitation of IP generated within the university;
– Ensure that discoveries, inventions and creations generated by staff and students are utilized in ways most likely to benefit the public;

– Establish ownership criteria;
– Define the responsibilities, rights and obligations of all stakeholders;
– Develop basic guidelines for the administration of the IP Policy; and
– Define rules for revenue sharing if the commercialization of IP generates income.

2. **Criteria for ownership.** While the general provisions on ownership of research conducted by university researchers with public funds are likely to be addressed by national legislation, the university's internal IP policy generally reaffirms the main principles, states the university's intentions with respect to the exercise of its IP rights and addresses a number of particular circumstances, such as:

– Cases in which IP rights are generated as a result of research sponsored (all or in part) by industry in the framework of research contracts;
– Cases in which IP rights are generated as a result of funding by a public sector agency that might have specific contractual terms associated with the funding;
– Cases in which IP is generated by researchers who are not bound by employment contracts, such as undergraduate or post-graduate students; and
– Cases in which inventions are developed in partnership with third parties (individuals, companies or institutions).

3. **Revenue sharing.** Provisions on revenue sharing are a key element of most IP policies. Revenue sharing provides an important incentive for researchers to ensure that they disclose their inventions to the relevant body and seek to find the best avenue for commercialization. Provisions on revenue sharing generally define clearly what type of income is to be distributed and generally applies not just to royalties but to any other lump-sum or milestone payment made to the institution for the commercialization of the technology. Common practice in this regard is that revenues generated must first cover any expenses related to the protection and exploitation of the IP and the net income is subsequently distributed between the researcher(s), the department, the university, the technology transfer office, the funding agency and/or other stakeholders in percentages that are established in the policy. IP policies often establish revenue thresholds, and the percentage received by the researcher(s) decreases as total net revenues increase. University IP policies may also define how decisions are to be taken on how to split the income when more than one researcher is involved.

4. **Collaborative or sponsored research contracts.** Collaborative or sponsored research involving a university and a private company are increasingly common in many universities. On many occasions, the private company funds research that is undertaken within the university by university researchers using university equipment. It is important to have clear rules on IP ownership in such cases as well as guidelines on whether the industrial partner is entitled to an exclusive or non-exclusive license, whether it would have to pay royalties to use the technology that results from such research and whether it would have the right to license or sub-license to third parties.[13] In some cases, research results are jointly owned by the partners to the agreement, but this may sometimes cause problems for commercialization. Another important issue to be addressed at the outset of any research collaboration is the definition of the background knowledge / information (including unpublished research results, patent applications, etc.) that each party to the agreement has before the research collaboration begins and the extent to which the other party will have any access rights to it. Finally, it is also important for universities that any research collaboration does not restrict its academic freedom to do research in any field of technology, does not constrain its ability to use the research results for further research purposes and enables it to publish results within a reasonable timeframe (without this compromising the patenting of the results). These and other issues will generally be addressed in individual contracts but may, in some cases, also be established as a matter of university policy.

13. An interesting resource in this respect are the five model research collaboration agreements devised by the Lambert Working Group in the UK. They are available with guidance and notes at: *http://www.innovation.gov.uk/lambertagreements/*

5. **Conflicts of interest.** A conflict of interest occurs whenever two or more goals or ends cannot be pursued simultaneously, and they are in potential competition. It has also been described as a situation in which a public obligation competes with financial interests. Collaboration between the university, the faculty, or other employees and industry may sometimes engender conflicts of interest. In particular, universities are often concerned that research is not skewed towards the interests of private companies, that the university (or its faculty) is not distracted from its core mandate or that researchers devote too much time to private consulting. In technology transfer activities, there may be specific types of conflicts of interest that need to be addressed, including situations in which university researchers (or their relatives) have a financial interest in any of the university's licensees. To avoid such circumstances, or minimize their impact, universities need to develop policies and procedures for the disclosure and management of conflicts of interest. This may be crucial for the credibility and image of the university and its researchers as well as to ensure that technology transfer activities are conducted in the public interest and not exclusively for personal gain. Policies on conflict of interests generally cover a wide range of issues that go beyond those that strictly relate to intellectual property rights and technology transfer.

6. **Responsibility for the management of IP.** IP policies generally determine which body of the university will be responsible for the protection and management of the university's IP rights. In many cases, such responsibility is assigned to the technology transfer office (see section III for more information on technology transfer offices). Responsibility for evaluating invention disclosures and taking decisions on whether or not to patent is generally also spelt out in the IP policy.

7. **Obligations of the university and of the researchers.** Internal University IP policies may state certain obligations for the researchers as well as for the institution itself. These may sometimes also be covered in university employment contracts with researchers. Obligations of an inventor may include, for example, (1) the need to disclose to the appropriate body determined in the policy any research results that could be protectable by IP rights; (2) not to disclose the invention to third parties in a way that may compromise its patentability; (3) to abide by any agreements signed with external parties; (4) to assist in the protection and management of IP; and (5) to disclose any conflicts of interest. Obligations of the university (or of its relevant bodies) may include, for example, (1) to evaluate every disclosure; (2) to minimize delays; (3) to maintain confidentiality over inventions; (4) to facilitate transfer so as to benefit the public; and (5) to assign ownership to the inventor, research funding agency or government if it decides not to patent or license.

8. **IP and career advancement.** The inclusion of patents and licenses as criteria for recruitment and career advancement of researchers may also be considered an important incentive for researchers to engage in such activities. The underlying rationale is that unless researchers are rewarded professionally for patenting and commercializing their research results they are unlikely to pursue this route, favoring a speedy publication of the research results instead that may compromise the possibility of patenting and transferring the technology thereafter. Different institutions have adopted different systems for motivating researchers to use the IP system and for evaluating patents and licenses for the purposes of career advancement, taking into consideration that it may also be important to avoid creating incentives for indiscriminate filing of patent applications.

9. **Spin-offs and start-ups.** When universities become involved in the creation of spin-off companies for the commercialization of research results developed within the university, a number of issues arise on which it is important to establish policies or guidelines. These may include, for example, whether the university, or its faculty, is entitled to own equity in a company; whether the university, or its faculty, can or should participate on the board of directors of a spin-off company; and whether, and under which conditions, researchers/professors are entitled to take leave to work in a spin-off company. In countries where university researchers are formally employees of a central research funding body or science and technology commission, which pays their salaries, such policies would have to be established at the national level.

III. Institutional Set-up and Practical Aspects for Technology Transfer from Universities to Industry

1. **Establishment of TTOs.** Technology transfer activities within universities may be served through the establishment of a dedicated office. In different countries or institutions technology transfer offices are known under different names and their tasks may be limited exclusively to IP management and technology transfer or their mandate may be broader thus including not just technology transfer but any interaction or contractual relation with industry. The advantage of having an office that is specialized in technology transfer is that it enables universities to professionalize their technology transfer activities, but the viability of such an office will depend on many factors including the volume of work that such an office would be handling. TTOs may be internal to the institution, attached to the university or faculty authorities, or responsibility for technology transfer may be transferred to a separate agency, foundation or university-owned company.

2. **Joint technology transfer offices.** The establishment of joint TTOs or shared services for groups of universities or PROs that are based in the same region or specialize in similar technical fields is an option that has been implemented by a number of institutions in developing and developed countries alike. One of the main reasons for establishing joint TTOs with shared services for a number of institutions is that individual universities may not generate sufficient work to justify the creation of a specialized office with skilled human resources. Arguments in favor of such an approach, therefore, emphasize the importance of having a critical mass and the possibility of hiring highly skilled human resources at a lower cost for each individual institution. Nevertheless, it may also be argued that it is important that TTOs are within the university itself so as to have more direct interaction with the researchers and to avoid situations of institutional mistrust when the TTO is shared with other institutions.

3. **TTO requirements.** The requirements for a TTO to function efficiently will depend significantly on each institution and the context in which it operates. As concerns funding, it is important to bear in mind that TTOs cannot become "money-makers" overnight, and funds will have to be allocated for their functioning for several years before they can begin to generate their own revenues and potentially contribute to the university's own income. Personnel requirements will also depend on the institution, the volume of work and the mandate of the TTO. It generally may range from an interdisciplinary team of people with legal, scientific, licensing and commercial expertise to a single individual that is capable of leveraging the necessary support from external experts. A crucial point for any TTO is to have the full support of university authorities.

4. **Developing simple and transparent procedures.** The development of simple and transparent procedures for disclosing inventions, patenting and negotiating with external partners is important so as not to unnecessarily delay technology transfer activities and ensure that the TTO is perceived as an efficient support structure by researchers themselves. The existence of a standard invention disclosure form is essential to make it easy for inventors to disclose their inventions to the appropriate body. It is also useful for TTOs to develop model confidential disclosure agreements, which can then be adapted to specific circumstances. Many TTOs also accumulate over the years a database of agreements which are used as the basis for drafting and negotiating new agreements and help in speeding up processes.

5. **Patenting decisions and costs.** TTOs, or the relevant body in charge of evaluating invention disclosures, are generally responsible for taking decisions on whether to patent, what to patent, where to patent and when to patent. Most universities rely on external patent agents with specialized knowledge to draft patent applications if the relevant expertise does not exist in-house, even if this is likely to raise the costs. It is crucial that patents be properly drafted for them to be of any value to business. As concerns costs, it is important that universities (or research funding agencies) allocate funds for filing patent applications. Some TTOs rely on their private industrial partners to shoulder part or all of the patenting costs.

6. **Licensing practices.** Licensing practices vary considerably between institutions and fields of technology. Many universities are keen to promote non-exclusive licenses[14] and seek to ensure that any exclusive licenses that are granted will include clauses to protect against failure by the licensee to carry out effective development and marketing of the invention. Thus, clauses requiring the working of the invention within a given time frame or clauses stating minimum royalties to be paid regardless of whether the technology is commercialized or not are provisions sometimes used by universities to ensure that the goal of commercialization is met. Universities may also wish to include provisions to ensure that the university (and possibly any other research institution) may use the invention freely for non-commercial purposes (especially in countries where research exemptions are weak or unclear), provisions that reserve rights for humanitarian commercial development,[15] or other provisions that aim at safeguarding any public interests. An important point to be made is that universities often also license inventions for which a patent application has been filed but has not yet been granted.

7. **Marketing protected technology:** TTOs are often responsible for marketing university technology and searching for commercial partners to license their protected technology. This is generally one of the most challenging tasks for TTOs. If commercial partners cannot be found and patented technology is not transferred to industry, patenting will only result in costs for the university. It is important, therefore, that TTOs take an active role in seeking targets for technology transfer and establish close relations with companies in the specific fields of expertise of the university. Experience has shown that a large number of successful licensing agreements result from contacts provided by the researchers/inventors themselves who are likely to know better than anybody else which companies might be interested in a given technology. As a result, some TTOs give researchers a lead role in identifying the appropriate partners for technology transfer.

14. Non-exclusive licenses may be of little interest to industries in certain fields of technology where important investments may be required to take the product to market. Universities may choose to offer exclusivity for a limited number of years after which they would be entitled to license to other companies on a non-exclusive basis.
15. On this issue, see, for example, some of the strategies outlined in Brewster, Chapman and Hansen, “Facilitating Humanitarian Access to Pharmaceutical and Agricultural Innovation,” Innovation Strategy Today Vol. 1, Number 3, *http://www.biodevelopments.org/innovation/ist3.pdf*

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