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Report

Seoul National University Advanced Institutes of Convergence Technology

서울대학교 차세대기술융합연구원

"Strategies for Promoting Successful International Collaboration in Convergence Technologies:

A Consideration of the Korean Biomedical Field"

【성공적 기술융합의 국제공동연구 촉진 전략개발에 관한 연구】

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"Effective Approaches to International Collaboration in the Biomedical Field for Korean Research Institutes"

1) Survey of Essential Conditions for Effective International Collaboration in the Biomedical Field for Korean Research Institutes (Vince Rubino)

1. Goals of this report

The goal of this paper is to present a careful analysis of the critical issues that will enable effective international collaboration in scientific research between Korea and the United States as well as concrete suggestions for how to successfully establish long-term relations for mutual benefit in the future.

1.1. In all scientific fields over the past 20 years, there has been a substantial increase in international collaboration. At the same time, the biotechnology, more than many other scientific fields, has seen a rise in cross-institutional collaboration[1]. For this primary reason, much of this paper focuses on biosciences and biotech. However, also important to collaboration are the end goals of scientific advancements and technological breakthroughs. In particular, biotechnology has the potential to improve healthcare issues by preventing illnesses from occurring instead of treating debilitating diseases. While the biotech industry is still relatively small, it will increasingly drive developments in many industries related to energy, health, nutrition, and the environment. A strong biotechnology sector is important to a nation if it wants to be a player in the global bio-economy rather than just a consumer.

1.2. Market forces are fueling the momentum in biotech in developing countries and Korea is not an exception. As a dramatic example, India's expanding middle class is demanding more treatments for chronic diseases, echoing the pattern observed in developed countries. India has over 50 million patients with diabetes and, according to World Health Organization estimates, 25% of the world's tuberculosis cases. The 100 million suffering from heart disease make it "the cardiovascular capital of the world," according to Patrick Keohane, Vice President of Research and Development, AstraZeneca Asia Pacific.[2]

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1 Ponds, Roderik, The Limits to internationalization of scientific research collaboration. *Journal of Technology Transfer*, Vol. 34 (2009): 76-94.

2 http://www.nature.com/biopharmadealmakers/pdf/main_feature_web.pdf

1.3. Understanding expectations and defining what each organization needs from a collaboration

1.3.1. How dedicated is each organization or how much do they need the relationship? What is the level of commitment each organization brings to the partnership? There is a myth that people are naturally drawn to collaborations. But when you see a collaboration that is successful, more often than not, it is successful because of necessity. Collaboration is an alignment of different interests, which may be difficult to negotiate, particularly if the organizations do not have a thorough understanding of both their collaborator and their own organization. We need to be able to answer in significant detail "what's in it for you? What's in it for us? And what's in it for me? Once these questions are answered and the results considered carefully, it provides a foundation that makes finding the right partner easier and facilitates negotiation and creation of a lasting collaboration.

1.3.2. For a collaboration to succeed, more is needed than just the right technology, star researcher or management system. Functional teams within the collaboration must have an understanding of where they fit in the overall system and how their work affects others. Local environments will differ in terms of infrastructure, regulations and work practices, economics and cultural values. Without a deep understanding of these differences, productive collaboration and innovative solutions will likely not take place.

1.3.3. The social setting for establish a successful collaboration is also critical. First impression as to the value and trustworthiness of the relationship and the capability for developing camaraderie are pivotal in moving collaboration forward. These factors can be improved with concentrated effort. Cultural differences may magnify themselves in seeming importance during this initial courtship phase of the relationship. It is imperative that this issue is given thoughtful consideration followed up by proactive steps to prepare US/Korean cultural differences and understanding among the participants. This topic will be discussed in more detail later in this paper.

1.3.4. Collaborations may also enhance productivity of members of different teams. "To get people to be broader and innovate is to get them out of their setting," says Ginger L. Gregory, global head of human resources for Novartis Institutes for BioMedical Research in Cambridge, MA. It offers them the chance "to get out of their therapeutic setting, magnified by getting them out of industry into an academic lab" and vice versa, says Gregory, allowing crosspollination in both spheres.[3]

1.3.5. Collaboration may be an opportunity to poach talent. "The relationship between big pharma, biotech and academia is that they are all competing for the best people," says Charlene Ledbetter of LedbetterStevens, a life sciences executive search firm in New York City. "They are out-and-out competitors" for

3 Wilan, K.H. *Cell* **129**, 847 (2007)

talent, with academia luring people with cutting-edge tools, biotech with equity, and big pharma with relative job security."[4]

1.3.6. US life science based companies may be cautious about collaboration with a Korean organization because of fears of IP dissipation. Lack of knowledge of the quality of public research institutions and private companies in emerging economies has been responsible for underperformance in many areas of off-shoring, including R&D. Thorough understanding of the partners in collaboration is very important.

2. Comparison of cultural, economic and development differences

2.1. South Korea's needs – selling points in establishing cooperation

2.1.1. Korea has limited natural resources, an aging society and a limited domestic market. Its export industries are crucial to continued prosperity and Korea faces growing competition from China. South Korea has little choice but to persist in building knowledge economy capacity.

2.1.2. The ongoing Asian outsourcing boom is an area where the Korea innovation organization can benefit from. Many multinational firms have already relocated R&D centers to Asia. But the drivers for the outsourcing boom and the selling point for innovation collaboration may have significant differences that will be discussed below.

2.1.3. The brain drain, the phenomena whereby Koreans, and others from developing nations, leave their homeland to be educated and conduct careers in more advanced economies, is now beginning to reverse. Foreign educated Korean professionals are returning to Korea to work and start businesses. This trend is a major opportunity for the creation of collaborative agreements between US and Korean organizations. The Chinese government has undertaken efforts to attract Chinese talent back from abroad by improving available financial and structural resources. Government officials from Chinese science parks have gone to places such as the biotech hubs of San Francisco and Boston in an attempt to sway the talent pools there to return to China[5].

2.1.4. **Built in and reliable government support** – a double edged sword.

2.1.4.1. In terms of gross domestic expenditure on R&D, South Korea at 42 billion US$ (PPP) comes fifth in the world behind the US, Japan, China and Germany and just ahead of France. A much smaller country and economy than France, South Korea has 223,000 researchers versus 211,000 in France. South Korea is also among the most aggressive

4 Wilan, K.H. *Cell* **129**, 847 (2007)

5 http://www.nature.com/biopharmadealmakers/pdf/contract_services_feature_web.pdf

spenders in the world, devoting more that 3% of GDP to R&D[6]. It is expected that this investment will pay off bid dividends in the future.

2.1.4.2. Reliance on government support builds organizational inefficiencies that are detrimental to the goal of product development and can impact all aspects of collaboration.

2.1.5. Significant **modern infrastructure** including state of the art airports, rail systems, high speed internet and qualified vendors providing certified calibration and other products and services. While investments in facility expansions recently swamped some of the global giants of the Contract Research Organization (CRO) industry based in the US, Korean CROs have survived with excess or underutilized facility space.

2.1.6. Korea is an established **ambassador of globalization to other developing nations**, particularly in Asia where Korean factories have been successfully established and managed for 20 years or more, where there are booming Korean tourist industries, and where Korean media products have had significant penetration and provide a source of national branding.

2.1.7. An **educated workforce focused on certifications** – a double edged sword.

2.1.7.1. High number of advanced degrees per capita but lacking entrepreneurial know how and capability due to reliance on government support among other reasons.

2.1.7.2. Promotes metrics that do not necessarily benefit business relationships.

2.1.8. Korean culture with a strong emphasis on communalism places strong emphasis on building relationships, and once firmly established, these relationships are expected to be long term. Building long term alliances is an area of great potential for Korean organizations. Analyzing successful collaborations between Korean research institutes and chaebols could provide a useful backdrop for planning collaborations between US and Korean organizations, with emphasis placed on what essential administrative or cultural elements may be missing from a US organization.

2.1.9. Korean business practices and cultural values in many ways reflect those that exist in other developing markets, and these developing markets are already familiar with the high quality that Korean products can provide. This is a very attractive consideration for the ultimate goal of collaborative product development and marketing.

2.2. South Korea's cultural limitations to consider before entering a collaborative agreement

6 OECD, World Bank, K4D, and UNESCO data in "Global R&D Funding Forecast 2009,"*R&D Magazine* and *Battelle*, December 2009, pp. 4.

2.2.1. Korea is relatively inexperienced compared to other regions in the area of international collaboration for the purpose of innovation. This is not to be taken lightly and it is critical that Korean partners be prepared to do the homework on understanding their own culture as it compares to others. The US in particular is not a single monolithic culture and US collaborators typically represent a collection of cultural backgrounds. Thus, a strong understanding of the biases that Koreans have about doing business, about foreigners, even the biases Koreans have about Korean culture should be discussed and visited frequently during the planning stages as well as during the collaboration phase. Many Koreans exhibit **uneasy relationships with non-Koreans** and, in certain circumstances, could be the demise of an otherwise successful collaboration.

2.2.2. The **language barrier** creates a considerable wall in building and maintaining collaborative relationships, and often results in bureaucracy of go-betweens and intermediaries. This is not a small issue as it dovetails directly into cultural biases. Because Korean language is not a global language and English is a global language, it is recommended that a Korean organization strongly consider operating in English in the context of cooperation.

2.2.2.1. Korea has created it's own IT ghetto based on a homegrown word processing system called Arihangul and the assumption that all computers use MS Windows and the Internet Explorer web browser. Consequently, much information is locked inside the Korean operating system and unavailable to outsiders. This situation drives Korean computer users into a type of "hermit kingdom". IT issues should be discussed early on in the negotiations and resources should be identified for allowing collaboration.

2.2.3. **Korean management and organizational styles** in some cases do not reflect global expectations. For example, many leading South Korean organizataions emulate the Japanese system of corporate-based innovation. This approach may be at odds with the more open U.S. system, based on individual entrepreneurship. An assessment of management structure and style should be conducted, including both official and unofficial reporting and decision making organizational charts. The results of this assessment should be communicated to potential partners in the negotiation process. They need to understand what to expect.

2.2.4. Emphasis on **lower base costs** than the US and other important competitors for collaborations.

2.2.4.1. This aspect of doing business and research in Korea is a selling point for a cash strapped collaborator. However, low cost rarely correlates to high quality, which is the primary deliverable for innovation, particularly if it involves healthcare or the environment.

2.2.4.2. Lower costs are linked to Korea's proven success with the use of platform technologies. Proven capabilities in the use of platform technologies has provided enormous wealth for Korea and in many ways has been the driver for Korea's current success in the global marketplace.

From finding improved methods to make quality athletic foot ware in the 1970s and 1980s, to state of the art touch screen mobile devices today, Korea has been an unqualified modern success in the effort to translate technology into lower cost commodities for the mass consumer. It can be very useful to play to strengths in luring collaborators. However, the flip side of this coin is that commodities are neither unique nor innovative, even if innovation is involved in their production. Korean collaborators probably do not want to compete for US attention based solely on lower costs.

2.2.4.3. Lower prices for land and labor are starting to appear in the US as a result of fallout from the global economic crisis, ongoing successes of their efficiency efforts and the repercussions of problems in the pharmaceutical industry. As the policies of globalization continue to redefine the world economy, we may find that base costs even out among nations and geographies.

2.2.4.4. There is growing competition from other low cost developing nations.

2.2.4.5. Price may not be a benefit that will last through the duration of long term collaboration as rising domestic costs due to inflation and increasing labor and material costs take hold.

2.2.4.6. Global collaborators often choose higher cost locations other than Korea such as Europe, Japan and Singapore for their investment destinations. For Korea to compete with more advanced nations for collaboration opportunities in healthcare in particular, they will need to compete, not only in the areas of quality management and scientific quality, but in efficiency. Korean business culture has not yet embraced efficiency the way that it has been accepted in the US. Maximizing efficiency is an area of enormous opportunity in many sectors of Korean business, including the business of research.

2.2.5. **Communalism**

2.2.5.1. Communalism in Korean culture fosters an environment where great emphasis is placed on maintaining harmonious relationships free of conflict.

2.2.5.2. **Positive**

2.2.5.2.1. Communalism fosters a sense of shared responsibility and reduces the need for security measures and formal, bureaucratic systems for managing situations. However, all collaborators need to be educated to understand the unspoken agreements of Korean culture.

2.2.5.3. **Negative**

2.2.5.3.1. Communalism in some cases fosters a culture of tolerance toward breaches of ethics in the sciences, animal welfare, funding distribution and other areas which have the potential to devastate collaboration with a US organization.

2.2.6. For collaborations using animal facilities in Korea, animal rights legislation was only put into law in Korea in January of 2008, and enforcement is not yet a substantial consideration affecting the operation of Korean businesses. Liberal public attitudes about the ethical use of animals permit freedom for both regulators and businesses in Korea. Earlier this year, it was reported in international news media that more than one million pigs were buried alive as a stop gap to an outbreak of foot and mouth disease. Regardless of the various excuses offered, this action violated the Korean animal rights law and set a standard for non-compliance that could come back to haunt the efforts toward setting and maintaining ethical standards for animal use. These sorts of events can also create potential pitfalls for long term collaboration with US organizations where there is a much more conservative approach to the use of animals.

2.2.7. Understanding should be built around the different cultural understandings of regulation and enforcement as these issues will eventually impact a collaboration involving laboratory work and/or healthcare. It is true that more regulation is not always better regulation, and tougher, more detailed standards do not always foster better results. And in the US there are issues where some researchers are too reliant on procedural and engineering solutions to protect them. In contrast, everyone in Korea has been conditioned to be accountable for their personal safety at all times, largely because the rules and systems are missing or are not enforced. A frank and open discussion about this topic and how it affects the laboratory and daily life in a Korea or US based collaboration is necessary.

3. **Key issues for creating long term relations**

3.1. An effort to identify and categorize the communication styles and other elements of culture that affect US/Korean collaboration is recommended. Hiring a sociologist or organizational management consultant to perform assessment and analysis should be a consideration.

3.2. Rituals and confidence building activities including retreats and exchanges at all levels can build viable connections between collaborators.

3.3. **Critical considerations** in developing a successful collaboration for the purpose of research and innovation include:

3.3.1. **policy coordination** among government departments responsible for innovation and/or funding

3.3.2. intention of policies - **mission-oriented** or focused on building a culture of innovation

3.3.3. **links between universities and the private sector**

3.3.4. **academic entrepreneurship** that would lead to commercialization of inventions

3.3.5. **highly innovative private sector companies** to provide examples and leadership

3.3.6. **accessing credit and financing** for ventures

3.3.7. key talent and capacity to conduct world class research.

3.4. **Typical design flaws** in arranging the scope of collaboration include timing, sizing and lack of flexibility. Depending on the scope and expected results, programs may be too short-term to succeed or may be too small to make a difference. Others may be too large, particularly if funded by the government, and may exclude private investors. Flexibility and the willingness of policymakers to learn from mistakes and make needed modifications is helpful for success. Implementation of a collaboration agreement may proceed before through evaluation is conducted, particularly of incentive schemes.

3.5. A number of authors have expressed concerns about the **effectiveness of national "catch up"** policies for biotechnology development in countries such as South Korea[7]. The concern is that massive public spending on biotechnology, without strong private sector participation may lead to wasteful failures as it has occurred in Europe.

4. Building effective alliances between institutions

4.1. Creating a biotech cluster

4.1.1. In the US, Boston is a notable leader in the global biotechnology industry. Massachusetts universities and academic medical centers have been an engine of innovation in critical new science that has had an enormous impact on. With 2000-2009 growth of 60% and more than 480 biotechnology companies with almost 900 drugs in development, Boston-Cambridge is one of the largest regional concentrations of biotech companies in the world.

4.1.2. The state of Massachusetts and its economy have benefited from this global leadership in biotech. During the past five years, employment in biotech has grown 10 percent annually and has contributed roughly half of the new industrial jobs in Massachusetts. Biotechnology accounts for 18 percent of the state's venture-capital investment, 27 percent of its R&D spending, 16.5 percent of its public companies, and approximately 10 percent of its market capitalization.

7 "The Fading Luster of Clusters," *The Economist*, October 13, 2007.; Su Y., Deeds, D., Peng, M., Jung, C, "Technological and institutional transformation: The biotechnology industry in Taiwan," Paper presented at the Four Decades of International Business Conference, Reading, United Kingdom, April 16-17, 2007.; M. Fonseca and J.M. de Silveira, "Building institutional competence in Brazilian biotechnology: Some theoretical and empirical remarks," Unpublished manuscript, 2007; H. Gottweis. and R. Triendls, "South Korean policy failure and the Hwang debacle." *Nature Biotechnology*, 24(2), (2006), pp. 141-144.

Having approximately 8 percent of the world's pipeline of new pharmaceuticals located in Massachusetts represents potential for growth and job creation.[8]

4.1.3. Founded in 1985 and at the center of the development of the Boston-Cambridge Cluster, Massachusetts Biotechnology Council (MassBio) is a not-for-profit trade association that represents over 600 biotechnology companies, academic institutions, research hospitals, and service organizations involved in life sciences and health care, and works to advance policy and promote education, while providing member programs and events, industry information, and services.

4.1.4. **Science parks and incubators**

4.1.4.1. While the concept of a science park and larger cluster definitely flourished in the US and lead to successes, current **US federal policies are no longer encouraging their growth**. In 2010, U.S. Representatives Gabrielle Giffords (D -AZ) and Martin Heinrich (D-NM) introduced “The Science Parks Research and Innovative New Technologies Act” (SPRINT Act - H.R.4413). The legislation would authorize the Department of Commerce to establish a $7.5 million competitive grants program for the development and construction of new science parks and expansion of already existing parks. The bill has sat in the Subcommittee on Technology and Innovation since it was introduced.[9]

4.1.4.2. An organizational component that focuses on the development and commercialization of innovation is often described as an “incubator”. As defined, **incubators** generate start-ups and support new innovative companies in succeeding on the market. The most effective incubators developed within Europe were put together as part of a regional political strategy to partner private industry with university research activities and research institutes within a specific region. The most successful incubator models were founded upon regional strengths and private-public-partnerships.[10]

4.1.4.3. Besides providing four walls and lab space, science parks, or more specifically their management offices, these days help identify financial and services support for new ventures, support technology transfer and incubation of new business, foster development of synergistic networks, and enable access to capital and construction of shared resource facilities[11].

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8 http://www.ambassadorprogramme.com/content/us/news/news_from_ambassador_programme/2011/boston-cambridge_a_life_science_cluster_that_is_second_to_none

9 http://www.nature.com/biopharmadealmakers/pdf/2011_feb_main_feature.pdf

10 http://www.nature.com/biopharmadealmakers/pdf/2011_feb_main_feature.pdf

11 http://www.nature.com/biopharmadealmakers/pdf/2011_feb_main_feature.pdf

In particular, the shared services nurture development of new firms. These services may be providing access to equipment or taking care of basic technical services such utilities, telecommunication or data centers. Shared facilities can also be more complex. For example, BioWin, the health cluster of the Wallonia region of Belgium supports three cell therapy companies by providing a joint regenerative medicine facility for the companies to share. Non technical services can also be found amongst science park management offices including legal and business development expertise, as well as channels for government funding. In the cases of India and China, relations with the government and opening trade channels also figure into to service offering.[12] However, strong government support alone is not a determiner for success. For example at the Shanghai Zhangjiang High-Tech Park, advanced management skills and serial high-tech entrepreneurs are in short supply. Research data indicates that there is more networking between the biotech companies and the government than there is amongst the biotech companies themselves at the cluster. Exclusive and closed networks makes it more difficult for start-up companies to benefit from innovation and competition as compared with other world-class clusters[13].

4.1.4.4. Another important higher level form of collaboration can happen between science parks and cluster associations, and can provide much needed access to other regional or foreign markets. A **cluster mapping report** can be conducted.

4.2. Mission oriented alliances

4.2.1. While a mission oriented alliance may detract from the goal of diffusion of an innovation culture, it has the advantage of a more readily understood scope and it is clearer who the stakeholders may be. It also has greater potential to attract innovation companies and private investors.

4.2.2. **Development of specific technology** areas is often a bridge to connect organizations. The number of companies involved in pharma development in Asia is growing. According to Grant Thornton's report on Biotech Alliances in Asia, during 2010 there were 322 global alliances between biotech and pharma companies, of which, 93 involved at least one Asian country. In another example, around 270 alliances were made between two biotech companies, 37 of whom involved at least one Asian country.[14] Some of these included Korean companies. For example, Quintiles investing $30 million to start a new joint venture company with Samsung Electronics.

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12 http://www.nature.com/biopharmadealmakers/pdf/2011_feb_main_feature.pdf

13 Yu-Shan Su and Ling-Chun Hung, "A Comparison Study for Biotech Clusters From Different Origins—Do Success Factors Differ?" *Technological Forecasting and Social Change*, 76, June 2009, pp. 608-619.

14 http://biospectrumindia.ciol.com/content/BioSpecial/21107118.asp

4.2.3. Besides the more obvious target of biological technology, **information technology** based systems are playing more and more of a role in bioscience innovation. Much attention, by industry, has been focused on improving the speed and accuracy of decision-making and thus enhancing the progress of drug development.

4.2.4. For targeted, mission oriented collaboration, **public-private partnerships** are common. Patient groups, health organizations and governments collaborating with pharmaceutical and biotech companies have yielded an array of organizational structures and creative deal-making. These *public-private partnerships* include a variety of innovative ventures addressing unmet clinical needs. Working with an abundance of collaborators from both academia and industry organizations such as Amyotrophic Lateral Sclerosis Therapeutic Development Institute (ALS-TDI) created a research lab that could test every federally approve d drug for the treatment of ALS. ALS is commonly known as Lou Gehrig's disease. Early on in its creation, ALS-TDI created a scheme for the automation of the therapeutic validation process and runs a program that tests dozens of potential therapeutics each year. ALS-TDI shepherds potential therapies from early stage to preclinical development and then secures industry partners to perform clinical trials as necessary. In ten years, ALS-TDI has spent nearly US $60 million on research into effective treatments and published works that have benefitted the field of neuodegenerative research.[15]

4.2.5. Other high profile private public development partnerships have been created to develop products for a specific disease such as Medicines for Malaria Venture (MMV), PATH's Malaria Vaccine Initiative (MVI), the Global Alliance for TB Drug Development. These organizations operate as coordinated partnerships between external product developers, scientific boards with disease-specific expertise and expert management teams.[16]

4.2.6. Related to this idea of focused therapeutic needs is an approach taken by Massachusetts headquartered Genzyme who have adopted a business model focusing on **orphan drugs** used for treating very small patient populations. This approach creates a built in close relationship with the patient groups for which they serve. Genzyme collaborates with patient groups on a worldwide basis and one of their objectives is to collaborate with health care systems where there is no treatment of a rare disorder. Genzyme has an internal patient advocacy group working to build relationships in different regions of the world across different diseases[17].

4.2.7. The Raymond and Ruth Perelman School of Medicine at the University of Pennsylvania launched a first-of-its-kind interdisciplinary center focused on discovering novel treatments for orphan diseases. Without institutional walls, the

15 http://www.nature.com/biopharmadealmakers/pdf/2010_nov_feature.pdf

16 http://www.nature.com/biopharmadealmakers/pdf/2010_nov_feature.pdf

17 http://www.nature.com/biopharmadealmakers/pdf/2010_nov_feature.pdf

new Penn Center for Orphan Disease Research and Therapy will establish methods to eliminate and treat orphan diseases by establishing dedicated research support facilities, translating findings into therapies, fostering targeted grant awards and educating physicians and researchers. The Center will provide core laboratories, techniques, collaborative relationships, and expertise to lead an international, coordinated effort in tackling orphan diseases. Working with other academic institutions, the National Institutes of Health, indusrty, and private philanthropy, the Center's goal is to lower the technological and financial burden of investigators working in isolation by supporting robotics for large-scale drug screening, repositories to store bio-samples, genotyping and bioinformatics services, cell-based systems for developing new tests, nano-scale systems for developing new drug delivery approaches, and small and large animal models for testing potential treatments[18].

4.2.8. A new model for neglected diseases is the idea of a **shared IP pool**. This approach was developed by GlaxoSmithKline with an initiative titled "Pool for Open Innovation against Neglected Tropical Diseases", which is a shared source of IP made available to any group aspiring to develop therapies or vaccines for neglected tropical diseases as defined by the U.S. Food and Drug Administration. Patents contributed by participating companies and organizations are made available for the research, development and manufacture of medicines for distribution in the world's poorest nations[19].

4.2.9. An area of immense strides in developed technology that has not seen its full potential in the clinical setting and revenue generation is the area of biotech called "**personalized medicine,**" which is technology that enables genetically guided diagnosis, treatment, and prevention of illnesses. According to Vance Vanier, CEO of personal genetic analysis company Navigenics, lack of adoption of the technology is one reason why personalized medicine is not yet a widespread clinical reality. This is a barrier Vanier calls the "adoption gap" between advances in the lab and benefits in the clinic."The world is awash in biomarker content. The key question is, 'What is the most effective mechanism to drive awareness among the primary care physician base?'".[20] The innovations that are needed to maximize the effect of technology may not be limited to the laboratory.

4.2.10. A report from the Tufts Center for the Study of Drug Development quantifies biopharmaceutical companies' commitment to advancing personalized medicine as follows:[21]

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18 http://www.uphs.upenn.edu/news/News_Releases/2011/07/orphan/

19 http://www.nature.com/biopharmadealmakers/pdf/2010_nov_feature.pdf

20 http://the-scientist.com/2011/06/14/the-ghost-of-personalized-medicine/

21 M. G. Duggan and F. M. Scott Morton, "The Effect of Medicare Part D on Pharmaceutical Prices and Utilization" NBER Working Paper No. W13917, April 2008.

4.2.10.1. 94% of companies surveyed are investing in this research, which often requires substantial investment in new technologies.

4.2.10.2. Often, these investments are translating into development of therapies that have a companion diagnostic to guide treatment based on a patient's genetics. Companies report that 12% to 50% of compounds in their development pipelines are personalized medicines.

4.2.10.3. Companies report they have increased investment in personalized medicine by approximately 75% in the past five years. They expect an additional 53% increase over the next five years.

4.2.10.4. Personalized medicine is fundamentally changing the way companies identify promising new biopharmaceuticals. All companies surveyed use biomarkers in the discovery stage of research to help learn more about a compound.[22] Biomarkers are often linked to specific gene expression.

4.3. **CRO modeled alliances**

4.3.1. The CRO outsourcing model based on the concept of a sponsor paying a laboratory to conduct research on their behalf. A typical CRO model is a "full service provider" model where a sponsor hires a completely separate organization to provide them data. With a variation of this model in mind to support innovation collaboration, a contract staffing model could be employed where one party plays the role of the sponsor and essentially hires contract staff through the party playing the role of service provider. The contract staff can be located either at the sponsor's site or the service provider's site or both. The partner playing the role of sponsor provides functional training and technical support while the salary and administration requirements are the responsibility of the service provider. This model offers important advantages, particularly if the project is otherwise not eligible for funding or if the organization playing the role of sponsor is pressed to retain control over the project for IP or other reasons. This approach allows for quality and management oversight, stricter cost control and can improve time spent on training. Importantly, this approach also allows for timely replacement of participants in the face of attrition.[23]

4.3.2. An example of a variation in the CRO model alliance is the case of Neuralstem. Instead of outsourcing research, Neuralstem outsources only the processing of paperwork through a CRO. While the CRO assembles documents such as electronic filings and quality control forms, Neuralstem maintains control over both the research data and regulatory matters.[24] Potentials for

22 Pharmaceutical Industry Profile 2011 (Washington, DC: PhRMA, April 2011)

23 Umakanta Sahoo and Faiz Kermani, "The Contract Research Industry in India." Advances in Biopharmaceutical Technology in India, *BioPlan Associates, Inc. and Society for Industrial Microbiology*, January 2008, pp. 297.

24 Berberich, 2009.

critical innovation may not only exist in the bio-laboratory but also in the way data is managed through IT systems. The ability for a researcher to understand and control information is essential to effective research, and doing so collaboratively across distances makes the effort even more difficult. Creating solutions to this problem offer great promise and would benefit many types of collaboration models and disciplines.

4.4. Collaborations with industry

4.4.1. Why is this important?

4.4.1.1. It is increasingly difficult to secure grant money for academic research. Industry can make the difference in enabling a program to commence or complete, especially for new and less well-established academic researchers[25]. Korean organizations may find it useful to recruit professional development officers who are tasked with identifying and applying for grants and other monies for collaborative research.

4.4.1.2. Creativity and inventiveness are essential characteristics of academic and industrial research, and discoveries from academic 'applied' research often form the basis of innovative commercially relevant technologies and therapeutics. But more often than not the experience and expertise of industry are necessary to develop and commercialize these ideas successfully.[26]

4.4.1.3. Innovative technology itself is also forcing academic and private for-profit laboratories into collaborations. “We used to be able to bring new technology into our own labs—cloning and genetic manipulation,” for example, says Joan Brugge, professor and chair of the department of cell biology at Harvard Medical School. “But now it is so advanced: imaging and microscopy and engineering approaches” that collaborations need to move beyond traditionally associated groups. “The interactions [with companies] were much more service-oriented ten years ago. Now interactions are [more] about discovery [and] a dynamic exchange of ideas.”[27]

4.4.2. What are the potential conflicts?

4.4.2.1. According to Andrew Gottschalk of Group AG, "the parties have very different perceptions and judgments about organizational structures, decision-making processes and time scales. The requirement for risk-assessment procedures is a corporate fact of life that is virtually meaningless to the entrepreneurial scientist."[28] Gottschalk believes

25 Wilan, K.H. *Cell* **129**, 847 (2007)

26 Kleyn, D. *Int. J. Innov. Management* **11**, 323–347 (2007)

27 Wilan, K.H. *Cell* **129**, 847 (2007)

28 Gottschalk, A. *Business Dev. Licensing J.* **3**, 23–25 (2007)

technology-transfer offices "can act as guides, mentors, shop stewards and midwifes to the deal." He also recommends ensuring collaborations include them because without them "rational negotiation is less likely."[29]

4.5. Step by step example for establishing a collaboration

4.5.1. Creating and approving a Statement of Cooperation marks the beginning of a collaboration in which both organizations expect to exchange knowledge, develop collaborative research projects and exchange researchers, staff, administrators, students, scholars, faculty and post-docs, etc.

4.5.2. Example Statement of Cooperation

4.5.2.1. Organizations will explore areas of potential collaboration with respect to the following activities:

4.5.2.1.1. Exchange of researchers, staff, administrators, students, scholars, faculty and post-docs, etc.

4.5.2.1.2. Collaborative education and research training

4.5.2.1.3. Shared management, faculty positions or other key organizational roles

4.5.2.1.4. Exchanges including research papers, indices to theses, books and journals, other data, recipes and confidential information.

4.5.2.1.5. Exchange of invitations to attend scholarly and technical meetings, forums, trainings and conferences

4.5.2.1.6. Producing joint conferences, seminars, workshops, trainings, exhibitions, fundraising and marketing events.

4.5.2.1.7. Review of other possible areas of cooperation in a variety of academic, research and product development projects.

4.5.2.1.8. Exclusions relating to obligations for committing funds or resources, non-disclosures, granting rights to intellectual property, etc.

4.5.2.1.9. Effective period for the Statement of Cooperation, legal jurisdiction and arbitration agreement as well as termination conditions.

4.5.2.2. Even though the initial agreement has an end date (eg. 5 years), it is important to ensure that the cooperation can continue as long as it yields mutually beneficial results. The agreed timeline ensures that an evaluation is not done prematurely and provides a clear message as to the intent of

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29 **10 April 2008, doi:10.1038/bioe.2008.4**

duration. During the collaboration, the expectation is not only to gain knowledge, but also to develop bonds that will be of great value to the organizations. Ideally, collaboration will result in a strong network of skilled scientists, academic and product developers, but also raise the bar for the research and products that are produced by both organizations.

4.5.3. Upon signing of the Statement of Cooperation, a symposium may need to be held in order for the two organizations to present their interests and research and for both groups to gain insight into how best to create synergies.

4.5.4. This symposium should be followed up by a rigorous assessment of which topics holds the most interest for the joint cooperation.

5. Finding funding

5.1. In the larger picture, the US is struggling with budget cuts while leading emerging economies such as Korea are making huge investments in scientific infrastructure and are increasingly able to offer new lab facilities that are at least as good as the many older ones in the US. **While some Western economies are struggling just to maintain their funding for science,**[30] **fast growing emerging economies are accelerating spending**.

5.2. In the US, funding support is more likely to be regional or coming from state and local governments or universities. Regions are increasingly important players in the knowledge-based economy and differ in terms of resources (human, social, technological and financial capital) and other factors of competitiveness. This leads to a great deal of diversity that could impact the quality and scope of collaboration[31].

5.3. As discussed earlier, there are many collaboration **opportunities in the development of innovative products**, particularly collaboration with private companies. In many cases, discovery output outstrips development capacity. The "bottleneck" in bringing innovative products to the market is not in discovery, but in development. It is development which also poses the greatest financial challenge and may be an area ripe for its own innovations.

5.4. The development of products and technology in the pharmaceutical industry typically require long timelines and substantial financial and management commitments. Couple this with a declining success rate for approval of marketed products. With declining ROI many developers are engaging in risk sharing collaborations and co-development strategies.

5.5. One of the big success stories in Asia in biotech innovation is Singapore, which has relied consistently on six pillars of economic growth: tight monetary policy, free trade, a business-friendly environment, encouragement of foreign direct investment, high savings and an efficient and proactive government regarded as among the

30 Anthony Faiola, "In Europe, science collides with the bottom line." *The Washington Post*, September 6, 2010

31 http://www.nature.com/biopharmadealmakers/pdf/2011_feb_main_feature.pdf

least corrupt in the world. Singapore provides an example of a successful long-term government strategy promoting high technology and entrepreneurship through a complex range of activities including:

5.5.1. fostering a functional legal environment

5.5.2. ensuring access to technology and knowledge

5.5.3. providing tax incentives

5.5.4. training potential entrepreneurs

5.6. **Government policy-driven strategy** has served well in creating life-science parks, the top-down "picking and choosing" of projects to receive government support at the convenience of the government officials is sometimes at the expense of bringing in private industry who have the expertise to handle the product development.

5.7. In general, **money for biotechnology is not easy to come by** as investors are often required to wait a decade or more before seeing returns.

5.8. "We don't have many venture capital funds in the biotechnology sector, largely because it is knowledge intensive and because the regulatory pathway is not very clear to the common investor," according to Vishal Gandhi, Vice President and Head of Life Sciences Banking at YES BANK, a private Indian Bank catering to the " Future Businesses of India"[32]. Evaluating opportunities in biotechnology can lead a potential investor into quite complicated science.

5.9. Morawala-Patell, founder and chairperson of Avesthagen (India's leading integrated systems biology platform company that focuses on achieving convergence between food, pharma and population genetics), claims that ack of available funding results from a conservative and unrealistic view of global economic power. "The financial institutions are caught in a trap after years of being brainwashed to think that the ability to sell in western markets is your ultimate solution for valuations, for fund raising and for anything that would make a successful drug. The whole game of finance needs a complete overhaul.[33]" Lack of capital makes it difficult for biotech entrepreneurs to think beyond a service-oriented business model.

6. IP Issues

6.1. As discussed earlier, self and mutual understanding is critical in the development of effective collaboration. Understanding builds trust, which is a key ingredient to any successful relationship. Knowing one another's priorities can expedite the negotiating process. And for collaborations involving commercialization of innovation, IP and technology transfer skills of major importance.

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32 http://www.ableindia.in/admin/attachments/reports/reports18_Biotech%20in%20India%20Nature%20Biotech%20supplement.pdf

33 http://www.ableindia.in/admin/attachments/reports/reports18_Biotech%20in%20India%20Nature%20Biotech%20supplement.pdf

6.2. In situation where there is technology transfer office, they also need to become part of the negotiation process as a stakeholder in the collaboration. The priorities of industry are usually obvious, as are those of academia, but the focus of a technology-transfer office can be less clear. A clear understanding of the working practices of technology-transfer managers and how they relate to the industry-academia liaisons will enhance the chances for successful collaborations.

6.3. It is a challenge to ensure all stakeholders appreciate the different needs of their organizations and adapt their approaches accordingly. The best way to understand key issues of a discipline is to have work experience within that area. However, the career profile for a tech transfer manager tends to be different than those for academics and industry professionals. Tech transfer managers are sometimes viewed by both academic inventors and industry professionals as an obstacle rather than a facilitator. Tech transfer managers have dual roles in the academic enterprise including protecting intellectual property and facilitating the transfer of technology and knowledge to businesses. However, another important part of their role is supporting the achievement of their university or science park's economic goals and protecting academic freedom. Balancing the prerogative for academics to publish and pursue scientific interests with the commercialization of their research can pull their decisions and activities in different directions.[34]

6.4. In academic settings and government funded organizations, lack of intellectual property know-how can be troublesome. "What we need to build are techno-commercial-legal skill sets in a single individual" says Morawala-Patell, chairperson of Avesthagen. "There are many youngsters eager to contribute, but a total lack of middle and senior management who can guide and shepherd the innovation." says Ravi Kiron, a partner at Adjuvant, a consultancy of business development transactional experts. Part of the problem is an education system which produces a high level of science expertise but channels students into strictly regimented disciplines.[35]

7. **Other efforts** to encourage international collaboration and innovation:

7.1. Intangibles, intellectual capital, innovation and in particular talent are all difficult to measure, especially if we rely on economic measures rooted in ideas developed during the era of the industrial economy. Innovation in the area of economics should not be ignored.

7.2. Innovations with the greatest positive impact in healthcare or energy may have more to do with human perceptions and social sciences than with advances in biotechnology. When you're a hammer, all problems start to look like a nail. Although the approach of collaboration based on a particular technology may look attractive because it plays to obvious strengths, it may obscure important innovation potentials. An approach based on solving specific therapeutic or energy needs may

34 **10 April 2008, doi:10.1038/bioe.2008.4**

35 http://www.nature.com/biopharmadealmakers/pdf/main_feature_web.pdf

better illuminate the potential for social sciences such as economics, psychology or media to in an innovation collaboration scenario.

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2) General Recommendations for international collaboration in Biotechnology (Pastreich)

In all scientific fields over the past 20 years, there has been a substantial increase in international collaboration. At the same time, the biotechnology, more than many other scientific fields, has seen a rise in cross-institutional collaboration[36]. This section will examine ways to minimize as many of the conflicts and barriers that are inherent in both trends, thereby raising the probability successful collaborations. First, these potential conflicts and barriers will be delineated, and then strategies about how to minimize will be proposed.

To begin, there are two separate sets of variables and challenges that are involved in international collaboration. The first set of variables consists of the various laws, norms and values, and scientific capacities of different international collaborators. The second set of variables comes from the different incentives, values and goals set for by different research institutions. Beginning with Roderick Pond's description of cross-institutional incentives, that set of variables has been expanded to the encompass the following points:

- Researchers working in academic organizations have an incentive to maximize the diffusion of their knowledge by publishing the outcomes of their research. The incentive structure also stimulates to do research on subjects that are most likely to enhance the scientific discourse.

- Firms, by contrast, produce knowledge to maximize the rents that can be derived from the right to use this knowledge. As a result, firms have an incentive to minimize knowledge diffusion (at least before it is possible to appropriate it) and to do research on subjects where it is most likely to be successfully applicable in new products and goods.

- Governmental research [institutions], or GRIs, have an incentive to produce knowledge that is in the interest of the government and its policy. These goals are sometimes supplemented with projects that are designed for knowledge creation and diffusion. There are some cases when GRIs conduct research with the purpose of applying the results to commercial products within a few years.

36 Ponds, Roderik, The Limits to internationalization of scientific research collaboration. *Journal of Technology Transfer*, Vol. 34 (2009): 76-94.

Simply stated, academic institutions want to create and disseminate scientific knowledge, and the incentive for collaboration is knowledge production (KP). Private firms, like pharmaceutical companies, pursue the best possible economic return on investment by turning their research into profitable commercial products (CP). While the incentives for GRIs include knowledge production, commercial products, as well as fulfilling science and technology policies that are in their national interest (NI).

Many of the scientists interviewed for this report cited common purpose and research goals as the foundation for successful collaborations. Therefore, scientists and administrators at Korean GRIs should match their own goals with international institutions that value the same incentives. If the goal of a particular project is knowledge production, then collaborations with academic institutions should be established. If the goal is to develop a technology for commercial use and profit, then private firms are the ideal collaborator. If the goal of a particular initiative or project is to fulfill a national science and technology policy, then the best collaborator will likely come from a GRI with similar national interests.

To be successful in such a project requires that the very institutions be internationalized. Signage in English must be found everywhere and the essential internal documents be made available in English as well. English speaking staff will be necessary, and staff with a sense of the needs of an international faculty. To achieve this goal, there may be a need to train staff in English and also hire staff on the basis of previous international experience. This staff should be available to assist Korean researchers in the initial steps of establishing international collaborations. We found consistently that the initial hurtle to international collaboration was simply finding the time to do the groundwork in English. To the degree that assistance is provided in this process, international collaboration can be increased.

Also, an environment in which the families of international researchers feel comfortable is necessary. That includes the possibility of programs especially for foreigners and their children and an effort to create an international community. The formation of international schools with instruction entirely in English run joint by a consortium of research institutes is one possible solution.

Progressive policies such as providing daycare for the children of female researchers within research institutes are critical to creating a truly international environment. So also, the promotion of women and non-Koreans within the institution will be critical to Korea's success in science in the future. Such an effort to internationalize should be conducted with the full understanding of all employees.

On a related topic, it is critical that experts be brought in to handle those aspects of internationalization that are beyond the expertise of the members of a research institute. Consultants in other countries should have long-term relations with Korean research institutes and be ready to address issues that the institute cannot address itself. Such an international network is essential to address relations with business, academics and government abroad on a case by case basis.

For example, there are considerable sources of funding in this cash-strapped age that can be used to finance research in biotechnology under the banner of disease control, the

environment and climate change. To be eligible for such funding, Korean institutes must be ready to present professional applications to international funding agencies such as the World Bank, the Asia Development, the United Nations, the Gates Foundation and the Macarthur Foundation. Such applications can result in substantial increases in funding. But research institutes do not have the expertise to locate such sources of funding and present professional applications for funding. If Korean institutes hired professional development directors in the United States, Europe and Japan on a contract basis and instructed them to seek out possible. Although hiring a professional development director to seek out funding opportunities can be expensive, the cost is more than paid for by the grants that can be obtained.

In a related manner, research institutes would do well to hire a foreign consultant from outside to do a comprehensive evaluation of their programs and strategies that will give suggestions for overall development. Such reports can evaluate the relative merits of programs, the needs for institutions for internationalization and effective strategies for finding funding. This report is a first step in that direction, but is overly broad by nature. That work should be supplemented by the establishment of an international advisory committee for each research institute consisting of internationally recognized experts that meets regularly. The OIST committee is an excellent example of such a program with a clear focus.

It is also possible to put forth a more carefully coordinated database on possible partners internationally for collaboration that will assist in finding partners. Although many databases exist, it was our impression that many researchers were not aware of where they should look to find possible partners abroad.

Finally, Korean research institutes do not need to increase the amount of exchange with external institutions as much as they need to change the quality of those exchanges. In many cases, exchanges with foreign institutions are limited to somewhat ritualized events involving MOUs and formal dinners that allow little time for creative, innovative back in forth about approaches for cooperation. To the degree that the visits of foreign researchers can be leveraged to create opportunities to brainstorm among a small group of experts, new approaches to expanding cooperation can be found. For example, retreats and focused seminars that allow foreign researchers to go for a walk in the forest with a Korean researcher and relax together would be extremely valuable. Often it takes ten hours of shared experience before a working relationship can be established. These carefully arranged events can help both the Korean and international researchers to get over their initial tensions and start to exchange ideas in a positive and stimulating manner.

3) International Collaboration in Japan: The Cases of OIST (Okinawa Institute of Science and Technology) and RIKEN

(Pastreich)

Why Japan important for Korea?

Japan has invested heavily in developing sophisticated platforms for international collaboration over the last fifty years and in the cases of OIST and RIKEN has attracted a significant number of first-class researchers from around the world. Equally significant has been the degree to which RIKEN and OIST have attracted top figures from the United States and Europe to serve on their executive boards, paving the way to smoother international collaboration.

The Case of OIST

Although Japanese scholars make major contributions in biotechnology and the biosciences, commanding the respect of the academic community, Japanese universities and research institutes have a reputation for being relatively inaccessible to the international community. Although Japanese scholars in the biosciences are involved in many international collaborative efforts, international scholars do not find it as easy to move to Japan as part of their career in the sense that they can easily circulate between the United States, Australia, Great Britain and France, for example. The first steps have been taken in Japan to create a new truly international collaborative environment, but the process may still require some time. Many international scholars speak of their frustrations with Japanese bureaucratic processes and a rather decentralized approach to research support that makes it difficult for those without an intimate familiarity with a specific institution to function effectively. A vast majority of top-class research teams and collaborative efforts are essentially Japanese.

More recently, however, RIKEN, Japan's most progressive research institute, has made great strides in opening the door for international collaboration and the recruitment of international faculty. Yet that effort is more corrective than it is innovative. There is one institute that stands apart from other in the breadth of its vision and the intensity of its commitment to a truly global perspective: the Okinawa Institute of Science and Technology (OIST). OIST, whose new campus is under construction on the hills above the picturesque town of Onnna Son along the coast not far from Naha, represents a clear break from the Japanese model.

OIST is in part an effort to re-imagine Okinawa itself, a cluster of islands with a more international traditional tradition than much of Japan that suffered terribly in the Second World War and has served as the home to US military bases. OIST is an attempt to transform that economy into an academic and business hub, taking advantage of the ideal climate and surroundings. The OIST project will contribute to Okinawa's development, and address a perceived need to integrate the region with both the rest of Japan and the world. Much of the strength of OIST's reforms derives from this overall vision of a new Okinawa and a community of scholars therein taking the islands in a new direction.

The Japanese government has granted OIST an extremely generous budget and a mandate to establish an institution that is "the best in the world," in the words of OIST's President Sydney Brenner. OIST started out with a focus on the neurosciences, and has already established itself in a short time as a major hub in that field. Since then the molecular sciences and mathematical and computational biology have been added in earnest. Plans are underway to begin another program in the environmental sciences in the near future.

The program is built around interdisciplinary strengths, fine facilities and equipment (such as the electron microscopy group). The researchers we spoke were deeply impressed with the equipment and services offered, suggesting that OIST is competitive because it makes research so much easier for everyone. In addition to an advanced array of research equipment

that makes advanced research easy, the institute has a DNA sequencing center and vivarium for the use of scientists that greatly facilitates experiments and means that OIST's distance from other research institutes in Asia has relatively little impact on the work of its researchers. Combined with the ideal setting by the beach and the comfortable life offered in Okinawa, OIST has attracted top scholars. Moreover, because of the experience with the US military bases, Okinawans have a higher level of English proficiency than most Japanese and feel far more comfortable interacting with internationals. We found a high degree of satisfaction among the international researchers with their interactions with the local community.

Since OIST was proposed in 2001 as a project, there have been numerous high-profile research conferences held in Onna Son. The intention of these events is to turn Okinawa's unique positioning as a chain of islands south of Japan into a strategic advantage. OIST is envisioned not only as a research cluster in its own right, but a preferred stopover for international scholars from throughout Asia and the Pacific. An environment that encourages international collaboration is at the very core of that effort.

OIST runs an Okinawa Computational Neuroscience Course every year that brings together distinguished researchers to teach graduate students from around the world. Other recent international conferences include an OIST-Korea workshop on neuroscience (February, 2007) and an OIST-Salk Institute seminar on neuroscience (November, 2007).

Among the most critical parts of this strategy is the decision to hire primarily international researchers at OIST and establish definitively that English will be the common language for both scholarship and social interaction. Plans are in place for large-scale hiring of qualified researchers from around the world to make OIST a world-class research institution. Although there are similar institutions with a largely international faculty in Korea, such as the Institut Pasteur and the International Vaccine Institute, OIST is remarkable in that it is a government research institute fully funded by taxpayers. There are plans to eventually obtain revenue from commercialization and technology transfer, at present, OIST is unique as a fully-funded government organization in its international commitment. The Japanese government has clearly identified the totality of the international environment created by the research institute as valuable and broadened its conception of the national interest in science and technology.

OIST has bent over backwards to be flexible regarding the needs of its international researchers. Although there is a need for dual forms in English and Japanese, essentially all paperwork can be handled easily in English by international researchers and a support staff with outstanding ability in English is in place to address possible problems.

OIST will eventually be a research institution and a graduate school (M.A. and Ph.D.) that offers remarkable flexibility in its research approaches and gives maximum autonomy to its researchers. Once the facilities are complete, emphasis will be given to collaboration with leading research institutions around the world and corporations and venture companies.

At present, the first stage of this project is undertaken by the Okinawa Institute of Science and Technology Promotion Corporation, headed by two international scholars: Dr. Sydney Brenner (Nobel Laureate) and Dr. Robert Baughman. Both are figures with substantial experience in international collaboration. Dr. Brenner works with several labs around the world and was selected because of his truly international position regarding scientific research. He values the global scientific effort, as part of a response to the challenges of health and the environment, above all.

This promotion corporation already oversees fully-functional laboratories, but is also deeply involved in the planning of future facilities for OIST. Dr. Brenner was appointed as president in August, 2005 and has been deeply involved in efforts to establish the institution internationally. Conversations with international researchers revealed that the degree to which

they were allowed to participate in the institutional development of OIST was a major appeal, and inspired in them considerable loyalty. The unique advantage of OIST as a center for international collaboration is that its researchers not only benefit from superb facilities, but can put forth their vision of how the institution needs to grow in the future with a reasonable expectation that they can shape its development. Most of the facilities and the very layout of the campus under construction were designed with the constant input of researchers to make sure that every possible need was covered. All of those scholars work at, or have worked at, first-class international research programs so the standards were extremely high.

OIST works under a mandate from the Japanese government, but scientific and administrative decisions are made by a board of governors of eleven distinguished scholars, including six Nobel Laureates: Dr. Jerome Friedman, Dr. Timothy Hunt, Dr. Yuan-Tseh Lee, Dr. Susumu Tonegawa , Dr. Torsten Wiesel and Dr. Sydney Brenner. On the Japanese side as well, the scholars involved maintain a helpful distance from the world of politics and administration, allowed a rare opportunity to step back and contemplate the needs of a leading research institute in the 21st century. The board of governors is entirely international in perspective, with the capacity of OIST to serve effectively as a research institute. There is none of the local politics and personal favoritism that often limits such government efforts. There are few research institutes with such a distinguished group of scholars so dedicated to their advancement.

At present plant are for a center building, and three laboratory buildings with state-of-the-art facilities by 2012. Twenty principle researchers are currently leading laboratories and more will come in 2009. There is currently a biotechnology research laboratory of considerable size in operation and an attractive seaside guest house with administrative offices and space for international conferences.

By that time, the expectation is that OIST will have at least fifty principle researchers heading laboratories and form a critical mass of expertise. All of those researchers are in turn linked to their own long-term research associates, thus bringing with them a larger collaborative network which will be at the center of OIST's future development.

In order to promote integrative research activity, a three-dimensional research lab has been employed that encourages interdisciplinary collaboration. Compact buildings encourage vertical exchange between floors. Common spaces are numerous and designed to encourage discussion and brainstorming between researchers. Even the restaurants and cafes are designed to be spill-over for discussion after lectures. International academic events, and events involving the local community, will be frequent.

The focus at OIST is on the needs of junior researchers. They are given five year research grants and then permitted to concentrate on their work intensively for that period of time without a requirement to submit periodic reports and other paperwork. Thus the environment encourages a full-commitment to research. Research is subject to careful review, but the initial effort is free from micromanaging that detracts from the need to focus.

The Case of RIKEN

RIKEN has a long tradition of supporting an international research program and paying attention to the hiring of women, the needs of foreign researchers and the support for an international community. The web site "Life at RIKEN," (www.lifeatriken.com) for example, shows considerable attention to individual needs that can serve as a reference as Koreans wrestle with many of the same

problems in bringing in international researchers.

Valuable programs at RIKEN include:

International Program Associate
www.riken.jp/engn/r-world/riken/organ/ipa.html

RIKEN Joint Graduate School Program
"International Program Associate (IPA)"

RIKEN is now inviting non-Japanese doctoral candidates attending a Japanese or overseas graduate school that is participating in RIKEN's joint graduate school program to conduct research at RIKEN under the supervision of RIKEN scientists as part of their work toward obtaining a PhD. Candidates accepted into the program will be designated as International Program Associates (IPAs).

> RIKEN's joint graduate school program is based on agreements with a number of Japanese and overseas universities. The objective of the program is to find and foster the development of young scientists who will in the future contribute to the advancement of science and technology by forming an international network of excellent research. The position of International Program Associate (IPA) was created in October 2006. Under the terms of the joint graduate school program, RIKEN may provide the IPA with a daily living allowance and cover the IPA's housing costs for up to a maximum of three years.
> RIKEN scientists with concurrent positions as visiting faculty at a collaborating university graduate school will supervise and instruct the IPA in the fields of physics, chemistry, biology, medicine, and engineering.

Foreign Postdoctoral Researcher Program
www.riken.jp/fpr

The Foreign Postdoctoral Researcher (FPR) program offers aspiring young foreign researchers with creative ideas and who show promise of becoming internationally active in the future the opportunity to pursue innovative

research at RIKEN under the direction of a RIKEN laboratory head. The FPR program is one of RIKEN's initiatives to open up its facilities and resources to the world and create a stimulating research environment that will place RIKEN at the forefront of global science and technology.

Foreign Postdoctoral Researchers are expected to make full use of RIKEN's research environment, under the direction of a RIKEN laboratory head, to apply creative and innovative ideas to research being conducted at RIKEN. By introducing promising young researchers from different countries into its institutes and centers, RIKEN hopes to create an invigorating research environment that transcends differences of nationality to make RIKEN a world leader in scientific achievement.

Program Features

- The FPR program offers young and promising foreign researchers the opportunity for creative and innovative research under the direction of a RIKEN laboratory head on topics being pursued at RIKEN.
- The FPR will have access to RIKEN's various facilities and installations to the extent possible.
- The FPR program is for young foreign researchers who have a PhD in the natural sciences (or who will have a PhD by the time of hire).
- The FPR is a fixed-term contract employee with a contract that must be renewed each year. This contract can be renewed, contingent upon a favorable review of the FPR's record, up to a maximum of three years. (The contract can be extended if time is taken off for maternity or childcare leave.)

Initiative Research Unit Program
www.riken.jp/r-world/research/research/iru/IRU.pdf

RIKEN is seeking an Initiative Research Unit Leader for FY2012. The Initiative Research Unit Leader Program was established in FY2008 to give young scientists with outstanding, internationally recognized achievements the opportunity to pursue independent, interdisciplinary research of their own design at RIKEN, and to thereby further the development of RIKEN's research fields, and promote internationalization of the RIKEN research environment. The unit leader will independently select research associates and technicians to form a research unit that will further his or her research objectives.

As part of this effort, RIKEN has invested heavily in overseas centers to facilitate cooperation

RIKEN-Hanyang University Collaboration Research Center
RIKEN China Office
RIKEN Singapore Representative Office
RIKEN-MIT Center for Neural Circuit Genetics
RIKEN BNL Research Center Brookhaven National Laboratory

RIKEN Advisory Council

RIKEN has established a RIKEN Advisory Council with major researchers from around the world who contribute their opinions on a regular basis. Only five of the total twenty five members are Japanese. The regular meetings serve as an opportunity for in-depth analysis of RIKEN's current strengths and rather detailed recommendations for future development.

Members include:

Dr. Zach W. Hall, Chair
Emeritus Vice Chancellor, University California, San Francisco
(founding President, California Institute for Regenerative Medicine)
Dr. Yuan Tseh Lee
Vice-chair
President Emeritus and Distinguished Research Fellow, Academia Sinica
(1986 Nobel Laureate)
Dr. Hiroo Imura, Vice-chair
Chairman, Foundation for Biomedical Research and Innovation
Principal Fellow (Chair), Center for Research Development Strategy, JST
(Professor Emeritus, Kyoto University)
Dr. Howard Alper
Distinguished University Professor, University of Ottawa
Chair, Government of Canada Science, Technology and Innovation Council
Dr. Teruhiko Beppu
Professor, Advanced Research. Institute for the Sciences and Humanities
Nihon University （Professor Emeritus, University of Tokyo、
former Chairman, Japan Bloindustry Association.）
Dr. Colin Blakemore
Professor of Neuroscience, University of Oxford
（former Chief Executive, UK Medical Research Council）
Dr. Rita R. Colwell
Distinguished University Professor, University of Maryland at College Park
(11th Director, National Science Foundation)
Dr. Mitiko Go
Executive Director, Research Organization of Information and Systems
(former President, Ochanomizu University)
Dr. Toshiaki Ikoma
Executive Vice President, Canon Inc.

(Professor Emeritus, University of Tokyo)
Dr. Biao Jiang
Director, Shanghai Institute of Organic Chemistry
Chinese Academy of Sciences
Dr. Paul Kienle
Professor Emeritus, Department of Physics, Munich University of Technology
(former Director, GSI Darmstadt)
Dr. Karin Markides President, Chalmers University of Technology
Dr. Rainer E. Metternich Vice President, Basic Research, and site head, West Point, Merck & Co., Inc.
Dr. Hans L. R. Wigzell
Senior Strategic Advisor/Professor, MTC, Karolinska Institutet

(former President, Karolinska Institutet)
Dr. Allan Bradley Director, Wellcome Trust Sannger Institute
Dr. Max D. Cooper
Professor, Department of Pathology and Laboratory Medicine
Emory University
Dr. Hidetoshi Fukuyama
Professor, Tokyo University of Science

(Professor Emeritus, University of Tokyo)
Dr. Sydney Gales Director, Grand Acceleraeur National D'lons Lourds
Dr. Sten Grillner
Professor and Director
Nobel Institute for Neurophysiology, Karolinska Institutet
Dr. Wilhelm Gruissem Professor, ETH Zurich, Institute of Plant Sciences
Dr. Jean-Louis Guenét Director, Unite de Genetique des Mammiferes, Institut Pasteur
Dr. Jerome Hastings Professor, Photon Science, SLAC National Accelerator Laboratory
Dr. Bengt Långström Professor, Uppsala University
Dr. Mark Lathrop Director General, Center National de Genogypage
Dr. Austin Smith
MRC Professor and Director, Wellcome Trust Centre for Stem Cell Research
University of Cambridge

http://www.riken.go.jp/engn/r-world/info/report/rac/pdf/7members.pdf

4) Making the Research Institute in the Biosciences Globally Competitive (Pastreich)

Current changes in society, the economy and globalization demand radical changes in our conception of the research institute. The sooner we grasp them, the better we will be able to pursue international collaboration.

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1) **Need for a vision of contribution to society**

In the long term, large projects are best funded if they feature an over-arching vision of explicit social contribution. In an age of limited budgets that need is even more critical. The research institute that focuses on biotechnology or nanotechnology is perfect from

an intellectual point of view, but we will need to make justifications in terms of responding to serious medical problems in the KOrea and around the world, addressing the crisis of environment and energy directly and responding to the challenges of technology's rapid development and the growing discord it produces in society globally. Creating such an intellectual backdrop in which Research institute is seen as leading the way not only in terms of new developments in medicine and biotechnology, but also in an ethical sense, is critical for future positioning, for finding large scale funding and for building international collaboration networks.

2) **Building of global coalitions**

The Korean research institute must have a solid group of outstanding researchers dedicated to solid research within the domains recognized in today's scholarly discourse. At the same time, it is critical for the research institute to build global coalitions for collaborative research on larger critical topics in which Research institute can play the leading role. Investment in the staff with professional and analytic skills necessary to identify valuable partners internationally and create win-win coalitions that can seek out creative funding packages on a global scale is critical. We can imagine larger coalitions that are in a position to apply for large-scale funding from the Macarthur Foundation, the Gates Foundation, International Vaccine Institute, the Asia Development Bank, etc.

We need a team to think through and experiment with creative ways to make such coalitions easier to form and to maintain. Everything from shared databases and webinars, to integrated systems for sharing computing power for analysis and resolving IP issues quickly needs to be systematically explored. If Research institute becomes the main player that links together coalitions and prepares strategies, the benefits will be enormous.

> One of the biggest challenges going forward will be putting together international financing coalitions to fund complex research projects over years. Such projects will require that the project be split among major research institutes around the world and that they be financed by corporations, by local and central governments, by foundations and international organizations. The process of putting together such complex financing projects to get a possible product or application through the "Valley of Death" is extremely complex and might be worth Research institute, or Yale, investing in putting together sophisticated teams to work on constructing such financing structures. Although clearly such efforts are already going on, perhaps they can be carried out in a more sophisticated and specialized manner. We will have to imagine teams with foreign language skills to carry on negotiations and discussions in Chinese, Arabic or Korean. So also Yale's assets in law can be used to help in gaining advantages in IP issues globally.

3) **Importance of an artists' colony**

Research institute needs a cultural, artistic and musical soul that will bring depth to its "institutional culture" and make it the preferred place to be at Yale and among research institutes. If we think of Soho and its transformation, the role was primarily played by artists, who created a unique thriving community, thereby transforming a series of

warehouses into the most desirable residential neighborhood. Research institute can be transformed in a similar manner. If, for example, we gave a corner of Research institute to a highly talented group of artists and gave them the resources to create art works and express themselves in an innovative manner, the whole of Research institute could be transformed. The café would be filled with interesting and creative individuals, the halls would feature intriguing art. Such a group of artists might also foster a more open and creative culture that would rub off on scientists and create a unique research environment.

4) **Artists and the visual representation of information**

One of the biggest issues these days in the biomedical field is the visual representation of information. We are producing such complex information on a large scale about molecules in three-dimensional formations that it is difficult conceptually for scientists to wrap their heads around the information that is thrown at them. Perhaps there is a new field just waiting in the marriage of the fine arts and sciences in the field of visual representation of information about the microscopic and molecular scale. In the last few years there have been several remarkable short movies made that try to visually represent the functioning of the cell. If we can form groups of artist and scientists to wrestle together with the question of visual representation, we can use effectively Yale's strengths in the fine arts to bring greater success in the biosciences. Such pairing is extremely promising and successes in this field of information representation could propel Yale to the forefront as the increasing usage of data crunching in research makes the question of the scientists ability to visualize critical.

5) Designing the lab itself with special attention to ergonomics and customized IT

One step that we can use to improve our laboratories is technology convergence. That is not so much convergence in the sense of combining silicon based and carbon-based mechanisms, but rather bringing in technological innovations in the laboratory equipment and the layout of laboratories. There are ways in which we can make laboratories more efficient and enjoyable to work in through a careful study of how researchers research. We can employ innovative ergonomic approaches, or cutting-edge IT innovations in the process of analysis to find new advantages not in terms of topics for research, but the manner in which research is pursued.

6) Prototypes for computers that are built on location, that can be modified and altered quickly

As the rate of technological change increases, new paradigms for research institutes must be adapted. One possibility is a far more flexible system for managing the IT infrastructure for research. We can imagine a commitment to design and build computers and equipment for the analysis of specimens on site with very customized functions-rather than buying them off the shelf. The IT infrastructure then becomes part of the experiment, carefully structured to respond to needs of the research and grow quickly in response to the experiment's needs. We can even imagine a laboratory in which the computers for analysis are brought in depending on the assignment and then taken away when no longer necessary—or the development of systems for effectively increasing the ability of

Research institute to process more data without actually increasing the number of computers on site. The problem would be one of logistics and collaborative alliances, but if done with great care, could give a substantial advantage.

7) Webinars, distance communications systems

The “death of distance” is at last starting to transform research. The future research institute will perforce need to couple up its work most intimately with partners around the world. The ability to link up data bases, to set up convenient and effective webinars, to develop effective means of conveying complex information over great distances will be critical. To the degree that Research institute invests in such innovations, it will be able to create alliances internationally and place itself at the core of multiple international collaborative efforts. We will see a massive consolidation of research centers over the next ten years. Research institute must be proactive.

8) Supercomputing alliances

Crunching information is a big part of the game and Yale will need to establish itself more prominently in the supercomputing world. There are numerous ways to draw Research institute into various supercomputing alliances, and I assume it is already happening, but it will be a critical issue going forward.

5) Proposal for a System to assist Korean institutions obtain international funding (Pastreich)

(In English)

Korea needs to establish effective institutions for international development in science and technologies. These institutions would focus on the details of applying and lobbying for grants internationally, understanding general trends in funding and creating collations of Korean and international researchers, from industry and academia, that can apply successfully for large grants.

At present, do not have sufficient means to effectively establish effective international collaboration projects in science and technology with first rate partners around the world. Moreover, there are considerable sources of international funding available from international foundations like the The Bill & Melinda **Gates Foundation**, The World Bank and Asia Development Bank, and hundreds of other major sources, not to mention corporate funding. There are also considerable funds available in Japanese that can be obtained through applications in Japanese language more effectively. This center will serve to facilitate the establishment of international collaboration for Korean research institutes and also search out and apply for funding on behalf of researchers, so that the researchers can be freed up to work full-time on research projects. As Korea finds an increasing need to develop new technologies based on original basic research, there will

be an increasing need for massive funding only available through strategically selected international projects.

Structure:

The staff of the Research Institute Development Center would include:

1) A group of experts with a profound understanding of international collaboration in important fields and work with experts in the US, Europe and Japan to identify promising collaborative projects, approaching Korean laboratories and international laboratories about promising opportunities. The staff will work with laboratories to help them with the bureaucratic process of establishing collaborative relationships and conduct background research concerning the most effective means of supporting and expanding that research. Work of the staff includes surveys of outstanding international programs to approach about collaboration and proposals for consortiums on important topics.

2) A group, including several foreigners, who work as full-time development directors. A development director seeks out sources for funding for research projects in response of the perceived needs of researchers and research institute administrators. The development director then fills out the application in consultation with the staff of major research foundations in the US, Europe and Japan and cultivates personal relationships with those involved in the funding process at places like the Asia Development Bank or Science and Technology Foundation of Japan.

3) Both groups work together to create new international consortiums based around Korean research strengths that can pull together leading laboratories around the world for high-value open innovation with significant international funding.

(In Korean)

출연(연)을 위한 국제공동연구 국제지원 진흥 센터구축방안연구

1. 연구의 필요성

○ 국제적인 대형 융복합 연구개발에 대한 필요성의 증가

○ 출연(연)의 연구비 원천의 다양화에 대한 필요성의 증가

○ 출연(연)의 국제적 연구무대 진출을 통한 국가적 위상의 향상 필요

2. 연구 제안의 배경

○ 출연(연) 연구원들이 세계적으로 저명한 연구자들과 함께 국제 협력을 통한 과학 기술 프로젝트를 효과적으로 추진할 수 있는 방법을 잘 모르고 있음

○ 기업자금, 빌&멜린다 게이츠재단, 세계은행, 아시아개발은행 등 수많은 국제적인 연구지원 자금이 지원되고 있으나 국내 연구비 확보 실적은 아주 미미함

○ 출연(연)에서 국제 협력을 보다 용이하게 할 수 있도록 도와줄 수 있는 시스템의 필요함

○ 연구자들은 연구 프로젝트에만 전념하여 연구에 몰입할 수 있는 환경제공의 필요성

○ 국제적인 대규모 프로젝트를 위한 막대한 자금소요에 대한 요구 증대

3. 진흥 센터의 역활

○ 출연(연)의 유망한 가능성이 있는 연구실과 외국의 연구실을 찾아내고, 서로 협력할 있는 **국제협력 프로젝트를 확인**하는 역할

○ 연구자들이 **국제적인 협력연구**를 확대발전시키고 가장 효과적으로 **지원**할 수 있는 **방안 마련**

○ 국제적인 **컨소시엄을 구축**하는 제안서와 협력을 할 수 있는 국제적인 **프로그램의 조사**

○ 연구기관의 경영자와 연구자들의 요구 등을 반영해서, **연구프로젝트**를 지원해 줄 수 있는 자금소스를 찾아 제안서의 작성

6) Interview with Michael Gehret
Associate Director
Institute for Advanced Studies (by Matthew Calabria)

What are the first steps Korean research institutes need to take to become global players from a development point of view?

What are the advantages that Korean institutes bring to the table? What are their weaknesses?

What arguments to Koreans need to make when applying?

What are some points that Korean institutions may not have thought about? What key points might they be overlooking?

What is the future of grant writing and development? If we have a Korean institute starting from scratch, what needs to be done first? How should Korea do it differently than the US or Europe?

What is your advice as to how to successfully pursue international collaboration?

What should Korean foundations be doing? How can the Korean government help most effectively?

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7) Interview with Richard Herman
Professor & former chancellor
University of Illinois, Urbana-Champaign
(Vince Rubino)

Questioner: Now, one of the things that I figured I'd start with is I'd like to find out what experience you have with Korea, if any, and then secondary to that is if not Korea, how about Asia?

Richard: I was in Korea a couple of times in the 80s, doing some work with a policy group. So I guess I got there via the head of the National Science Foundation Eric Flatt (?? 0:48??). Lou Grandscom was there, Bill Ayers who headed the original math and physical sciences of the NSF was there. So I did visit a couple times. Once to see a number of companies. And once I went to Cheju Island, which was kind of a strange place to see men running around in suits among all these honeymooners! But I gave Sandy (?? 1:24??) a delegation two years ago to Korea with a fair number of Korean alumni and a fair number of Korean faculty. But my work with Asia has - as I started out as a mathematician I didn't have many chances. But with my work as an administrator I've

been working significantly with China and with Singapore. So we did manage to bring about a partnership with Singapore government which had them providing us with an IT facility in which we could do research in Singapore. Through all of this I'd say the principal contact in Singapore was (??2:22??) Philip Yelp, a man who aided the agency with science things. And all with China, the university had many partnerships. At one point it had 30% of the PhDs in the United States given to Chinese students were given by the University of Illinois.

Q: wow!

R: Yah, there was a relationship between the president at the time of around the turn of the century, whose parents were missionaries, and he, I guess it was reparation money from one of the wars, he went to Teddy Roosevelt and suggested it be used to help students study in the US rather than just collect the dollars. And he created a unique kind of relationship with China which holds to this day significantly with agricultural universities in (??3:51??) Gangsuk province which I visited, and better-known universities like Gene Ryan, bae dal, bu-dak (??4:00??). So I guess I've been to China five times. So I know its a long trip, it is. But Singapore is further.

Q: Yes, absolutely. So with this experience that you've had, what do you think could be some practical steps that we could take here in Korea to foster and encourage international collaboration in science and technology.

R: A lot of these Korean universities have been fairly successful in bringing faculty back from the United States. I don't know whether that's still going on, I' not up to date on the data. But of course these individuals bring a whole host of contacts themselves. You must already have a - there is a bi-national agreement I'm sure with the Korean National Science Foundation and the US National Science Foundation. I assume it exists.

Q: And I don't know myself but this is a good thing for us to check into.

R: And you know that allows faculty partnerships to be supported by research funds. It has worked in the past. We have a wonderful agreement with the French, with the CNLS. And its about 60,000 dollars a year from each side. And maybe 50 faculty and students go back and forth each year. and the projects include art history, mathematics, and science, and architecture, so really its quite profound. And I meant to look up these data points, but one of the things you could do is try to increase study abroad in Korea. So there are a couple of complications of course. I don't know how many students study, say, from the United States, in Korea right now. That's easily-obtainable data. But if you want to increase that, one of the batteries to doing that is the question of how the courses are taught. are they taught in Korean or in English? At KAIST I know they teach in English. I don't know what goes on at Seoul National.

Q: And honestly I don't either. I took some graduate level classes at Inha university in Incheon a couple of years ago, and two of the classes were in Korean but used English-language textbooks. And then the third had no textbook but it was all in English. And it was one of these professors who had studied in the US and had been recruited back to Inha.

R: Now Inha - there is a big effort to grow at Inha. (??8:00??) unintelligible sentence. And I think ultimately those methods will work. You know I think its very hard to get a university to open up a branch in another country. Australia National University did this in Shanghai, at least I think it was Shanghai, but definitely China, but it closed within a year. But NYU just opened up in Shanghai, and its starting to be small. And it'll be populated to some extent by NYU faculty, and it'll be an opportunity for students to come there from the United States and be taught both by Chinese faculty and by US faculty. So I mean honestly I'll be much more interested in opening up focused efforts. ** phone rings ** My wife's got it. Actually I think what we're doing in Singapore with Illinois, and

MIT has a similar one - but its the graduate work and research. So those - its hard to get students to go back and forth. It took use two years to make that happen. And that was with lots of trips, sponsored by the university. Because (??10?06??) High Vigil came to me with some of this, uh, I just said go ahead and do it, and we'll see if we can make it happen. But slowly people began to see the possibilities. And there, English is spoken, but its bloody hot. But eventually we got a faculty member to go over there and run this institute. And we had many faculty going back and forth. And now they study information technology and its going to expand to vertical farming - agriculture, in association with the college of agriculture.

I think to some extent Korea needs to make a decision about what it wants to be good at. You know obviously you have some first-class industries, really world-class industries. Will the private sector step up and help fund research at universities, perhaps in partnership with another institution maybe even outside the country? Now when i was in Illinois we got 500 million dollars for a cloud computing project, in collaboration with Berkeley. That's only 3,000 miles, but depending on the project, it could happen. And you have to worry a lot about intellectual property rights, and how to protect graduates who want to be able to publish. So we got through all of that. I think partnerships and relationships are going to be more important for institutions to grow. You've got LG, you've got Samsung. Which universities do they work with?

Q: Well, LG and Samsung, I imagine... well Samsung has their own private research organizations like that Advanced Institute of Convergence Technology. I imagine that they are collaborating with numerous universities. I would imagine.

R: This is one of the things that could mean something internationally. So Microsoft and Intel invested in Berkeley and Illinois for cloud computing. There are two centers, geographically disparate. I don't know if they were even physical get-togethers. But the vice-president of research at Microsoft goes and visits both places. And its kind of interesting if one of those two companies did likewise. Of course you've got automobile manufacturers and the United States is kind of trying to rebuild its manufacturing capability. However that would create possibilities. But ultimately the collaborations are going to come around - are they going to be project based? Based on people going back and forth? I would try and develop some kind of sponsorship or collaborations with a first-class individual university. And then they could take on some theme. If you had to evaluate Korean universities, what are each of them good at?

Q: So getting that focus and the scope of the collaboration identified up front is helpful in trying to market that idea to collaborators.

R: But ultimately you know if you can rise in the international community. I mean every university, and every country, is trying to do this. China is investing vast sums in its universities. I think one of the places where they've perhaps missed the boat... (?? 15:23?? Richard cuts out for 4 seconds, then they discuss the problem) ... less creative for multinationals. I mean one of the ... China produces ten times as many engineering graduates as does the United States. Yet at the same time the graduates are not entirely suited for work in multinationals.

Q: Can you elaborate on that a little bit? What is the weakness?

R: Well, one, there was a study done by McKintey a couple of years ago. There are some data to support what I've just said. Two, there is a book called Run of the Red Queen, which I've just finished, which points out that the policies of the mixture of the centralized policy and you know the economic zones which compete with each other creates a certain kind of ambiguity which discourages people from taking risks. Because they can invest themselves for 3 years in a certain project and they find out that the central government doesn't wanna do that anymore. So there's no real plan and people don't commit the same way that they might in Korea. So I don't know whether you have

this problem or not. What multinational exist in Korea?

Q: You mean besides the Korean ones?

R: Right, right.

Q: Well my knowledge is mostly centered around the bio and healthcare industries. NGE is here, a lot of the big pharmaceutical companies are here. The problem though is that who shows up is marketing. And so they have a marketing office - multinationals. Lots of them have marketing offices. But they don't really invest so much in factories, in R&D. There is some of that as well. Bayer animal health has a facility, a manufacturing facility here. there are a number of multinational pharmas that have small factories. I'm sure in the IT industry there are a bunch of things happening that I'm not really aware of. But in general they are not the big employers in Korea, multinationals.

R: Are they welcomed?

Q: Well,... sure. I mean we have all these free economic zones dotting the landscape here whose duty is to try and encourage multinationals and other investors to set up shop. Whether that's legitimate is a real honest-to-goodness good deal for these multinationals and whether they really do feel welcome is a whole other thing.

R: Well i think even around Inha there are plans for a giant research park.

Q: There is a big huge project called New Songo City that is enormous. And back to what you mentioned about universities, SUNY, the state University of New York, is setting up a campus there this next year.

R: I know, they did inquire whether Illinois wanted to do that. I mean... as I say I'm not convinced setting up a whole campus would work. But it would be wonderful if it did. But I do think finding ways to increase the flow of people back and forth is perhaps critical to rising in the international community. But the bottom line is that if you look at all these international partnerships, they are going to be based on the kind of research that gets done. And ultimately you have to bring back the people. And I think one of the methods has been to bring back expats. And interestingly now Vietnam is trying to build, and I was there less than a year ago. They are more complicated, because bringing back people who left - many of them left just after of the war. And they are not necessarily viewed, you know, so kindly. There is a very complex situation. Whereas in Korea people went to study abroad and did well, and they are brought back by various inducements. One of the things I should ask is: Are all professors paid the same or are they paid differentially by field?

Q: The different free economic zones?

R: No I mean does an engineering faculty member earn the same money as an English professor?

Q: I don't know, however my understanding is that engineers are not highly paid in Korea. So we may not see the differential here in Korea that you see in the US.

R: I honestly think that differential pay is not the only thing. In France, for instance, its not overly differential. But in england its not differential at all. I remember giving a talk in Ireland and suggesting this. This is what happened in the US and there was great negative reaction. So there are cultural things that get in the way. The solutions have to be ones which work in the country.

Q: Have you experienced any cultural aspects of Korea from your work at Illinois with students and faculty and such or other of your experiences that you would notice as

either particular strengths or particular weaknesses in this business of setting up these international collaborations?

R: I see no barriers to doing it. I think at the end of the day you know, its going to be facilitated both by the government, through dollars, they have to decide to want it. But ultimately the collaboration isn't going to come about because of dollars, its going to come about because faculty X in Korea knows faculty Y in the united states and so forth, and they are willing to work on a project together and have their students go back and forth. One of the programs along that line, one of the programs that i started in china was to have their students who were studying at Chinglau (??24:43??) which is a very good school, to study there for three years and come to Illinois for two years. And they would get both a bachelors and a masters, and the two years they would spend in a co-op program with a company like Caterpillar, which has like seven plants in China. And the idea was to get their undergraduate degree from Chinglau, they get their Master's degree from Illinois, they work for Caterpillar, and they go back as research leaders in Caterpillar in China. And the people who I worked with in Cat said, look you're asking me to get involved in recruiting a brilliant employee, and its a no-brainer. So they went for it. But I gotta think things like that, partnerships like that with universities and the private sector. It was kinda fun to glue those pieces together. And the glue is ultimately (?? 26:00??) A longer-term solution is what Singapore does. They pay for students to study across the world. Both at the undergraduate and graduate level. And these students have to come back, and so its sort of like ROTC. I don't know what the number is now but a few years ago if you didn't come back you owed the funder 250,000 dollars. Now I think that's probably a hard thing to make happen in Korea. Now we tell people about this in the United States and it sounds like indentured servitude. And then we say we have ROTC. Well that's not quite the same. And I am thinking that the American government could do something like that. I went to school on a certain number of scholarships which were forgiven if I went and became a teacher. So that was a mild inducement to enter the teaching profession. I think collaboration with a good institution, and the easiest thing is to find a place where there are a large number of Korean clout that would help drive it, and then they themselves are more respected. And then pick a focus area, and then you know somebody's gotta supply the grease. And that's harder and harder as you know at universities in the united states, especially public. on the other hand, you know, people are always going to be intrigued by the international aspect. I mean the number of schools targeting at the undergraduate level in the US have 12%, and they'll probably get another 12% this way. So i think there is great push to internationalize the undergraduate student body - for good reasons and for less than good financial reasons. now I suspect, and this is something you need to check - where do the wealthy Koreans send their kids to school?

Q: Stanford, Berkeley...

R: Right. They now (??29:28??)

Q: No.

R: Do they come back? And they are great. I mean when I went to graduate school, 10% of Taiwanese students were going back. about ten years ago, 40% were going back. (?? 30:00??) And that's I think how Korea got many of its expats to return. having a good career, still called a doctor. Maybe mid-career in their 40s, and Korea offered new possibilities. And one of the ways you can get a researcher to come back, is they're gonna want to be able to draw graduate students. Experimental work you can't do without graduate students. Most faculty are going to be drawn by A. colleagues and B. Graduate students. One of the things I think can be done is to hire in clusters, so that you pick an area and you hire a team. So obviously you pick within a university or department, so it needs to be an are of emphasis that the department's interested in, and maybe they have some good people but not the top, and you bring in two or three people. And there you have an instant group. I've done that, and it does work. But you

know it means that going down to a department, a certain physics department. Lets say there's a physics department. Lets say there are 20 areas of physics that are viable. You can't take these three positions and offer them to two different areas. I mean you can but how would they collaborate? So it means there are political battles to be fought. SO how is Korea compared to... they probably have done this already. No matter which technology is important, we the Korean government are going to push, and we're going to do this in partnership with a university and LG. LG will use it, they will make the effort, and ca yo convince the university to follow this lead? I think the answer's yes.

Q: Yes.

R: I mean you pick an area that's hot, established, or so. And its not the leader well hire a handful at a time. And reputation is built on that. And then you have, you got to get people to go visit it, and they try to steal your faculty but maybe you can keep that together. And you start to get graduate students attracted a lot. And undergraduates. One of the things that the United States has done, of course they always have the institute for advanced study at Princeton, that's been around for years. but at Berkeley they created the mathematical center for research. which had themes year after year. and these people would come to Berkeley, it wasn't at the university proper but just up the hill so to speak, and many good things took place and good collaborations were created with Berkeley faculty. Of course Berkeley was not always Berkeley. And In more recent memory, San Diego came out of nowhere by hiring only members of national academies. not only those guys but many. I think there are various aspects but its one thing to talk generalities and another to go in and analyze the university scene. Which are the best universities?

Q: and the measure is publications.

R: well, its gonna be one of them. if we look at it... which university has the faculty who are most recognized. and part of it is going to be publications, and part of it is going to be what invitations they get to speak at big conferences. and where do the students who graduate go? how successful are they, whatever that means [ed note: not sarcastic, an earnest question] And then you know, what applies to the undergraduates. I mean in Japan the university of Tokyo, you had to go to the university of Tokyo if you wanted to work for the government. there's just, there were no other way. I mean Kyoto was a very fine university, but not if you wanted to work in the government. So I think there are various ways to judge universities and people do do it. what is it, shanghai, jong-tong, rang-rang (??35:50??) whatever?

Q: right, right.

R: and you know that has, some credibility. But what's the goal here? Is the goal to feed the private sector with graduates? I mean there are many - think of an institution rencellier polytech (??36:29??) which is not, I would say, one of the higher-ranked institutes. Its highly ranked but not that high. They feed a lot directly into the private sector. I mean when Illinois talks about ... we like to say that we are number one with proctor and gamble. so how does it... who's the audience? the audience is A: other universities, but its also where your graduates go. If you look at the engineering rankings, there are five categories overall. And one of them is what the recruiters think of the school. They're one of the audience.

Q: yes, who are the stakeholders?

R: exactly. To answer the question that first of all I raised... to try to make some headway, a good model i think is excellent is (??37:40?? man it is extremely unfortunate that the recording seems to cut out during good parts, like names and sentence subjects) which some feeding places for the private sector. as far as i understood. and all of a sudden now its, thanks to its last president, its really done some stunning things. its

hired some good researchers. so you know the question is where you begin, i think the benchmarks of success. I mean (??38:15??) you can get a few, but they won't be the only ones. You don't want to become an adjunct to industry. on the other hand if you're careful about it and doing research in the private sector is something that both can help society and provides new opportunities for faculty and students.

Q: so it sounds like a lot of this basically boils down to the organization having a clear vision of what it is that they want to achieve, who their audience is, their stakeholders, what they want, and developing these fundamental relationships between key members of the organizations, faculty, the various universities or within industry, the vice-president of R&D in an industry or something, and fostering these relationships. Those are the key ingredients to the success of these collaborations.

R: And I don't think there's any secret formula that's going to guarantee the success. And what you have to do is to be willing to risk failure. And so Novartis the drug company decided to go to Berkeley to get research done. I think it was that the department of biochemistry but I'm not sure. They ...

Q: You're talking about Novartis, is that right?

R: Yeah. And they dropped 25 million dollars over five years, and it caused a giant brouhaha. And it was done anyway, but in the final analysis Novartis walked away, after the five year period, because they didn't feel they were getting enough... that it was affecting the company. And its cheaper for companies to do research at universities, and it is (??40:50??) but having said that there was obviously a more complicated situation.

Q: yeah there was a lot of political push-back from the grassroots, from the community.

R: and from some of the faculty! When my colleague at Berkeley Bob Bershnapp (?? 41:10??) when he was talking about this BP arrangement. he went before the faculty senate and was upset, and they bought out again, and blah blah blah. and he said that he didn't think it was appropriate for one group of faculty to tell another group of faculty who had to get their support from. And two minutes later he was called a prostitute. So I tell you this because it has a certain amusement value - bob is a wonderful man. But its an example of all politics. And I mean none of that happened in Illinois. I didn't get one question. So you noticed in Berkeley is a hotbed of activism, whereas the Midwest is more conservative in the political sense, but somehow their emotions have a smaller amplitude.

So hang on, I think you have to find the right institutes. And already the Korean government is I think a very keen to do things. You mention this research park you spoke of is one such. and I don't know how much money is being put in, and who's putting it in. But you know, thinking big, picking out an area where university work is critical, to the success, training students, graduates and undergraduates in that area. Getting visiting faculty, I mean you have to, if you really want to do that.. you know it wasn't a hardship living in Berkeley for a year. I mean in Berkley, San Francisco, the weather is nice, faculty are great. And people will come to work. I mean they'll... one of the things that's going on in the united states is that a lot of the people who would normally stay with the university are now retired because many universities tried to get people off the books. so they can make up for the monies they were losing. so they offered inducements to retire. So I think there are wonderful faculty that are presently available who probably are all (??44:25??). So would they come to Korea and work for a year or two? You know and you have to think about what the status would be there. So you have to create an environment where... i mean if you're living in Seoul that's one kind of an environment where there are many things available. I don't know how is health care in Korea? If someone will come and visit they're not going to fly back to the United States to have an appendectomy.

Q: probably wouldn't be necessary, but that's another conversation.

R: I mean I'm just saying, I didn't think it was, but these are things that... but if you want people to come and visit for longer periods of time. For months, a husband and wife will go and visit a university and they'll have a skype conversation with their spouse. But if you want them to come for six months or a year then they're unlikely to leave their spouse unless they're intending to do other studies. So I think that you have to create an environment which will attract the people. And that doesn't mean that... i mean I went to Bielfell in Germany for a year with my wife and three kids. I went there because - and this is one other technique - there was a whole year in mathematical fields. And it was making people in mind with the right area. So I got supported and went - just packed up. It wasn't the greatest place in the world to live. But we traveled actually about three months that year. It worked out, and the kids survived, my wife survived. I made research partnerships that I wouldn't have otherwise. So one possibility is to hold a year on a topic and invite people to come for a year. And so you get big names to come for two or three months and that brings others and that brings graduate students and post-docs. And I think that's one way to do it. And you publish your proceedings. And this year was held at the university of yext (??47:20??) and there were attendants who got to know not just the people who were there at this institute but at the university. It takes a while to build this. The first time I went to ... the first time I went as chancellor... no i guess I was provost come to think... was the time we got two Nobel prizes, a national medal of science, and a Crawford prize all in one year. And every place I went I was asked how does Illinois do this? And there's no fairy dust to sprinkle, but its creating the kind of environment in which people can get their work done. And I don't know what the structure is in Korea, but I know the department heads should have a lot of autonomy to bring in great faculty. And research should be supported and risky research should be supported.

Q: Well this has been very very good general information, not necessarily specific to Korea and Korean culture, but with your experience with setting up these collaborations this has all been very very fundamental and very useful information that emanuel and I will be able to compile into this paper that we're working on.

R: Yeah i understand you are and I'm happy to look at drafts, and in the meantime i need to gather some data on Korea, I mean my data is more than a decade old. I mean other than knowing individuals.

Q: and that's fine. I mean Emanuel and I have been living here for years and we've been very involved so we kind of have some of that, the nuances in dealing with situations in Korea. However, what you've been providing is very very useful from a macro perspective and very practical. and very thorough. thank you.

R: ok, well look, we can... you know, just send me an email if you want to talk again, and I'll probably be talking to Emanuel in the near future. So thanks for the time. good luck to you and we'll keep in touch!

Q: yes sir, thank you so much!

8) International Foundations that can be good sources for Korean institutions conducting research (Jae Suk Lee)

Appendix A: Example Sources of US Funding

1. ***Center for Integration of Medicine and Innovative Technology (*CIMIT)**

   A non-profit consortium of Boston's leading teaching hospitals and universities, CIMIT fosters interdisciplinary collaboration among world-class experts in translational research, medicine, science and engineering, in concert with industry, foundations and government,
   to rapidly improve patient care. CIMIT is a proven and successful model for initiating and accelerating translational medical research in the domain of devices, procedures, and clinical systems engineering. Our approach is based upon four assumptions:

   - With active effort, sophisticated technology from other industries can be applied in healthcare to improve the quality and safety of patient care.
   - Early-stage, high-risk, high-reward ideas have little access to funding.
   - The solution to many of the current problems in healthcare today is best achieved through active collaboration between the clinical and engineering research communities.
   - Facilitation and coaching at every stage of the innovation cycle adds value, produces better outcomes and yields better researchers.

   Korea University participated in a CIMIT sponsored workshop in 2010.

   Proposal applications can be started at this web address:
   http://www.cimit.org/grants-fullProposalTemplate.html

2. ***Georgetown University***

   International Collaborative Research Grants are awarded by the Provost's Faculty Committee for International Initiatives and designated for Main Campus tenured and tenure-track faculty. They are intended to support scholarly collaborative research.

   Research conducted under this program must be collaborative in nature; generally, *the collaboration should be essential to the success of the research project*. The principal collaborator (or collaborators) must be from a foreign academic institution. Acceptable types of institutions include: universities, institutes, research labs, government agencies, and other organizations where scholarly research is conducted.

   The grant will support travel and living expenses of the Georgetown applicant or applicants. In addition, applicants may request up to 30% of the total grant amount for essential research support (e.g., expendable research supplies, data acquisition costs). The total amount of the grant is not to exceed $6,000. The grant ***cannot*** be used to support the following:

   - Participation in conferences or workshops
   - Purchase of equipment
   - Honoraria
   - Page charges for publication
   - Projects that have already received funding from the Graduate School or the FLL

- Travel expenses for a collaborating foreign colleague or graduate student assistants

Additional information about grants can be found at this web address: http://provost.georgetown.edu/initiatives/international/nav/facultycommittee/collaborativeresearch/

3. National Science Foundation

> The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" NSF is the only US federal agency whose mission includes support for all fields of fundamental science and engineering, *except for medical sciences.*

More information about applying for funding through NSF can be found at this web address*:* http://www.nsf.gov/funding/

4. University of Pennsylvania Global Health Programs (GHP)

Coordinates global activities of the School of Medicine at the, and supports the international aspects of our research, educational, and service programs. Activities include: (i) placement of Penn medical students in international rotations, and hosting of international medical students at Penn; (ii) facilitation of international research initiatives and sponsored programs undertaken by faculty of the School of Medicine; (iii) coordination of global activities with other schools of the University, and the Office of the Provost; (iv) provision of information for faculty, students, and administration; and (vi) representation of the School of Medicine in interactions with international universities. The GHP at PennMed was launched by the School of Medicine in 2004, in response to requests from Penn's medical students who had formed a global health interest group. Since its initiation, the program has grown in a stepwise fashion, with the participation of programs and faculty from many departments. For convenience, global health activities may be divided into three major rubrics: (i) Education and Training; (ii) Research; (iii) Service and Clinical Programs.

http://www.med.upenn.edu/globalhealth/

5. Macarthur Foundation

The MacArthur Foundation supports creative people and effective institutions committed to building a more just, verdant, and peaceful world. In addition to selecting the MacArthur Fellows, the Foundation works to defend human rights, advance global conservation and security, make cities better places, and understand how technology is affecting children and society.

The Foundation makes grants and loans through three applicable programs:

- International Programs focus on international issues, including human rights and international justice, peace and security, conservation and sustainable development, migration and human mobility, and population and reproductive health.
- U.S. Programs address issues in the United States, including community and economic development; housing, with a focus on the preservation of affordable rental housing; juvenile justice reform; education, with an emerging interest in digital media and learning; and policy research and analysis.
- Media, Culture, and Special Initiatives support public interest media, including public radio, documentary programming, and work to explore the use of digital technologies to reach and engage the public.

Instructions for applying can be found at this web address:
http://www.macfound.org/site/c.lkLXJ8MQKrH/b.913959/k.E1BE/Applying_for_Grants.htm

6. **Ford Foundation**

The Ford Foundation supports innovative thinkers, leaders and organizations that are working to reduce poverty and injustice and to promote democratic values, free expression and human achievement. When making grants, we think about long-term strategies, knowing that lasting social change requires decades of effort.

Although active in China, Indonesia and other developing nations, the Ford Foundation does not currently support activities in Korea. However, collaborators based in the United States can apply for a global grant, which could also cover Korea. They also do not fund inventions. They do not focus on technology. Their programs address nine significant social justice issues that can be found at this web address:
http://www.fordfoundation.org/Issues

7. **Hewlett Foundation**

The Hewlett Foundation makes grants in five core program areas: education, environment, global development and population, performing arts, and philanthropy. The Foundation funds organizations working in the areas identified above, based on specific goals and strategies outlined by the programs. Almost all grants are awarded to organizations identified by the Foundation. The Foundation does accept unsolicited Letters of Inquiry from organizations looking for funding in limited areas. Only on very rare occasions are grants awarded in response to these unsolicited funding inquiries. Only the following programs currently accept unsolicited Letters of Inquiry:

Education Program	
Deeper Learning	Accepting Letters of Inquiry
Open Educational Resources	Accepting Letters of Inquiry
California Education Program Info	Letters of Inquiry accepted through Rockefeller Philanthropy Advisors: http://www.rockpa.org/cepf

Environment Program	
The West	Accepting Letters of Inquiry
Energy and Climate	Accepting Letters of Inquiry
Bay Area Communities	Accepting Letters of Inquiry
Global Development and Population Program	
Quality Education in Developing Countries	Accepting Letters of Inquiry

The Foundation does not fund individuals and generally does not fund scholarships, endowments, capital campaigns, building construction, for-profit organizations, unincorporated associations or groups. The Foundation's funds can be used only for purposes that are consistent with its status as a charitable organization.