Seventh US-Japan Joint Science Policy Seminar

Appendix E: Plenary Session III: Human Resources for Science and Engineering

Abstracts of Remarks by:

Plenary Session III: Human Resources for Science and Engineering

Shirley M. Malcom

Within the United States issues related to the development of human resources for science and engineering are addressed by the professions through their organizations as well as by government. Societies often assume the role of monitor of the health of the field, advocates for quality education and/or guardians of the standards of conduct within the discipline.

Examples of the complementary role played by the professional societies include the following:

- Issuance of standards and accreditation of departments of chemistry by the American Chemical Society.
- Collection and dissemination of employment data on the status of persons graduating with degrees in physics by the American Institute of Physics.
- Development of curriculum standards in mathematics by the National Council of Teachers of Mathematics.

In addition to stimulating the discussion surrounding goals in science education for all students through Project 2061 the American Association for the Advancement of Science has supported enhanced public understanding of science and the development of the talents of women, minorities and people with disabilities, groups currently underrepresented in science, mathematics, engineering and related professions. Through Science's Next Wave, another AAAS program, undergraduates, graduate students and persons newly entering the science and technology job market receive career information and advice from persons engaged in a variety of careers both inside and outside of academia.

In keeping with the human resources development needs the activities of the societies, including AAAS, span from pre-kindergarten through post-graduate and career development. They include support of and advocacy for policies that strengthen science and engineering education.

We believe that the United States has much to learn about the structure and rigor of science and technology education, about the teaching of science and mathematics and strategies for human resources development from other countries. We believe that our experience has much to offer as well, especially regarding strategies for non-governmental groups interacting with government and efforts to extend quality science education and careers to all.

Plenary Session III: Human Resources for Science and Engineering

Human Resource Development in Higher Education in Japan.

Yasufumi Sakitani

Abstract

After World War II, higher education in Japan made a rapid expansion mainly id undergraduate education. The attitude of university academic staff was generally research-oriented. The contents of graduate courses also inclined toward training of successors as researchers, and the quantitative and qualitative improvement of the provision of graduate schools, in response to diversified needs of society, has not been well achieved.

However, at the time of remarkable changes of economic and social circumstances, including changes of industrial structure and progress of science and technology, society's demands on universities are becoming more diverse and sophisticated. For example, there are increasing demands for recurrent education of adults based on the idea of life-long leaning. Now universities are required to reconstruct their functions of human resource development. On the other hand, universities are beginning to prepare for heated competition for students resulting from the decrease in the 18 year-old population, exploring a broader range of students including adult and overseas students. For example, there are more and more graduate courses which aim at training not only researchers but also other professionals

Monbusbo is carrying out the following measures to improve functions of education and research in higher education, taking into due consideration on-going deliberations by the University Council on the future of the Japanese higher education system:

- To improve the function of undergraduate education
- To expand the provision of graduate schools and improve the quality of their courses
- To train researchers in graduate schools
- To train other professionals in graduate schools
- To implement thee Supporting Plan far 10,000 Post-Doctoral researchers
- To enhance the mobility of researchers through collaboration among universities, industries and government.
- To promote international research cooperation and student exchange

I believe that it is especially important to try and reform nor only the system of higher education but also the attitude of academic staff through promoting the mobility of researchers and evaluating appropriately education and research, in order to enhance the human resource development function of universities.

Plenary Session III: Human Resources for Science and Engineering

Human Resource Development for Science and Technology in Korea

Sook-Il Kwun

Abstract

The single most important element for a country to be competitive in the world is its science and technology manpower. In Korea, human resource development is widely recognized as a key element of our national policy. It also plays an important role as a driving force for the political, economic, social and cultural changes necessary for a country to evolve into a new horizon. In 1997, the Korean Government enacted a special law of the *Five-Year Plan for Science and Technology Innovation* that contains a human resource development plan as one of the main components. (Another component is that Korea plans to increase the share of government expenditures allocated to R&D to at least five percent of the total national budget by the year 2002.)

It is frequently pointed out that the Korean economy, with scarce natural resources, would never have been able to achieve current levels of economic development without the massive provision of well-educated, hardworking human resources. The education and training system in Korea has evolved in unison with changes in industrial policy. In the 1960s, when development of light industries was the main focus of government policy, priorities were set to expand and qualitatively improve vocational high schools as a whole. In the 1970s, as the government's focus shifted from light industry to heavy and chemical industries, the volume of technical high schools expanded very rapidly. In the 1980s, restructuring towards skill intensive industries gave emphasis to producing highly educated workers and technicians by expanding universities and vocational junior colleges. In the 1990s, the emphasis has shifted from quantitative expansion to qualitative improvement in training and education. Higher education in Korea has shown phenomenal expansion due to persistent demand. In turn, high demand for higher education has instituted high qualification standards.

During the first decade of the next century, Korea plans to increase the number of highly qualified researchers up to 200,000, which equates to 40 researchers for every 10,000 people. Also for the knowledge-based economy and the information era, the education system will be restructured to produce highly creative and talented scientists and engineers who can lead a coming generation. The government is also making an effort to transform the graduate programs at universities towards being more research oriented. To this end, it has provided financial support to universities selectively on the basis of their research performance.

In the United States, technical institutes for higher education have been established around industrialized areas to develop and supply scientific and technological manpower for industry.

The Engineering Research Centers and Science and Technology Centers supported by the National Science Foundation are playing a great role in enhancing industrial competitiveness. They provide scientists and engineers with opportunities to improve their research competence through participation in joint research activities between companies and universities.

Japan is investing over 40 percent of its science and technology budget in developing human resources. Universities and companies are cooperating to supply this manpower. Universities provide basic science and technology manpower, and companies provide further training for these human resources by focusing on field experience and applied technology. Local governments are helping small and medium sized enterprises that don't have this ability to develop self-supported manpower.

Korea has been trying to enhance joint research activities and post-doctoral programs with other developed countries to train qualified human resources for science and technology and to obtain information on advanced science and technology. Although implementation of the Five-Year Plan became threatened by the economic crisis which started in November 1997, the new government recognizes that the increase of R&D power will help solve the crisis.

As the experience of many advanced countries shows, the best policy during an economic recession is to train manpower to prepare for better times in the future when their skills will be sorely needed. We Koreans will do our best to keep these highly qualified people by various means, such as providing post-doctoral support in Korea and abroad.

As a newly industrialized country facing a competitive world economy, Korea recognizes the need for a new international cooperation strategy. Korea is seeking to play an active role in the international science and technology community, not only to contribute to scientific advances, but also to harness new knowledge for the nation's social and economic development. To this end, it actively pursues both bilateral and multilateral cooperation with foreign countries and international organizations.

As a part of its contribution to the APEC Science and Technology Network (ASTN), Korea has initiated a scientist exchange program and an R&D management-training program. The R&D management training program implemented by the Science and Technology Policy Institute (STEPI) aims to bridge the gap in R&D capabilities among the regional economies by providing R&D management training for the researchers of developing countries and by facilitating the sharing of science and technology development experiences among the member countries. To facilitate active exchange of scientists by providing opportunities for advanced research, the scientist exchange program was started on a pilot basis in 1997 by the Korea Science and Engineering Foundation (KOSEF) as the APEC Post-Doctoral Fellowship Program. As this program gains momentum, it is anticipated that the number of post-doctoral fellows will be increased.

There are other post-doctoral and senior scientists programs based on bilateral agreements between KOSEF and counterpart institutions in other countries. We have also recently inaugurated the Korea Institute for Advanced Study (KIAS) to nurture and train young and active scholars in the basic science areas. The aim and structure of KIAS is somewhat similar to the Princeton Institute for Advanced Study. The Asia Pacific Center for Theoretical Physics (APCTP) began its operation last year. It is the Asian counterpart to the famous International Center for Theoretical Physics in Trieste, Italy. It is a non-governmental organization supported by the Asian participants. We expect to develop, through the projects like APCTP, effective multilateral researcher programs. Korea will strive to set up a "foreigner-friendly" environment in the years to come.

Since the development of human resources for science and technology takes a long time, the demand should be predicted well and a long-term plan needs to be set up. Thus, the Korean government is planning to develop qualified scientific and technological manpower through the Five-Year Plan and multilateral cooperation. As you probably know, Koreans have a strong desire for higher education and are willing to invest time and money for better education of their children. Thanks largely to this dedication, Korean students from elementary to high schools consistently rank among the best in the world in science and mathematics aptitude tests.

The problem, though, seems to arise when these bright young students enter college. Because we do not yet have world-class research universities, their talents cannot be adequately developed further. The Korean government recognizes this problem, and is now pushing hard for educational reform that emphasizes quality rather than quantity in higher education.

To attract young and talented students to the science and engineering community, an exemption policy from military service and the science high school system are being put into operation. Additionally, the number of high-quality female researchers is increasing rapidly, and it is important to take this factor into consideration for future planning.

It is certain that Korea will become internationally competitive by means of the optimum utilization of scientific and technological manpower in the next century.

Plenary Session III: Human Resources for Science and Engineering

Industrial View on the Demand-side: Human Resources for Science and Engineering in the 21st Century

Tsuneo Nakahara

Abstract

The optimal direction of national and corporate policies is decided by three external factors - politics, economy and science & technology. Science and engineering are underlain by universal principles. In this sense, we may say that science & technology embodies the idea of globalization and a borderless world. Economically, the world is now in the process of shifting to liberalistic, market economy and then to borderless economy, led by WTO, IMP, etc. Politically, independent governance still prevails in today's world. On the momentum of the trend towards globalization, inter-governmental dialogue has just started, which, however, is still at a preliminary stage.

The recent rapid progress of information technologies has created global networking environment, and is further accelerating the trend toward globalization and borderless economy. Such extensive networking environment, on the other hand, allows criminal acts of an international scale as well as large-scale speculative trading which might result in instantaneous financial panic. These unethical acts involve the risk of spoiling the global merits of a borderless economy, and, more importantly, presenting a threat to the survival of democracy and liberalistic market economy in the international society. To prevent such situations from developing, the following action plans must be implemented successfully.

1. To create an environment to realize sustainable economic development by encouraging growth of new high-tech industries, which will contribute to the solution of the problems of unemployment and financial difficulties in developed countries, and to develop human resources for science and engineering to this end.

2. To create an environment to develop technical skills and human resources for science and engineering locally in order to ensure continued improvement of productivity of the production systems introduced in developing countries.
3. To form an international team of experts in laws, ethics, economics, science and engineering to discuss the establishment of international laws and ethical standards. The fields that require introduction of such laws and standards include environment, energy, life science and intellectual property.

The important thing is, how Japan, the United States and other relevant countries could contribute to the successful implementation of these action plans through application of science and engineering. From the industrial viewpoint, the greatest emphasis should be given to the following goals:

Plenary Session III: Human Resources for Science and Engineering

Susanne Huttner

Abstract

California is the birthplace of modern biotechnology and the site of its transformation into an entirely new high technology business sector - commercial biotechnology - mediated by relationships between entrepreneurs and scientists. As the number of California firms has quickly grown (reaching one-third of all U.S. biotechnology companies), the state has established itself as a world leader in harnessing a new international economic development vector. With that success, however, has come an expansive array of human resource needs and opportunities that are largely dependent upon the graduate education process.

The capacity for innovation that spawned the biotechnology enterprise is embodied in *people* - faculty, students, and other researchers working in federally funded projects in academic laboratories, and scientists and engineers working in the private sector. More than any other single factor, *people* drive biotechnology. The knowledge and skills of people fuel innovation and provide leadership. Viewed this way, commercial biotechnology can be counted as a product of more than 40 years of federal and state support for research and training in the biomedical sciences.

California's success has also revealed challenges that graduate education institutions must address if the scientific workforce is to keep pace with opportunities and needs in the coming decades. First, as advances in the biosciences themselves have evolved, the nature of research and the research environment in which graduate training takes place have changed dramatically. Consider just two cases in point - computational biology and biomaterials. These fields have advanced through new, broadly cross-disciplinary approaches that wed life sciences such as genetics, biochemistry and molecular biology, with physical sciences, like physics, chemistry, computer sciences, and mathematics. This has created new opportunities for advancing research and applications. It has also created new needs for highly skilled personnel who are trained in different ways than we have trained graduate students in the past.

Second, there are significant emerging needs for scientific personnel in non-traditional fields outside of academic research. It is not at all unusual in California to find people with advanced biosciences degrees who are pursuing careers in business, finance, venture capital, law, regulatory affairs, and journalism. You also find them in teaching, basic research, clinical research, and R&D positions that are somewhat better aligned with conventional graduate training. Even in those career paths, however, training needs are evolving. Diverse employment opportunities place pressure on the graduate education process, demanding greater flexibility in the breadth, organization, and goals of the graduate curriculum. They also create a challenge of a different kind. Faculty are faced with graduate students who increasingly wish

to pursue career paths that diverge from the traditional academic path. Whether faculty approve and support student goals, or disapprove and discourage them, has significant impact on student choice.

There is considerable concern about the future directions of graduate education in the United States. This concern arises, in part, from the accelerating relevance of basic research and training in national and world economies. It also arises from the view that our graduate training programs are not keeping pace with this changing environment. How basic research and graduate training evolve will impact both local and international economic development.

Following the enactment of the Science & Technology Basic Law in 1995, the Japanese government adopted an action plan called the Science & Technology Basic Plan in 1996 to pursue national development by encouraging development of science & technology. This plan places importance on basic research, and calls for establishment of an environment to develop creative powers and human resources. To be specific, the plan aims to achieve the following goals by the year 2000; to double the amount of grants-in-aid to be allocated to universities and national research institutes; to increase the number of post doctoral fellows to 10,000; to launch more effective measures to support venture businesses; and to foster stronger cooperative ties among industries, governments and universities.

The first thing to do to encourage emergence of new high-tech ventures is to develop entrepreneurial skills. Success of a venture business depends largely on the effectiveness of its core business plan and ability to raise funds. There are basically three channels through which ideas for a core business plan can be conceived. First, through the invention of a founder of a business himself. Second, through basic research conducted at a university, and third, through a business plan which a large company has developed but elected not to launch. In any of these cases, intellectual property rights play a critical role. To assist venture businesses in raising funds, on the other hand, amendments of related laws are currently under way following the example of the United States, while self-supporting efforts of ventures are also called for.

As for acquisition and implementation of intellectual property rights, countries around the world maintains its own legal system independently of each other. However, intellectual property rights would be of no use if they could not protect inventions and be put into actual use in the international community. In this sense, it is necessary to direct more efforts toward harmonization of international laws and codes of conduct, extensively covering industrial property rights and copyrights.

To conclude, in our efforts to further development of science & technology, we must emphasize human resources development for science and engineering as well.