AC 2007-1979: CHALLENGES FACING GLOBAL ENGINEERING EDUCATION CONSIDERING CURRENT U.S. POLICIES

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Challenges Facing Global Engineering Education Considering Current US Policies

Abstract

Engineering Education and student exchange programs have suffered since the global security crisis began in 2001. The tightening of immigration policies and Visa issuance in the US has drastically affected the number of graduate students studying in engineering schools across the United States. Global Engineering Education demands ease of student exchange and study abroad practices. The pertinent question at hand is: could this be done without jeopardizing national security, and at what price? This paper will look at these challenges and provide some examples and solutions to guide policy makers at institutions within the US and abroad interested in having student exchange programs.

Introduction

Policy implications affecting international graduate students and postdoctoral scholars in the United States impact the success of US educational institutions in producing qualified engineers and the success of the US economy in the long run. Since the end of World War II, the United States has been the most popular destination for science and engineering graduate students and postdoctoral scholars choosing to study abroad. The nation has drawn on human resources from abroad for its science and engineering workforce for numerous years. However, competition for educated engineers has grown as other countries have expanded their research potentials and created more opportunities attracting international students. The difficulty of obtaining student visas by international students has curbed the number of science and engineering students studying at US institutions.

Based on a report by The National Academies, to maintain and extend its excellence in science and engineering, the United States must recruit the most talented people for positions in academia, industry, and government. In order to do this, the best international talent must be sought, while simultaneously seeking to improve domestic Science and Engineering Education and promoting the education of women and members of underrepresented minority groups. This dual goal is especially important in light of global competition for the best Science and Engineering students and scholars.[1]

The education and training of scientists and engineers is one of the most vital tasks of a knowledge-based society. The quality of students and researchers determines a nation's innovative capabilities and forms the basis of economic competitiveness and national security.

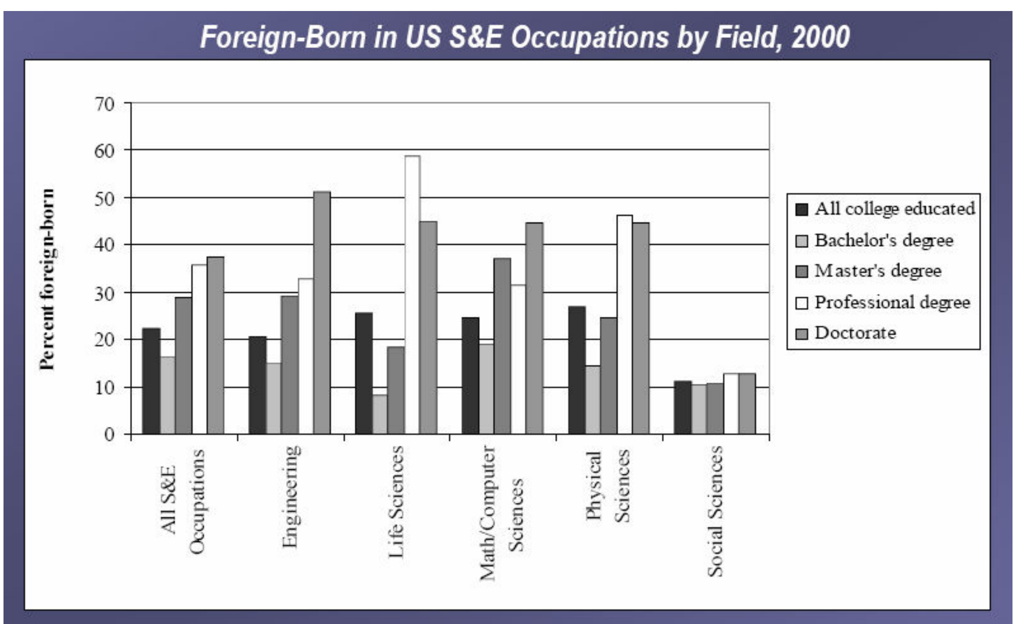
There are conflicting points of view regarding the competitiveness of the world, and whether it is "flat" or not so flat. In Thomas Friedmans' book, The World is Flat, he assess the case of this "flatness" as a result of easier access to information technology and rising technical competence on the part of the developing countries. He argues that the flatness of the world is a positive economical and geopolitical trend. It is important to note that global flatness is good for a particular country if it gives them the capability of competing in the global markets. [2]

Another view contradictory to the belief that the world is flat argues that although the world is more competitive today, it is not "flat". The danger the US is facing because of the flight of high technology jobs is proposed as being no more than the threat posed by the Soviet Union in the 1960s and 1970s, or from Japan in the 1980s. This group believes the US response must include the proper retaining of those who are disadvantaged by creating adaptive institutional and policy responses that would keep this nation at the forefront of the technological advances.[3]

Impact of foreign born scientists and scholars

Data by National Science Foundation shows thirty eight percent of doctorate-level employees in 2000 were foreign-born, an increase of twenty-four percent compared to the same data collected in 1990. More than one in three of US Noble laureates from 1990 to 2004 were born outside the United States. Nearly half of the doctorate-level staff and fifty eight percent of the postdoctoral staff at National Institutes of Health were foreign nationals in 2005.[4]

The data collected in the study also indicates that nineteen percent of all the Science and Engineering faculty teaching in U.S higher education institutions and thirty six percent of the faculty in different engineering fields were foreign born in 2005.



Adopted from the National Academies[1]

Data indicates that in 1966, seventy eight percent of Science and Engineering doctorates were born in the US, and twenty three percent were born outside of US.[1] In 2000, sixty percent were born in US and thirty nine percent were born outside of US. In 2003, international students earned thirty eight percent of the doctorates in Science and Engineering and about fifty nine (58.9) percent of the doctorates in Engineering fields.[4]

The Role of Academia and industrial partnerships

Today, American higher education institutions are aware of the importance of globalization and the challenges ahead. University vision and goal statements indicate the urgent need to move in that direction. Despite this awareness, there seems to be no consensus among the higher education institutions as how to proceed. Northern Kentucky University is striving to internationalize its campus and has made it a part of its 2015 vision. President Votruba's 2006 Fall Convocation states that NKU will become international in its perspective. He believes the university will provide a region that attracts, retains, and celebrates people from diverse backgrounds, races, cultures, ages, incomes, and family structures. He says, "We will create a culture of tolerance and inclusion where all can thrive... Vision 2015 emphasizes the need for the region to become more global in its perspective and the University can and should lead the way."[5]

Dr. Votruba continued to state that one of the greatest contributions that NKU can make to the region is to become a more internationalized campus. This would involve more of our domestic students studying abroad, more international students studying on our campus, more partnerships with international universities, more faculty exchange programs, more partnerships with international companies, and revisions in our curriculum to make it more international in its scope. It's clear that, for NKU students to succeed in their careers and as citizens, they must have an international perspective. Votruba also said "We need to become a more international campus for the sake of our students and our region."

For these visions to be realized, I believe that it is vital for NKU to increase its role as a hub for the development, exchange, and distribution of science and information between different industries in the region. Today, multinational companies such as GE, P&G, and Toyota as well as some smaller companies located in the Grater Cincinnati area conduct R&D activities that are hard to match at the university level. While much of this new technology is proprietary, universities can and have served as centers for the exchange of related knowledge. These types of exchanges foster more focused research on the part of the university, and most importantly, create environments suitable for educating scientists, engineers and other graduates that have a competitive edge in the world market.

Working with multinational companies will help further the university's internationalization tremendously. Working on joint projects abroad would provide the opportunity to educate faculty and staff and stem new connections and ideas in the process. A cohesive effort also needs to be made to provide opportunities for faculty and staff to work with other higher education institutions abroad on joint degree programs. This can be achieved by encouraging faculty to teach in other countries at different times

– during their sabbaticals for example. Another useful method for increasing internationalization is also establishing extension offices in developing countries that would offer courses toward degrees at NKU.

Industrial scientists and engineers are sent overseas on a regular basis to carry out projects abroad, and NKU would greatly benefit from joining these endeavors. Working with various countries would allow the university and our students to broaden our horizons and train graduates who are truly versatile (having the skills to function in different environments).

The primary issue underlying any kind of internationalized engineering education is the adoption of the correct standard teaching practices. Some fundamental issues in teaching engineering subjects include: curriculum design and evaluation, liberal education for engineers, use of new technologies in engineering education, international collaborations, education for sustainable development, exchange mechanisms in engineering education, academic/industry collaborations, international mobility, linkages between developed and developing countries, and effective management of academic and engineering institutions.[6]

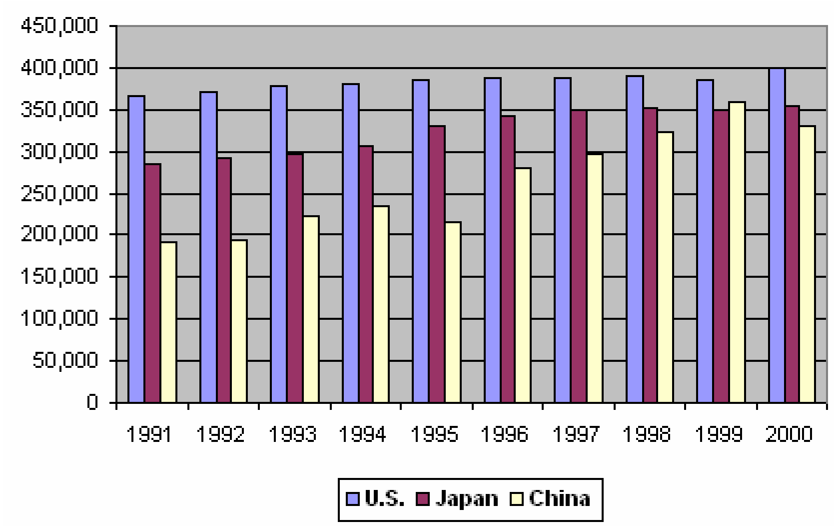
To be competitive in the world of today, NKU students need to study and coop with companies abroad on a normal basis. Understanding other cultures and how to function efficiently within them takes time and effort, but it is effort well spent. Experiencing and surpassing the initial culture shock of different cultures is one of the first steps NKU and our students can take in understanding and benefiting from the ever-shrinking world we live in. Cloyed believes universities must take on the responsibility of: 1) creating the interest and providing the quality teachers for the physical sciences and mathematics in K through 12 education, 2) creating important new technology platforms through leadership of basic research, and 3) creating knowledge based businesses.[7] Creating more interdisciplinary academic programs is an step in the implementation process toward the recommendations mentioned above.

The need to revamp US Policies

The brightest and most intelligent graduate and postdoctoral scholars have been drawn to the United States because of the availability of high quality research universities, stipends and research funding, as well as opportunities for employment after schooling, and an “open-door” immigration policy. [1]

The US Department of State, Educational Information and Resources Branch booklet series publication under the title *If You Want to Study in the United States* lists steps necessary to apply for a student visa. The time frame necessary to plan and obtain a visa under normal circumstances is 18 to 12 months, depending on the competitiveness of the institution. [8]

In 1952, the student nonimmigrant F and J visa categories were established. Students interested in studying in the US are required to apply for one of the above visas to enter the country. Federal regulations and laws need to be reexamined to find innovative ways to reduce the time required to obtain and legally enter the United States. The F-1 visa category is the most common student visa type designated for undergraduate and graduate students. The J-1 category is for graduate or exchange students, teachers, scholars, and researchers who come to the United States under educational exchange programs (such as the Fulbright Program). J-1 students must be financed, at least partially, by either the US government, their home government, or the US institution that they will attend. They may also be part of an exchange program.[9]



Source: National Science Foundation: 2004 Science & Engineering Indicators (Appendix table 2-34)

Today, emerging sources of innovation are commonly found in Low-Income Markets. Tom Friedman describing the "flat world" states that many countries in Low-Income markets are now an excellent source of quality and low-cost manufacturing.[2]

Multinational industries seek to tap into the innovation and know-how by using the mindset that "if I need an idea or have a technical problem to solve, someone, somewhere has what I need." Such needs can be found across the world, and successful countries have sought these money making opportunities. Gloyd explains that P&G set a goal in 2001 to capture 50% of its ideas, technologies, and products from outside the company. "We got the solution to one of our chemistry problems from a graduate student in Spain".[7] The capability to find solutions to problems, economically, across the world is one of the advantages of the "flat-world" concept.

The United States has been producing over 20 percent of the Science and Engineering PhD degrees issued in the world. To maintain this current US leadership in the fast-rising global competition for Science and Engineering infrastructure and training, is essential to develop an effective global network of scientific and economic strength. Indeed, there is considerable evidence that that process has begun.[10]

"The Committee on Science, Engineering, and Public Policy is a joint unit of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine.

Most of its members are current or former members of the Councils of the three institutions." [11] COSEPUP conducts studies on cross-cutting issues in science and technology policy. It addresses "the concerns and requests of the President's Science Advisor, the Director of the National Science Foundation, the Chair of the National Science Board, the heads of other federal research and development departments and agencies, and the Chairs of key science and technology-related committees of the Congress." It also monitors key developments in US science and technology policy for the Academies' leadership. COSEPUP studies are usually conducted by special interdisciplinary panels comprising the nation's best scientific and engineering expertise. While many studies are sponsored by government agencies, COSEPUP procedures safeguard its studies from the influence of sponsors or other outside groups"

There should be a new national priority for enhancing innovation capabilities. The United State needs a set of mandates to change the current slow and inefficient visa system in place today with one that is responsive. The Department of State should adopt a policy that seeks and attracts qualified scientists and engineers.

The time to act is now

It is very clear that by the year 2020, if educational trends remain as they are, there will be a horrific void in scientists, mathematicians and engineers in our country, and thus, our technological competence will fall sorely behind the rest of the world. Therefore it is imperative that our current mission be to find every conceivable way to make young people, especially middle school students aware of The Science, Technology, Engineering and Mathematics Education (STEM) careers, provide them with opportunities to engage in hands-on activities that simulate the type of work these careers entail, and help give them the interest, confidence, content knowledge and skills to aspire to those careers. "However, for what it is worth, iSPACE uses as its mantra, "Our Vision is 2020; Our Mission is Now."[12]

> *"...we have done a very poor job of conveying to kids the value of science and technology as a career choice...we should be embarking on an all-hands-on-deck, no-holds-barred, no-budget-too-large, crash program for science and engineering education immediately."* [2]
>
> *"We cannot educate today's students with yesterday's technology and expect tomorrow's success."*
> Albert Einstein

Conclusion

To maintain US leadership in science and engineering education, there needs to be a rapid change of paradigm. This requires the establishment of a global network of scientific and innovation centers to attract resources from around the world. The United State's status as the best destination for science and engineering education has changed. Graduate students and researchers currently have other opportunities to study and work in places besides United States, and thus, US policies need to change from inactive to proactive in finding and recruiting such graduate students and scientists.

To stay competitive, U.S. universities and industries need to face global realities and drive the changes necessary to take advantage of new opportunities. Open innovation is a global reality. It is important to recognize this and utilize the best, most productive capabilities wherever they exist.

There needs to be a new national priority for enhancing the country's innovation capabilities. To do this, The Committee on Science, Engineering, and Public Policy (COSEPUP) needs to take up the task of coordinating, collaborating and aligning global innovations with technological needs in the United States. This federal organization, under the auspice of COSEPUP committee, should take on the responsibility of aligning industrial needs with domestic or international resources capable of meeting these needs. This organization should also discover and set the stage to recruit the most talented individuals from around the world to come to the United States and work as part of research teams.

Globalization of Engineering Education mandates that graduates understand the cultures, traditions, and languages of countries where they will work. These engineers must understand the implications of their designs or end-products on the environment that the technology will be utilized. Engineering education in a given country or region must reflect and respond to local conditions.

Bibliography

1. A report by the Committee on Science, Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States, The National Academis, http://www7.nationalacademies.org/internationalstudents/
2. Friedman, T. L. (2005). The World is Flat: A Brief History of the Twenty-First Century, New York: Farar, Straus and Giroux.
3. Bhagwati, J. (2005). The World is not flat. The Wall Street Journal. August 4, P. A12. Web at http://print.nap.edu/pdf/0309100399/pdf_image/17.pdf, (February, 2006).
4. National Science Foundation. 2004. *Science and Engineering Doctorate Awards: 2003* (NSF 05-300). Arlington, VA: National Science Foundation. Data are available at *http://www.nsf.gov/sbe/srs/nsf05300/tables/tab3.xls.*
5. Web at http://www. NKU.edu, President Votruba's 2006 Fall Convocation.
6. Gunnink, B. Sanford Bernhardt, K. L. (2002). WRITING, CRITICAL THINKING, AND ENGINEERING CURRICULA, 32nd ASEE/IEEE Frontiers in Education Conference, November 6 - 9, 2002, Boston, MA
7. Cloyd, G. G. (2006). Innovation in the Global Marketplace: The Opportunity for Industry & Academia, Innovations 2006, ISBN: 0-9741252-5-3
8. Web at http://educationusa.state.gov.
9. Web at http://educationusa.state.gov/graduate/pubs/iywts2.pdf
10. Todd M. Davis. (2003). *Atlas of Student Mobility.* New York: Institute of International Education.
11. Committee on Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States, Board on Higher Education and Workforce, 2005. National Research Council Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States Committee on Science, Engineering, and Public Policy (COSEPUP) ISBN: 0309096138
12. Neenan, L. Executive Director, iSPACE, Inc. www.ispaceohio.org