How Flat is the World?

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Abstract

There is a lot of discussion among engineering faculty and professionals on the implications of Thomas L. Friedman's book "The World is Flat- A brief history of the twenty-first century"[1]. The fundamental issues are concerns regarding the large number of engineering (and science) graduates that are being produced by emerging economies such as China and India, and the consequences thereof to the increased off-shoring of technical jobs. Also at issue is the lack of national (United States) prioritization and investment in engineering and science education and research and fear that this trend would continue unabated and inevitably lead to a loss of US economic competitiveness.

The book and its premise has become a rallying ground for engineering faculty and has served to coalesce some sense of urgency in allocating more resources to engineering fields. The purpose of this 'paper' is not to argue against the basic premise of the book, but to look more closely at the educational system of India as a way to better understand the trends of the past half century and the resulting complexity in economic terms. The discussions are also true of other emerging economies.

This paper will dwell upon three fundamental departures from conventional wisdom:

- The increase in engineering graduates in India is not due to increased government attention or resource allocation, but a consequence of India's embrace of open market and growth of the public sector.

- Quality of engineering graduates is managed very differently in different parts of the world. Also relevant is the education system that precedes engineering education and the life-long learning that follows.

- Impact of globalization and consequences to education is drastically different in different fields of engineering (information technology vs. others).

The paper is not a scientific study but a starting point for deliberations on these differences that could lead to a better understanding of the situation. It could help identify and resolve issues related to engineering manpower faced by employers including faculty in the US.

Background

In late 2007 Alfred P. Sloan Foundation vice president Michael S. Teitelbaum told the House of Representatives Subcommittee on Technology and Innovation that " contrary to conventional wisdom, [the U.S.] has more than enough scientists and engineers"[2]. His position on behalf of

researchers who track the labor market cited lack of data and objectivity in the assumed shortage of engineering and scientific manpower. The testimony eluded to federally funded research at universities producing PhDs and post-doctoral researchers who do not have relevant job prospects from the industry.

In some sense this contradiction in viewpoint is analogous to a National Foundation Report in the late 1980s about impending shortage of PhDs in engineering and sciences. The report appeared at a time when the author was applying for faculty positions and was one of 150+ candidates in many search pools! The report had dubious credibility but was well-cited at that time.

In the department of Civil Engineering at the University of New Mexico the shortage of engineers is evident in the fact that all graduating seniors have multiple job offers. This is partly due to the fact that in a 'big' city such as Albuquerque all seniors have part-time jobs in the relevant industry and hence they transition into full-time jobs very easily. High industry demand for graduating BS students coupled with the difficulties of hiring quality graduate students is indicative of shortage. Only in recent years has this led to any significant increase in starting salaries or mid-level salaries for Civil Engineers. However while this demand is true for Bachelors and Masters level graduates the situation for PhDs is nebulous at best and production is at times in the self-serving interest of academic departments which are rewarded for PhD production.

Discussion

The objective of this section is to depart from the conventional wisdom in the three areas identified earlier in the abstract.

Falacy #1: Government funding is behind the growth of engineering schools abroad

While this section uses India as a benchmark based on the author's personal experience, it is relevant to most emerging economies where market forces are of increasing significance. As mentioned earlier the growth of engineering schools and the consequent increase in output of engineering graduates in India is not due to direct government allocation. A complex interaction of socio-economic forces has led to the growth. For the 1st 50 years of Indian independence the nation was primarily focused on protecting the world's largest democracy through socialistic policies. With a few exceptions the government was the primary employer and hence bore the burden of creating an educated workforce. Admission to engineering schools especially the top tier Indian Institute of Technology (IITs, 5 campuses in the late 1970s) was limited to approximately 1,500 incoming students nationwide per year. The second category engineering schools such as the regional engineering colleges and state-run engineering schools could also be very selective in spite of the fact that their level of funding per student was a small fraction of that of the IITs. In all approximately 10-20 thousand engineering graduates were produced each year. Contrasting this to a population of approximately 900 million (which would typically have a graduating high-school class of approximately 15 million a year) implies that only an insignificant fraction of the population had access to engineering education. A large number of qualified students did not have access to engineering education or professional education of any sort.

In the past 20 years India has progressively opened its economy, which has led to significant increase in Gross Domestic Product (GDP) from approximately 4-5% per year to the current rate of 8-10% per year. Privatization implies that the government is no longer the sole (or primary) employer and hence the private sector is indirectly expected to pick up the tab for education. Also coupled with this is the advent of surplus capital in the hands of the upper middle class, which led to lower interest rates worldwide. The same phenomenon is responsible for low mortgage rates in the US in recent years. Loans for education were non-existent in the 1980s but readily available in the new millennium, due both to surplus capital (low interest rates) and low risk of unemployment upon graduation.

Availability of qualified workforce is one of two major reasons behind off-shoring, the other (often more significant) reason corporations are looking abroad is the potential market in those countries[3]. This too is a phenomena closely tied to privatization and open market policies.

Falacy #2: Increasing qualified engineering workforce is as simple as opening more engineering schools.

As a consequence of rapidly growing demand for engineering workforce in India (mostly in the Information Technology (IT) sector) and the availability of private funding, private engineering schools have proliferated. Most of these are 'under the umbrella' of well-established institutions and the curricula are fairly uniform. However implementation is not. Resource allocation for infrastructure, laboratories, faculty salaries and other forms of student facilities are inadequate. In the absence of accreditation standards quality control of programs and its graduates is illusionary. This is in spite of most private engineering schools charging upwards of $2,000 in tuition per year, a high amount compared to personal income. The government-funded universities and colleges, which were effectively free (including room) in the 1980s, have also instituted tuition fees in the range of $1,000 per year.

Production of Engineering graduates is not simply a function of engineering schools but builds on interest and training imparted in high-school and the formative years. Increased access to engineering education of the current era is not accompanied by a comparable access to high quality school-level education. The social complexities of these are much more formidable and include issues such as school funding, transportation, teacher's salaries etc.

Recruitment of good (academically excellent and committed) faculty is illusive. Private colleges do not offer tenure or the level of implied job security offered by the government sector. Academia also has to compete with the public sector in terms of salaries and perks and comes out woefully short. In the US the only reason faculty positions continue to be attractive is the opportunity to engage in research which supplements academic salary and allows the administration to use synergies between research and teaching to manage operational costs.

The situation in India is analogous in many transitioning economies such as Eastern Europe[4]. Enrollment increased 64% between 1994 and 2002. Private universities were authorized in 2000 and now have enrollment comparable to that of government-run universities. Meanwhile funding has not kept up with growth leading to large class size and dependence on part-time faculty.

In contrast the overall enrollment in undergraduate Engineering programs in the US has remained essentially unchanged between 1999 and 2006 while there have been shifts in interest among the various engineering disciplines[5].

Falacy #3: All Engineering is created equal.

It is critical in this context to isolate Information Technology from all other types of engineering (Mechanical, Civil, Chemical etc.), because of India' success in this sector and the growth of outsourcing. The top 20,000 high-school graduates in India can now be absorbed in a variety of IT-related degree programs. Since the availability and quality of high-school education has not increased in the same proportion, the ability of other fields of engineering to attract good students has dropped significantly. This also has implication on the US job market, which for decades benefited from a diverse pool of engineering graduate students from India. Today, such students are in general only available in Information Technology fields. Lucrative job offers at home prevent them from looking abroad for higher education or employment. The University of New Mexico is looking in other countries as potential sources of good graduate students. Education reform often precedes economic reform by decades. In India the investment in high-quality education in the 1960s has been an important factor in the current economic boom. Nations that have good educational systems but a sagging economy tend to be better sources of quality graduate students.

Within specific fields there are differences. A National Academies' report at the behest of the National Science Foundation points out that the US is particularly strong in areas of Mechanical Engineering that interface with other disciplines (bioengineering, design etc.) and lag in other areas of Mechanical Engineering such as Dynamics, Tribology etc.[6]. US authors still accounted for the lion's share of cited journal articles.

Conclusion

Actions that relate to the book 'The World in Flat' needs to distinguish between private and public funding, college education vs. pre and post college education in terms of resource needs and quality, and IT vs. non-IT engineering fields.

References

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