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THE DIRE STATE OF OUR UNIVERSITIES

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Introduction

Our university and technical-institute systems are in a dire state, continually marching towards lower standards. They mainly are producing 'worker bees' to feed the ever-growing markets for English-speaking, call-centre operators and computer coders to support the large software companies that cater to the overseas markets. While this does provide lucrative jobs for young college graduates, it comes at a major cost that can have long-term national security implications: Although the many rankings of such institutions may differ, none of our institutions rank amongst the top 400, and only two are listed in the top 500 universities in the world. In contrast, neighbouring Australia, China, Japan, Singapore, and South Korea have two, three, three, one, and one institution, respectively, within the first 100 best institutions in the world; even New Zealand has one university in the top 300. So, the annual fruitless ritual of ranking our technical institutes and universities – such as the various AIIMS, IIMs, and IITs, and the many burgeoning universities – is like trying to measure minor tuft-height differences on an otherwise smooth carpet surface. This is dangerous because it glosses over the really poor worldwide standing of our academic institutions.

This article attempts to identify the characteristics of great universities, how they become so, what it would take to stem the ever-declining standards of our universities, and even to dream of creating at least one Indian world-class, pace-setting academic institution.

Characteristics of Universities

The main characteristic of outstanding universities and technical institutes are determined by their faculty, comprising home-grown giants in their fields. They act as role models for the pipeline of new young PhD Assistant Professors from all over the world, only a select few of whom get promoted, the rest move on to the next tier of universities. Their senior faculty work on, and even define, leading edge research, influencing the focus of entry level-faculty. Their postgraduate students, amongst the best attracted from all over the world, are immersed in an atmosphere of leading-edge research, and learn about pioneering work being done elsewhere through outstanding invited seminar speakers. As a result, their PhD theses tend to push academic frontiers forward. An outstanding faculty from the best in the world, and the best postgraduate students from around the world, is what keeps these universities at the leading edge.

In contrast, in Indian universities – especially in technical institutes which for the longest period only had undergraduate programmes, where students were primarily taught by faculty with undergraduate degrees – MA and MSc students were guided by PhD faculty with limited abilities. This system had very little mobility, so that the departments stagnated – very few vacancies mainly created through retirements resulted in very little continuing infusion of fresh blood. In time, this faculty rose to higher ranks. Later, arguing that the old system with one full professor in a department did not have avenues for growth of other equally competent faculty, increasing pressure resulted in a system of time-bound promotions; in time, this culminated in more senior professors than newer incoming faculty members. The more disquieting result of this policy caused the departments to be manned by professors whose research, if any, fell far short of international norms. As a result, the rankings of these institutions fell with time.

Indian universities were modelled on Cambridge and Oxford, in which many colleges are affiliated to a university that sets the curriculum and acts as the centralized body for conducting examinations. It worked reasonably well when the number of affiliating colleges were few and the student body was small. Now, a large number of colleges with very large numbers of students appear in common university examinations. More importantly, because students essentially prepare for examinations for narrowly defined syllabi, the faculty in a college have very little freedom and incentive to innovate. In this system the only difference between the more desirable colleges and others is that the former has better facilities and faculty, which helps them attract the best students, and thereby produce the 'best results.' This purpose could be more efficiently served by a centralized national university that examines all Indian university students through common examinations based on a common rigidly defined curriculum. But creativity would still suffer as in the current university system.

Evolution of Modern Universities – Focus on Curricular Reform & Research

Most western countries have outstanding universities; the largest number of which, with the largest student bodies, are in the US. Prior to World War II the US was served by two types of universities: (1) The pace-setting, Ivy League Schools with distinguished faculty – Harvard, Columbia, Cornell, Dartmouth, University of Pennsylvania, Brown, Yale, and Princeton. These privately funded universities, which took great pride in the *quality* of scholarship, had large endowments that – with continuing increases from alumni bequests – allowed them to nurture their faculty without having to worry about funding; they hired and nurtured the best PhD students to grow their faculty inhouse. Until the first quarter of the twentieth century, undergraduate education emphasized liberal arts education; the quality of instruction of undergraduates was very high. These elite schools had high fees and mostly catered to the upper, wealthy classes; preference to admission was given to children of alumni. While some of these universities had strong programs in mathematics and science, even the best of them did not compare with the European universities, such as Cambridge in the UK and Göttingen in Germany, wherein the standard of postgraduate education was far superior, and research was at the frontiers of science. During that period, aspiring Americans went to these leading universities for obtaining their PhDs. (2) The state-funded (government), land-grant colleges – so-called because of the land granted by the states – often having 'Agricultural & Mechanical' in their names, aimed at improving agriculture and providing support for agricultural equipment. These state-supported schools, with modest fees, focused on educating very large student bodies. The faculty essentially spent most of their time in teaching undergraduates; research had little priority.

Then, because of Hitler's racial and Benito Mussolini's fascist policies, a host of superstar mathematicians, scientists, and engineers immigrated to the US in the 1930s: Among them, Albert Einstein (1933) and Hans Bethe (1935) from Germany; Kurt Gödel (1933) from the Czech Republic; Theodore von Karman (1930), John von Neumann (1933), Eugene Wigner (1933), Edward Teller (1935), and Leo Szilard (1938) – all five from Hungary; and Enrico Fermi (1938) from Italy. Wherever these masterminds went they seeded future centres of excellence. In addition, they were magnets for attracting many distinguished visitors and research scholars, resulting in America eventually becoming the preeminent centre for universities and research.

World War II catalysed rapid changes in both the quality and quantity of science and engineering in which many universities were actively involved. Examples of these innovations include the construction of the first programable digital computer (the ENIAC) at the University of Pennsylvania, the development of radar in the Lincoln Labs affiliated with MIT, the development of the atom bomb, advances in jet engine design and manufacture, and the development of faster aeroplanes. The subsequent Cold War, which essentially became a race for science and technology leadership, provided consulting opportunities for faculty from research universities because, at that time, industry – which was mainly geared towards providing technology for the slowly-moving peacetime needs of society – did not have engineers with advanced degrees to tackle the totally new challenges. These developments resulted in qualitative improvements in engineering curricula.

In November 1944, President Roosevelt asked the Director of the Office of Scientific Research and Development, Vannevar Bush, to map how the successful application of scientific knowledge to wartime problems could be carried over into peacetime, and to recommend a national policy for science. In 1945, Bush presented his report, "Science: The Endless Frontier." to President Harry S. Truman; it envisioned a new agency, the mission of which would promote progress of science by supporting basic research at colleges and universities. In 1950, the US Congress passed a law establishing the National Science Foundation (NSF) and the National Science Board. Over the years the NSF has grown into a large agency that supports university research through highly competitive grants.

The Cold War catalyzed a broader study of engineering education, of which the most notable was the 1955 Grinter Report – chaired by Linton E. Grinter from the University of Florida. This report, quite controversial in its time in the postwar era, is widely recognized for having pushed the concept of engineering science, and for establishing a more science-based engineering curriculum; its recommendation to give a more prominent place to the humanities and social sciences was even more contentious.

Then, in 1957, at the height of the Cold War, the launch of the first satellite, the Sputnik, by the Soviet Union surprised and shocked Western nations. This catalysed the formation of the Defense Advanced Projects Agency (DARPA) in the US with the objective of assuring that "it would be the initiator and not the victim of strategic technological surprises."

In addition to funding innovative projects within the government and industry, DARPA initially became an important source of funding for the universities. Besides spectacular advances in military applications, such as precision weapons and stealth technology, DARPA initiated the Internet, automated voice recognition and language translation, and Global Positioning Systems.

DARPA funding also resulted in major increases in research in the state-supported universities that till then had mainly focused on undergraduate teaching. Exceptions, such as the University of California, Berkely, and the University of Michigan, Ann Arbor, which had good research programmes in some departments, became leading-edge centres of excellence. Another change was that universities no longer had to rely on long gestation periods for developing faculty. They could 'buy' outstanding faculty to jump-start the quality of their departments – for example, the University of Texas, Austin, hiring away two Nobel Laureates, Julian Schwinger from Harvard, and Archibald Wheeler from Princeton.

Not only did this competitive environment result in an enormous increase in the production of postgraduate students, it catalysed major curricular reform in undergraduate technical education: Prior to World War II, engineering education was machine, or technology driven, with a few courses of mathematics and science taught by faculty from what, essentially, were service departments that did little or no research. The unpopular 'humanities' and 'economics' courses essentially taught technical writing and 'industrial economics.' This paradigm was adequate for an era in which technology was evolving very slowly – technical education mainly focused on design and manufacture – but lacked the innovative spirit to respond to faster changes. As an example, because the 'fluid mechanics' taught to engineers – called hydraulics, a mish-mash of empirical data mainly used for the design of civil works such as canals and dams, and for pumping water, which Theodore von Karman called 'the science of varying constants' – was totally inadequate for characterising the flow of air past aerofoil sections that form the wings of aircraft, the new discipline of aeronautical engineering was spawned. Mechanical engineering, which should have covered the design of aeroplanes, essentially mechanical devices, at that time focused on heavy equipment for the design of which 'factors of safety' were used to cover inadequate evaluation of stresses – this process could not be applied to design aircraft, for which low weight is a prime requirement.

In the 1950s, changes in the old technology-based curricula to the more engineering-science oriented programs, with a healthy dose of the humanities and social sciences, accelerated, as did the growth of new departments to cover emerging fields. Besides excelling in all fields of basic science, MIT spawned major revolutions in fields as diverse as linguistics and cognitive science. As a result, MIT is now the highest rated university in the world, excelling in almost every field. One important measure for the standing of a university is the honours and awards received by its community. A partial list for MIT includes 100 Nobel Prizes, 60 US National Medals of Science, 30 US National Medals of Technology and Innovation, 81 MacArthur Fellows, 16 A.M. Turing Awards, and 6 Pulitzer Prizes.

Consequences of Demographics & Indian University Education Funding Patterns

As mentioned earlier, in the US the highest-quality education is imparted to a relatively small student body by the privately-funded Ivy League Schools, the very large endowments of which allow them to focus on quality and grow the best faculty that continually seeks to work on new frontiers of knowledge. Although these schools have very high tuition, once a student has been admitted purely on merit, depending on the student's financial standing, generous merit-based grants can reduce the tuition to zero. Also, these schools consciously seek diversity among their undergraduates, including overseas students. The curricula in these universities are not rigidly defined and the faculty has complete freedom on what and how to teach it. In contrast, the state-funded, land-grant schools (universities), which have relatively low affordable tuitions, cater to the bulk of the very large body of undergraduate students. While postgraduate education has improved in such schools, the academic standards are modest. Notable exceptions include the University of California, Berkeley, and the University of Michigan at Ann Arbor.

In stark contrast, the funding patterns are reversed in India: The bulk of higher education is funded by Government agencies. Many institutions, such as the IITs, the IIMs, and the AIIMs, helped raise Indian academic standards in post-independence India. In principle, these autonomous institutions are free to develop and manage curricula. But their ability to innovate is limited by the quality of faculty that is conditioned by the traditional curricula they have studied. Notable exceptions are high-quality institutes set up with private funding, such as the Indian Institute of Science, Bengaluru, established in

1909 with the active support of Jamsetji Nusserwanji Tata, and the Tata Institute of Fundamental Research, now in Mumbai, set up in 1944 with the active support of J.R.D. Tata, both of which at their inception were heads and shoulders above all other Indian universities. Examples of other privately-funded undergraduate engineering colleges include the G.D. Birla-funded engineering college, BITS, established at Pilani in 1964, which has evolved into a full-fledged university. All these institutions are now essentially government funded.

Together with a major push for literacy, India's rapidly growing population resulted in ever increasing numbers of high-school graduates. The political imperative of increasing seats in universities to match the ever-growing demand from these high-school graduates was understandable. Unfortunately, the government took the easy way out, especially in technical education: It rapidly increased the number of IITs from 6 to 23, while at the same time increasing the number of undergraduates. This single action resulted in watering down the standards of the IITs and in limiting their chances of achieving international standards. Instead, the Regional Engineering Colleges, now called the National Institutes of Technology, should have been the ones expanded to accommodate the large body of students aspiring to attend engineering colleges; this would have allowed the first six IITs to focus on high-quality postgraduate education and research. Many of the current IITs cannot even match the standards of several of the older, better-quality Regional Engineering Colleges.

At the same time, university-level education was opened up to private enterprise. While very few such private universities have acceptable standards – a positive example of what is possible with private funding is the high-quality Manipal (Mangaluru) group of institutions – the bulk of the mushrooming universities and technical colleges essentially are 'mom and pop' money-making enterprises that just pay lip-service to quality. Their faculty quality and student admission-standards are low; essentially, students rejected by regular universities are admitted to these institutions by paying exorbitantly high fees. Some such universities have even been charged with 'selling degrees!'

So, the Indian higher education system is two-tiered: First are the well-funded government institutions with relatively modest fees that attract the best students, but even they do not fall within the top 400 universities in the world. Second are the mushrooming privately-funded, money-making 'universities' that are patronized by students who do not have adequate academic credentials.

If university standards are as low as asserted in this article, then what explains the success of the products, namely the students? The answer lies in the superior quality of Indian students vying to get into the best technical schools – as opposed to advanced countries, in India the very best students go in for engineering and computer science.

Technical Education in India

The first engineering college in India – Thomason College (which later become IIT Roorkee) – was established in Roorkee 1847 to train Civil Engineers. This was followed by Civil Engineering College at Pune (1854), Bengal Engineering College in Shibpur (1856), Banaras Hindu University (which later spawned IIT (BHU) Varanasi) (1916), and Harcourt Butler Technological Institute, Kanpur (1920). These institutions offered practice-oriented curricula that, while initially current, did not change much with time. As an example, the engineering curricula in Banaras Engineering College did not change much between 1930 and 1955, at which time students still were designing compound-expansion steam engines, even though that technology essentially had been on its way out for some time.

The All India Council for Technical Education was established in 1945 to oversee all technological education (diploma, degree and postgraduate) in the country. Recognizing the dated state of engineering education, in 1945 the Indian British Administration appointed the Sarkar Committee to map the requirements for technical education in the post-WWII era; it recommended the creation of four high-quality engineering colleges – of the calibre of 'University of Manchester and MIT' – one each to be set up in East, West, North, and South India. In post-independent India they were realized in four greenfield engineering institutes: The first four IITs – at Kharagpur (1951), IIT Bombay (1958), IIT Madras (1959), and IIT Kanpur (1960) – were set up by the Government of India's Institutes of India Act, 1961, which was later amended to include IIT Delhi (1961), and, much later, IIT Guwahati (1995). Most of them followed the practices of the financial donor countries – Kharagpur with UNESCO aid, and WWII surplus equipment essentially had the same curriculum as existing colleges but had better quality faculty, and also started postgraduate programmes; Bombay with Russian aid emphasized heavy equipment; Madras with German aid emphasized engineering practice; and Kanpur with American aid emphasized a multidisciplinary, engineering-science, and humanities and social-sciences oriented approach.

The curricula in these IITs were slightly better than in existing colleges, but they produced better results mainly because of the exceptional-quality students they attracted. IIT Kanpur was an exception: While its curriculum for the first three years was no better than in most engineering colleges, the involvement of nine American universities – Massachusetts Institute of Technology, California Institute of Technology, Carnegie Institute of Technology, Princeton University, University of Michigan, University of California Berkely, Purdue University, Ohio State University, and the Case Institute of Technology – resulted in a new five-year curriculum based on the recommendations of the Grinter Report – perhaps the only institution in the world to base the entire curriculum on its recommendations. Because the new engineering-science based curriculum also stressed humanities and social-science courses, students were required to take one such course every semester. IITK was the first to introduce the semester system, to teach computer science, and to initiate student placement. More importantly, it was the first to emphasize only hiring faculty with PhDs, with little emphasis on experience, resulting in a very young faculty. It instituted a strong committee structure in which all academic decisions were made by faculty committees with representatives from each department, the headships of which were by rotation for three-year periods. This system provided a sense of ownership to the faculty that was free to try out novel courses and methods of teaching. At the urging of the young faculty, postgraduate courses were started by several departments before the first undergraduate class had graduated. Although it initially drew much criticism, the experiments at IIT Kanpur had a profound effect, and became a role model for major changes in Indian technical education.

At a time when in the IITs had a 30% shortfall in qualified faculty, and just when the IITs were beginning to initiate nascent PhD programmes, driven by the ever-increasing demand from the enormous output of high schools, in 2008 the government approved the creation of eight new IITs, and at the same time, asked for major expansion in the number of students. And, as opposed to the Sarkar Committee recommendations, two existing colleges – at Roorkee and Banaras Hindu University – were upgraded to IITs. This effectively killed what should have been a push for postgraduate education and high-quality research, and set the path for an irreversible continuing decline in the status of our institutes, which now essentially are factories for pumping out large numbers of undergraduate students. Without understanding how difficult it is to improve the quality of academic institutions, in one stroke the government demonstrated how easy it is to lower academic standards. Just as cutting down an existing orchard takes little time, but planting and growing a new one takes over a decade.

The flaws in the IIT system had been pointed out earlier: In 2008, as Chairman of a central panel tasked with reviewing higher education, Yash Pal, a former Chairman of the University Grants Commission (UGC), said, “The IITs are today a little more than undergraduate factories. That needs to change. They must be converted to help improve the standard of research that is far behind top institutes in the developed world.” One possible solution considered was to transform the IITs into full-fledged universities, which the Directors of the six existing IITs had opposed. But the initial expansion of the IITs by eight did not stop; today India has 23 IITs.

Unfortunately, experts charged with overseeing the quality of our academic institutions come from the same mediocre faculty pool: When asked to evaluate advanced strategic technologies in which our competitors have been growing expertise for some time, their approach is to throw money in those areas, such as AI and drone technology, into the existing nonperforming IIT system. Metaphorically, this is similar to funding geographers in the flat-earth era to prepare more detailed maps of the world.

The decline of the universities is accelerated by the poor quality of students entering postgraduate programmes: The best graduates of the IITs either go abroad for further studies or join the IIMs or accept jobs in industry; some join the competitive government services such as IAS. The remaining students, mainly from second and third tier colleges, join masters’ (MTech) programmes. The best of the MTechs go abroad; those that cannot find jobs join PhD programs. The PhD streams are mostly fed by students up the chain from second or third tier colleges. Then, because of acute shortage of faculty in the technical institutes, these PhDs with weak academic backgrounds start filling the vacant faculty positions in the many burgeoning IITs, the academic standards of which are thereby doomed from the very beginning.

Path Forward

Quality does not from quantity follow. The nation must decide whether it wants to continue along the trading-mentality path of only producing worker bees for short-term gain, or whether it also wants to stand tall among the academically advanced countries. The world is now changing at an exponential rate, just standing still means falling behind.

The current paradigm will result in a continuing decline in the standards of our institutes and universities; at the very least, steps should be taken to stem this tide. Immediate, implementable solutions include insulating the top four to six IITs from the pressures of undergraduate education, getting them to focus on postgraduate education and innovative research, and hiring only the highest quality faculty possible, which will require substantially increased salaries; also, their names must be changed to differentiate them from the other institutes. They must aim at attracting the best graduates to join the postgraduate programs. A medium-term objective for these institutions should be for them to fall within the first 200 universities in the world.

Following the example of why the IITs were established in the first place, we need to create a few institutions of international standing that can set the bar for the other institutes and universities. This will require competitive, international-level salaries and an infrastructure to attract the best faculty in the world, together with ample funding for their postgraduate students. How this would be actualized requires much creative thought. But if we want such an institution in our country, which must attract the best faculty and students from all over the world, we must be willing to change our education paradigms.

World-class institutes and universities cannot be created overnight – such transformations require a generational timeframe. First, considering its long-term security needs, the nation must decide whether or not it wants a truly world-class institute, and whether it would provide the required long-term funding. Then, as a nation, it must set a *long-term* objective to create a world class institute or university. The nation must recognize the time scale for this, and provide funding accordingly. An alternative could be to create narrowly focused institutes, such as for advanced computer science focused on emerging areas such as artificial intelligence.

While current funding patterns would point to the government, it may be time for the many world-class Indian companies to take-up the challenge of financing a truly world-class institute in the spirit with which Jamsetji Nusserwanji Tata established the pace-setting Indian Institute of Science nearly a century back.