Exporting MIT: Science, Technology and Nation-Building in India and Iran

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Introduction

MIT redefined engineering education in the 1950s, then became a model and mentor for the rest of the world in the 1960s and 1970s. Responding to the challenge of US policy makers and foundation officials, and driven by its own sense of mission as the center of an international network of engineering research, teaching, and practice, MIT assisted in establishing two new technical institutes in India, and a third in Iran. The sponsors and supporters of these efforts, both in the US and in the host countries, expected these junior MITs to provide the engineering expertise and leadership considered essential for economic and political modernization. While acknowledging that the "MIT Idea" might be difficult to define precisely, and even more difficult to emulate, its proponents agreed that they could "identify the major characteristics of MIT which has made it different from other institutions of technology, and… that this characteristic is an exportable quantity."[1]

Predictably, given MIT's long tradition of relative autonomy among schools and departments, the "MIT idea" could be interpreted any number of ways. Some faculty and administrators looked back to pre-war MIT, where an emphasis on engineering practice and cooperative education set the pace. Others looked to post-war MIT, where "engineering science" and a closer coupling of the basic sciences and engineering throughout the curriculum and through interdepartmental laboratories prevailed. Post-war MIT, they recognized, encouraged a new entrepreneurial spirit most visible in the startup companies that turned Route 128 from "the road to nowhere" into the main street of high technology industry.[2] Still others looked ahead to a future MIT where interdisciplinary centers would reorganize research and teaching around sets of problems rather than by conventional departments. Each version of MIT would have its champions, and its opportunity, as an appropriate model for engineering education in the developing world.

Gordon Brown, a key figure in all three technical assistance programs, embodied the "MIT idea"--past, present, and future. As an MIT undergraduate and graduate student in the 1930s, Brown studied in an electrical engineering department still dominated by power systems and analog computing. During the war, as an ambitious young professor, he founded the Servomechanisms Laboratory, which pioneered digital computing and numerical control for machine tools. Named head of the electrical engineering department in 1952, Brown overhauled the curriculum for the electronics age, with a solid foundation in advanced mathematics and fundamental science.[3] As Dean of Engineering, beginning in 1959, Brown extended his ideas about "The Engineering Of Science" to the entire school, backed by a $9 million grant from the Ford Foundation for "the development of a science-based engineering curriculum"[4]. Engineering, for Brown, would be more theoretically rigorous, but no less practical: "The tough part of the program that we now envision at MIT will be to help students acquire the purposefulness, the creativity and the sound judgment found in the brilliant engineering of science—and become men who get things done."[5] Brown called his vision a "University Polarized Around Science", a place where the basic sciences encompassed and contributed to interdisciplinary centers, constituent departments, and education at all levels.

Whatever else the "MIT Idea" may have implied, for Brown and his colleagues it meant national, indeed international, leadership. MIT considered itself a national resource, never more so in the 1960s when its laboratories constituted America's "first line of defense"[6] and its faculty and administrators served as prominent policy advisors to the White House. Was any other university better positioned to make good on the challenge, first laid down as the 'fourth point' in President Truman's inaugural address of 1949, to "embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas"?[7]

Oddly enough, given the relative numbers and reputation, the work of MIT's social scientists has overshadowed the arguably more enduring foreign policy legacy of its engineers, who believed that MIT itself could be a powerful model for economic development and nation building. MIT's Center for International Studies (CENIS), under the leadership of Walter Rostow and Max Millikan certainly helped put modernization theory and "nation building" at the center of America's foreign policy agenda for the developing world. Rostow's influential The Stages of Economic Growth, provocatively subtitled 'a non-communist manifesto", provided a compelling vision for a postcolonial world, and led to Rostow's appointment as a highly placed advisor on foreign policy for the Kennedy and Johnson presidencies.[8]

Though certainly aware of CENIS and modernization theory, MIT's engineers had another agenda, to train the future engineers and engineer-administrators capable of leading developing nations to modernization. Having spent a decade perfecting engineering education at home, they welcomed the opportunities offered by the Department of State, by the Ford Foundation, and by businessmen and political leaders in developing countries, to share their hard-won success abroad. They recognized that MIT drew much of its strength from its relevance to the particular technological challenges facing the US, and that any foreign version of MIT would have to do the same within its national context. Still, they believed that the "MIT idea" could provide at least a road map for other countries. Much like Rostow's 'stages of economic growth,' there might be regional variation, but no serious alternative. Brown and his colleagues believed that modern engineering, like modern capitalism, was essentially global and linear. The less developed would advance by learning from and emulating the more developed.

However committed in principle to modifying the "MIT Idea" to accommodate local goals and resources, in practice the intellectual architects of these new MITs could never really let go of their original blueprints, nor imagine genuine alternatives. Had they been able to understand how much the models of technical education they offered India and Iran embedded within them distinctly American experiences and expectations , they, and their sponsors, might have been less surprised when these new schools found themselves at odds with the political and economic realities of places with different histories, visions, and values.

IIT-Kanpur

IIT-Kanpur took contemporary MIT as the appropriate model for the developing world, underscoring "engineering science" and cutting edge research in fields such as electronics, computer science, and aeronautics. No non-aligned nation seemed more pivotal to US interests in the late 1950s and early 1960s than India, and none more supportive of efforts to upgrade its science and engineering education.[9] John F. Kennedy, as senator and later as president, considered India a critical yardstick of democracy and economic development in the contest with China, and so a major target for US foreign aid.[10] The Ford Foundation likewise looked to India as a testing ground for new initiatives in economic planning and development.[11]

India inherited from the British a system of technical education "geared only to produce overseers, surveyors and mechanics of various hues, just as literary education produced clerks and pleaders."[12] While India could boast some notable scientific institutions (The Indian

Institute of Science) with some world-class talent (C. V. Raman, H. J. Bhabha), engineering lagged far behind. Its few strengths lay in civil engineering, primarily for railroad and irrigation projects intended to sharpen Britain's "tools of empire."[13] Britain opened a half dozen engineering colleges under the raj, but kept their graduates clearly subordinate to their imperial supervisors.[14]

In planning for independence, Indian and British officials alike looked to MIT as the appropriate model for technical education in the national interest. Even before World War II, MIT had been the destination of choice for many aspiring Indian engineers, who considered its science and laboratory-based instruction a refreshing departure from an Indian educational system still dominated by lecture and recitation and the "affectation and snobbery often found at elite British universities."[15] Separate studies by British Nobel-laureate A.V. Hill and by Ardeshir Dala, the director of the Tata Iron and Steel Company (and Viceroy Executive Council member) concluded that an "Indian MIT", indeed several of them, would be critical in helping the country prepare itself for economic as well as political independence. With support at the highest levels of Indian industry and government, a blue-ribbon panel headed by N.R.Sarkar formally recommended "not less than four higher technical institutions", geographically dispersed throughout the country but sharing a curriculum modeled on MIT's.[16] Prime Minister Jawaharlal Nehru, a strong advocate of science and technology in the service of the state, personally laid the foundation stone for the first IIT, at Kharagpur, near Calcutta, in 1951, calling it India's "future in the making."[17] IIT-Kharagpur's founders envisioned it as the template for the ITTs to come, with sufficient autonomy to ensure its standing as an "institution of national importance." India's faltering economy during the first five-year plan and an apparent surplus of engineers put the other IITs on hold for the moment.

Paradoxically, the first "Indian MIT" got no direct advice from MIT. Despite assistance from the Americans (principally through the University of Illinois), the Soviets and even the West Germans, IIT-Kharagpur never received sufficient financial or intellectual resources to break the traditional mold of Indian higher education. While perhaps inspired by MIT, IIT-Kharagpur, as its first ten-year review concluded, was no MIT. **Prime Minister Nehru wished to balance influences of East and West, and sought to diversify India's educational portfolio by establishing IIT's based on several national models.** Determined to push ahead, Nehru jump-started the IIT program by challenging UNESCO and its members to support India as generously as it had developing nations elsewhere. He subsequently secured cooperative agreements for additional IITs in Bombay (in partnership with the Soviets), Madras (in partnership with the West Germans), and New Delhi (the British).[18]

India clearly expected US assistance for IIT-Kanpur, already slated for a textile city southeast of Delhi. In 1958, the International Cooperative Administration (ICA) invited MIT to send a team to India and help prepare an initial blueprint for IIT-Kanpur. When MIT begged off, citing a shortage of manpower, the US sent the American Society for Engineering Education (ASEE) instead. Gordon Brown, for one, considered the ASEE's subsequent recommendations little more than a blueprint for "an institution similar to the engineering school one would find in a good, middle-western state university" and sought assurances that if MIT got involved, IIT-Kanpur would become "<u>the</u> graduate and research technological institute" of India.[19]

The Indian government did its best to make MIT an offer it could not refuse. Max Millikan, then in India for CENIS, reported to MIT president Julius Stratton that India's government advisor on science and engineering education, and the former head of the Indian Institute of Science, M.S. Thacker, had "underlined the willingness of the Indian government to meet almost any conditions to persuade M.I.T. to take on this task" and added that "we are unlikely to find any opportunity for institutional assistance to science and engineering in the underdeveloped world more promising and more practicable than this one."[20] Ford Foundation president Henry Heald (who had just given MIT its largest single grant) appealed to MIT's sense of obligation, and its vanity:

> MIT has such a splendid reputation throughout the world that it would be an excellent thing for it to sponsor an institution which could hope to have something like equal significance in the Asian area. If the proposed Indian Institute is intended to aspire to such a position of leadership, then MIT should help. On the other hand, if this is to be just another college of engineering then some other American institution would do as well.[21]

Bowing to the pressure, MIT appointed a three-man delegation led by mechanical engineer Norman Dahl to study the prospects for IIT-Kanpur. Dahl and his colleagues learned what they could from catalogs and other sources, then spent January 1961 on a whirlwind tour of India that included meetings with government officials, visits to the other IITs, universities, national laboratories, and selected industries. The MIT team praised Indian undergraduate education--"They pray to the same gods we do!" one member commented[22]—and discovered that Kanpur was not entirely the industrial backwater they had imainged. The newly appointed head of IIT-Kanpur, P. K. Kelkar, the former deputy director of IIT-Bombay, genuinely impressed them as a person of intelligence, energy, and vision. He seemed to them to have "a philosophy of engineering education similar to our own and an eagerness to push ahead at Kanpur with an experiment along completely American lines", with American rather than British-style examinations, US textbooks, and strong graduate and faculty research programs.[23] MIT agreed to organize and lead the Kanpur Indo-American Program (KIAP), to be funded by the USAID, and subsequently invited Caltech, Carnegie-Mellon, Case Institute, Berkeley, Purdue, Ohio State, Michigan, and Princeton to join in advising and assisting IIT-Kanpur.[24]

As Dahl read the landscape, “The primary engineering need there is for ‘problem recognizing’ and ‘problem solving’ graduates who will have the confidence, inclination, and training to do something about India’s problems.” [25] Given the limited numbers of potential US faculty, KIAP’s long-term goal would be recruiting and training a permanent Indian faculty. Top-quality Indian engineers could be found in abundance in US universities and industries. How many, though, would be willing to relocate and remain in Kanpur? The Americans wondered if India was even ready for modern engineers. A future program director from MIT told Dahl after an initial visit:

> I have come to realize that the Indian culture is straining through a transition period and is in many ways only superficially receptive to the objective techniques of science and engineering. The capable, modern, imaginative engineer with initiative is a misfit, a man a little ahead of his time who must have courage, perseverance and patience in the face of endless frustration.[26]

That assessment perhaps said more about American prejudice than India experience. For the Americans, Kanpur seemed “the poorest, most backward, most unattractive part of India…With the exception of the few on the faculty who ‘belong to’ Kanpur, as the phrase goes, there is probably no one from the Director on down who would not prefer to live somewhere else—and who could not get as good or better a job somewhere else—in India.”[27] For many Indians, on the other hand, IIT-Kanpur was a place where they thought they could make a difference. The first round of faculty postings brought in a thousand applications, a fifth of them from the US and Western Europe.[28] Two-thirds of the Indian faculty earned their degrees in US universities. Those without foreign degrees or experience were often sent to one of the consortium universities for advanced training, and then paired with American counterparts on individual research projects once they returned. Turnover was far less than at the other IITs.

Despite initial skepticism, MIT aeronautical engineer Robert Halfman, KIAP's second program leader, had to admit "that the faculty already gathered here is a really first-rate group without equal in India…the word is really now going around among overseas Indians as well as within India that IIT/Kanpur is the place to go because that is where things are really happening."[29] With 1000 undergraduates, 400 graduate students, and 150 faculty, IIT-Kanpur was on the move. From the start, undergraduate admission was dauntingly rigorous. The first hundred students came from a pool of 7735![30] All told, IIT-Kanpur would receive $14.5 million in US aid for American "experts", fellowships for Indian faculty, and equipment.[31] The Indian government invested even more.

Even though India had intended IIT-Kanpur to draw on the US model, "American style" had its drawbacks, especially during tense political relations between the US and India, notably the second war between India and Pakistan over Kashmir in 1965 and US arms sales and military assistance to then East Pakistan in 1971.[32] IIT-Kanpur **still** endured bitter debates over English (the language of instruction at IIT-Kanpur); **(unproven)** accusations of CIA infiltration; late, lost or damaged laboratory equipment; student strikes; and **some** Indian officials unaccountably (at least to the American faculty) enthusiastic about the Soviet models of technical education **being tried at Bombay.[33] For the most part, those disputes reflected limited American awareness of Indian history, politics and academic culture--the British colonial legacy, a sometimes strident political neutrality, an overly bureaucratic and occasionally corrupt national educational system. Should it be all that surprising that Indian students, much like their counterparts in the developed world, would become**

increasingly willing to challenge conventional academic authority? MIT would face far more serious campus demonstrations at home over CIA funding, classified research, and defense contracts.[34]

Far more troubling than petty resistance to American methods was a sense that IIT-Kanpur might be pushing itself to the front rank of Indian engineering education on terms set by its American advisors, not by Indian engineering educators themselves. If anything, perhaps the Indians had not been forceful enough in questioning American assumptions. After reading Halfman's "End-of-Tour-Report" (essentially a five-year evaluation), the USAID bureau chief for South Asia asked the $14.5 million question:

> How does A.I.D. manage to steer institutions in the direction of the West and orient personnel to the West, without educating the personnel away from their own environment?…Could we not hypothesize that the bringing of scholars regularly to this country from Kanpur might operate to alienate them from their own environment and contribute to the very thing that Dr. Halfman says India cannot afford, namely 'research designed primarily to raise individual investigators to international reputations.[35]

Perhaps the biggest disappointment for the Americans was Indian industry's apparent indifference to IIT-Kanpur. India's top educational advisor had predicted as much at an early planning meeting at MIT. "Industry in India," he said, "has not yet reached a stage of development or enlightenment that is sufficient to generate ideas within the technological institutes."[36] Would-be faculty consultants discovered that local companies "manufacture the way they have always manufactured. Or if they adopt a new process or a new machine, they usually bring process, machine, and even know-how in from the outside."[37] An "electronics park" to take advantage of IIT-Kanpur's growing strength in electrical engineering--"With encouragement there might be repeated at Kanpur the type of industrial development that has occurred around M.I.T. in Boston and around Stanford in Palo Alto"[38]—went nowhere. So did a proposal to create a center of excellence in nuclear engineering. Pioneering programs in aeronautical engineering, computer science, and materials science, so effective at MIT, turned out students overqualified for jobs at home and best prepared for graduate training and eventual employment abroad.

By the end of the ten-year KIAP contract in 1972 the Americans and their Indian partners had accomplished more than anyone thought possible. Virtually from scratch, they had created one of "India's intellectual treasures." IIT-Kanpur had an undergraduate enrollment of 1600, a graduate enrollment of 400 and a faculty of 260, 132 of them Indian scholars recruited from abroad. Altogether, 122 American faculty spent time at IIT-Kanpur, while 47 IIT-Kanpur faculty and staff trained at KIAP institutions.[39] IIT-Kanpur's computer science program had become the envy of India, thanks to its IBM 1620 (India's first) installed in 1963, and an IBM 7044, added three years later. IIT-Kanpur's short courses, workshops and conferences made it an internationally recognized center in computer science and trained the first generation of Indian programmers.[40]

Perhaps IIT-Kanpur modeled itself too closely on MIT. Dahl moved on to the Ford Foundation, and from that broader perspective had to acknowledge that despite its founding mission, IIT-Kanpur had so far "been an irrelevant factor in the industrial and social progress of India….a kind of isolated island of academic excellence but not part of the mainstream of India's development."[41] In the short run, at least, IIT-Kanpur accelerated rather than reversed India's 'brain drain'. Of the 840 undergraduates who had earned degrees by 1971, a quarter had gone abroad to complete their educations, while a fifth of the 576 master's students had done so, including the cream of the crop. None of the 111 Ph.D. graduates had taken a position abroad, because the best prospective candidates had already left for US universities.[42]

KIAP's founders intended to create an Indian MIT, not merely an MIT in India.

> [It is] critically important for the faculty and staff to develop a pride in the Institute as an Indian institute of technology not as an imitation of some foreign technological institute. This entails an orientation toward problems confronting India and a realization that the development of an Indian technology for dealing with Indian problems can be both interesting and exciting….It does no good to plan an ambitious program and then watch the best B. Tech., M. Tech., and M.Sc. graduates go off to foreign countries to complete their studies….Technological institutions in the West have been successful primarily because they applied themselves to problems of local or national importance. The same model must apply to IIT Kanpur. Its constituency is India and the Indian people[43]

In practice, though, IIT-Kanpur had not yet established its independent identify as an Indian Institute of Technology attuned to local or national challenges, nor has it since, sending up to four-fifths of its computer science graduates on to the US. More than three decades after its founding, IIT's-Kanpur's graduates remained "the only high-tech product in which India is internationally competitive."[44] As a common witticism in India holds, "when a student enrolls at an IIT, his spirit is said to ascend to America. After graduation, his body follows."

Birla Institute of Technology and Science

The Birla Institute of Technology and Science (BITS) looked to MIT's past as the right model for India, with an emphasis on cooperative education and collaboration with local industry. Industrialist G.D. Birla decided that his companies, and his country, needed a private IIT, and that MIT alone should provide the blueprint for the institute and train its faculty. A self-made 'mogul' in the Carnegie and Rockefeller tradition, Birla parlayed his original jute mill near Calcutta into a powerful conglomerate with holdings in textile mills and paper mills, aluminum and copper foundries, and light and heavy manufacturing. A political insider and long-time confidant of Gandhi (who would be assassinated in the garden at Birla House in New Delhi), Birla sought a middle way between Gandhi's self-sufficient villages and Nehru's state socialism, and saw India's entrepreneurial spirit as the key to its industrial progress and eventual self-reliance.

To cultivate that spirit, and to train future engineers and managers for his own companies, Birla invested heavily in vocationally-oriented education at all levels, from kindergartens to the Technological Institute of Textiles in the Punjab, with its own 600- loom mill.[45] As a final legacy, he proposed endowing an all-India Institute of Technology modeled on MIT, and in so doing, comments his biographer, "showed himself to be an enthusiastic participant in Nehru's project of nation-building with its emphasis on science, technology and modernization."[46] With no patience for middlemen, Birla wrote directly and repeatedly to James Killian, chairman of MIT's board of trustees, until he got an answer. Killian finally provided a list of prospective consultants, headed by Thomas Drew, an MIT graduate in chemical engineering who had spent his professional career at Columbia University. Drew, nearing retirement, found the idea of advising or perhaps heading Birla's Institute "to say the least, intriguing and I am in fact not so firmly wedded to Columbia that I could not be persuaded by a good cause."[47] Birla could be very persuasive. He hosted Drew that summer in India where they discovered a shared conviction that what India needed most were neither narrowly trained "technicians" nor "highly sophisticated research engineers" but instead "field and plant and applications engineers (as distinguished from 'desk engineers') able to take the responsibility of figuring out what needs to be done in the circumstances, [and] how to do it in the Indian scene with Indian materials and workmen."[48]

Birla next shopped his idea to the Ford Foundation's India representative, Douglas Ensminger. The Ford Foundation had recently begun funding European physics, as much to promote American values and cultural reintegration as to advance science.[49] Its only technology program in India, outside agriculture, had been on-the-job training for 500 young Indian production engineers in US steel plants.[50] Ensminger immediately recognized in Birla's ideas an important opportunity for the Ford Foundation to broaden its programs to include industrial as well as rural development and thought the right expert "could—in a short time—help Mr. Birla sharpen and define his objectives….in short, temper a wealthy industrialist's hopes and aspirations with the wisdom of the respected educationalist."[51] Ensminger's New York superiors dismissed the idea—"please, not technical education!"[52]—but Birla, as usual, had the right connections, in this case Killian and Julius Stratton, current MIT president, and Ford Foundation trustee. Birla paid them a personal call in Cambridge when he dropped off his grandson as a freshman at MIT that fall. Stratton, in return, accepted Birla's invitation to visit India the following January. The Ford Foundation sent Drew and an MIT colleague back to India in the spring of 1963 to draw up detailed plans for transforming a lackluster complex of colleges supported by the Birla Education Trust, including the Birla Engineering College, into a worthy competitor of the IITs.

Drew faced a far more daunting challenge than had the IIT-Kanpur team. Birla insisted on locating BITS in his ancestral village of Pilani, a tiny oasis in the vast desert 125 miles west of Delhi. IIT-Kanpur started with a clean slate, a young, dynamic director, freshly recruited faculty, the latest equipment, and lavish funding from USAID and the government of India. Birla had perhaps $3 million to invest, at least initially, with Ford willing to put in about the same, plus an entrenched faculty more concerned with job security than state-of-the-art research and teaching. What BITS had that IIT-Kanpur did not was a patron who truly understood Indian industry. Birla's vision of an Indian MIT, inspired by his American consultants, reached back to an earlier tradition. One trusted US advisor told him what India needed was engineering, not engineering science.

> The five government engineering institutes, even with all their money and foreign technical assistance, are likely to fall short of the quality of engineering education that India needs. By 'quality' I don't necessarily mean the ultra-modern, high-sophisticated space-oriented engineering that is now prevalent in United States engineering schools. India needs high-quality engineering education of the type that was prevalent in the better U.S. engineering schools in the period 1935-1950.[53]

The Ford Foundation, at the direct urging of Birla himself, asked MIT to serve as the formal American sponsor for BITS, to provide an advisory board, develop a curriculum, select equipment, upgrade the library, and recruit and train Indian faculty, essentially everything that KIAP had agreed to provide for IIT-Kanpur.[54] To simplify the program administration, MIT gave Drew a courtesy appointment through its chemical engineering department. Dean Gordon Brown immediately grasped the implications. "The problem seems to boil down to this: There are two institutions in India that have now declared their desires to be developed along the lines of M.I.T. But there is only one M.I.T."[55] Having incurred one substantial obligation, could MIT do justice to a second? The original IIT-Kanpur team did not think so. They considered a contract with BITS a tacit breach of contract with KIAP, and an unacceptable drain on MIT resources since BITS seemed to have such little promise of becoming an "institution of excellence comparable to the goals we have set for Kanpur." They strongly urged "that MIT have not official connection with the BITS project."[56] Brown, though "troubled" by the possible conflict of commitment, took the longer view:

> India needs a good engineering school. Birla and the Ford Foundation in good faith are committed to a program that is well conceived, will make things better, and could surprise us. It seems to me that the price of being M.I.T., or being at M.I.T., or having the freedom ourselves to use M.I.T.'s name, imposes on us some moral responsibility to act in a statesmanlike and wise manner.[57]

Noblesse oblige, perhaps, but Brown's position carried the day. In August 1965 the Ford Foundation approved a two-year, $1.45 million grant to MIT for developing BITS, with the expectation of a renewal down the road.

MIT faculty, especially Kanpur veterans, considered BITS a bad bet. Asked to size-up physics, a visitor commented, "the department can not be called a department even of bad physicists".[58] Louis Smullin, who had been a member of the original IIT-Kanpur advisory team, thought that MIT could not hope to accomplish much such relatively small resources. "Is it really clear that a company owned school isolated from the world within a company village can develop the freedom and spirit to lead Indian education?" he asked Gordon Brown. "Any lesser goal for BITS would be unworthy of MIT, as you instructed us when we went off to look over Kanpur in 1961."[59] Drew, on the other hand, appreciated Birla's more limited objectives, and the predictable response of Indian faculty and students to perceived American condescension:

> I do not believe [Birla] supposes or wants an American MIT set down in India. In my judgment to attempt to develop such an <u>American</u> institution in India would be like trying to graft apples on a pine tree. We have not been asked to make such an attempt. We were asked to help devise in India and Indian technological school to produce graduates with the know-how to produce knowledge pertinent for India. …In many respects they consider us immature, rude, hypocritical barbarians who in certain respects happened to hit it lucky. To be viable in India an institution much be framed with Indian values in mind.[60]

If Kanpur looked unpromising to American eyes, Pilani looked far worse. They wondered how such a place—"It reminds one nothing so much as an old movie about North Africa, complete with camel caravans and hooded tribesmen"[61]—could possibly attract top faculty and students. Perhaps MIT could train future BITS faculty back in Cambridge or provide assistance through IIT-Kanpur, but imagining BITS as an influential engineering school in its own right seemed preposterous. The Ford Foundation, on the other hand, would accept nothing less from MIT than the kind of energy and resources it was putting into IIT-Kanpur.[62]

BITS clearly needed leadership, an MIT advisor willing to make BITS a top priority, as Dahl and Halfman had done at IIT-Kanpur, and an Indian director with the vision and vigor of P.K. Kelkar. Electrical engineer David White, who had made five shorter trips to BITS starting in 1964, accepted a two-year stint at BITS in 1968 as resident head of the MIT advisory group, replaced Drew, who had reached mandatory retirement age. Impatient with the pace of change, Ford Foundation and its MIT advisors convinced Birla to reassign the popular, long-time director to another part of his industrial empire and hired in his place C. R. Mitra, former head of a private technical school in Kanpur. [63]

BITS's signature programs, in chemical and electrical engineering closely following the 'practice school' modeled originally proposed by Drew and supported by White. Mitra pushed for a practice school program far more ambitious than anything MIT had done, as a requirement for all faculty and students. With its five-year undergraduate program, BITS had sufficient time in the curriculum for more than the usual industrial internship. Students, as part of small, interdisciplinary teams intended to model real-world experience, spent two months of "Industrial Training" during the summer after their third year, six months of "Practice School" during the summer and first semester of their fifth year, and two months "Design Practice" after completing their formal coursework. Each BITS Practice School Station at one of the participating companies was a sort of miniature BITS complete with professors (themselves learning current industrial practice), laboratories, libraries and classrooms.[64] Starting with his e Birla Industries connections, Mitra expanded the program the Central Electronics Engineering Research Institute (a Birla-supported national laboratory adjoining the campus), and finally to the National Physical Laboratory and the National Institute of Oceanography.[65] Within a few years the practice school option had essentially become a requirement, at least for the engineering students, with 95% enrollment.

By the numbers, BITS could hold its own with IIT-Kanpur. In a decade of MIT-Ford Foundation support, it trained more than 3000 undergraduates and more than 1000 graduate students, while dramatically increasing and deepening its applicant pool. If not quite an "educational paradise in the desert",[66] BITS nonetheless had an enviable placement record, with 'BIT[S]ians' more likely to take jobs with Indian firms than the 'IITans'. Some 60 or 70 students in each class had job offers before graduating. Keeping faculty did prove challenging in the early years, and in any given year BITS would face a deficit of ten to fifteen positions, but that turned around dramatically the year after Ford support ended, with 46 hires and only 23 departures. Like IIT-Kanpur, BITS sent its best faculty for advanced training in the US, all but one to MIT. Of the first 20 participants, 16 returned and stayed at BITS, another enviable record.[67] Ford Foundation evaluators discovered an encouraging "esprit de corps" coupled with a "particularly practical direction that may be more difficult to accomplish in the IIT's." They proudly noted that the Indian government, despite having given no direct financial support, "was looking to BITS to provide a model for future development in education in engineering and science in India."[68]

BITS offered an opportunity, as IIT-Kanpur did not, to build "a leading technological university in India" responsive to India's goals, "to produce practicing engineers who will be in a position to graduate and to build industries in India, under Indian conditions."[69] With its emphasis on the Practice School and ties to Indian industry, it helped educate Indian industrialists along with Indian engineers, and so avoided the pitfall of (re)creating an

American university in a foreign country while neglecting more pressing and appropriate local challenges.

The Arya-Mehr University of Technology

The Arya-Mehr University of Technology (AMUT) gave MIT the scope to envision the future, a technical education where interdisciplinary research centers transcended traditional disciplinary departments. Established by imperial decree in 1965, AMUT marked an American turn in an Iranian higher education long modeled on the French system. The Shah put higher education near the top of his reform agenda. He sent record numbers of Iranian students to the US, and built new, specialized universities in partnership with Harvard, Georgetown, and Columbia.[70] Still, he considered MIT an essential model for a rapidly industrializing Iran. When he appointed Hossein Nasr (the first Iranian undergraduate at MIT) as AMUT's chancellor in 1972, the Shah explained that he wanted an Iranian MIT, not an Iranian Harvard or Princeton, because Iran needed "a problem-solving type of education."[71] By the time AMUT's Tehran campus graduated its first class, just 257 students, Iran had already contracted with the US consulting firm Arthur D. Little for a master plan for a far more ambitious campus in Isfahan, Iran's second city and leading cultural center. There AMUT could provide the expertise and leadership for a major industrial initiative anchored by a new Soviet-designed steel mill. Like India's leaders, the Shah respected Soviet engineering but distrusted the politics of its engineers.

As "special consultant" to Arthur D. Little, Gordon Brown had an opportunity to put into play the ideas about research centers he had been promoting at MIT for a decade, without much success. Brown was particularly impressed with what engineering dean George Bugliarello had done at the University of Illinois Chicago Circle campus to encourage "a much-needed degree of flexibility to cope with changes that are certain during the next decade or so as interdisciplinary work becomes more and more necessary" and so avoid "the compartmentalization and rigidity that the customary organization into Electrical, Mechanical, Civil, Chemical Engineering, etc., imposes on an institution."[72] Brown, AMUT's vice-chancellor Medhr Zarghemee, and Arthur D. Little's project leader met with Bugliarello, and incorporated many of his ideas into their Master Plan for Isfahan. In his handwritten notes, Brown outlined a basic organizational scheme for AMUT that included six divisions--materials, energy, information, food, systems, and basic sciences—rather than departments.[73] The final Master Plan closely following Brown's outline:

> The main idea in this organization of instruction is to organize the academic activities on the major technological problems of the country instead of the usual disciplines. The reality of the needs of Iranian society and the aspirations for Iran's accelerated development requires that their educational system should not be a copy of the obsolete aspects of western systems by a lag of twenty years, instead, it must be based on Iranian culture and societal characteristics.[74]

Nasr, perhaps better than anyone, appreciated the challenge of integrating western technology with Persian culture. Though he completed his undergraduate degree in physics at MIT, Nasr found the history and philosophy of science more compelling than science itself, and earned his doctoral degree in that field at Harvard. He then returned to Iran to teach and to immerse himself in the study of Islamic philosophy and history. As a member of a prominent and politically well-connected family (his father and grandfather had been physicians to the royal house), Nasr had close ties to the Shah, who personally asked him to become chancellor of AMUT. Nasr agreed, with the stipulation that he could develop vigorous programs in Islamic history, philosophy and culture to complement its engineering training.[75] "What I wanted to do as president of the university," Nasr explained, "was to create an indigenous technology in Iran, and not simply keep copying from Western technology."[76] He sought a culturally appropriate technology, with deep roots in the Persian traditions, a project the Shah viewed with considerable skepticism Where Nasr intended to embrace history, the Shah preferred to bury it in the hope of insulating the shock troops of his “White Revolution” from radical politics.[77]

Nasr interpreted his charge at AMUT as proving to the Shah that AMUT could train engineers who could compete on a world level without abandoning their cultural values. He had been a student at MIT during the years when strengthening the humanities and social sciences had first become a priority, and drew a completely different lesson than Brown and his colleagues. MIT administrators considered the humanities a matter of broadening the horizons of future engineering leaders and corporate managers. Nasr believed that in the Iranian context the humanities were a question of national identity and purpose, the bedrock of a technical education, not a cultural veneer. At IIT-Kanpur, BITS, and at MIT itself, student protest seemed an occasional nuisance. In Iran, it represented a serious political threat to the regime. Brown returned from his first visit to Iran in 1972 convinced that the study of “technological and social systems” at AMUT might actually blunt student activism by engaging social issues on a less threatening technical level “in a country that is somewhat rigid and under the direction of one man—the Shah—who does not tolerate student radicalism or anything that could be called subversion. They executed several students after the university strike last June.”[78] Brown’s first-hand encounter with Iran found expression in the Master Plan’s conclusion that “student disturbances pointed to the necessity for higher education to become more closely integrated with the social and economic life of the country and responsive to the citizens that it serves” and the hope that “students will enjoy an exciting educational experience and in coming into grip with the societal problems, be it technical, social, or economic, face the reality of the country's problems and shake off the distorted views of what is happening in the country. It is hoped that this system will be successful in diminishing the student problem."[79]

On the Shah's direct instructions, Nasr sought an active partnership with MIT. He contacted MIT president Jerome Wiesner (a classmate from undergraduate days), about faculty sabbaticals at MIT for AMUT professors, sending AMUT graduates to complete their graduate training at MIT, and joint research programs between the two schools. He scheduled a visit to MIT to discuss his proposals with top administrators, and in turn invited Wiesner and his wife to Iran to visit the cultural sites and to meet the Shah.[80] In briefing Wiesner for his discussions with Nasr, Brown betrayed a strangely parochial view for someone of such international experience. Perhaps tongue in cheek, he urged Wiesner to read The Adventures of Hajji Baba of Isfahan (a classic piece of 19th century British "orientalism"), and, more ominously, warned him: "The matter of getting paid by Iran can be a sticky problem as your business associates have learned their dismay. Persians love to bargain and haggle. It is a way of life—a game—for them. We are amateurs."[81] With oil prices soaring in the wake of the 1973 OPEC oil embargo, and Iran exporting oil in record quantities, there potentially would be plenty to haggle about.

In June 1974, MIT, Wiesner spent a week in Iran discussing the proposed MIT-AMUT agreement. He toured the campus sites, met with top government ministers and deputies, and had an hour's audience with the Shah. Wiesner returned upbeat:

> The general mood in Iran, at the moment is one of optimism, expansionism and general ebullience, based of course on the vastly increased funds available to the government for social development. It is obvious that everyone expects the rather successful industrialization of Iran will now move considerably faster and that the accomplishment of many social dreams having to do with education, social development and the elimination of illiteracy and poverty can be vastly speeded up.[82]

Over the summer, Brown (as official MIT liaison) and Zargamee (as AMUT vice-chancellor) drafted a formal understanding of collaboration between the two schools. They expected AMUT to “educate a group of elite engineers who would become the key instruments of the future economic and social development of Iran” and in the process “to accelerate the transfer of science and technology into the societal fabric of Iran to ameliorate the pressing industrial, economic, social, and human problems of a fast-paced industrializing society.”[83]

Oil wealth inspired ambitious thinking. Iran seemed a natural sponsor to help turn MIT new Energy Laboratory, established in the wake of the first energy crisis and headed by BITS veteran David White, into a “Super International Energy Study Center”.[84] Wiesner also asked his faculty to prepare short proposals on centers for geophysical research and oceanography for Iran’s consideration.[85] He appointed the head of the Sloan School of Management as coordinator for MIT’s educational and research efforts in Iran, and hired a former American ambassador as a consultant on Middle Eastern affairs. The ambassador suggested that an AMUT for Kuwait would be the perfect way to “open the door to other highly and mutually profitable MIT associations with the Klondyke on the Persian Gulf in the future.”[86] At the request of the Shah’s sister, MIT even committed itself to planning the Shiraz Technical Institute as a “’lighthouse’ institution for hands-on technical education in Iran”, though MIT had so little experience with vocational training that it subcontracted virtually the entire venture to Wentworth Institute. MIT did agree to advise on curriculum design oversee the project, at $300,000 a year for five years.[87] With a draft proposal on the table for a $50 million “Pioneering Association in Energy Research” to be supported by Iran at MIT’s Energy Lab, someone might well have asked who would be assisting whom?[88]

By far the most controversial collaboration involved training Iranian nuclear engineers. In July 1974 the Iranian counselor for cultural affairs contacted MIT's departments of Physics and Nuclear Engineering about arranging a special master's program for students selected by Iran's Atomic Energy Organization.[89] The department chairs thought they could accommodate the sixty new students (thirty a year) Iran wanted to send, as long as Iran was willing to pay a slight premium. MIT nuclear engineers encouraged AMUT to consider a minor in nuclear engineering within its energy center, with close ties to the nuclear research reactor being planned for Isfahan.[90]

They did not anticipate the political fallout from their colleagues. The $1.3 million with Iran contract enraged MIT faculty and students opposed to the Shah and to nuclear proliferation. Angry editorials appeared in the campus newspaper and students and faculty mounted a sit-in protest at the Department of Nuclear Engineering.[91] Computer Science professor Joseph Weizenbaum wrote a long article condemning the collaboration, under the inflammatory title "Selling MIT: Bombs for the Shah."[92] Brown responded with a revealing personal letter to Weizenbaum setting out the administration's point of view. "Because I respect the integrity and value system of our faculty," Brown wrote, "I am relieved to learn that we will have a chance to instill our value system into the minds of the Iranian students...to give them the resolve to see to it that nuclear technology is only used for peaceful purposes." Brown maintained that if MIT did not supply the training, others would, and MIT would then "*not* be a part of the establishment in Iran that within the next decade, will bring nuclear fission power under adequate operational control. We can ensure that the Iranians can be educated to the highest standards of competence and integrity." "By working within the system," Brown concluded, "some of us can be part of the action--a member of the club so to speak. But we will not be admitted if we shut the door in their face."[93] Unconvinced, Weisenbaum wondered if "'insiders' have the greatest chance to affect changes and influence events." After all, he pointed out, "often the initiation fee of the clubs one must join in order to become an insider is precisely that one must adopt the very rules, standards, and modalities of action that at the outset one wished to change."[94] Even faculty who did not share Weizenbaum's opinion that "identification with Iran identifies us with torture" had strong misgivings about accepting "special students" likely screened for "political reliability."[95] What would have thought had they known that MIT's Draper Laboratory (the world's leading center for missile guidance and control technology) had been negotiating a separate contract to provide a comparable facility for AMUT?[96]

No one at MIT imagined that the programs it was designing for the Shah would soon fall into the hands of Islamic revolutionaries. No one would have believed how many of the Iranian students and faculty it was training would support that revolution. For historian of science Nathan Sivin, one of Nasr's campus talks had raised serious questions about whether MIT fully understood what it might be getting into. He told Wiesner that he and Brown "have had a couple of conversations on...the institutional relations Hossein Nasr has been mediating...I have a very high regard for Gordon's judgment with regard to American society and the role of science and engineering in it. I have felt the need to convince him of the complexity of what might be called the social relations of science and engineering in societies that are still largely traditional. In particular, it seems to me extremely important to gather the widest possible cross-section of Iranian points of view before committing the good name of MIT in what I would assess as extremely unstable circumstances."[97] Wiesner did not disagree, though he fell back on the Brown defense, that whatever his personal distaste of the Shah's rule, MIT and the US had more to gain by taking advantage of the "opportunity to play a constructive or supporting role in Iran" than by ignoring or undermining it, in the same way, and for the same reasons, that the US maintained relations with the repressive Soviet Union.[98] Wiesner got a similarly astute assessment from a member of MIT's board, who understood the Shah's deep distrust of higher education: "He knows he can't accomplish his mission without highly trained and sophisticated intellectual capital…On the other hand, his personal experience has alienated him from understanding—or even tolerating—the independence of those who think for themselves."[99]

The Islamic revolution that toppled the Shah came as a shock to MIT, especially since AMUT became a leading center for revolutionary student activity. Nasr, who had resigned the chancellorship in 1975 after three stressful years, had seen it coming:

> Technology is not value free. It brings with it a kind of culture of its own. And so once you get into it on a high level you can become very easily alienated from your own culture and that creates a breeding ground for the worst kind of political activity. And that was also one of the reasons why the Shah paid so much attention to the new university. He said we must do everything possible to have our own scientists and engineering, to create our own technology, without this social and political explosion.[100]

AMUT had delivered what Nasr had promised, top notch engineers grounded in Iranian culture, who, contrary to his intentions, interpreted revolutionary politics not as a variation of modernization, but a repudiation of it. The faculty, traumatized by the revolution and tainted by association with the Shah, left, 213 of out of 230 went elsewhere, 102 of them to the US..[101] The revolutionary government subsequently split AMUT into two separate universities, Sharif University of Technology in Teheran, renamed for a martyred electrical engineering student, and Isfahan University of Technology. Both suffered through the early years of Iran's "cultural revolution", which temporarily closed the universities and stressed ideological purity and egalitarianism over academic excellence.[102] Some exiles did return. Zargamee, briefly jailed as a supporter of the Shah, recalled, "At the time of the Revolution there was suddenly a very significant surge of interest in returning to Iran. Everybody became a revolutionary and they went back and wanted to get something done." One of the students sent to MIT became minister of science, many others entered government service at all levels, some took their professors places. "So what was the impact of MIT?" Zarghamee reflected, "Well, it strengthened the Revolution."[103]

AMUT turned out to be a better student than MIT imagined. Sharif University of Technology has grown into a major research university on the MIT model, with 8,000 students selected by competitive examination, and with many of the research centers (energy, communications, materials, ocean engineering, structural and earthquake) its MIT advisors had originally envisioned.[104] Isfahan University of Technology, with 7,000 undergraduates and 2,000 graduate students, followed a similar path, with research centers in information technology, steel, sub-sea exploration, and robotics.[105] Like its mentor, it became the center of high tech industry, notably in the defense sector. Under Ayatollah Khomeini, Iran established a new center for nuclear research in Isfahan, which also became home to Iran's major missile, aircraft, munitions, and chemical weapons plants.[106]

Conclusion

MIT did not so much fail as fail to understand the full implications of exporting its brand of technical education to the developing world. Gordon Brown certainly gained an appreciation the challenges. After reading a proposal from Vanderbilt's dean of engineering about "Exporting Engineering Manpower" he mused:

> My experiences in India, Singapore, and last week in Tehran convince me that the problem is extremely complex, different in every country, and not one that will be solved by sending boys on a man's errand. In the past, I believe the U.S. has fragmented its attack on the problem, failed to plan for a five- to ten-year involvement, failed to understand the infrastructure or the 'software' side of the society in which we were working, provided too little help for too short a time, and often of the wrong kind.[107]

Yet for Brown and his MIT colleagues, "software" was not essentially different than 'hardware'. Politics, cultural traditions and social patterns remained obstacles to be overcome, problems to be defined and solved. Lacking perspective on the political and social changes swirling around them, they tended to see only "resistance to [technical] change,"[108] rather than alternative paths to technological and national development.

MIT could successfully plan technical institutes closely patterned on itself, and it could train engineering educators to staff and administer them. It could not, however, escape the limitations of its own model. The very strengths that gave MIT its international stature could end up being weaknesses when put into practice elsewhere. An education designed to prepare undergraduates for the best American academic programs did just that. IIT's original motto, "Dedicated to the Service of the Nation", led to the inevitable question, 'which nation?'.[109] And no wonder, when four-fifths of the IIT's graduating computer science majors complete their educations, and subsequently make their careers, in the US. The roster of IIT alumni reads like a 'Who's Who' of top American engineers, entrepreneurs and venture capitalists,. Close to half of all IIT graduates, 125,000 strong and counting, live and work outside of India, 35,000 of them in the US.[110] Silicon Valley alone employs an estimated 200,000 non-resident Indians, including the cream of the IITs..[111] Even more disappointing is that the IITs, for all their success in training future engineers and entrepreneurs, have contributed so little to their larger mission. Aptly enough, "The Role of IITs In Nation Building" was a key theme in the conference marking their golden anniversary. Despite a level of technical excellence no one could have imagined a half-century ago--getting into an IIT is ten times tougher than getting into MIT, just 2500 places for 200,000 hopefuls--the IITs have not provided much national leadership for India.[112] BITS has had more success in keeping its graduates in India, though perhaps at the cost of a lower international profile.

Sharif University of Technology and Ifanhan University of Technology certainly did their share of nation-building, though not for the kind of nation AMUT's supporters had in mind. Under an Islamic republic, these schools continued to send their faculty to American universities, including MIT. Yet as revolutionary ardor gave way to the harsh realities of un- and underemployment, Iran faced a brain-drain as serious as India's. The numbers may be under dispute—one International Monetary Fund ranked Iran first in lost scientific manpower, a figure Iran contested[113]--but Iran loses a distressing amount of its top scientific and engineering talent to the developed world.

MIT's leadership saw their institution at the apex of an international system of expertise. Their assumption was that junior MITs would follow their example, and so become nodes in an international network of scientific and engineering expertise. What they did not factor in was the asymmetry of the international community, which gave every incentive to graduates of these schools to pursue better opportunities in the developing world. MIT's engineers understood the world through the lens of modernization theory**. The history of MIT in India and Iran suggests both the strengths and limitations of that view.**

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