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Abstract

Purpose – *This paper seeks to explore the processes by which the offshoring of technology development to India and China by Western and Japanese multinationals has evolved from the localization/simplification of technology for local markets to the development of advanced technology in India and China for global markets.*

Design/methodology/approach – *Case studies were developed based on 190 interviews conducted in China, India and several other countries. Respondents included multinational home country and offshore managers, as well as local entrepreneurs.*

Findings – *Rather than following carefully thought out corporate strategies, the offshoring of technology development by multinationals is more often incremental and driven by the ambitions and expectations of Chinese and Indian entrepreneurs and managers. Meanwhile ''technology competition'' policies proposed in the USA and elsewhere are not taking sufficient account of the processes by which technology development is being offshored.*

Originality/value – *Techno-nationalistic policies designed to allow one country to win a race with others in developing and monopolizing new technologies are increasingly dysfunctional. The identification of multinationals with ''home countries'' continues to weaken. At the same time, technologies and technology workers are more mobile than ever before. Better policies would allow nations to seek mutual benefit through today's more globally dispersed technology development capabilities. Multinational managers in our study were not sufficiently accounting for the costs of offshoring and outsourcing technology, nor were they giving much thought to the longer term implications of their diminishing capabilities to develop or even control the development technology. More thought should be given to what aspects of technology constitute ''core competencies'' and which provide sustainable competitive advantage in the emerging global environment.*

Keywords *Offshoring, Outsourcing, Technology development, Globalization, Multinational companies, Developing economies, India, China*

Paper type *Case study*

Multinational enterprises (MNEs) have made systemic changes in their approach to the development of new technology in recent decades. Until the late twentieth century technology was widely regarded as a ''core competency'' to be kept under tight control. Many leading MNEs went so far as to avoid innovations that were ''NIH'' (''not invented here'') (see, for example, Katz and Allen, 1982). Nor was there a sense that US, European and Japanese (triad) MNEs need look beyond their boundaries to get the technology needed to serve their markets. Some MNEs did locate R&D facilities near leading foreign universities, but these universities were always in the Triad. While the emerging economies produced many talented scientists and engineers, the most ambitious and talented of them went to US or other triad universities. Most hoped to find jobs after graduating at MNEs, or to become techno-entrepreneurs in technology ''hot spots'' in the Triad. Comparable opportunities did not exist in their home countries.

Offshore development work by the MNEs in the emerging economies amounted to little more than the localization of products and production technologies, with no expectation that the

adaptations would be applicable in the Triad. A Whirlpool facility in India, for example, redesigned washing machines so the machines could keep out rats, survive shipment on bad roads, and cope with sharp fluctuations in the power supply (WSJ, June 12, 2004). At a triad automobile plant in another emerging economy, we were told that until recently ''engineering'' had consisted mostly of such things as developing oil pans able to survive severely potholed roads and the scaling down of production systems (Lynn and Salzman, 2007). Even as offshoring increased, products and processes were modularized to facilitate the lengthening of value chains (Flecker and Meil, 2010). While more engineering was relegated to emerging market suppliers, it was generally process engineering and minor, incremental development work on component products. Offshore engineering work was generally constrained to conform to OEM specifications or specifications and product design done by onshore suppliers.

Engineering managers at a US electronics firm told us that 15 years ago they did not even consider doing work on their more advanced technologies at a site in India,. There was no market in India for products based on newer technologies, and India did not provide a viable export platform. Furthermore, the firm was discouraged by laws that until recently had prohibited foreign firms from owning a controlling interest in Indian subsidiaries. Triad MNEs were also reluctant to locate advanced engineering activities in most emerging economies because of fears that intellectual property (IP) would be lost. As a consequence, engineering teams that were active in the emerging economies worked in relative isolation from their counterparts at triad facilities and provided little that was attractive to triad markets. Nor was the work they did challenging enough to attract and retain the most talented scientists and engineers in those countries.

That world was transformed by a confluence of disparate developments: many MNEs moved from regarding technology as a core competency to regarding it as just another link in the value chain and, like other links, subject to aggressive cost cutting; trade barriers were reduced with the advent of the World Trade Organization in 1995; Eastern European markets were opened to Western firms; as were product and labor markets in the emerging and transitional economies. Other relevant developments included the introduction of the internet and other technological changes, dramatically increased international movements of science and technology workers (often to new destinations), and markedly improved education systems in some of the emerging economies.

One result of these and related changes has been a heightened sense of anxiety in the Triad. Are the US and other Triad countries losing the technological lead they have so long enjoyed? What consequence would such a loss have for jobs, general economic well-being, and national security? Can, or should, the Triad seek to reverse these trends by investing more heavily in education, and perhaps by discouraging offshoring by triad MNEs? Some advocate higher government spending on R&D to counter increased spending in China. Yet others complain that often the Chinese, like the Japanese and South Koreans before them, have outperformed US firms in the market with products based on technology developed in the US, creating jobs and wealth that ''rightfully'' belong to Americans. Some Americans would restrict access by foreign scholars and students to government funded university research. Such techno-nationalist policies do not recognize that R&D now routinely flows across borders through modern communications technologies, the increased global mobility of people, and internal processes of MNEs. It would likely be impossible to stop these flows without causing catastrophic ''collateral damage.'' A more practical approach might be less technonationalistic, focusing on policies that leverage the increase in the human stock of technology through the new globalization of technology development to contribute to a global commons, while also providing high level, high-wage jobs for the Triad as well as for the emerging economies.

This paper seeks to provide perspectives on the new processes of globalization, particularly on how these processes are leading to the tighter incorporation of China and India into a global system of technology development. The next section of the paper describes some of the specific changes in the environment for Foreign Direct Investment (FDI) related to technology development in India and China. The paper next reviews four cases that

elucidate the processes by which Indian and Chinese sites of US MNEs have developed and how their roles have evolved. The paper then turns to a discussion of the implications of the cases.

The changing environment for knowledge work in India and China

In the early twenty-first century India became increasingly attractive as an offshoring destination owing to changing government economic policies, the rapidly improving quality of a few Indian institutions of higher learning, and other factors (for a detailed discussion, see Arora, 2006; Arora and Gambardella, 2005; Dossani, 2006; Dossani and Kenney, 2003). Hubs for customizing software and providing IT services emerged in various regional clusters, most notably in Bangalore. Triad MNEs offshored large amounts of IT work to India in the late 1990s as back-office programming work, particularly on ''legacy systems'' spurred by the system modifications needed in anticipation of the ''Y2K problem.'' Not enough programmers in the US knew the older programming languages (Salzman and Biswas, 2000). Work on the Y2K problem led to the development of partnerships, new and expanded offshoring arrangements with triad firms, and new levels of expertise in the Indian workforce. This experience, coupled with increasing numbers of their own IT staff who were Indian expatriates increased the ''comfort level'' for triad MNEs in trusting Indian firms to perform IT services. After the Y2K crisis passed, the MNEs continued and expanded their outsourcing of IT work to India.

One result of this, coupled with past infant industry policies of the Indian government that had supported the development of technological capabilities by domestic firms, was the growth of major Indian companies such as Infosys, Tata Consultancy Services, and WIPRO (the latter a joint venture with GE). A number of small specialized independents and captive units of MNEs, including some in our study, also gained ground during this period.

Another factor contributing to the growth of the Indian IT industry was the US's H-1B visa program, which provided special visas for certain categories of workers. This visa program was used extensively by offshore IT companies to locate project teams in the US so they could work with clients to facilitate IT offshoring (Hira and Hira, 2005; Salzman and Biswas, 2000). The large number of Indians educated at US engineering and other schools (many of whom had gained entrepreneurial experience in Silicon Valley or managerial experience at American IT firms) provided an important human capital base for developing IT company management capacity (see, e.g. Saxenian, 2005). Sources for technological talent also increasingly came from the Indian education system through the development of IITs and IISc, regional colleges and a number of private colleges.

The Chinese economy began opening to foreign investment after Deng Xiaoping's 1978 economic reforms. Foreign investment was granted legal status in 1979, and special economic zones were established in Southern China. This allowed increased access for foreign firms, although initially numerous barriers limited the attractiveness of investment in China. Foreign firms were not allowed to exchange their Chinese currency earnings for hard currencies. Many feared the liberalization policies would be reversed. Working with the Chinese bureaucracy was often problematic. Nearly half of FDI in China between 1979-1982 was in the form of contractual joint ventures in which the foreign partner provided technology and sometimes part of the capital. The Chinese contributed the less mobile assets such as the land, labor, physical facilities, and materials, thus lowering the risk for foreign investors.

In 1982, the decision to open China to the world economy was formalized in the state constitution, and in 1983 regulations on Chinese-Foreign Joint Ventures were liberalized. New special economic zones were established, and some were designated as Technology Promotion Zones to expedite the transfer of technology. New areas were opened to foreign investors. FDI steadily increased. FDI inflows further accelerated after Deng's ''tour to the South'' in 1992. China became the second largest FDI recipient country in the world and the largest recipient among developing countries. As the perception of risk declined so did the use of contractual joint ventures. By the early 1990s more than half of the FDI in China was in

the form of equity joint ventures in which the Chinese and foreign partners shared profits and risks.

From the mid-1990s tax policies and other forms of selective financial support were offered to encourage FDI linked to domestic industrial objectives, including energy and telecommunications. China's large market potential, increasingly favorable government policies and low labor costs attracted many MNEs in such industries as telecommunications, automobiles and petrochemicals. The relative share of wholly owned foreign enterprises began to increase, and the relative importance of equity joint ventures declined. It was in this environment that our Chinese case studies sites were established (on FDI in China, see, for example, Long, 2005).

Thus, while India became a center for offshored IT activities, China became a center for low-cost manufacturing. India had the advantage of a large English-speaking population and China had the advantages of a better physical infrastructure and strong state-directed policies and initiatives to facilitate FDI. China quickly attracted huge amounts of foreign capital and technology to develop rapidly in the automobile, steel, chemical, and semiconductor industries. As these industries developed China further emphasized, as a matter of government policy, the further development of infrastructure, notably the generation of electrical power as well as the building of modern cities and highways. Between 1997 and 2007 China added more than 30,000 miles of new interprovincial highways (Lynn and Salzman, 2010). These developments further enhanced the attractiveness of Chinese sites. By comparison, reliable infrastructure in India was generally limited to export zoned industrial parks that had privately built their own water, electricity and other systems. Poor infrastructure outside these enclaves limited the transportation of physical goods (e.g. Gregory *et al.*, 2009).

Case studies of MNE offshoring of technology development to India and China

To examine the evolution of offshore innovation in China, India, and other emerging economies, we developed a series of cases in 2006-2008 using the comparative case study method (Yin, 2003; and more broadly Eisenhardt, 1989; Glaser and Strauss, 1967). We collected detailed accounts from those directly involved in setting strategy, managing the processes of offshoring, and conducting the engineering/innovation work on and offshore. For each case, we interviewed respondents at an MNE site in its home country and then at its sites in India and China, as well as in other developed and emerging economies. Our pool of respondents was then extended to include some technology entrepreneurs who supplied technology and/or engineering/innovation services to the MNE, either to its offshore site or directly to its home country site[1]. The interview information was supplemented by published and unpublished written accounts. We presented our findings at two of the MNEs to groups of managers for feedback to help us assess the validity of our descriptions and conclusions. As the research proceeded, we also presented our findings before groups of academics and government officials in several of the countries.

Our sample included sites of firms in the IT software and hardware industries; and in the vehicle, vehicle parts, engineering, electrical and heavy electrical systems industries. This provided a wide range of technologies. We identified large companies in each industry that were involved in a significant number of offshore engineering activities. This enabled us to examine leading edge and emerging practices and changes. We interviewed managers, project leaders, and engineers/technologists at the home country site and in one or more emerging economy site. This yielded 190 interviews at 67 sites of 38 MNEs in eight countries[2]. Interviews were also conducted at eight smaller, techno-entrepreneurial IT firms in India. All the firms in our study had offshore engineering or product development sites that had been operating for at least two years. All of our sites were engaged in new product development or innovation. Respondents were promised confidentiality, so the names of the companies discussed in this paper are pseudonyms. In this paper we focus on four MNEs, two in the IT industry and two in manufacturing.

''All-IT'' is a global IT services company that develops and maintains large back office systems. It is a *Fortune 500* company with more than 25,000 employees world-wide. The All-IT division we will discuss here had developed large data management systems over the last thirty-five years, including some from the early 1970s that are still in use. At the time of the interviews, the division was involved in the development of a very large new system, with many of its activities being offshored. We visited three All-IT sites in the US and Europe, two sites in India and China, and two of its suppliers in those countries.

''PC Products'' (PCP) is a global producer of software for computer applications. It is also a *Fortune* 500 company. We conducted interviews at sites of this company and two of its suppliers in the US, India, and China.

''Powerstar'' is an MNE that has consistently been ranked among the ''best companies'' and ''most admired large companies'' in the US business press. It is widely praised for its approach to corporate strategy, especially in how it decides to allocate corporate resources. Powerstar is in several industries producing heavy electrical equipment for a number of industrial, utilities and domestic applications. We visited Powerstar sites in China, India, Europe and the US.

''EnergySystems'' is the power systems division of a very large US MNE noted over several decades for pioneering new management systems. EnergySystems has operations in Asia, North America, and Europe. We interviewed four EnergySystems managers at a site in China, and a number of managers from other EnergySystems divisions in the US.

All-IT

At the time of our interviews, the All-IT division was developing a new-generation data management system to replace its 20-year old legacy system. All-IT initially planned to concentrate its development activities for the new system at the US site that had developed and maintained the legacy system. However, after being questioned by Wall Street analysts about the company's ''offshoring strategies,'' a senior All-IT manager ordered the division to offshore a certain large percentage of its work. No systematic calculations were made of how much money (if any) might be saved by the offshoring. The mandate was simply that a certain percentage of work be offshored by a certain, arbitrary date. Ironically, because of the drive to offshore, and bans on adding head count, one All-IT manager told us he had outsourced work to an Indian firm operating in the US. The Indian company had obtained the content expertise it needed by hiring laid-off All-IT workers to perform the same functions they had previously performed for All-IT. There was no actual offshoring of activities. Costs reportedly were higher, but the ''onshore'' headcount was lower and the ''offshoring'' ratio was higher, which presumably made All-IT look better to financial analysts, contributed to All-IT's reputation for good management and helped its share price.

Like other large IT MNEs, All-IT was already offshoring much of its work. The company had established an Indian subsidiary in the 1980s, but because of government restrictions on foreign ownership, sold the subsidiary to an Indian firm in the early 1990s. When government restrictions were relaxed, All-IT reentered India, using local contractors. The contractors were small companies that initially provided maintenance services for legacy software. When the senior management mandate to increase off-shoring came down, All-IT outsourced components of its new-generation data management system to two Indian firms. The division in charge of developing the system found that once it had offshored some work, it needed to offshore more work to address new problems related to the transfer of tacit knowledge, general logistics, and coordination. Eventually the US site's diminishing onshore capacity as well as upper management pressures to increase the share of work offshored required the firm to focus exclusively on offshore strategies.

Product quality declined, because higher level work was being transferred to less skilled, less experienced workers. It was expected that the workforce quality gap would diminish as the offshore team gained experience. All-IT managers complained, however, that as soon as they had trained staff members at their major Indian contractors the staff members were rotated to other positions not related to All-IT. The Indian contractors were using their

business with All-IT to help train their staff and use this enhanced capability to secure higher-skilled, higher value-added work. The subcontractor was using its work for All-IT as a business development strategy to become a technology entrepreneur firm doing not just IT service work, but also IT development work.

In response to concerns by outside analysts that the company was becoming overly reliant on offshore contractors, All-IT established a ''captive site'' in Bangalore. This also resulted in the offshoring of technological capabilities. The original plan was to do only legacy development work at the Indian site. This soon changed, however, both because the IT staff in India insisted on doing more challenging work and because the US staff (which had been reduced in size as work was outsourced) no longer had the capability to do it. By the time of our interviews in 2006, the work allocated to the US and Indian sites had undergone an almost complete reversal from the original intent. As one of the programmers in Bangalore explained:

> We specialize in our areas of expertise: the US has the knowledge of the legacy systems since they developed them, and we work on the new systems [. . .] we are younger and have learned the new programming languages for these systems.

PCP

At PCP development activities were traditionally highly centralized, requiring its developers to be co-located. As a software development manager at PCP explained in an interview, ''it was always thought that all the developers had to breathe the same air, be under the same roof.'' Nonetheless the company's development work is increasingly being offshored. This is not so much as a result of corporate strategy as a consequence of external events and bottom-up processes beginning in the late 1990s.

A key event in India was the establishment in the mid-1990s of a firm called ''NewTec''. One of NewTec's two co-founders was a returning Indian national who had gone to the US for graduate education. He had worked for a US MNE, but returned to India because he was, ''bored with working at a large company,'' and also because he wanted to be near his family. NewTec developed and sold PC consumer applications for the Indian market, which at the time was protected from MNE competition. To help fund its product development work, NewTec also did lower-level sales and service work. When the government eased access to the Indian market for foreign MNEs, NewTec became PCP's Indian sales representative. As foreign products became more widely adopted in India, NewTec shifted its focus to work for PCP and other US MNEs. NewTec's product development staff had expertise far beyond the simple maintenance and localization work that PCP was sending to India, so NewTec proposed that it do more technically challenging and deeper product development work, suggesting ways to optimize subroutines and even product modules. Thus NewTec's expanded role in PCP's product development work was initiated ''bottom up,'' and, in effect, gradually became part of PCP's offshoring strategy. NewTec continues to expand the scope of its work for PCP. Interestingly, NewTec's founders and many of its high-level technical staff, recognizing the change in emerging market technology needs, have rekindled their earlier goal to become a product company. Although it is too soon to know the likelihood of NewTec's success in becoming a global innovator, it does signal a growing change in aspirations and strategy by these technological entrepreneurs. In terms of strategy, human capital, and ambition, there is the groundwork for a new phase in the global technology development system – one in which a triad MNE may no longer be at the top of the technology development chain.

In another development, a high-level PCP developer/analyst at the main development site in the US, an Indian national, wanted to return to India. He proposed establishing a small office for tools development to support product development at the main research campus. With a team of other Indian expatriates and some local hires he set up the Indian office. For some of the expatriates, India offered better career opportunities than those available in the US. In their view, PCP was becoming an increasingly staid company. Furthermore, India was changing with more efficient services available, and less interference from the government bureaucracy. As one of the Indian managers who had gone back said: ''It's exciting to be

here. It's like Silicon Valley.'' While the immediate goal of the lab was to develop tools, the founding managers had much broader longer-terms goals. As one senior manager described it, the India office was:

> [. . .] not for outsourcing or cost cutting, but to tap the local talent pool, because people here [India] chose not to go to [the] US Labs. We will attract different types of people and study different types of technology problems. [This is especially true in] emerging markets. To penetrate [these markets], we need to understand what kinds of software make sense; not slice and dice [our current product] but understand what people want, not just take parts of, or adapt [product X] but understand the local needs for products and solutions that might have implications for other markets. So we're here to tap into it, in other places; we co-locate people here and let inspiration come from individuals, from the grassroots.

PCP's teams in India, China, and other emerging economies continued to move from concentrating on sales to localizing PCP products (for the most part this entailed translating screen commands into local languages). As a part of this process, bug reports were posted online. This provided an opportunity to expand their role. When a local team discovered a bug, they would post it on an internal bulletin board that teams in different countries as well as at the home office could view. At the time, all development except for localization was done in the US so only US teams had ''ownership'' and responsibility for bug fixes and development work, but any team could offer fixes. Eventually home office managers began noticing a growing number of successful fixes coming from China and India. This should not be surprising. PCP managers said they were able to hire very talented people in China and India because PCP was a desirable western company to work for, and wages were above local market rates. However, the localization tasks were relatively simple, and the programmers began looking for more challenging work. As they proved their abilities, many rose into management ranks.

PCP is also increasing its reliance on emerging economy contractors. A manager in Beijing described current PCP operations in China as having evolved into a mammoth virtual organization in which very large software projects are contracted to small entrepreneurial technology firms. The manager said that when one of these projects is completed, PCP can quickly downsize without having to lay off its own people. For PCP a new force driving offshoring is the reduction of fixed costs by increasing the company's ability to adjust engineering costs over project life cycles. To support this strategy of building a large supplier base composed of smaller firms, PCP helped sponsor university programs in China to train software engineers. This increased the supply of software workers to staff small contractor firms. And, since PCP had found few existing entrepreneurial software development firms that it could rely on in China, this manager said it was actively encouraging the formation of these firms, and then supporting their further development.

The offshoring ''strategy'' at PCP thus evolved in large part as a ''bottom up'' evolution, of offshore teams spontaneously demonstrating and seeking greater product development responsibilities, from Indian and Chinese managers based in the US returning to their home countries, and as a consequence, changes in the comfort levels of US headquarters managers with offshore development. Gradually headquarters found more and more activities it was willing to offshore, and began to formalize the process into an offshoring ''strategy.''

Powerstar

At Powerstar, the manufacturing MNE, the motivations for outsourcing technology development to China and India were reported to have been a mixture of cost cutting, gaining access to new markets, and gaining talented human resources. But the offshoring was begun largely as a by-product of a global rationalization of engineering activities sparked by the acquisition of a major European subsidiary.. That subsidiary had been active in China for several years. After the acquisition, engineering teams from the US firm and the European subsidiary began work on a global development project, which eventually led to substantial investment in, and re-organization of one of the European subsidiary's sites in China.

As at All-IT and PCP, there was a gradual progression. Engineering teams from the US firm and the European subsidiary began work on a global development project. Powerstar decided to establish a technology development facility in an industrial park around 100 miles from Shanghai. The second level manager at this facility was a Chinese national who had joined Powerstar immediately after receiving a graduate degree from a US university. For some time this manager had wanted to be based in China. We were told that the desire to retain this manager was a factor in Powerstar's decision to begin establishing the Chinese site. Also, the company now had an experience manager to lead the new facility while local talent gained managerial experience. Because of intellectual property concerns, Powerstar initially confined its activities in China to localization engineering and testing, but the site's activities gradually expanded. One reason for the expansion was the presence of the highly-regarded Chinese manager. There is, however, a major constraint on the transfer of activities to China – Powerstar has a core proprietary technology. Company policy mandates that no activities that might result in a leakage of the explicit and tacit knowledge related to that technology be conducted outside the US.

Powerstar's transfer of technical activities to India followed a different course. In India the main motivation was to develop capacity to support its engineering divisions in the US and Europe. Initially, Powerstar contracted with an Indian engineering services firm to work on specific projects. The goal was to set up a low-cost engineering service center. Contracting out was viewed as a low-risk experiment. After a few successful years of this arrangement, Powerstar decided to expand its engineering capacity in India. It established its own facility in the same city as the contractor and, exercising an option in its agreement with the contractor, hired the contractor's project team that had been working on its outsourced projects.

Powerstar's offshoring of engineering gradually expanded. Engineering managers in the US and Europe were not allowed to add headcount at their sites because of cost pressures, so they added headcount in China and India. They increasingly placed ''secondary'' projects in China and India that they could not support in the US or Europe. The engineering teams in China and India demonstrated their capacity to do more complex work, and actively sought more interesting projects. In some cases, they initiated their own projects, or took over projects that seemed unattractive at other sites because of the costs of engineering human resources or because of differences in local markets.

EnergySystems

EnergySystems, the power systems division of a large American MNE, initially opened an engineering office in China to provide engineering sales support for its Chinese sales office, offering technical assistance and systems configuration. However, the Chinese government required the company to do more engineering work in China as a condition for obtaining government contracts. This was a major consideration because at the time the Chinese government was planning major new power infrastructure projects, and Energy Systems hope to gain contracts in these projects. EnergySystems acquired a relatively unsuccessful plant owned by a European MNE. EnergySystems was confident its much lauded managerial techniques would allow it to turn around this operation.

A senior EnergySystems engineering manager was a Chinese national who was interested in returning to China as he prepared for his retirement. The company appointed him president of the China office and assigned a younger Taiwanese as the vice president. The Taiwanese vice president viewed his job in China as part of a career path that might take him to top management with the MNE in the US or somewhere else in the world. Two of the other senior managers were Chinese nationals who had been based in the US, and the rest of the engineering staff was hired in China. The extent of the engineering work that would be done in China was still being determined at the time of our visit. There was Chinese government pressure to increase the amount of engineering/innovation work, and EnergySystems also saw this as a way of expanding its capacity. At the time of our interviews, EnergySystems was aggressively addressing productivity issues at the plant – transferring management systems from the US not only to the plant, but also to its local Chinese suppliers. A major

objective was to upgrade the performance of these other firms so they could better support the EnergySystems site.

Because EnergySystems' technology is so specialized, it typically takes three to five years for a new engineer to become what EnergySystems managers call a ''contributor.'' Consequently not much advanced engineering had been done at the site at the time of our visit. Still, EnergySystems has been able to attract the best engineers in the Chinese labor market, and from our interviews with engineers at the site, it was clear that their goal is to make the site a ''center of excellence,'' providing leading edge engineering within EnergySystems.

Discussion

The business press and the scholarly literature emphasize three major motives for the offshoring of technology development activities: cost cutting, gaining access to new markets, and gaining access to human resources (e.g. Thursby and Thursby, 2006; Zedtwitz and Gassmann, 2002). Our cases add nuance to this.

Many MNEs are outsourcing and offshoring out of a desire to minimize the cost at each link in their value chains. But the perception that offshoring saves money can motivate offshoring that does not make economic sense, as we saw with All-IT. Indeed, at All-IT the appearance of cost savings seemed to trump the real potential for cost savings. In interview after interview, All-IT managers told us they doubted whether there had been any significant savings in their particular area, and many mentioned significant costs to offshoring that seem to have been ignored. Offshoring had resulted in increased working time by exempt employees who needed to coordinate work with offshore sites through telephone conferences outside normal working hours. Additional work was also needed onshore to rework offshore deliverables. These additional costs were apparently ignored by decision-makers[3]. At PCP, an initial motivation for offshoring was also to cut costs. However, in the process of tapping into existing pools of human talent in China and India – and in helping to augment these pools, PCP increasingly focused on gaining access to human resources. At Powerstar, there was a mix of motives, based on opportunities which opened up as a by-product of the acquisition of a European firm active in China. At EnergySystems, the primary motive initially was to meet government requirements and gain favor with the Chinese government so as to assure access to the Chinese market. Expatriate Chinese and Indian managers at triad MNEs also facilitated and encouraged their firm's movement of technology development activities to their countries of origin.

Offshoring, like other strategies, develops for a number of reasons in different companies and then becomes accepted as a standard operating procedure. Then, companies increasingly adopt this strategy as a ''solution'' to a wider range of problems and to reflect the prevailing consensus as to what constitute ''best practices.'' This business dynamic in which conformity with perceived best practices provides legitimacy to a company but not reflect actual practice or benefits has been described as processes of ''Myth and Ceremony'' (Meyer and Rowan, 1991).

The reduction in barriers to MNE activities in China and India have clearly facilitated the movement of MNE technology development to those countries, but the experience of PCP in India suggests that protectionism can help enhance local capabilities as we saw at NewTec. This point has also been noted in other recent reports (e.g. Bardhan, 2010). Although derided by many economists, infant industry arguments for protectionism may be valid in limited situations. Japan's experience up until the early 1970s (Anchordoguy, 1989; Lynn, 1994) certainly seems to suggest protectionism can foster the development of local industries, though protectionism can easily become harmful if maintained for too long, or if it is applied in industries where top-down guidance risks guiding in the wrong direction. Government can also use incentives (or disincentives) to attract MNE technology activities as we saw with EnergySystems in China. Our cases also show how MNEs have contributed to the technological infrastructure of both China and India – bringing back highly skilled

nationals, supporting educational programs, improving the technological strength of contractors, and promoting technological entrepreneurship.

Our cases illustrate a new globalization trajectory that has profound implications both for the triad nations and for their MNEs. This new trajectory represents shifts along at least two dimensions. First of all, the emerging economies are growing into global innovation leaders. Secondly, triad MNEs are severing their ties and identities with their home countries. These changes are having both micro and macro level impacts, including impacts on careers, effective triad MNE strategies, and appropriate ''competitiveness'' policies for both triad and emerging economy nations.

What impact do the proliferation and fast changing roles of offshored sites have on career and employment prospects for triad engineers? Many US MNE managers in our study admitted to concerns about where current trajectories are leading. They said they would not encourage their own children to pursue careers in engineering. They believe that in the future the more interesting work will no longer be done in the US and that wage pressures from offshore sites will make engineering an unattractive career.

What are the resources that might allow the US MNEs in our sample to sustain competitive advantage? Might it be the much heralded American strength of excellence in engineering innovation? When we asked more than a dozen engineering managers at All-IT, the IT services company, what will keep All-IT competitive with emerging Indian rivals, none of these managers referred to innovative capabilities. It did not seem to occur to them that they had a sustainable technological edge over the emerging Indian IT firms. Many of the Indian firms are well endowed with technical talent. Moreover All-IT has transferred most of its technical formal and informal knowledge to the firms to which it has outsourced core technical work. Instead, they mentioned things like ''closeness to customers'' or that All-IT would always be the ''systems integrator.'' Some of our interviewees said All-IT's relationships with suppliers will prove to be a key resource allowing it to sustain competitive advantage. Yet, these responses struck us as being overly optimistic. All-IT itself was bringing staff from its Indian contractors to solve customer problems in the US because All-IT no longer had its own staff who could do this. Presumably this will eventually obviate any special advantage of closeness to customers or unique contacts with the ultimate suppliers of services that All-It may once have had. And, ironically, All-IT engineers with skills in systems integration had learned these skills by moving up through the ranks, doing jobs that have now virtually all been offshored. It would seem that in the process of offshoring All-IT is losing its abilities to be a systems integrator.

PCP, the global supplier of software products for the computer industry, may have better prospects. It may have created a valuable, difficult to imitate resource by building up its network of technology entrepreneurial firms and maintaining its ties to top universities in China, India, and elsewhere around the world. In other words, it may be creating a global innovation network that provides greater capabilities than more nationally limited firms. Still, we wonder about the prospects for the PCP main research campus in the US. The PCP offices in India and China devoted to new product development are still relatively small, as are the projects they are working on, but increasingly these sites are working on independent projects with less reporting to the main research campus in the US. The future expansion of these offices depends on the extent to which they are able to develop new products or product extensions with global applications. The sites in India and China may not be taking over core development activities from the US teams, but they do hold the promise of developing innovations more suitable for growing, emerging market economies. Additionally, as a number of US-based and offshore-based interviewees remarked, the offshore sites may have the potential to be more innovative than the main campus because they are less constrained by existing frameworks.

At Powerstar, the electrical component and electrical machinery manufacturer, the crucial resource seems to be a proprietary technology that Powerstar keeps closely guarded. Meanwhile, pressures grow from Powerstar's offshore sites to be given more challenging work. The engineers at the European subsidiary perceive the expansion and upgrading of

the Chinese and Indian sites as a potential threat to their employment futures and would like to limit offshore work to secondary, service tasks. Will this lead to difficulties in retaining onshore personnel? And, as the proprietary technology eventually becomes obsolete will another easy-to-protect proprietary technology replace it and continue to sustain Powerstar's competitive advantage?

EnergySystems, the power systems division of a conglomerate, has its acclaimed management systems. This could support a sustainable advantage, but only as long as the EnergySystem's management systems continue to add significant competitive advantage, and history is filled with stories of highly acclaimed ''excellent companies'' that in retrospect were found to have weaknesses that soon led to decline. In any case, the advantages of scale and scope once held by these triad MNEs may count for much less in a world where competitive advantages is found by occupying key positions in tightly integrated technology creation chains.

The overall image suggested by these case studies is one in which Chinese and Indian sites are increasingly playing key roles in emergent global technology development value chains. They are developing technologies not just for their home or other emerging economy markets, but for global markets. Activities once more or less monopolized by Americans are shifting to China and India, and the location of the most exciting future projects are likely to be contested. The nominal nationalities of the MNEs are of little consequence when it comes to benefiting their home economies.

Conclusions: corporate strategies and government policies for the new globalization

In the 1950s and early 1960s, US MNEs were dominant in such industries as steel, automobiles and consumer electronics. As competitors developed in East Asia, the MNEs adopted a variety of stances. The integrated steel firms sought government help in limiting imports, hoping to maintain profitability in the face of serious cost disadvantages compared to foreign producers. Market protection, however, was not enough to sustain these firms. Some venerable major producers disappeared entirely through bankruptcy or merger, some were taken over by foreign producers, some diversified out of the steel industry. None remain at anywhere near the scale and importance previously enjoyed. The US ''big three'' automakers also pursued a strategy of seeking protection for the domestic market, but also sought to cut costs through offshoring, and through huge investments in new production technologies. Even so, they have needed substantial additional government help. Consumer electronics firms that sought to maintain competitiveness by a sole emphasis on offshore production to cut costs (e.g. Zenith) did not survive. On the other hand firms that combined strategies of outsourcing, international partnerships, and movement to new product lines have thrived (e.g. Intel, GE, Apple, Motorola). The strategies of successful companies seems to have been based on creative engagement with offshore challengers, rather than struggling to compete with them on the basis of costs or relying on government intervention to keep competitors out of the US market.

The challenges faced by triad MNEs in today's global environment are only vaguely parallel to those of half a century ago. The challenge, at least for now, is not so much new emerging economy firms taking triad markets away from the triad MNEs. Rather, the main focus of the current race is between triad-based firms and indigenous firms seeking to dominate markets in emerging economy markets at a time when supplies of human capital are developing globally.

These new offshore markets are potentially are far larger than the triad domestic markets. Triad MNEs that thrive in this new environment are increasingly recasting themselves as global companies with limited national allegiances. Since their traditional domestic markets will no longer provide their main opportunities for growth, these companies are catering to the national policy pressures of emerging market countries. MNEs are racing to satisfy emerging economy governmental requirements so they can enter those markets ahead of their competitors. It seems that for many MNEs there is no price of entry, such as technology sharing and local production (that is, meeting protectionist measures of those nations), that

is considered too high. At the same time, the large supplies of skilled labor appear tremendously attractive, whether employed in the US through guest worker programs (e.g. H-1B visa programs) or offshore.

In the 1970s it was the loss of the US market to Japanese companies that was the major threat, now the threat is exclusion from China, India, Brazil, and other emerging economies. These growth markets will increasingly demand cutting-edge innovation, not ''localized'' end-of-life-cycle technologies from the Triad. Some new markets may demand frontier technologies to meet local conditions. Some will develop indigenous firms that compete at the high end in global markets.

Our cases suggest important lessons for US MNEs in the new environment. One is the need for a careful evaluation of the potential costs as well as the benefits to the offshoring of technology development. A second is the need for a strategic consideration of the emergent role of the triad MNEs. For example, by failing to evaluate costs and consider future implications, All-IT, in our view, is on a perilous path. By increments it has moved onto an offshoring path that is leading to ever-greater losses of its core capabilities to offshore subcontractors who are developing their own product visions. A third lesson is the greatly increased need for internationally-minded managers – some from emerging economies, some from the Triad, but with an enthusiasm for international experiences and savvy judgment about global strategies in terms of both costs as well as benefits.

Policymakers need to recognize that the competitiveness and profitability of MNEs are less and less connected to the ''competitiveness'' and economic well-being of their ''home'' countries. Triad firms are globally mobile, but triad governments have to be concerned about jobs, communities and national security. Triad government policymakers, like the leaders of triad MNEs, may be tempted to follow strategies that seemed successful in the past, but are not suited to the new global environment. Traditional triad government competitiveness policies sought to support domestic firms in global competition, improve the science and technology education system, spend on R&D, and attract/retain the most talented young scientists and engineers from around the world. In this view, the US is in a competition with China, India and other countries in which progress is defined by comparative student test scores in math and science, numbers of engineering graduates turned out each year, and percentage of GDP spent on R&D. Oddly, the number of good paying jobs or the increases in job quality are seldom offered as metrics for assessing triad country trajectories.

Another point needs to be made on the decreasing importance of nationality for triad MNEs. As these firms increasingly hire professionals and senior managers in other countries, the best jobs in an MNE are not necessarily held by the MNE's home country citizens. Several iconic US firms have had foreign CEOs, and in the last decade or so foreigners even became CEOs at Sony and Nissan – something that would earlier have been unthinkable. Conversely, more Americans are finding good jobs at foreign firms. While subsidies to US firms once added good jobs and provided technological boosts to the US economy, subsidies to domestic companies now often flow offshore with minimal returns to the home country. R&D subsidies may keep a small number of R&D jobs in the US, but the technologies resulting from the R&D may quickly move offshore. Further, as MNEs increasingly find their talent globally, they have less of a stake in their home country workforce. Our interview respondents told us that his company's ties with US universities were more distant than in the past, while managers at the same companies told us of their efforts to strengthen engineering programs at Chinese and Indian universities.

In this new environment, what we have termed ''third generation globalization'' (Lynn and Salzman, 2004), policies of the past are not only ineffective but may now be dysfunctional. Take, for example, the calls for policies to entice more US students to enter the fields of science and engineering, coupled with proposals to expand S&E guest worker programs. While it may seem desirable to expand the US stock of human science and technology capabilities, the risk is that resources will be displaced from other worthy objectives as

national education systems are narrowly defined in terms of assumed (but unproven) contributions to competitiveness rather than to broader social goals. Indeed, in the new global economy a country's success may depend even more on educating the young to understand the rest of the world than on encouraging them to be come technologists. Further, talent may be wasted as young people are enticed to pursue careers in which they have little interest or which offer comparatively poor career prospects. A glut of engineering graduates would presumably lower salaries and lead to unemployment for many of the graduates. Indeed, many highly talented people in science fields are already frustrated to find their most likely career path is two post-docs that have little likelihood of leading to opportunities for good employment (Teitelbaum, 2008; Black and Stephan, 2010; Davis, 2005). Resurgent concerns that the fruits of R&D do not necessarily go to those who invest in it could de-incentivize all from making such investment. They could also lead to efforts to restrict the flow of scientific information.

Immigration policies that target the acquisition and retention of foreign human capital are being proposed to increase US competitiveness. These policies might contribute to US human capital in science, technology, and entrepreneurship, but they would also deprive other countries of some of their most valuable human capital. In the past, ''brain drain'' was seen as being driven by those seeking opportunity in the US or escaping hostile conditions in their own country. It was justified on humanitarian grounds or as the inevitable outcome of global mobility. It was also seen as ultimately providing benefits to the sending country, as the new immigrants sent money home. Now US immigration policy is proposed more nakedly as an effort to corner the world's human capital. This new approach to immigration policy is being embraced across the political spectrum – from free-market capitalists to liberal commentators. On the one hand, the problem seems to be defined as the US needing to gain control over scarce human resources; on the other hand, the problem seems to be defined as countering the fast-growing stock of highly-skilled human resources in other countries. One often overlooked point is that while there is an increasing trend for science and technology and entrepreneurial people from emerging economies to return to their countries of origin, many of them maintain their linkages to the US and often develop globally linked businesses adding value both to their home country and the US.

Both MNEs and their new cadre of globalized managers have multiple affinities and do not view the world as partitioned into competing teams in the same way as did their predecessors and many current policymakers. Instead, they may view linkages as a means of further developing emerging economies and expanding their company's profits and market reach. The Americans among them view such developments as providing benefit to the US, but they have no particular interest in, nor do they see any need for, US dominance of the global system gained through disadvantaging other nations. While they may favor relaxed immigration policy, this is viewed as a means of supporting global human capital circulation, not of promoting unidirectional flows to, and accumulation by, the US[4]. And, just as global business strategies have led MNEs to be less tied to national identities, to some extent the same is true of people. In a world of inexpensive and extensive travel, individuals relocating in a distant place no longer need to sever their ties with their country and locality of origin. More generally, policymakers need to recognize that global flows of science and technology human resources reflect not just individual choices but firm structures, firm hiring policies, and firm location decisions.

There are parallels between protectionist technology and control and protectionist trade policies. Protectionist trade policies do not just hamper free trade and limit potential global wealth creation, they often also directly harm to the nation pursuing them. Protectionist policies that provided short term relief to US companies in previous decades generally did little more than allow the firms to continue doing business as usual. These firms, their employees and other stakeholders inevitably suffered from the inexorable global shifts in comparative advantage. Technonationalistic policies like protectionist trade policies also pose the risk of stimulating destructive technonationalism in other countries.

Appropriate technology policies for the new environment should promote multi-lateral flows of technology. Of course, government needs to ensure the flows are not all outbound. While we should encourage Chinese company alliances with US universities in the development of alternative energy, this must be done with the same requirements for technology and IP sharing being imposed on the Chinese companies as for US companies. Some of these requirements are explicit, but others are implicit based on historical traditions and practice in the US The implicit understandings should be codified to the extent possible. China has imposed technology sharing requirements on foreign firms, requirements that ensure a one way flow of technology to the Chinese. The US should lead the way in imposing requirements that technology be shared in a way that contributes to the global IP commons.

Efforts should be made to develop a common regime of intellectual property rights that can be easily and rapidly employed globally. Such cooperative policies would be more beneficial to the US, as well as to India and China, than technonationalistic policies in which each country constantly struggles to be the first to develop a new technology even when a beneficial technology might be more quickly developed elsewhere. Or where competing countries attempt to sequester new technologies. The results may range from public benefits (e.g. a new vaccine) to new IT solutions where the productivity gain for users may provide the triad economy more benefit than would monopolizing the new technology.

If this is to happen, the triad countries that are currently dominant, that have leading innovation, human resources, and political and economic strength, will need to establish the path toward the global commons. It is imperative that, as the country with the most open system of innovation and largest stock of technology, advanced human resources, and intellectual property, the US lead this effort in developing and defining the rules of the common rather than find itself a weakened player on a global playing field of techno-nationalist nations.

Notes

1. The study was conducted in collaboration with colleagues in Mexico (Carlos Acosta, UDLA-Puebla), in India (Balaji Parthasarathy, IIIT-Bangalore; P. Vigneswara Ilavarasan, IIT-Delhi and Tojo Thatchenkerry, George Mason University, with expertise in India), China (Wang Zhong-Ming, Zhejiang University), Korea (Geon-Cheol Shin. Kyunghee University). These colleagues helped us with contacts and interviews and greatly stimulated our thinking. The authors, however, are solely responsible for any conclusions reported in this paper.
2. The cases reported on here are primarily based on data collected at sites in the US, China and India, though some interviews with information relevant to engineering activities in India and China were also conducted in Germany, the UK and Holland. Other cases not reported on here were based on data collected in Japan, South Korea, Brazil and Mexico.
3. While some of these managers may have wanted to downplay the benefits of offshoring out of concern about their own jobs and those of their colleagues, but by their reports no cost-benefit studies of offshoring had been conducted and accounting practices seemed routinely to shift actual costs from Indian to US sites. If product from India had to be reworked in the US, for example, those costs were attributed to the US operation, inflating the cost of US operations and reducing those in India. And, importantly, the vastly increased coordination costs by US managers, including their trips to the offshore site, were all charged to the US site. While we don't know how common these practices throughout industry, some of these and similar practices were reported at other firms and interview sites. An R&D manager at another US MNE (not one of the cases presented here) told us with great bitterness how his department was charged with all of the coordination costs of the company product development sites in China, while the Chinese site was credited with labor-savings and other costs savings. The result is a snowball or cascading effect of the offshoring itself increasing the costs of onshore sites (e.g. for further discussion of this dynamic, see Lynn and Salzman, 2006).
4. For an interesting recent discussion of the international business megastars who seem less tied than ever before to national identities see Freeland (2011).

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