# "Innovation Shift" to the Emerging Economies: Cases from IT and Heavy Industries

Leonard Lynn
Case Western Reserve University
leonard.lynn@case.edu

Hal Salzman
The Urban Institute
Hsalzman@ui.urban.org

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The current shift of technology development work by multinationals to the emerging economies is distinctive, as many are now observing. It is now high-end (rather than adaptive) development that is being carried out in countries like India, China, Brazil and Mexico. And, increasingly, multinationals from the U.S., Japan and Europe are finding themselves competing against, or working with, new technology-based companies from the emerging economies. Our study focuses on the process and outcomes of globally distributed engineering. Field work was carried out at 67 engineering headquarters or development sites in eight countries. The firms in our study were in IT and a range of other industries, though in this paper we concentrate on the IT and heavy industries sectors. Based on our fieldwork we conclude that this new shift in the location of technology work at the top of the value chain is not only distinctive, but it is also disjunctive, not following past trajectories of offshoring. We also find that it is occurring as a matter of incremental value chain creep, rather than being guided by "strategy." We believe current trends are inconsistent with some widely accepted postulates and prescriptions of organization and innovation theory. We find that the consequences of these trends have not been well conceptualized by managers and policy-makers.

## INTRODUCTION

One of the most dramatic developments of the past decade has been the offshoring of technology and product development by Multinational Enterprises (MNEs) to emerging economies (EEs). This trend appears contrary to a historical trajectory in which large firms evolved as increasingly integrated organizational structures, followed management strategies that focused on protecting their core competencies and the resources that gave them sustainable competitive advantage, and also devoted considerable resources to the development of human capital. All of these activities were very much geographically embedded, and national innovation policies were predicated on this embeddedness. While a number of studies have documented the increasing globalization of R&D activities (e.g., Thursby and Thursby, 2006), the implications for national policies have most often been considered in terms of specific threats to jobs or vaguely conceived notions of "national competitiveness." Less attention has been paid to the content of this aspect of globalization and the broader transformations that may be occurring,

For decades MNEs have cut costs by offshoring some production and engineering activities to lower cost regions of the world. They have also established development centers to adapt their global products to meet the distinctive needs of countries with poorly educated and low income workers and consumers, and poorly developed infrastructures. As these processes took place, the MNEs retained their system integration and top-of-the-value-chain activities in their home countries, or at least in other sites within the Triad (North America, Europe and Japan). The central strategic concern was for the MNE to maintain tight control over whatever gave it competitive advantage over other firms. To have sustained competitive advantage a firm needed to have resources that were valuable (by giving the firm the ability to exploit opportunities or neutralize threats), rare among the firm's current and potential competitors, difficult to imitate, and not easily substitutable (Barney, 1991).

Is the current wave of offshoring a linear extension of these past trends, with Triad MNEs still orchestrating global activities to maintain their strategic advantage? Or is something different happening? Are decision-makers fully accounting for the implications for the long-term strategic interests of firms when they move top-of-the-value chain and system integration activities to emerging economies? Does the current wave at once represent a change in

longstanding theories about the organizational integration of core activities and the geographical stickiness of innovative activity?

In this paper we first review the organizational and innovation theory that underlie current thinking about industrial development and national competitiveness. We then turn to a description of a study of technology offshoring projects in a number of industries. From this study we present descriptions of the factors motivating offshoring, and the processes by which offshoring evolved at two IT and two heavy industries firms.

**Organizational paths and integrated innovation**

In a widely accepted interpretation, Alfred Chandler (1990) attributed the success of U.S. industrial firms from the late 19th century through the first two or three decades after World War II to their effective exploitation of economies of scale and scope. To achieve and maintain economies of scale and scope, Chandler wrote, the successful firms built strengths in production (ensuring that economies of scale could be obtained), marketing and distribution (seeking both economies of scale and scope), and management (to efficiently coordinate resources and to effectively respond to new threats and opportunities in the environment). Early success in achieving the economies of scale and scope by the giant U.S. firms essentially kept others from entering the rich U.S. market. When the U.S. firms moved offshore it was to further exploit the advantages they had derived from their economies of scale and scope. Here again, their strengths in scale and scope made their position in global markets virtually unassailable. The widely followed prescription until recently was that firms needed to maintain tightly integrated, well-coordinated structures.

National innovation and technology policies were developed in correspondence to, and interaction with, these corporate organizational structures and strategies. In the United States innovation policies were effective in supporting the U.S. rise to international leadership in technology in the 20th century. Notable among these policies were: strong national and local support for land grant colleges that emphasized practical technology, strong antitrust policies to spur competition, heavy government spending on technology (much of it related to military research and procurement, but also substantial amounts on medical research) (Mowery and Rosenberg, 1998). The overall U.S. support for technology, increasing strength of U.S. research universities, and strong institutional support for entrepreneurship attracted and gave opportunities to an unprecedented population of talented people seeking careers in technology. At first it extended these opportunities to Americans who in the past could not have afforded higher education. After World War II the U.S. also attracted the best and brightest young science and engineering students from around the world, initially a supply greatly enriched by a European exodus, and then from a widening number of emerging economies. Additionally, U.S. firms strongly supported engineering programs through internship and coop programs, and sometimes money and equipment.

During the last decades of the 20th century many American firms faltered in their competition with fast rising Japanese rivals. Chandler (1993) argued that this was because the U.S. firms had allowed their previous strengths to deteriorate. Other observers had a different interpretation. In one of the most cited business articles of the late twentieth century, Prahalad and Hamel (1990) argued that U.S. firms were failing in competition with the Japanese because senior management conceived of their companies as portfolios of discrete business units, divesting those with weaker returns regardless of possible synergies with other units or

possibilities for future strategies. Still others argued that the competitive environment had shifted, and firms needed to adjust. Michael Porter (1985) introduced the concept of "value chains." The value chain was a series of value-generating activities, and a firm's profits depended on minimizing the cost of each link in the chain. Based on one form of value chain analysis or another, managers at many firms decided to outsource activities as a means of lowering costs.

The focus on "core competencies" led firms to shed various activities to organizations outside the firm, and to develop stronger relationships with external organizations. One form that was widely expected to become the predominant organization of industry was the "networked firm." Firms were said to be "hollowing out." Later, the locus of innovative activity was widely thought to be in the process of being transferred from large firms to entrepreneurial firms, such as those in Silicon Valley (Saxenian, 1996; Lee et al., 2000). We would argue that a more fundamental (but related) change is now occurring. This is a change in the patterns of "geographical stickiness" of technological development and innovation (Von Hippel, 1994).

The core competency focus required developing supply chains, but did not imply anything about the types of firms that should be in the supply chains. Depending upon the industry, firm, and the time period, firms of different sizes and types were used as suppliers. Initially some firms sought small suppliers whose costs were lower and were in a weaker negotiating position on price. Over time, however, there was a consolidation among suppliers in some industries. As suppliers were given a broader range of responsibilities with the move to modular systems, they further increased their size and capabilities (e.g. Baldwin and Clark, 1997; Schilling, 2000; Sturgeon, 2002). Flextronics, for example, began assembling circuit boards, nearly went bankrupt, and is now a vertically-integrated electronics supplier with over $15 billion in sales and 100,000 employees. Its growth and transformation occurred by

> bulking up, flouting some key tenets of New Economy wisdom. While many gurus rave about virtual corporations, Flextronics and its rivals have been quietly picking up the abandoned brick-and-mortar pieces and reassembling them into new versions of vertically integrated empires. The new age production experts are happily shelling out billions to acquire competitors along with factories once owned by Siemens, IBM, and Nortel. To broaden their services, they are also acquiring top design and engineering firms—specialists in creating anything from customized semiconductors to prototypes of futuristic wireless-Web phones. (*BusinessWeek* August 28, 2000)

Although initially only non-core, commodity products were outsourced, supplier capabilities expanded alongside other changes in the outsourcing firm and suppliers began to provide proprietary technologies, such as components supplied to Apple for its iPod. This raises under-researched questions regarding who controls technology value chains. One might note the recent highly-publicized instances where Triad multinationals have surrendered entire products to firms that once were smaller producers of components in emerging economies, such as Siemens cellular telephones (to BenQ) or the IBM PC (to Lenovo).

The value chain shifts in electronics began to occur in a wider range of industries in recent years, representing a fundamental shift in the types of technology obtained from suppliers. Perhaps most notably in the IT industry, but increasingly throughout all industries, technology and innovation are increasingly sourced from other firms, and smaller technology firms have become a source of innovation and technology acquisition to a greater extent. This would seem to be part of a new strategy quite different from the Porter outsourcing model in which a firm

outsources commodity components, but carefully protects core technologies and capabilities by keeping them within the firm. In part the basic strategy of "core competencies" was redefined to be quite flexible and refer, *ex post facto*, to those components that remained in the firm while other components were, by definition, not "core" even if they involved proprietary technology upon which a product was based (again, the iPod example is most widely known)[1]. We suggest that this use of core competency was rather "flexible" and, at this point, may no longer be a useful concept for prescribing which activities should be kept within the firm's boundaries. We find that if control over key technologies is the source of power in technology value chains, Triad MNEs may also be losing this traditional basis for competitiveness. As *Business Week* (2000) observed in their analysis of contract manufacturers seven years ago, "as the role of contractors grows, the brand name on a product may not indicate the real power behind an industry."

The outsourcing of innovation that is core to a company's competitiveness grew out of a number of changes in organizational form, practice, and of engineering and innovation practices. Some relate to the growing practice of MNEs in industries ranging from pharmaceuticals to microprocessors of supporting entrepreneurial firms to explore and develop various technological options, rather than doing this in-house. Some relates to firms outsourcing the production of modular components, with the expectation that subcontractors will develop the technology embodied in the modules.

It also involved new relationships between large and small firms and the growth of technology entrepreneurship. The development of innovation and technology acquisition strategies by large firms is a very recent change that has resulted from three major shifts in: engineering and technology, organization, and financing.

(1) In the face of more intense competition from East Asian firms, MNEs were pushed to overcome the notorious "Not Invented Here" syndrome. Indeed, many even turned to modular designs that *encouraged* suppliers to take responsibility for design and innovation.

(2) Organizational definitions of core competencies and strategic resources changed. Many MNEs began investing their research dollars in technology entrepreneurial firms rather than in their own R&D centers. Organizational structures became more fluid, as firms routinely sold off divisions and acquired others, moving from one industry to another. Competitive advantage in some products depended on technologies that were traditionally identified with other industries, such as happened when electronics began to provide competitive distinctiveness in automobiles.

(3) Shifts in the financial/investment community produced new support for startups. Most notably there was a shift in investment in intangible assets and investments by large firms in startups and small firms (sometimes as a first step toward acquisition, but sometimes to support partners with a common interest in a advancing the larger firm's networks, standards or system of complementary assets).

[1] The correct strategic approach tends to be known only long after the decision as made, as the contrasting cases of Apple's iPod and IBM's operating system case illustrates. Of course, it could be argued that Apple learned from IBM, and is controlling its iPod suppliers more effectively than IBM did with Microsoft.

In this paper we draw on data from a large study of the globalization of technology development to emerging economies to focus on the following three areas.

1. **The motivating factors**. What were the main reasons given for developing offshore engineering, R&D, and other innovation activities? How systematically did MNEs valuate their options before deciding to offshore technology work? In hindsight, did they achieve their objectives?
2. **The processes.** How did MNEs go about deciding what activities to offshore and where to locate them? How did they go about establishing these activities (e.g., go it alone, use foreign partners). Were there common evolutionary paths?
3. **The outcomes.** Where do current processes seem to be taking the firms? How well do they fit the longer term interests of the firms? Were there impacts on technology development value chains?

We begin with descriptions of our methods and our sample. We then present our findings in each of the three areas.

## THE STUDY

### Methods

A comparative case study method was used to examine the issues of interest. The focus was on learning about emerging practices and identifying the evolution of offshore innovation through detailed accounts by those directly involved in setting strategy, managing the offshoring, and in conducting the engineering/innovation work on and offshore. We employed comparative case studies (Yin, 2003; and more broadly Eisenhardt, 1989; Glaser and Strauss, 1967) and a linked case study method in which a "case" consisted of a central node of the firm's site in its home country and then its remote sites in EEs. This was then extended to include offshore outsourcing and contracting by adding a tertiary set of nodes of technology entrepreneurs who supplied technology and/or engineering/innovation services to the firm either to its offshore site or directly to its home country site. Semi-structured interviews were conducted. Nearly all of these were tape recorded.[2] The interview information was supplemented by published and unpublished written accounts. At two MNEs we presented our findings to groups of managers for feedback to help 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.

### Sample

Our sample included sites of firms in the IT software and hardware (including both services and products) industries; and in the vehicle, vehicle parts, engineering, electrical and

[2] The study was conducted in collaboration with colleagues in Germany (Pamela Meil, ISF—Munich), Mexico (Carlos Acosta, UDLA-Puebla), Tojo Thatchenkerry (George Mason University, with expertise in India), in India (Balaji Parthasarathy, IIIT-Bangalore; P. Vigneswara Ilavarasan, IIT-Delhi), China (Wang Zhong-Ming, Zhejiang University), Korea (Geon-Cheol Shi 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.

heavy electrical systems industries. This provided a wide range of technologies and innovations. 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 used convenience sampling within this group, inviting leading companies in each sector to participate in the study. We then interviewed managers, project leaders, and engineers/technologists at the home country site and in one or more EE site (China, India, Mexico). This yielded 190 interviews at 67 sites of 38 MNEs in eight countries (See Table 1). Interviews were also conducted at eight IT firms in India. Respondents were promised confidentiality, and so the names of companies are disguised in this paper.

**Table 1. Interview Sites**

| | Industry | Electrical, Electronics | Heavy Industries: Power generation, vehicle mfg | IT hardware or software | Country total |
|---|---|---|---|---|---|
| Country | | | | | |
| | US | 11 | 10 | 7 | 28 |
| | Europe | 3 | 2 | 1 | 6 |
| | Japan | 1 | 1 | | 2 |
| | South Korea | 1 | 1 | | 2 |
| | Brazil | - | 1 | - | 1 |
| | China | 7 | 2 | 3 | 12 |
| | Mexico | - | 3 | - | 3 |
| | India | 1 | - | 8 | 8 |
| Industry total | | 24 | 20 | 19 | 63 |

Note: Four sites at three other firms in other industries were also part of the study.

To be included in the study, firms had to have engineering or product development sites offshore that had been operating for at least two years. We only included sites engaged in new product development or innovation, not those involved in other types of engineering such as process engineering or localization.

The IT firm sample included 12 firms and 19 sites. Three large IT firms were both IT product and services firms. The sample also included 6 small IT firms based offshore that were suppliers to the large firms.

In this paper we will provide some detailed description of processes and outcomes at two of the large IT Firms. Because we promised to keep firm names confidential, we use pseudonyms for them in our discussion here.

"All-IT" is a global IT services company that develops and maintains large back office systems. One ALL-IT division we studied (and will discuss here) had developed large data management systems that had an installed base dating back more than 30 years. 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 U.S. 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. We conducted interviews at sites of this company in the U.S., India, and China and two of its suppliers.

The manufacturing firms in our sample included 44 sites. In this paper we will provide some detailed description of processes and outcomes at two of these firms. Again, they are identified by pseudonyms in this paper.

"Powerstar" is a U.S.-based MNE that has often been mentioned in management textbooks as having superior processes for the formation of corporate strategy. Powerstar is in a variety of industries producing heavy electrical equipment for a number of industrial, utilities and domestic applications. We visited Powerstar sites in China, India, Europe and the United States.

"EnergySystems" is the power systems division of another highly admired MNE. EnergySystems has operations in Asia, North America, and Europe. We interviewed four EnergySystems managers at a site in China, and earlier a number of managers from the MNE of which it is a part.

## FINDINGS

### 1. *Motivating Factors:*

Both the business and scholarly literatures suggest that firms have three major motives for the offshoring of technology development activities: cost cutting, gaining access to new markets, gaining access to human resources/technology from new areas (e.g. Zedtwitz and Gassmann, 2002). We wanted to look more closely at how these and other factors entered into decisions to offshore technology development.

The general story of the globalization of IT work to include important activities in India and emerging economies is widely known. Much outsourcing was begun in the 1990s, primarily for the maintenance of legacy systems and to make Y2K modifications. Back office programming work, particularly on "legacy systems" was spurred by the system modifications needed for Y2K. At that time, there were not enough programmers in the U.S. who knew the older programming languages, and the increase in short-term work required firms to outsource IT. MNEs than began to seek other cost-savings by outsourcing to India and other countries.

In the case of the ALL-IT division, however, the motivation was as much the *appearance* of cost savings as the reality. At the time of our interviews the ALL-IT division was developing a new-generation data management system to replace a twenty-year old legacy system. When this project was initiated, some three years before our interviews, ALL-IT had planned to concentrate its development activities at a U.S. site. But then, under pressure from Wall Street analysts, the head office ordered the division to offshore a certain large percentage of its work. No systematic calculations were made of how much money (if any) would be saved by the offshoring. The mandate was simply that a certain percentage of work would be offshored by a certain date.

At PCP a major motivation was to access talent in the emerging economies. As a manager in Beijing described it, the operations in China could create a huge virtual organization by subcontracting components of huge software projects to small technology entrepreneurial

firms. When the project was over they would not have to lay their own people off. But PCP did not just find a large pool of well-trained talented people in China and India, it helped sponsor university programs to train software engineers. And it did not find that a large number of entrepreneurial software development firms it could rely on already existed in China. It actively encouraged the formation of these firms, and then supported them.

At Powerstar the motivations for outsourcing technology development to emerging economies were a mix of cost cutting, gaining access to new markets, and gaining talented human resources. But the offshoring was actually begun almost as a by-product of a global rationalization of engineering activities that was sparked by the acquisition of a major European subsidiary some years ago. Engineering teams from the U.S, firm and the European subsidiary subsequently began work on a global development project, which eventually led to the location of a new site in China, described below.

At EnergySystems' site in China the primary motivation for the offshoring of engineering work was a desire to secure business working on newly planned huge governmental power infrastructure projects. A relatively unsuccessful plant owned by a European multinational was taken over by EnergySystems. EnergySystems was confident its superior managerial techniques would allow it to turn around this operation.

In brief, then, the motivations for offshoring technological activities to emerging economies in our sample companies broadly fit the categories previously identified – cost cutting, access to market, access to human and other technological resources. Yet, things were sometimes more complicated than the simple categorization might suggest. At All-IT it seemed to be the *appearance* of cost savings, even more than the real potential for cost savings. Indeed, in interview after interview managers told us they doubted if there had been any significant savings in their particular area (many mentioned significant costs to offshoring that seem to have been ignored). At PCP the primary motivation was access to human resources (and entrepreneurial firms), but in some cases these were resources that PCP helped to create in the emerging economies. At Powerstar there was a mix of motives, but these became salient only after new opportunities were revealed as a by-product of an acquisition in Europe. At EnergySystems it was initially to gain favor with the Chinese government, but with the conviction that good management could overcome problems that had faced another MNE trying to gain the same advantage.

2. ***Processes:***

The processes by which the MNEs in our study chose the sites, activities, partners, etc., and those by which they projected their technology development activities into the emerging economies were also somewhat messier than theory might suggest. We found that the processes tended to be incremental, guided by no explicit strategy.

Several patterns of offshore development occurred in the companies we studied. There were some similarities among the IT companies that went offshore for back office work, among companies that went to localize and market products, and among those that went to manufacture products or to work on infrastructure projects. But all developed their offshore engineering activities and their engagement with local technology entrepreneurs through similar, step-by-step, incremental processes, which we term "value chain engineering progression".

The U.S. IT MNEs we studied had longstanding relationships with smaller offshore firms dating back at least to the efforts to cope with Y2K. By the time the Y2K "crisis" had passed,

offshore firms such as Infosys, Tata Consulting Services, and WIPRO were large well-established firms, experienced in working with U.S. and other Triad MNEs. They had begun to expand their efforts to meet other software development needs. The H-1B visa program in the U.S., which provided special visas for certain categories of workers, was used extensively by offshore IT companies to locate their project teams in the U.S. to work with clients (Hira and Hira, 2005; Salzman and Biswas, 2001). The large number of Indians educated at U.S. engineering and other schools (and sometimes with entrepreneurial experience in Silicon valley or managerial experience at American IT firms) provided the human capital base for developing IT company management capacity offshore by both offshore companies, entrepreneurial startups (e.g. Saxenian, 2006), and U.S.-based companies developing technology development sites in India. The Y2K experience also increased the "comfort level" for U.S. MNEs in relying on remote technical services.

The All-IT division we studied had earlier established a subsidiary in India, but because of restrictions on foreign ownership, sold the subsidiary to an Indian firm in the early 1990s. When the division reentered India it used local contractors. These were small companies that initially provided maintenance services for legacy software. Next, the division outsourced components of the large new system it was developing to two Indian firms. As was mentioned above, offshoring increased as the division was mandated to increase the percentage of its work done offshore and as the division found that once it had offshored some work, it needed to offshore even more work to address new problems related to the transfer of tacit knowledge, general logistics, and coordination.

Initially, the work offshored to India was handled by contractors. But then, in response to concern by outside analysts that the company was becoming overly reliant on offshore contractors, ALL-IT established a "captive site." The site was located in Bangalore (primarily because of Bangalore's reputation as an IT center). Initially, again, ALL-IT intended 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 U.S. 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 done in the U.S. and India had undergone an almost complete reversal from earlier intentions. 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."

PC-Products (PCP) had traditionally highly centralized its development activities, requiring its developers to be co-located. They had a philosophy similar to the Microsoft development approach, as expressed by a software executive: "Microsoft used to believe that development was a contact sport; 'You needed people bumping into each other. In Redmond, you wanted your entire development team in the same building. Ideally, they'd be on the same floor.'" (Kirsner, 2005). Similarly, as a manager of software development 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." Three things occurred at around the same time (between the late 1990s and around 2003) that led to the shift to offshore development work.

First, an offshore firm, "NewTec", was started up in the mid-1990s in India by two men. One was a returning Indian national who had gone to the U.S. for a graduate education. He had worked for a U.S. firm, and then decided to return home because he was "bored with working in a large company" and also because he wanted to be near his family. NewTec began as a product

company, but it also did sales and service work to fund the product development. It was a sales vendor for PCP, but because it had deep development capacity, it began to do some maintenance, testing, and development work for PCP on subroutines. NewTec's own products found a market niche, but, these did not generate high sales volume. Meanwhile, the demand for service work (testing, localization) by PCP and others was growing rapidly so All-Tec shifted its focus to work for U.S. MNEs. Its founders and many of its high-level technical staff still harbor the goal of becoming a product company. NewTec continually proposes expansion of its work for PCP, asking to do greater portions of the component products and, through this knowledge and expertise, develop new product modules for PCP's products.

Second, a high-level PCP developer/analyst at the main development site, who was an Indian national, wanted to return to India. This programmer had gone to graduate school in the U.S. and was now at PCP's main research campus in the U.S. He proposed establishing a small office that would do tools development to support product development at the main research campus. With a team of a few other Indian expatriates and some local hires he set up the Indian office. For some expatriates, India offered better career opportunities than those available in the U.S. Some saw fewer promotion opportunities in the U.S. and found PCP becoming an increasingly staid company. Furthermore, India was changing with more efficient services and less government bureaucracy. As one the Indian managers who had gone back said: "It's exciting to be here; it's like Silicon Valley in part, Bangalore feels the same way." The goals of this lab were evolving. The immediate goal was development of tools but the founding managers had longer-terms goals that were much broader. 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 US. Labs in different places will attract different types of people and talent 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.

The third development was that teams in India and China began solving bug problems for teams in other countries. For many years the offices in India and China had concentrated on sales. Then, they began to localize PCP products (mostly translating screen commands into local languages). Teams were set up to do low-level localization programming. As part of this process, bug reports were posted online. Although the bugs were officially the responsibility of the team that "owned" that aspect of development, anyone could offer fixes. In the home office managers began noticing a number of fixes coming from China and India. In our interviews at these offices, managers commented that they had been able to hire very talented people 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 these programmers had much greater abilities and ambition so they looked for challenges. They also wanted to "prove" to headquarters that they were capable of much higher level work.

The offshore capabilities became more apparent to those in headquarters, and an increasing number of foreign-born programmers and developers were rising into the

management ranks. Together a greater appreciation for offshore capacities developed, as did the general prominence of offshore companies

In manufacturing there was a similarly gradual progression. After Powerstar acquired a major European subsidiary, engineering teams from the U.S, 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. In interviews we were given several reasons for this choice. The company had a long-established manufacturing facility in the industrial park. The second level manager was a Chinese national who had received his graduate degree in the U.S. and joined Powerstar immediately after graduation. This man was highly regarded by the Powerstar division managers. For some time he had wanted to be based in China. This increased the attractiveness of a Chinese site for Powerstar. The other engineers at the Chinese site (eight at the time of our visit) were all Chinese, and all had received their engineering degrees from Chinese universities. 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 Chinese engineer, who was well-known and trusted by managers in the U.S. There is, however, a major constraint on the transfer of activities to China – Powerstar has a core proprietary technology. Out of concerns about intellectual property rights it has a company policy that no activities will be carried out outside the U.S. that might result in a leakage of the explicit and tacit knowledge related to that technology.

In India Powerstar pursued a different strategy, developing engineering capacity to support engineering divisions of the company in the Triad. 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 years, Powerstar decided to expand its engineering capacity in India. It established its own facility in the same city as the contractor, and (following an option its agreement with the contractor) hired the contractor's project team.

At both sites the engineering activities gradually expanded. Engineering managers in the U.S. and Europe were not allowed to add headcount in the Triad 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 U.S. 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 differences in local markets.

The EnergySystems division we studied had initially opened an engineering office in China to provide engineering sales support to 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 of obtaining government contracts. EnergySystems had a senior engineering manager who was a Chinese national 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 national as the vice president. The Taiwanese vice president viewed his job in China as part of a career path that might lead to top management in the U.S. Two of the other senior managers had been based in the U.S. and the rest of the engineering staff was hired in China. The extent of 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 the company saw this as a way of expanding capacity as well as assuring access to the local market. As mentioned above, EnergySystems acquired a relatively unsuccessful operation from a European MNE. At the time of our interviews it was aggressively addressing productivity issues at the plant – transferring management system from the U.S. not only to the plant, but also to its Chinese suppliers. A major objective was to upgrade the performance of these other firms.

Because EnergySystems' technology is so specialized, it typically takes three to five years in the Triad for a new engineer to become a "contributor," not much new engineering has been done at the site yet. Still, EnergySystems was able to attract the best engineers in the Chinese labor market and from our interviews with them, it was clear that their goal is to become a "center of excellence" providing leading edge engineering within EnergySystems. The senior managers were not as confident about the site's engineering capabilities, but had a "wait and see" attitude.

**3. *Outcomes for MNEs:***

Many of the MNE managers in our study admitted having concerns about where current trajectories are leading. They said they would not encourage their own children to pursue careers in engineering, because the more interesting work would no longer be done in the Triad, and that in any case wage pressures from offshore sites would make engineering an unattractive career. When we asked more than a dozen engineering managers at ALL-IT what would keep ALL-IT competitive with emerging Indian rivals, the managers said things like "closeness to customers" or that ALL-IT would always be the "systems integrator." Yet, these responses seemed hollow. ALL-IT itself was bringing staff from its Indian contractors to solve customer problems (it no longer had its own staff who could do this) and it was becoming apparent to customers where the real expertise lie. Those at ALL-IT with skills in systems integration, we were told, had learned these skills by moving up through the ranks, starting with jobs that have virtually all been offshored, sometimes to other companies.

Interestingly, while these and other managers seemed fatalistic about the prospects for their careers and their companies, often the fatalism was not based on a technological or economic determinism. Some of the offshoring appeared to be occurring when (these managers claimed) a full cost accounting would not justify it. Some technology offshoring occurred simply because other technology activities had already been offshored. To be sure, some technology offshoring is almost certainly inevitable at this division, and it may even be beneficial for those working on sites in the U.S., but there is reason to believe too much is being offshored too quickly, with careful consideration being given to broader issues that will affect the long-term viability of ALL-IT.

One might ask, what are the core competencies of the MNEs in our study? What are the resources that will allow them to sustain competitive advantage? Managers at ALL-IT seem to hope that its relationships with suppliers will prove to be a key resource – but seems to be handing that resource over to rivals from India. So, too, as was mentioned, it seems to be allowing its strengths as a system integrator to atrophy.

It may be that PC Products has better prospects. It may prove to 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. Still, we

wonder about the prospects for the PCP main research campus in the United States. The PCP offices in India and China devoted to new product development are still relatively small, as are the projects they are working on. One trend to watch, however, is that much of the current work is on independent projects with less reporting to the main research campus in the U.S. The Indian and Chinese offices are increasingly autonomous. 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 offshore sites are not taking over core development activities from the U.S. teams, but the initiatives undertaken by PCP's own sites and their vendors are focused on new innovation. The offshore sites hold the promise, or at least have the goal, of developing innovation more suitable for growing, emerging market economies. Additionally, as a number of U.S.-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 crucial resource seems to be a proprietary technology that it keeps closely guarded. Meanwhile pressures grow from Powerstar's offshore sites to be given more challenging work. Will this lead to difficulty in retaining offshore personnel? And, what will replace the proprietary technology that will continue to sustain competitive advantage. EnergySystems has its highly acclaimed management systems. Perhaps this will prove to be sustainable. In any case the advantages of scale and scope once held by these companies count for much less than in a world of tightly integrated technology creation chains.

## DISCUSSION

These cases suggest that the process of offshoring is far less controlled and rational than normative theories of management strategy might lead one to expect. There is a substantial random element in when, whether, how and where to offshore, such as the presence of valued expatriate employees who want to go back to their homeland to work. The motivating factors behind the offshoring of technology development and the processes by which it is pursued are incremental and opportunistic, with little concern about preserving or developing resources that might give the firm sustainable competitive advantage.

To be sure there are plausible rationales behind the offshoring projects we describe: to cut costs, to gain access to talent, to be allowed entry into promising markets. But when one looks more closely, one sees that less rational elements have importantly shaped the decisions. If Wall Street analysts believe that offshoring saves money, managers may feel pressure to offshore as much as possible, irrespective of any cost-benefit analysis. The choice of a site may be based more on the desires of expatriate employees than more systematic evaluations of various possibilities. Most of all, as resources are acquired or off-loaded, little thought seems to be given to the retention of resources that may be needed for the longer term sustenance of the firm.

Our research also suggests a need to reconsider some theories on the relationship between geography and technology development. The operating premise of firms, management consultants, and researchers has generally been that core activities, and particularly innovation activities that involve tacit knowledge, need to be geographically proximate to each other, to managers, and to new product development teams in the Triad nations, and sometimes to a particular region such as Silicon Valley (Lee, et al, 2000). For these reasons, innovation activities have been considered to be geographically "sticky" (Audretsch and Feldman, 1996); Brown and Duguid, 2002; Cumbers and MacKinnon, 2004; Porter, 1998; Von Hippel, 1994). But

the relative strength of the forces that cause stickiness and work to overcome it have been changing quickly (Cairncross, 2001).

The attractions for the "best and brightest" emerging economy technologists and entrepreneurs of life in the United States and of employment at Triad MNEs, as we saw in our interviews, has sharply declined. It should not be surprising that many Indians and Chinese would rather work in their home countries – assuming the opportunities there are comparable to those in the United States. Given the dynamic growth of China and India, it should also not be surprising that opportunities in those countries may be more attractive than those in the mature triad economies.

More generally, it seems clear, as described earlier, that innovation networks can be developed with increasing ease following the increased flexibility and permeability of organizational boundaries, and the development of organizational capabilities that allow firms to work first across organizations and second across geographical distance. As we have seen in some of our cases, this has allowed new entrepreneurial opportunities for emerging economy technologists. Following the reduction of the geographical and organizational constraints on the innovation value chain, the global diffusion of innovation activity has followed human capital, significantly the availability of high skilled labor and the reverse migration of U.S. immigrants.

The offshore location attracts much of the attention in current globalization, but receiving less attention is the changing role of technology entrepreneurs on and offshore. Our analysis of innovation shift finds that technology entrepreneurs in the innovation/engineering value chain provide a different role than firms in previous waves of outsourcing, such as the contract manufacturers. This innovation acquisition is different from outsourcing. Outsourcing is of an activity that was formerly inside; innovation acquisition is buying new products/ideas — in a sense it is outsourcing of R&D but it is also acquisition of things that were never inside and might never have been, e.g., in acquiring an innovation outside of current business lines. Outsourcing, companies developed new innovation strategies involving acquisition; although acquisition of firms has always occurred, particularly to expand the scope of a firm, it is only more recently that innovation acquisition has developed into a targeted innovation strategy.

This innovation shift is more significant than just offshoring of activities that were integrated in the Triad-based sites of an MNE or in a Triad region such as Silicon Valley. It involves the development of new innovation capacity and new types or directions of innovation, serving as both complements and substitutes for onshore innovation activity. It is important to understand this aspect of innovation capacity development in emerging economies, of the innovation shift component. The extent to which it represents an innovation shift means that it goes beyond just developing domestic or foreign human capital and R&D capacity. This innovation shift is emerging from the geographic dispersion of "capacity" — know how, human capital, and fixed assets via MNEs. Although some MNEs are regarding their offshore sites and technology entrepreneurs as just another cost reduction strategy, others are undergoing more substantive organizational and strategic shifts that build on not just an additional but different type of innovation capacity in the emerging markets. Navi Radou (2006b) has characterized these firms as "Globally-Adaptive Organizations".

We have argued elsewhere (Lynn and Salzman, 2006; 2007) that changes in the strength and meaning of organizational, regional and national boundaries render many extant policy proposals obsolete. The exponential increase in mobility of people, companies, and technologies

makes obsolete policies that are based on the hope of capturing spillover benefits from investments in education or research. Thus we have argued against relying on efforts to have the U.S. concentrate on graduating more scientists and engineers than other countries or to monopolize technology. Sounder policies are based on understanding the world system and finding a place in it.

Our cases do suggest that the policies of emerging economies to attract foreign MNEs are succeeding in creating technology spin-off benefits. Not only are these policies resulting in jobs being created for their most talented people, which keeps them in the country and also brings back some who have left), but they are creating entrepreneurial opportunities for engineers and scientists. If the initial jobs and opportunities are beneath the qualifications of these talented people, there is a strong pressure for them to move up the value chain.

In some respects there would seem to be nothing new about this "new" system. Large firms have often subcontracted work to small firms, or even families and individuals – with large variations in the degree of mutual gain involved. The main difference is the high technology now involved and the attendant dynamism of inputs and uncertainty of outcomes. This may give a new level of power and opportunity in these relationships to the subcontractors. The offshore strategies for innovation activities, unlike Business Process Outsourcing (BPO), involve more risk both because of the potential loss of intellectual property and because of the potential creation of competitors. As a result, the MNE-technology entrepreneur networks that developed in the U.S. are not being mirrored offshore but, rather are evolving along their own path.

The initial movement of technology activities to emerging economies by MNEs in our study was generally done on an experimental basis, usually offering few opportunities for new technology entrepreneurs. The emerging economy entrepreneurs in our study typically established firms that initially engaged in activities with little technology content, though some had a strategy to develop higher-level work. In the case of the Indian IT industry, for example, most of the small offshore firms we interviewed had their origins in the 1990s. They began by unsuccessfully attempting to do product development, and then transformed themselves into offshore IT firms. Now that development work is beginning to move offshore from the Triad, and local emerging economy markets are rapidly growing, some of these firms are moving into component product development. As part of this they are doing engineering/innovation work for the products of a large multinational firm. Similar to the U.S.-based technology entrepreneurs, their strategy is dependent upon the MNEs. A major difference is that their development work is being done within a contractual relationship rather than "on spec" and with the goal that the company will be acquired. In the IT field we did not observe, nor did we hear of, technology entrepreneurs working on independent innovations with the intention that their company would later be sold.

Another difference between offshore technology entrepreneurship in emerging economies and that based in the U.S. or Europe is the need to account for the potential risk of creating competitors. In the Triad nations it would be unusual for a small supplier to use its relationship with an MNE customer to acquire technology and knowledge, and then enter into direct competition with the MNE. In countries like China and India this is a real risk: IP regimes are less rigorous, the explosiveness of domestic market growth offers tremendous opportunities, there may be strong financial and other support from domestic governments, and monitoring by the MNEs is much less effective. One well-known example is Huawei in China, which began as a parts supplier and distributor for Cisco, and then began to develop its own products, allegedly using proprietary Cisco designs. After Cisco severed all ties with them, Huawei then developed a

partnership with 3Com, supposedly with an understanding that limited direct competition in some markets. However, Huawei appears to be developing into a global company that will soon be directly competing in all global markets with Cisco and 3Com. For these reasons, MNEs may be more cautious about working with offshore technology entrepreneurs on core innovative activity. It should also be noted that, at least for now, MNEs may still find it easier to attract innovators in the emerging economies to work directly for the MNE.

**Conclusions**

This paper has concentrated on the offshoring of technology development at just four companies, two in IT and two in heavy industries. Nonetheless, the conclusions we draw here are consistent with patterns observed at other firms in these and other industries. They are also consistent with a fast growing body of research and commentary by others.

In sum, we find:

A disjunctive "innovation shift" to emerging economies is rapidly occurring. This innovation shift is disjunctive in that it includes a shift in the control of innovation value chains away from Triad Multinationals, and away from the Triad – rather than enhanced control by the Triad Multinationals as in the past.

Triad MNEs are being driven to offshore technology development not only by opportunities to cut costs, gain access to human and other technological resources, and enter new markets, but also by the desire to appear to gain these benefits and because once the offshoring begins, it sometimes takes on a life of its own. There is reason to believe that much of the offshoring would not be justified by a careful cost-benefit analysis.

In this process of offshoring technology development firms are not following precepts of strategic management that would have them protect core competencies and resources needed for the sustainability of their firms. Interdependencies between functions and activities are ignored as functions are moved offshore.

Geography still matters for technology, but the forces of attraction and retention are changing. The forces that caused high-end technology to be concentrated in the Triad are weakening as emerging economy entrepreneurs and technologists find it easier to move their activities to their home countries. Not surprisingly, many of these people want to go home. The technology creating and training missions of U.S. universities are less supported by U.S. firms than in the past, while emerging economy universities grow in strength – again reducing the relative attraction of the U.S. as a center of technology creation.

As geographical boundaries and attractive forces change, so, too, are organizational boundaries. Core technological innovation activities are carried out far away from MNE headquarters (and perhaps far from the observation and control of headquarters). Some of these activities are entrusted to other firms.

All this implies that policy-makers in the Triad need to re-think policies. It may not just be jobs that are moving offshore, but also opportunities for entrepreneurs. Attracting outstanding science and technology students from emerging economies may not provide the same benefits as in the past (when many could be counted on to stay and enrich the economy), though it may provide other benefits (such as helping U.S. science and technology students learn how to function in the changing global economy).

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