Collaborative Advantage: Multinationals and the Globalization of Technology Development: Stress Points, Misconceptions and Collaborative Competencies

COLLABORATIVE ADVANTAGE

Multinationals and the Globalization of Technology Development

Stress Points, Misconceptions and Collaborative Competencies

One of the most profound changes facing the world today is that the comparative advantages once enjoyed by Triad multinationals are shifting to the emerging economies and, increasingly, to emerging economy multinationals. That is where managers and analysts see growth as the fastest in markets, technological capabilities, and science and technology human resources.

Today's globalization is not just following the historical trajectory where firms from the Triad nations (US, Western Europe, and Japan) shed low-end work while moving up the value chain. In three major research projects funded by the National Science Foundation and Kauffman Foundation, we have found that engineers and engineering managers at many Triad firms are struggling with new challenges as the globalization of technology development extends to the emerging economies. The responses firms make to these challenges will set them on a course that either enhances or constrains their ability to prosper over the long term in a world of global technology development chains. We are finding that the obvious attractions of the emerging economies—highly skilled lower-cost human resources and increased access to huge fast-growing future markets—may be dulling their perception of the pitfalls in their rush to expand offshore. Under strong pressures from investors and senior managers to offshore as many activities as possible, and often overwhelmed by new challenges in managing cross-cultural teams and coordinating activities across time zones, managers are incrementally reducing not only their firms' technological strengths, but also their abilities to coordinate technology development, and collaborate profitably with the fast growing new multinationals from the emerging economies. It seemed apparent in many of our interviews that at a certain level managers at Triad firms are avoiding a confrontation with these issues by taking comfort in dubious notions of preserving the competitive advantage of their firms.

US, European, and Japanese multinational enterprises (MNEs) are rushing to cut costs and gain access to the world's fastest growing markets by locating major parts of their technology development capability in China, India and other emerging economies. They don't seem to have much choice: Wall Street analysts are convinced that firms can only be competitive by lowering costs through offshoring, and marketing managers see the emerging economies as the main source of significant new growth. In the rush to locate ever-greater portions of the value chain offshore, there is a nagging doubt, however: "Might these companies be giving away their technological core competencies?" Lenin famously said: "A capitalist will sell you the rope you use to hang him." Many wonder if US, Japanese, and European MNEs are now selling lots of rope to the Chinese, Indians and others.

Take the case of Siemens, the giant German MNE, for example. A few years ago Siemens moved much of its mobile phone development to China in an attempt to become more cost competitive. The Chinese facility was successful in developing mobile phones for Asian consumers, but Siemens never gained a viable foothold in China. Nor did the telephones developed in China help Siemens build market share in the rest of the world. Today Siemens' Mobile Phone Division is part of BenQ, a Taiwanese company. BenQ learned the cell phone business as a contract manufacturer for Motorola. Are GM and VW follow-

ing the same path, creating a formidable new Chinese rival though their joint ventures with Shanghai Automotive Industry Corporation (SAIC)? With the help of technology acquired through the joint ventures, SAIC now produces about a million cars a year. But this is just the beginning. The company plans to assemble 200,000 of its own brand cars by 2010, about one quarter of them for export markets. These will not just be rudimentary low-cost vehicles; SAIC also hopes to produce hybrid cars within five years. Backed by a supportive government and a huge fast-growing home market that the Japanese could only have dreamed about, SAIC could emerge like a latter-day Toyota on steroids.

Infosys, Wipro, Tata, and an ever growing list of Indian IT companies arose by doing the mundane low value-added IT work that US companies passed on to them. Now, the Indian firms are poised not just to provide low value-added IT services, but also to do core development work on the most advanced software. Importantly, as the software industry has matured, the areas of innovation have changed and shifted to the Indian advantage. Increasingly, Indian firms are advancing process improvements that give them an edge in the software market, much as the Japanese focus on process a generation ago, gave them an advantage in manufacturing. But there are big differences that will lead to even bigger challenges for today's MNEs than was the case a generation ago. The movement of Japanese, and then South Korean, firms into the automotive and electronics industries was partly fueled by the induction of technology purchased by Japanese and South Korean firms from US and European multinationals. But both Japan and South Korea severely restricted the on-shore activities of foreign multinationals (Amsden, 1989; Johnson, 1982; Kim, 1997). Moreover, MNEs saw little reason to engage in R&D activities outside the US and Western Europe, and dismissed the innovative capacity of the Japanese as limited to mere product refinement. And so, the MNEs generated as much revenue as they could by selling know-how to Japanese and Korean firms. Some of the revenue generated was re-invested in R&D activities in the US and Europe.

Today, MNEs are not merely selling technology to foreign firms; they are involved in a wholesale transfer of their base technological capabilities offshore to China, India, Brazil and other emerging economies. Sometimes the transfer is to wholly-owned facilities, sometimes to joint ventures, sometimes to independent firms. In the case of IT, as the capabilities of the Indian firms, supported by offshoring, continue to grow, the firms giving them work are increasingly losing the ability to do the work themselves. Why keep high-priced programers in the US on your payroll, when the work they formerly did has been outsourced? To one degree or another, similar patterns can be seen in pharmaceuticals, electronics and other high-tech industries. Our research, supported by growing numbers of news reports and several industry studies, suggests that the emerging economy firms are moving up the value chain far faster than the Triad firms. Many emerging economy firms are acquiring the innovative capacity to go head to head with the Triad multinationals. And, it is not just the offshoring of innovation by multinationals, but also the development of indigenous human capital in the emerging economies that is pulling in top-of-the-value-chain activities.

These developments pose new challenges for Triad MNEs, challenges that so far have not been systematically articulated and been poorly understood. This article is an effort to use findings from three major research projects by the authors to sketch the landscape.

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Findings From a Global Study of Technology Managers

Our perspective on the globalization of technology development comes from research "in the trenches." Over the past five years we have interviewed 200 engineers and engineering managers at 41 MNEs and eight smaller firms based at a total of 67 engineering developments sites in 14 countries (four in Europe).[1] 23 of the sites were in the electrical/electronics industry, 20 in auto or aerospace related, 19 in IT hardware or software and 5 in medical/pharmaceutical. (See the Exhibit). In addition to our interviews at companies, we visited universities in China, India and Mexico to hold discussions about global technology job markets with faculty, university administrators and engineering students. We solicited criti-

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cal review of our findings in presentations before some of the companies where we conducted interviews, as well as academic and government organizations in China, Europe, India, Mexico and the US.

In our interviews with multinational managers, we asked about the processes by which their companies had decided to offshore technology development, how they had gone about it, what had influenced their decisions as to which activities to offshore, and how they had decided where to locate them. We asked how the projects were working out (Were they meeting expectations? Had they led to unanticipated problems?). And, we asked these managers and engineers about their sense of the longer-term consequences of the offshoring of technology—in terms of their careers, the prospects for the companies and the national implications. Most of these managers had little doubt about the potential benefits from off-shoring technology. Most also seemed uneasy about the long-term risks to their companies, and to their own careers. Nonetheless, the managers we interviewed seemed to feel they had no choice but to focus on the short-term needs of their jobs, following general corporate mandates to cut costs or sometimes specific requirements to reduce domestic engineering headcounts.

To the extent that corporate strategies are emergent and bottom-up or middle-up (e.g. Mintzberg and Waters, 1985; Nonaka and Takeuchi, 1995) and thus embodied in the actions of middle managers, the picture that emerges is one in which MNEs are finding it difficult to know how to deal with the big picture, so they are simply ignoring it. Often, we find, engineering managers and engineers have a false sense of security based on deeply embedded assumptions about the strengths their MNE will gain as globalization proceeds. In our case studies, we found the following assumptions were particularly common.

Brand Equity and Closeness to Customers Can Be Counted on as Long-term Competitive Strengths

When asked about their strategies for surviving over the longer term, almost all of the fifteen managers we interviewed at one Information Technology MNE that was aggressively offshoring its technological activities cited their company's strengths with respect to "brand name" and "closeness to customers." Similar responses were given in our interviews with managers from companies in the automobile, auto parts and electronics industries. There was little appreciation of the fragility of brand equity. Lenovo laptops are now entering US corporate and consumer markets and being accepted as though they still carried the IBM brand name. It's no secret to consumers that not much more than the nametag changed when IBM sold its PC division to the company already making its PCs. Not long ago the premier brands in the American market for television sets included Zenith, Admiral, RCA and Motorola. Nowadays the top sellers of flat panel televisions are brands US consumers had never heard of ten or even five years ago. Conversely, the rights to use some venerable Triad brand names like IBM PCs, MG automobiles, RCA and Westinghouse television sets, and Siemens mobile phones were acquired at bargain rates by firms in emerging economies.

If brand equity can be somewhat ephemeral in the US market, it is an even less reliable asset in the emerging economies, where famous MNE brands are not well-established. And, of course, China, India and some of the other emerging economies are the world's fastest growing markets for a wide range of products. Motorola is reportedly having trouble in the Indian market for low-price cell phones because in India, as a taxi driver told a *Wall Street Journal* reporter (January 3, 2006), "You never hear about that brand here." Firms like Panasonic find their reputation in Japan does not help them in the fast-growing Chinese market. They have to compete based on price, just like unpedigreed Chinese companies.

So, on the one hand, in the world's fastest growing markets we will have Chinese and Indian consumers who see no reason to pay a premium for foreign brands they have never heard of. And, on the other hand, consumers in the Triad nations are increasingly recognizing that fewer and fewer products are actually made by the famous MNEs that market them. As firms raise their stock value by trumpeting their offshoring to Wall Street, they are also advertising the virtues of these offshore companies to Main Street, further undercutting their own brand equity. This is an area where academics could help through new studies of the implications for brand equity of the new forces generated by globalization.

Triad Multinationals Have A "Manifest Destiny" to Remain at The Top of Global Technology Value Chains

Triad engineering managers we interviewed often assumed that their Triad

Exhibit
Interview Sites

Country	Industry	E	A	I	M	Country Total
US		11	10	7	2	30
Europe		3	2	1	3	9
Japan		1	1			2
South Korea		1	1			2
Brazil		-	1	-	-	1
China		7	2	3	-	12
Mexico		-	3	-	-	3
India		-	-	8	-	8
Industry Total		**23**	**20**	**19**	**5**	**67**

Notes:
(1) E = Electrical, Electronics
A= Auto, auto parts, aerospace
I = IT hardware or software
M = Medical/pharmaceutical

(2) The 67 sites belonged to 41 multinational enterprises, plus eight smaller Indian IT firms.

operations will always be at the top of the technology value chain. Manager after manager repeated the mantra, based on the experiences of past generations, that it would be the routine and low value-added activities that would be off-shored, even while giving us examples that suggested otherwise. There seemed to be a strong implicit notion that Triad operations are inevitably privileged to move to the top of global technology chains. Perhaps the prevalence of this mind-set should not be surprising. For half a century or more US firms were closer than foreign rivals to the world's best universities. They had preferential access to government-funded research. They had the world's best technological human resources. And, they were headquartered in the world's most dynamic market for technology. This gave US firms huge advantages in technologies ranging from biotechnology to semiconductors (Audretsch and Feldman, 1996; Saxenian, 1994; Mowery and Rosenberg, 1998). The European and Japanese firms had a similar edge to a lesser extent. Now, however, the Triad helixes (Etzkowitz and Leydesdorff, 2000) of universities, government-funded research, and their pools of science and technology human resources no longer enjoy the leads of the past. Indeed, in some areas the Triad countries now lag behind some emerging economies. Nor do Triad MNEs have as much preferential access to the technology developed in projects funded by their home country governments as they may have had a generation ago. For one thing, foreign multinationals have aggressively sited R&D facilities to tap into foreign systems. For another, the Internet and the globalization of intellectual communities have extended the geographical range of R&D spillovers (Dalton et al., 1999). With the dramatic liberalization of trade over the past decade, being a Triad citizen doesn't give an MNE a dramatically easier access to its home markets.

Conversely, in developing technology for lucrative markets in the emerging economies, Triad MNEs would seem likely to be at a disadvantage compared to the new emerging economy MNEs. The managers we interviewed gave numerous examples of where the existing technology was being pushed by consumers in the high growth, emerging markets who are demanding more technological sophistication in products. This was true in products ranging from cell phones to heavy electrical systems.

The cold reality is that while the Triad will certainly retain many technological strengths compared to the rest of the world, centers of technological excellence will increasingly be globally distributed. This, after all, is one of the reasons MNEs are moving their technology development activities offshore. At one time, a firm could attract the best and brightest technical hands in the Triad, including those who had no choice but to leave their homes in the emerging economies if they wanted to pursue world-class careers in technology. This is no longer true. Nor, in the not-too-distant future, will MNEs have to stay in the Triad to be close to the world's best universities in a growing number of fields or to draw on the technology spun off by government research institutes. And, while one's access to the world's most sophisticated and demanding consumer markets was thought to be an advantage held by the Triad MNEs, in a *Harvard Business Review* article, Prahalad and Lieberthal (1998) point out that this view reflects "corporate imperialism" which MNEs of rich countries need to overcome in order to thrive in the new global economy. Prahalad (2005) also notes one of the faulty assumptions, also relevant in this context that only developed countries appreciate and pay for technological innovations.

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In our interviews, engineers and engineering managers reported a number of instances where their offshore sites, or even their vendors, had moved to the top of certain technology value chains. In one case a product was developed in China for an attractive market in Southeast Asia. Managers in the US had earlier rejected proposals to develop similar technology because the US market for the product was too small to warrant the investment in development. Once initial development work was done in China, however, it turned out the product could be adapted at little incremental cost for use in North America. The lead expertise for this technology, of course, remains in China. A European automaker in our study developed technology at its site in Mexico that improved the high-altitude performance of cars. The Mexican engineers had a much better practical understanding of high-altitude fluid mechanics than the Europeans. The technology was later used in cars marketed around the world. As centers of technological excellences are increasingly globally distributed, so too will be the positions at the top of global technology value chains.

Technological Competencies are "Maintenance-free."

Our analysis of these cases suggests that many Triad MNEs are inadvertently sliding into a dangerous disinvestment in their science and technology capabilities. At one American MNE we studied, production was outsourced and offshored to a firm in China a few years ago. Production process engineering capabilities within the firm atrophied. Product design and engineering still remain at the firm, and within the US. But for how long? In interviews at the vendor's plants in China we were told that greater efficiencies could be realized if the product design and engineering work were also done by the vendor—they could design products for lower cost manufacturability. The vendor was preparing a proposal making these points to the US firm. So, it would not be surprising if a few more design engineers in the US will soon lose their jobs. The product development manager at the American MNE supplied by the Chinese vendor said so much of his firm's product development activity has already been offshored, that he is no longer sure what capabilities remain in-house.

Some MNEs in our study are maintaining their technological capabilities, but not in the US. At companies of industries ranging from IT to heavy electrical products and automotive parts, we were told freezes had been imposed on the hiring of engineers in the US; headcounts could only be increased offshore. Some managers told us they are now offshoring projects, not to cut costs, but because so many technical competencies have been offshored that these projects can no longer be done in the US. Managers we interviewed at a US IT firm reported that they now frequently have to ask employees of one of their Indian subcontractors to join them when they meet US customers to discuss the maintenance and extension of software developed by the US IT firm. The American firm no longer has the technical capability to do this on its own.

The unbridled expansion of offshoring and outsourcing at the top of the innovation value chain seems likely to undermine the basis for the future competitiveness of these firms, and that of the Triad more generally. Some years ago US technical people and firms were criticized for having the "Not Invented Here" Syndrome. Now they run the risk of moving to a situation of "Can't Invent it Here" as they offshore core knowledge in the narrow pursuit of cost savings.

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Offshoring Almost Always Reduces Costs

If the offshoring of technology development is sometimes pulled beyond original plans because of unexpected synergies and emergent engineering offshore, it often is also pushed offshore beyond the level that makes economic sense. When we asked respondents about the cost-benefit analyses their MNE had undertaken before offshoring technology development, we found that little systematic analysis had been done. At one firm top management had simply mandated that a certain percentage of technology development be offshored; our respondents said this was in response to Wall Street expectations that more offshoring always results in lower costs. In other instances there was a tendency for firms to make an overly-simplified cost-benefit calculation of offshoring. Note would be made of the difference between the salary of an engineer or developer in the US and that of one in China or India, with the inference being made that the total cost savings is of a similar magnitude. If a software engineer in India can be hired for one-fifth the cost of one in the US, the unexamined assumption was that the firm could save close to 80% of its costs by hiring the engineer in India. To be sure, the costs of travel, coordination, lower productivity, and necessary rework, are mentioned. But these costs are difficult to anticipate and often were absent from cost accounting systems.

Managers at two of the IT firms in our study, for example, reported that it typically takes five offshore employees to do work that could be done by three onshore employees. Added to this are the costs of checking and rework due to misunderstandings. Ironically, at one firm in our study, the costs for the additional inspections required for a new product made offshore were borne by the US facility—inflating the apparent cost of US production, and reducing the apparent cost of offshore production. Firms that are offshoring often find that more documentation is needed to ensure that expectations are consistent. Frequent travel by managers and team members to improve coordination can add substantially to a project's costs, with each trip costing as much as $10,000 to $15,000 per person. In complex projects, it is usual to have several employees from the US IT firm regularly travel to the vendor's site and several from the vendor on long-term projects travel to the US site (since the foreign employees based in the US have to be paid extra living costs and salary adjustments, they cost the US firm as much, and often more, than comparable US employees).

There were other costs that are difficult to track. Since most of the engineers and engineering managers are on salary, unaccounted for is the tremendous amount of extra time they put into coordinate activities across time zones, and the need for them to work outside normal office hours to make conference calls. The team man-

agers are "on-call" 18 hours a day, and some even 24 hours a day, receiving calls any time during the night if necessary to answer a question by the offshore team. Conference calls at 6 a.m., and at 10 p.m., were typically on every team's weekly schedule. An American manager who had been based in Beijing said when he returned home from an eight hour day at the office, it was like beginning another eight hour day at home to take part in global teleconferences. Nowhere did we find all these costs listed in the tally of offshore savings. And, beyond the financial statement, these long shifts and constant accessibility would seem unsustainable for most workers and managers. When we raised the issue of extended work hours due to the globalization of engineering projects at a presentation of our findings at an electrical equipment multinational, several managers spoke out to say these schedules "are definitely unsustainable." Others in the room nodded in agreement. The problem is not confined to Triad MNE managers; it also extends to managers at the emerging-economy firms working with them. One highly successful global entrepreneur we interviewed said he was spending about 60% of his time traveling to coordinate the activities of his three plants in China with his MNE customers in the Triad. He is only thirty-five, but said, because of the pressures of his work he would like to retire early. Unfortunately, he said, he hasn't had the time to get married and produce an heir to his business.

Cost accounting often seems to follow a management decision to go offshore. At the firm mentioned above where the decision to go offshore was driven in large part to impress investors, calculations were made ex post facto to justify it. As we interviewed managers at several levels at one MNE, we concluded that the company had underestimated offshoring costs by as much as 50%, making the actual offshore cost advantage rather small.

Other studies have estimated the true cost differential at about 15%, which is consistent with our estimates. While some of these offshoring costs might decline over time as systems improve, the savings from lower offshore wages are likely to decline at a much faster rate as salaries in emerging economies go up, and as likely changes in currency rates (especially in the case of China) take place.

Wages for engineers in India, for example, are typically increasing at 15 to 25% per year. Some of the engineering managers we interviewed expressed concern that the supply of technical people in India and China who have the language skills and managerial training to work effectively for MNEs is rapidly being depleted by the fast-growing demand—which is causing spikes in the pay needed to attract and retain these people. A manager of an electronics MNE told us that on a recent trip to India he decided to double the salary of several of his key staff people to keep from losing them. Although China, India and some other emerging economies are graduating large numbers of engineers, only a small percentage are of high quality. One study conducted for the Indian software association NASSCOM, for example, found that only a third of Indian university graduates with an engineering degree were employable, and only 15% were qualified to begin work without extensive additional training. And in our interviews at universities in India, we found that many of the brightest engineering students plan to go into finance or start their own business and thus would not even be in the technology hiring pool for MNEs.

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Existing Technology Support Systems Can be Safely Neglected

At the headquarters of one US MNE we asked an engineering manager about the longstanding relationships the firm maintains with the universities in his region. He thought for a moment, then said: "Since all of our software development is now offshore, and all of our entry-level hiring is offshore, we really didn't see any reason to continue providing equipment and internships to the four universities we used to support." In the past, this manager had been a regular participant at university career days, had cultivated relationships with professors, had offered internships to students, and had donated equipment to the engineering schools at the regional universities.

This response was not unusual. Driven by quarterly performance metrics, it is becoming difficult for the firms that are increasingly offshoring their engineering work to justify investments in US universities. Cutting investments in the universities clearly makes sense for engineering managers with scarce resources—why invest in the education of people you are unlikely to hire? But, we were dismayed to find that at more strategic levels, MNE managers were giving little thought to the longer-term gains that might be made by helping US universities develop the new global engineers and managers that will be needed. (An exception, perhaps, that may provide a model for what firms could do is IBM's investment in UC Berkeley's new Services Sciences, Management and Engineering program). Importantly, government support of R&D will not be productive unless firms also invest in the US-based research infrastructure.

Studies should be made to see what is happening to Triad engineering co-op and other programs as MNEs shift their attention offshore.

Competent Global Engineering Managers Will Continue to Come Up Through the Ranks at Triad MNEs

In interview after interview, engineering managers described the past positions that had given them the skills they now use as global engineering managers. Most of the lower level technical managerial positions they described have now been offshored. How, then, will the global engineering managers of the future be trained? When asked about this, some managers acknowledged that it was a problem, but none said that anything is being done about it.

Globally dispersed engineering, and cross-boundary technology development require new sets of managerial, technical and cultural skills. Many, perhaps the majority, of those who have emerged with those skills so far have been engineers from emerging economies who have gone to universities in the US or Europe and have the social skills to work across both cultural and technical boundaries. They are able to move easily from one cultural and/or technical milieu to another, whether working with suppliers or with their own company's engineering team in a foreign country. These managers tend to come from emerging economies because their career paths have provided them with the experience and training for the role of global engineering manager. Often we found these managers almost accidentally fell into these positions, sometimes pressed into service because they had knowledge of the offshore country though not necessarily from the technical or product area that was located offshore. Those who succeeded in this role were able to thus work across these multiple boundaries, but typically, the company did not formally recognize this new role as distinctly different from existing positions in the organization.

Companies have been slow to recognize the need for global liaison manager. It is a demanding position, requiring extensive travel with long periods away from home and a special set of skills. People with high level engineering and managerial skills who can function in a Triad multinational, and have the language and other skills needed to succeed in a country like China and India are very rare. Typically the Triad MNEs in our sample had not systematically sought out such people. More often they had been fortunate enough to employ them already in other positions. In a common scenario, a Triad MNE manager planning to offshore technology work would approach an ethnic emerging economy manager and offer him (all were males in our study) the opportunity to return to his country of origin. Indeed, a Chinese manager at a large US electronics firm in our study had created his own opportunity—persuading his firm to open a facility in China and send him there. In some cases the choice of country to host a technology development site was partly determined by the availability of managers within the firm from various countries. Increasingly, qualified managers with technical skills who speak Chinese with native or near native fluency can earn a higher salary in China than a comparable manager in the US. The problem for their employers is that these managers are receiving frequent telephone calls from headhunters. We would not be surprised if some of the firms depending on these people will soon lose them. The pool of people with comparable skills is not large, and multinationals, at least at most of the ones we studied, are not developing effective strategies to develop stable cadres of global engineers. It seems unlikely that MNEs can hope to succeed while continuing to rely on a strategy of serendipity.

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The challenge for companies, engineering and managerial schools, and for policy makers in the Triad, is to recognize these new types of positions and develop required programs to train this new cadre of global managers.

Firms will increasingly need to reconsider the value they place on global technology managers. These people have unique skills and the competition to hire them will only increase. Corporate policies may make it difficult to give salary increases generous enough to keep people—but it should be recognized that those eventually hired to replace them may cost even more. It may be necessary to develop special rules for the most valued members of the global technology management corps. A common complaint in our interviews was that global managers, especially those playing a liaison role, are often not acknowledged for that role. They are just expected to work across the globe without consideration of the value they provide above and beyond their technical or managerial function; i.e., they are seen as just another manager or engineer… and typically they are foreign born. A number of times we talked to global managers who said they were not recognized as such by the firm, and not given any special consideration or compensation even though they put in more hours, more travel, and were away from home much longer than managers at same level but based primarily in the US/Europe. Many of those who were foreign born seemed to feel they were being taken advantage of, and had a mild sense of being discriminated against.

Standard HR Practices Can be Applied to Global Engineering Projects

Developing offshore innovation centers is far different from developing

offshore back office operations or outsourcing low-value added activities. If companies are developing their core, or near-core activities offshore, and hoping to retain them as proprietary activities that contribute to their competitive advantage vis-à-vis other companies (in the Triad or in the emerging economies), they need to integrate these operations and personnel into their organization. The problem of employee turnover was mentioned in most of our interviews in emerging economies. At one Industrial Park in India, we were told, Indian engineers from various countries routinely socialize with each, telling each other of new job opportunities as new MNEs come to the Park. This seems to be common in many parts of the world. Indeed, it seems reminiscent of the high turnover traditionally associated with Silicon Valley. In the emerging economies, however, it is not just an issue in software development or biotechnology; we were told of similar patterns of turnover in industries ranging from truck and automobile manufacturing to the production of utility equipment for buildings.

High turnover was not a problem at all of the sites we visited in India and China. At one US firm's site in China's Yangtze Delta turnover was not an issue. One of the managers we interviewed was Chinese-American, one was from mainland China, and the other was from Taiwan. All had worked for the MNE in the US and at other sites around the world. All seemed to identify much more strongly with their MNE than with their country of birth. This was apparently a result of their frequent assignments to different posts around the world. This firm was unusual in our study in the degree to which it gave explicit attention to the development of global managers. All these managers intended to spend their entire careers at this company. The situation was similar at the site of a major US software firm in Beijing. When asked about the retention problem, the technology manager said this was not a problem at his firm. To be sure, on one occasion in the last two years an outstanding engineer had been attracted to another firm by the offer of a salary double what he had been making. But this had only happened once in the memory of the manager we interviewed. At this company the prospects for career growth were seen as so attractive, that most employees considered it shortsighted for a good engineer to leave to take an immediate offer of more money.

Once Global Virtual Networks are Established The Battle is Won

Another challenge facing the MNEs in our study is maintaining effective virtual networks across the globe. At one firm in our study, engineers and managers had regularly traveled across the ocean to ensure smooth coordination when new operations were first set up in Asia six or seven years ago. Special funds were budgeted for this purpose. However, as time has passed, project team members and managers report increasing difficulty getting budget approval for overseas trips because offshoring is seen as a means of cost reduction rather than as an ongoing investment in innovation capability. Managers at this firm complained that there had been some deterioration in the performance of their globally-dispersed teams. One of the more robust findings in academic research on dispersed working groups is that regular face-to-face meetings are needed to maintain efficient working relationships (e.g., Mills, 1999; Gronbaek, 1992). In our studies of global engineering projects, we have found there is typically a 6 to 9 month "contact decay curve" in which periodic face-to-face meetings are necessary to support and renew high-level collaborations. Sometimes it is more than just a matter of maintaining mutual understandings with acquaintances. Teams take on new members who have never been to the other sites, and have never met the people they are supposed to be working with. This problem was especially severe at one US MNE in our study. This firm had outsourced much of its technology development to a firm in India. The Indian firm frequently rotated its staff. Even people from the US who had visited the Indian site found their knowledge of the site and its staff quickly became obsolete as the people they knew were transferred to other positions.

Local Value-adding Networks in Emerging Economy Can be Developed Just as They were at Home

Some firms in our study have been very successful in developing and drawing on local firms in emerging economies. One software firm in our study has cultivated networks of local technological entrepreneurial firms in China, India and elsewhere. This allows it to quickly ramp up capacity for new large-scale projects, without having to invest in its own capacity. Firms like Intel and others have also worked to foster entrepreneurial technology startups in emerging economies. A firm producing heavy electrical equipment had identified (or helped develop) local suppliers near their offshore sites that provided high quality low-cost components, allowing global savings in production costs.

Sometimes, however, corporate policies were mentioned that inhibited the development of local networks. At one MNE in the motor vehicle industry, for example, efforts

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were made to get local suppliers to propose technology upgrades for new products. The problem was that these suppliers were evaluated at the US corporate headquarters based on evaluation systems developed for US suppliers. Firms that were technically qualified, but less adept at going through English-language paper work were sometimes eliminated from consideration.

Global Engineering Projects are Part of a Zero-sum World

A major concern at all the companies we studied (and, judging from press reports, more broadly) is that intellectual property rights are compromised due to the offshoring of technology development. In our interviews managers described a variety of strategies being used to minimize the risk of technology leakage. One firm in the industrial coatings industry deals with the intellectual property issue, as one of their managers put it, by "making sure there are always missing pieces to the puzzle." An electronics firm makes sure that work on its core technology is always done only in the US. A pharmaceutical R&D manager based in the US told us that only the most routine testing is done in China. An executive from a European automaker told us that his company seeks to return all of its investment from joint ventures in China within five years—after that they believe they will no longer be needed by the Chinese as a source of technology and will be kicked out.

While these strategies may all seem prudent under current conditions, they have their costs. They often result in less interesting work being done in emerging economies, and thus inhibit the ability of MNEs to get the best science and engineering human resources and add to an already serious turnover problem. This, of course, limits the ability of firms to place activities where the highest competencies are. They reduce the potential for mutually beneficial arrangements.

Conclusions

Collaborative Competencies and Creating New Management Models

One of the most profound changes facing the world today is that the comparative advantages once enjoyed by Triad multinationals are shifting to the emerging economies and, increasingly, to emerging economy multinationals. That is where managers and analysts see growth as the fastest in markets, technological capabilities, and science and technology human resources. This poses new challenges both for managers and for management scholars. Triad MNE managers will need to learn to thrive in an era of mutual gain collaboration with new partners from emerging economies. The point will be not to attempt to seek dominance over every technology value chain, though certainly there will be many opportunities for Triad MNEs to form and lead some of these chains. In the new global economy, technology, skilled human resources, cutting-edge research centers, competitors and strategically vital collaborators will be more widely distributed around the world than ever before. Successful firms will know how to identify these centers of strength and to draw on them. To do this, MNEs, their managers, and their technical people will need to develop specific new competencies.

Pure technical skills are becoming a commodity, even at the high end. The key competence that will give firms collaborative (and thus competitive) advantage will be the set of abilities needed to work effectively across boundaries — organizational, technological, and cultural. Collaborative competencies based on mutual gain are different from those based on managing from a dominant position and monopolizing innovation. A generation ago, firms worried almost exclusively about technical skills in evaluating engineers and other knowledge workers. It then became apparent that they needed technical people with some of the softer skills—the ability to be productive members of teams, or to interact with customers and suppliers. Now the unmet need is additionally for people who have a strong curiosity about other cultures, and are eager to travel (a relatively unusual characteristic in the US engineers and managers we have interviewed). MNEs need to develop a new corps of global technology and managerial human resources. At some firms this is beginning to happen, but in a rather slow and unsystematic fashion. One manager we interviewed at a highly regarded *Fortune* 500 company mentioned that he had recently hired an engineer who happened to have a passion for travel. This person had only average technical skills, but was turning out to be invaluable as the company globalized its engineering activities. Such people need to be more aggressively and systematically sought out. Firms need to develop hiring criteria, training programs, and career paths that will produce engineers and managers who add to the MNE's global collaborative competencies. And, quite importantly, they need to work with colleges and secondary schools to develop these competencies rather than unreflectively call for a narrow, technical curriculum.

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The challenge and opportunity of globalization for this generation of Triad MNEs is to develop competitive advantage through collaboration with firms in emerging economies. Triad MNEs can simply offshore technology development to cut costs or increase technical staff head counts. This may

help in the short term, but a more comprehensive approach is needed. A generation ago the US makers of television sets moved plants offshore to cut their costs, but this short-term solution failed because it ignored larger issues of product quality and design. Cost cutting was not enough. In that era the firms that survived were those that moving up the value chain, abandoning many consumer and commodity products (Kenney, 2004).

Today this strategy of moving up the value chain is unlikely to work for Triad MNEs as well as it did in the past for a number of reasons already mentioned. Nor are many Triad MNEs likely to succeed by dominating technology value chains. There are just too many new sources of technological excellence cropping up around the world. Firms may be systems integrators for some technologies, but they cannot ignore the profits to be made by playing other roles in other technology value chains. Triad MNEs need to follow a new strategy of "collaborative advantage." The key, we believe, is developing the ability to tap into the global technology system by working with firms all over the world. Some of these will be firms from emerging economies that were unknown a decade ago. Sometimes, it will be the firms from the emerging economies, not Triad MNEs that will be at the top of the technology value chain or closest to the markets that matter most. To secure a valued position in these value chains, Triad multinationals will have to have strategies based on what and how they strengthen the collaboration.

Specific "collaborative competencies" must be developed (Lynn and Salzman, 2006). These competencies are based on developing mutual gain strategies and new technical and managerial skills as well. The new skills needed combine technical expertise with the capability to work across organizational, cultural, and technical/disciplinary boundaries. At the strategic level, managers need to think through the implications of all decisions about who will develop technology and where they will develop it. The point is not just to worry about the loss of "core competencies," but also the implications for "collaborative competencies." This entails a number of things. MNEs need to develop more comprehensive strategies for the offshoring and outsourcing of technological activities. As we have seen, cost, all too often, is the over-riding factor. And, even the cost numbers may be drastically understated. Firms may need to invest in systems that more fully account for costs. They may need to stand up to pressures from financial analysts who automatically assume that offshoring must always be cost-effective and must, therefore, always be desirable. Non-financial costs also need to be taken into account. What technological capabilities will the firm need in the future to have a role in new technology value chains? What investments, onshore and off, should firms make to develop those capabilities? And what co-investments with government are needed to ensure productive human resource development?

Research suggests two evolutionary strategies that business firms use in their struggle for survival. One is to seek maximum efficiency in exploiting the environment. The other is to allow a requisite diversity. The diversity strategy is less "efficient" in the short term, but is most suited to dynamic environments. Maximum efficiency in one environment may be dysfunctional after an environmental change. The lesson here is that in building collaborative competency, MNEs have to allow for changes as new technologies and new centers of excellence evolve. They must retain a range of basic technological capabilities so they can respond to new needs. They must be careful in outsourcing capabilities that may seem expendable in the short term, but may have longer-term possibilities.

Business scholars will also have to reconsider the implications of globalization for theories of management, and what insights might be drawn from older theories such as the internalization theory of MNEs (Buckley and Casson, 1976, 2002), strategy and organization structure (Chandler, 1962), and evolutionary economics (Nelson and Winters, 1982). Internalization theory posits that MNEs internalize the cross-border markets for knowledge-based assets. They can do this more efficiently than might be done through the use of external markets. Our research suggests that tensions are developing as regards the extent to which this happens. Chandler mapped how successful firms changed their organizational structures to allow the strategies needed to meet changing market conditions. Surely the changes facing MNEs now are as great as those encountered by General Motors, Sears Roebuck and DuPont three generations ago. Evolutionary economics shows how environmental dynamism may destroy the advantages of overly specialized niche efficiency. The notion of "core competency" (Hamel and Prahalad, 1994), widely used as a guide for management strategy, may also need to be re-examined. New core competencies may be required for MNEs to thrive in a world of global technology development chains. A key one we see is a set of collaborative competencies requiring managers with new skill sets. Alternatively, it may be that areas traditionally thought of as core competencies will no longer be as stable as in the past as new competitors come from unexpected places.

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