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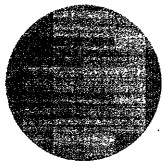

CROSS-PACIFIC INTERNATIONALISATION
OF R&D BY U.S. AND JAPANESE FIRMS

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For many decades both management theorists and managers believed that R&D would remain concentrated in the home country of multinational corporations (MNCs). Even in the early 1980s, leading management scholars argued that the concentration of technology development and new product research and development in the home country was one of the few remaining mechanisms that enabled the headquarters to control the strategies of its subsidiaries (Doz and Prahalad 1981).

However, the 1980s witnessed a rapid geographic dispersion of R&D in the world's major MNCs. Many firms engaged in offshore R&D for the first time during this period, some by acquisition and some by the establishment of new laboratories. Other large MNCs had considerable experience managing offshore development activities, but they moved during this decade to enhance the capabilities of their overseas facilities and to integrate them more closely with the home country organisation and with each other. The R&D expenditures of U.S. firms overseas have been growing more rapidly than their expenditures at home, even though R&D continued to be dominated by the home country: in 1988 U.S. firms spent the equivalent of 10.5% of their domestic R&D expenditures on R&D overseas, compared to 7.6% in 1985 (Brainard 1992: 8). A survey of Japanese firms by Japan's Science and Technology Agency in 1989 found that 19.2% of large Japanese companies already maintained R&D operations offshore and that another 9.6% were planning to establish R&D offshore in the future.[1]

No single factor adequately explains these developments. Instead, a combination of factors involving changes in scientific and technology systems, markets, competition, and government policies have led firms to try to penetrate the technology systems of countries outside their original home base and to

increase the cross-border coordination of their technology development centres (Doz 1987; De Meyer & Mizushima 1989; Westney 1990). The impact of these changes was reinforced by (and integrally linked to) dramatic changes in the model of the multinational corporation (MNC). Influential management writers such as Prahalad and Doz (1987), Bartlett and Ghoshal (1989) and Ohmae (1990) traced the emergence of a "new" kind of MNC, the "network" multinational composed of interdependent subunits whose capacity for cross-border coordination and learning made it possible for the MNC to take advantage of the "best" elements of each of its many locations. The rapidity with which this concept was espoused by top management in MNCs worldwide was revealed in a survey of top managers in U.S., European, and Japanese MNCs conducted by a leading consulting firm in the late 1980s. It found a consensus among those surveyed that: "What we have called the 'global network' model of technology management is clearly the 'wave of the future' when it comes to competing globally. This model consists of a network of technology core groups in each major market -- the U.S., Japan, and Europe -- managed in a coordinated way for maximum impact." (Perrino & Tipping, 1989: 13)

However, attempts to develop coordinated international R&D networks took place not only from different historical bases of internationalisation but also in the context of differing national and industry trends in the role of R&D within the corporation. In general, the 1980s saw large, R&D-intensive U.S. corporations making efforts to link R&D more closely to products and customers by linking the function more closely to business units and to make better use of external technology and reduce the reliance on internal technology development (Corcoran 1992). R&D budgets tended to be under considerable pressure in the 1980s in many industries, particularly in the second half of the decade: in the United States, the average annual real increase in industrial R&D expenditure was only 1.5% between 1985 and 1990. Japanese firms, on the other hand, were trying to expand their work on fundamental technologies and become more "autonomous" in technology development; R&D budgets in most firms were expanding steadily.

The paper examines the strategies of cross-Pacific internationalisation of R&D in U.S. and Japanese firms in the electronics industry. It examines the

context of these strategies in the changing models of the MNC and different trends in the evolution of the R&D function, and the differences and similarities in the management challenges these firms have faced and expect to face in the coming decade.

1. Changing Models of the Multinational Corporation

By the mid-1980s, an emerging typology of MNCs distinguished between those whose organization was "multi-domestic," in which national subsidiaries were focused on their local markets, carried out production and marketing activities locally, and had a significant measure of autonomy from headquarters, and "global" companies who concentrated their production and administrative activities in one location (usually the home country) in order to reap the cost and control advantages of economies of scale (Bartlett, 1981 and 1986; Porter 1986).

No sooner had the model been articulated and widely diffused, however, than managers and researchers found themselves moving beyond it. Increasingly, firms found that they were facing simultaneous pressures for global integration and local responsiveness. The vulnerabilities of the "global" organizational structure had been revealed by the volatile exchange rates of the 1980s, which exposed a firm whose production was concentrated in one country to unpredictable variation in costs relative to revenues (Kogut, 1985; Lessard, 1986). As a growing number of "global" firms tried to disperse manufacturing activities in order to reduce their political risk and exchange rate exposures, "multi-domestic" firms moved to find a division of labour among their subsidiaries that would enable them to capture greater scale economies within their multinational network. In other words, a growing number of multinationals seemed to be trying to move toward a model that combined elements of the strategies of both the global and the multi-domestic. This new form has been given various names -- the "transnational" (Bartlett, 1986; Bartlett & Ghoshal, 1989); the "dual focus firm" (Poynter and White, 1989); the "multifocus" firm (Prahalad and Doz, 1987); and the "heterarchical organization" (Hedlund, 1986). Academic usage seems to be converging on the somewhat less idiosyncratic term, "the integrated network

model" of the MNC (see for example Solvell and Zander 1991).

Although the general features of the network model are widely shared, the very different patterns and timing of internationalisation in European, U.S. and Japanese firms have left them with very different challenges in moving toward the "integrated network". To oversimplify considerably, U.S. and European firms have historically developed relatively strong country subsidiaries in major markets (although Asia remains for many a "black hole," to use Bartlett and Ghoshal's term for a country or region that is strategically important but where the MNC lacks significant presence). Such firms are most concerned with increasing cross-border integration based on global product organisations or business units and with reducing the role of country subsidiaries and local integration. Japanese firms, which have much more recently moved production offshore, have tended to have relatively weak country organisations and relatively strong functional (and increasingly business) linkages between Japan and the offshore operations. The variant of the integrated network model popular in Japan emphasizes the need to build strong regional (rather than country) subsidiaries in North America and Europe, with a complete integrated value chain from product development to sales (e.g. Iwai 1991). In contrast to the Western firms' emphasis on cross-border integration, the Japanese variant of the model emphasizes intra-regional or local integration as the first priority in building the network MNC.

The integrated network model insists on the importance of an international "innovation network," of which dispersed technology development capabilities are a critically important element. Two key countries in this dispersion are the two leading national science and technology systems in the world, the United States and Japan. But trends in the scale and organisation of industrial R&D have differed considerably in these two nations in the 1980s, and these trends have a powerful impact on the patterns of internationalisation of R&D followed by U.S. and Japanese firms.

2. Trends in Industrial R&D in the United States and Japan

In very general terms, industrial R&D in the 1980s in U.S. and Japanese

firms was profoundly shaped by the increasingly intense cross-Pacific competition. Often responding to Japanese competition, large U.S. companies tried to reorganise their R&D systems to increase the link between the marketplace and technology development, in order to reduce time to market, increase quality and manufacturability, and improve responsiveness to customer needs (see for example Stalk and Hout 1990). In practice this often meant putting more of the power to allocate R&D funding in the hands of business units and reducing the time frame of R&D projects (Corcoran 1992). These efforts were complemented by efforts to make more effective and efficient use of external technologies (Mowery and Rosenberg 1989: 213-219).

Large Japanese firms, in contrast, excelled in the close linkage between R&D and manufacturing, setting the world standards for time to market and design for manufacturability. They were also seen to outperform U.S. firms in making efficient and effective use of externally-derived technologies (Mansfield 1988). However, in Japan growing emphasis was placed on jishu gijutsu -- self-generated technology, meaning increasing reliance on technology generated within Japan (see for example the 1988 White Paper on Science and Technology, subtitled Sozoteki Kenkyu Kankyo no Kakuritsu o Mezashite [In Search of the Foundations of an Environment for Basic Research], and growing reliance on internally generated technology within firms.[2]

This has meant rapidly rising expenditures on R&D in Japan and a growing emphasis on fundamental research and on longer time horizons for R&D. In part these trends were a response to growing resistence from Western firms on giving their Japanese counterparts access to their technology, and in part to a perception that as the Asian NICs gained on Japan in terms of production technology, the Japanese comparative advantage would increasingly lie in technology development (see for example The Economist, Jan. 12, 1991).

Companies in each system were bent on learning from each other: U.S. corporations tried to analyse and learn from Japanese systems for linking R&D with production and with the customer, while Japanese corporations studied U.S. fundamental research institutions such as Bell Labs, IBM's corporate research

centres, the major U.S. research universities, and technology centres such as the North Carolina Resaearch Triabgle Park. U.S. firms tried to make their R&D organisations more responsive to the needs of their business units, while Japanese firms emphasized the role of their R&D organisations in creating new businesses from technology "seeds". And as part of this learning and extension of technical capabilities, U.S. firms began in increasing numbers to set up R&D facilities in Japan, while Japanese firms extended their R&D organisations into the United States (Herbert, 1989).

But U.S. and Japanese firms approached the challenges of building an international R&D network with somewhat different concepts of the ideal MNC and different trajectories of change in their R&D systems.

3. Cross-Pacific R&D Investments by Leading Electronics Firms[1]

One of the ironies of the cross-Pacific internationalisation of R&D in the last few years has been that while U.S. firms have been quicker to seize on the rhetoric of the "transnational" or integrated network model than the Japanese, the Japanese firms have actually come closer to building an integrated cross-border R&D network, and U.S. firms have come closer to building the strong local presence that the "localisation" rhetoric of Japanese firms has held up as a model.

This pattern is exemplified by the electronics industry. The 1990 global Fortune 200 included fourteen U.S. electronics firms and 10 Japanese firms (Exhibit 1). Of the U.S. firms, only five maintain dedicated, wholly-owned R&D centres in Japan (Exhibit 2). IBM has three R&D labs in Japan, the largest of which employs over 3,000 people. Eastman Kodak, DEC, and TI have all recently invested in major new laboratories in the Tokyo metropolitan area, which combine under one roof several technologies and both global and local research mandates. For IBM, Eastman-Kodak, Dec, and TI, the Japanese R&D facilities are legally part

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[1]. Over the past year, an MIT research team conducted interviews in six corporate and fourteen divisional labs of Japanese electronics companies in the United States, and three of the four U.S. electronics firms that maintain sizable wholly-owned R&D facilities in Japan.

of their Japanese country subsidiary.

Four companies, including H-P, have large joint venture firms that had a significant technology development capability (the others are Xerox, 3M, and Honeywell). They all created those ventures in the era when a wholly-owned subsidiary in Japan was virtually impossible for foreign firms. The oldest, Yamatake-Honeywell, was set up in 1949, Sumitomo-3M in 1960, Fuji-Xerox in 1962, and Yokogawa-Hewlett-Packard in 1963. Yamatake-Honeywell was centred on Honeywell's building controls system, and its technical capabilities in that field now rival those of its parent. Technology ties between the two firms are not close, compared to the other three firms, which regard their Japanese joint ventures as an integral part of their technology network, although many such firms would like to improve the flow of technology from Japan back to the rest of the MNC.[3] After years of struggling for autonomy and for recognition of the value of expanding its capabilities, it is sometimes difficult for a joint venture company to accede willingly to closer integration with its offshore parent. However, Hewlett-Packard is the first U.S. company in this industry to supplement a long-standing Japanese joint venture with a wholly-owned R&D subsidiary. It is an integral part of the corporate R&D operations rather than the Japanese joint venture.

The remaining six firms (GE, Westinghouse, Motorola, Raytheon, TRW, and Emerson) have no designated R&D centres in Japan; the level of their involvement in Japan varies from the relatively high profile of Motorola (with wholly-owned manufacturing facilities in Aizu-Wakamatsu and a manufacturing joint venture with Toshiba that included a development capability) to Raytheon's one relatively small joint venture. Interestingly enough, when GE acquired RCA it also acquired one of the oldest Western-owned technology development facilities in Japan: the RCA Engineering Laboratories Ltd. in Tokyo, founded in the 1950s as a basic research laboratory. Even even under RCA this "lab" had been reduced to a virtually nominal presence; it now functions as a licensing office.

Of the ten Japanese firms listed, only one -- Sanyo -- has no significant wholly-owned R&D presence in the United States (see Exhibit 3). For the

remaining nine companies, the extent of their presence varies across companies, but most maintain multiple units. Five of the firms have both corporate and divisional labs, mirroring to some extent their R&D structures in Japan. The corporate labs are often incorporated separately, and are legally wholly owned subsidiaries separate from the manufacturing and marketing organisations in the United States. These labs are widely dispersed geographically, and vary considerably in size and management systems.

Fujitsu, for example, not only has a minority stake in Amdahl, a computer company with a significant R&D capability, but also seven wholly-owned R&D organisations, distributed across North Carolina, Texas, and several sites in California. Sony has two corporate R&D labs in the U.S. and 11 divisional labs. Matsushita has eight R&D facilities, in several sites in California, New Jersey, and Illinois. Two other companies (Toshiba and Hitachi) have relatively small R&D presences, although Toshiba has supplemented this by acquisitions of small high-tech firms such as Diasonics in medical equipment and Vertex in semiconductors. Most of the facilities are relatively young, many being set up between 1988 and 1991 (of the twenty labs we visited in the course of our research project, only two were established before 1988). Sharp has a single engineering facility in Oregon.

The Japanese R&D investments that have attracted the greatest attention in the U.S. have been those that established basic research labs. NEC, Mitsubishi Electric, and Canon have all set up basic research centres that are have relatively broad mandates and long time horizons. NEC's Princeton facility, opened in 1989, is the largest with 50 professionals; Mitsubishi in Cambridge, Massachusetts, and Canon in California, both established in 1991, each have under 10 professionals, but plan to expand to 25 in the near future. NEC also maintains a divisional-level laboratory in Massachusetts; for Canon and Mitsubishi Electric their basic labs are their first entries into serious R&D activities in the United States.

4. Wholly-owned U.S. Labs in Japan

The wholly-owned R&D centres of the five U.S. companies in Japan represent

an enormous range of capabilities, from IBM Japan with nearly 3500 R&D employees complementing its full value-chain of manufacturing and marketing, to Hewlett-packard with 20 engineers.

IBM represents for many mutlinational companies the ideal of a dispersed R&D network, and its success in establishing a strong R&D organisation in Japan that competes effectively with leading Japanese companies for the technical graduates of the top universities was cited as a model by several U.S. firms in Japan, outside as well as within the electronics industry. Of the three R&D facilities that IBM maintains in Japan, two are product development labs and one a research centre. The oldest, the Fujisawa Laboratory, initiated in 1971 and opened in 1973 adjacent to the Fujisawa factory, now has over 3,000 employees. The other product development lab is much smaller in scale: the Yasu lab in semiconductor technology has over 200 employees. The Tokyo Research Laboratory, currently employing about 250 researchers, evolved from the Tokyo Scientific Center, established in 1982 as the fourth "R"-focused laboratory in the IBM system (after the T.J. Watson Center and Almaden in the United States and the famous Zurich lab in Europe). All three laboratories are legally part of IBM Japan, and are managed by Japanese.

The other three firms with major R&D centres in Japan are relative newcomers. Digital Equipment's centre is the oldest, established in 1982 on the initiative of the Storage Systems and Architecture group (that is, it was a divisional rather than a corporate initiative). It was incorporated separately from DEC Japan, which was a marketing organisation with no manufacturing capabilities in Japan.. In 1987 it was merged with DEC Japan to become part of a unified country subsidiary. In 1990 it moved to a new research facility in Yokohama, and employs over 200 professionals both in hardware and software development. Its first director was a bilingual and bicultural Japanese with extnsive experience in industrial research in the United States; its second director, in a reversal of usual patterns, is an American.

Eastman Kodak began planning the establishment of an R&D centre in Tokyo in 1984. The company decided to concentrate the activities on the new centre on

research and development in its commercial and business systems group and in electronic imaging, rather than in its traditional areas of chemistry-based photographic materials. It hired its first employees in 1985, and in 1988 moved to a new laboratory in Yokohama; it currently has over 100 technical employees. It too is legally part of the country subsidiary, in this case Eastman Kodak (Japan) Ltd. Like DEC, Kodak established R&D in Japan with an extensive sales and marketing organisation but no manufacturing presence. Its first director was an American from the corporate research labs; after his five-year assignment ended, his responsibilities were divided between an American Vice-President for R&D and a Japanese Laboratory Director.

TI, on the other hand, began manufacturing in Japan in 1968, and now has four factories in Japan. In the mid-1980s it established a design centre at one of its semiconductor plants, and now has four design centres in Japan. In addition, it opened a corporate R&D facility, the Tsukuba R&D Centre, in April 1991. The building is designed to accomodate 350 technical professionals, in the fields of new materials, advanced electronic devices, integrated systems, and systems information science (Sakamoto 1991). The centre is legally part of TI Japan, Inc. but it is organisationally part of Corporate Research, Development, and Engineering. In all four cases, therefore, the R&D centres are formally part of the country subsidiary, although they have strong functional links to R&D in the home country. Its first director is an American, who plans to be succeeded by a Japanese.

Interviews with R&D managers in these facilities indicate that from the beginning most have evoled a human resource management system that blends features of Japanese technology management with parent company patterns. For example, all have created career paths that are distinct from those in other functions, allowing engineers to continue a research or research management career, in contrast to the dominant model in large Japanese companies, where the prevailing career trajectory still leads from R&D into divisional line management (Westney and Sakakibara, 1985). For at least two of the firms, this is a necessity: Eastman Kodak and DEC do not maintain manufacuring divisions in Japan,

and the salaries and prestige of the marketing organisation do not match those of the R&D organisation. In part because their appeal to the "new generation" of younger Japanese technical graduates rests on their not being traditional Japanese R&D organisations, their "hybrid" management systems constitute a departure in some respects from established Japanese patterns, even though in their interface with the Japanese technology system (in recruitment and in joint projects, for example), they tend to follow established patterns.

Perhaps because of the powerful model offered by IBM Japan, and still more because of the isomorphic pulls of the home country R&D organisation, the U.S. firms have tended to establish diversified facilities with a full array of geographic mandates (from localisation of existing products to the generation of new products for global markets) and a range of technologies. In all four companies, the Japan-based R&D centres aim from very early in their evolution to achieve the capacity for developing new products, and to plan carefully for enhancing their capabilities over time, within the constraints imposed by the budgeting process. Those constraints can be considerable, as we shall see below.

4. Japanese R&D Centres in the United States

The most marked distinction across the different Japanese labs in this industry is not the difference between corporate and divisional labs (so marked in Japan -- see Westney and Sakakibara 1985) but between the basic research labs, which have strong similarities across the three companies, those (corporate or divisional) established directly by the Japanese parent, and those that have been acquired.

The basic research labs have been given guarantees of funding from corporate R&D in Japan for a five year period, and the expectation is that they will be planning for a five to ten year horizon. The broad parameters of the research fields in these labs was set by the parent company, but the U.S. professionals being recruited to staff these centres have very great latitude in setting the research agenda. These facilities are very consciously given a great deal of autonomy in management systems as well as in research agendas: all three companies have stated publicly that among their goals in establishing the

facility is learning more about U.S. systems of managing basic research. All three centres are staffed by Americans and limit severely the number of Japanese researchers on site. The NEC lab in Princeton has stated that all its researchers must be U.S. citizens or permanent residents, and the other two labs have stated that they will limit the presence of Japanese researchers to one or two. As is common with basic research labs everywhere, their densest communications links seem to be with universities rather than with other local company facilities or even with the home-country R&D organisation. For all three, the main "output" expected is published papers and patents: the adoption of the U.S. academic research model is very marked, and several of the leading researchers have been recruited from faculty positions in leading universities.

The labs that were acquired already had established a product niche and a management system; they tended to be fairly large (usually over 100 researchers); and therefore they tended to maintain a level of autonomy second only to the basic R&D labs. Among the labs studied by our research team were four that were incorporated into the company's R&D networks by acquisition: two in Fujitsu and two in Toshiba. Fujitsu acquired Intellistor, a Colorado computer peripherals firm, in 1985, and brought it under the Fujitsu umbrella of Fujitsu Computer Products of America, Inc. Intellistor's founder serves as President and CEO of FCPA, and reports formally to one of the Directors of Fujitsu Ltd. in Japan. Intellistor, with 180 employees, has become Fujitsu's main development centre for disk drives, and has only four Japanese on its presmises: two to assist on design, and two to act as communications links to Japan. There are no Japanese in management positions. This spring five of Intellistor's engineers were on secondment to Fujitsu in Japan, transferring technology to the parent company (for further details see Voisey 1992).

Fujitsu's most recent acquisition, OSSI (Open Systems Solutions Inc.), purchased in 1991, is a much smaller-scale enterprise, with only 30 employees. It is a California-based software company that works for its parent on a contract basis. It is also working closely with Fujitsu's UK subsidiary, ICL, on joint software development.

Toshiba's two acuqisitions provide an interesting contrast. The first, Toshiba America MRI Inc., was produced by putting together an acquired enterprise (acquired 1989), the magnetic resonance imaging division of Diasonics, with Toshiba's own MRI unit. After the acquisition, Toshiba's attempts to have the new organisation sell Toshiba's own competing lines of equipment and to merge the acquired unit into its own management systems led to a massive outflow of technical people (over 100 left during the first two years). The President and the head of the Finance Department are currently Japanese, and there are 2-3 Japanese technical people in the organisation of 220 employees (110 of whom are engineers).

Perhaps as a result of this experience, when Toshiba acquired Vertex Corporation in 1991, a company that designs and manufactures high-performance ASICs, the company was left with a very high level of autonomy. It is the only U.S.-based Toshiba subsidiary not have have a Japanese top manager, and no Japanese have been assigned to its 100 employees. Turnover in employees since the acuqisition has been low, and the company has been assigned the sole responsibility for dealing with the high end customers for ASICs. The company is only beginning to face certain problems of integration as it embarks on projects that involve closer technical coordination with the Japanese technical organisation, but clearly the initiative for dealing with those problems, to date, lies with the U.S. operation.

There is great variation across the other corporate and divisional-level facilities in size, technology mandate, and management systems. But one commonality is their relatively high level of specialisation and focus: each lab tends to work in one technology or product area, and to lack the capacity to generate a complete product. In consequence, they must interact closely with the Japan-based parent technology organisation.

In general, while both Japanese and U.S. R&D managers in these companies agree on the need to use American rather than Japanese management systems in the United States, those labs that interact with local manufacturing operations are being pulled toward modifying some U.S. patterns of project management in order

to work more effectively with manufacturing operations that have followed some Japanese-style patterns. This echoes trends that are more advanced in the auto firms, where the R&D centres of Japanese firms have found it necessary to introduce some Japanese-style R&D management systems in order to follow Japanese practices of design for manufacturability and simultaneous engineering. Perhaps in consequence, they tend to have a higher proportion of non-locals in the facilities than is the case for the basic research centres, the acquired units, or indeed the U.S. units in Japan.

However, one can argue that perhaps these facilities constitute a more fruitful opportunity for the U.S. technology system than either of the other two types of Japanese-owned facilities. Just as the U.S. firms in Japan pose an alternative set of patterns to those institututionalised in large Japanese labs, so the introduction of simultaneous engineering and other features of Japanese technology management in these U.S. facilities, and its "hybridisation" with other asepcts of management, will constitute a valuable source of variation within the U.S. technical system.

6. Comparison of U.S. and Japanese Approaches

The four U.S. firms with wholly-owned R&D facilities in Japan have under one roof (or in IBM's case, three roofs) an array of technologies and a set of research mandates that include both the development of new products for world markets and the adaptation of existing products to the local market. The Japanese facilities tend to be more specialised both in technologies and in research mandates; a number of facilities are still extremely small. The most obvious explanation for the Japanese pattern -- the relative newness of the R&D investment in the United States -- gives way before the observation that at least two of the U.S. facilities are equally new. And at first blush it would seem that a foreign company would find it far easier to build critical mass in an R&D centre in the United States than in Japan, given the much tighter Japanese technical labour markets.

However, technical labour markets do provide a partial explanation for the

U.S. pattern: given the great difficulties in Japan of attracting good technical people, the visibility and the symbolic commitment of a consolidated, large, and well-equipped laboratory have been valuable in recruitment. Moreover, the much greater geographic dispersion of technical centres of excellence and of lead users in the United States provides greater incentives for dispersion and specialisation. Fujitsu Network Transmissions Inc., for example, splits its R&D activities between two sites: one-third of its 120 engineers are in a software development group in San Jose, one of the nation's major centres for software development, and the rest in Texas near one of the division's most important customers, MCI (Voisey 1992). Still another factor behind the Japanese pattern may be that the companies are making a virtue of one of the features of U.S. technical professionals that they find most difficult: the very high levels of specialisation and relative indifference to the integration of an individual specialty with other parts of the value-added chain, even within R&D[4].

But however reasonable and well-suited to the particular context the U.S. and Japanese approaches may be, they pose somewhat different management challenges. One consequence of the greater specialisation of the Japanese R&D centres is that they are, of necessity, more closely integrated with the R&D organisation in Japan than with other local functions or with each other. Technology developed in the U.S. -- whether it is the software development that constitutes a very significant element of the activities of the Japanese companies in this industry or the technology being developed at the basic research labs -- must be either passed to Japan and integrated there for embodiment in products and systems, or integrated in the United States with strong support from Japan. While this pattern can be portrayed as closely approaching the "integrated network" model extolled by writers such as Perrino and Tipping, it is a substantial mismatch with the ideal of the localised regional company articulated by the top management of most of these firms. And this contradiction can create future problems, both internally (in the violation of the "psychological contract" with U.S. engineers who expect greater autonomy) and externally (in the growing public policy debates over technology flows that

are likely in the United States in the 1990s -- see Mowery and Rosenberg 1989: 274-289). In the public policy context, ironically, one of the main foci of contention may be the basic research labs that Japanese firms are establishing in the United States, although these have the highest degree of local autonomy and the most clearly enunciated goals of contributing to the local technology systems through the creation of new knowledge. The fact that these centres are not integrated with local development and manufacturing operations, but rather with advanced development groups back in Japan, may be seen as a contradiction of the "localisation" rhetoric of Japanese firms.

U.S. firms in Japan, on the other hand, face a different problem: integrating their Japan-based R&D with the rest of their R&D organisation and building its capabilities to the point where it can indeed become the global-scale technology development centre, contributing and applying technology to the overall company R&D network. There are three major ways to integrate across borders: integrated funding systems, joint projects, and cross-border assignments of technical people. As mentioned above, most U.S. firms (not only in this industry) have moved in the 1980s to allocating most of their R&D budgets through their business units on a world-wide basis, in order to link R&D activities more closely to business needs. One consequence has been (at least reportedly) a shorter-term orientation, one concommitant of which is a reluctance to put funding into projects in new and relatively untested R&D centres offshore (a problem, we should note, that is not distinctively American; it is shared by several Japanese companies).

One way for an offshore R&D centre to build internal credibility and to enhance its own capabilities is the joint project with the home-country R&D organisation. However, managing cross-border joint R&D projects is a complex undertaking, and the learning involved often takes more time than anticipated. A common result is a delay in the schedule. At a time when most US firms are focused on reducing time to market, businesses are reluctant to continue to invest in building cross-border learning curves.

One potential reaction to the vicissitudes of funding is that the offshore

centre tries to develop its own project agenda, often focused on the local market, and to shield itself from the uncertainties of interactions with the parent organisation. Historically, R&D in firms such as IBM and Fuji-Xerox developed their capabilities to the enviable level of today by focusing on local innovations for the Japanese market, largely funded by the local organisation. However, the extent to which U.S. firms have relegated to country subsidiary to a nominal role in their organisation, subordinating country to business and function, have given country organisations much less ability to allocate funding to local R&D. However, the pulls toward local autonomy remain strong in Japan-based operations of foreign firms, especially in R&D, and may work against the realisation of the "global network" model.

Cross-border assignments of technical people are a critical element of cross-border integration in this function, and provide a further contrast. The Japan-based R&D organisations of U.S. firms are staffed overwhelmingly by locals. While firms do assign some of their home country nationals to Japanese R&D centres, the dominant mode of cross-border transfer is to bring locals to the home country organisation for training and for network-building. Japanese firms have engaged in some posting of locals back to the home country organisation, the dominant mode of cross-border postings is dispatching Japanese to work in the United States. Once again, although there are sound reasons for these differences, the effect is a contradiction between the flow of people and the internationalisation model espoused on each side of the Pacific.

7. Conclusion

U.S. and Japanese firms alike engaged in a rapid cross-Pacific internationalisation of R&D during the last decade, each side being driven by strongly-held models of what an international firm should be and what kinds of capabilities it needed to develop. But the patterns of R&D facilities that were actually established in response to the R&D agendas of the firms and the technical environments in which they had to operate offshore are in some sense out of line with the models of internationalisation each side is espousing. The potential dangers of this mismatch of grand strategic vision and implementation

are considerable. Firms may have to reevaluate either their strategies or their implementation in ways that go beyond the R&D function alone. U.S. firms may have to reexamine their subordination of geography to business and function in their grand strategies; Japanese firms may have to change their model of "localisation" to a model of "transnationalisation".

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2. See for example the 1987 publication by the Japan Productivity Association (Nihon Seisansei Honbu) entitled Jishu Gijutsu Kaihatsu to soshiki.jinji senryaku (Organisational and Personnel Strategies for the development of Autonomous Technology).

3. Based on presentations by company spokepeople at a National Research Council Council Japan-U.S. workshop on industrial R&D in Calfornia, 1990.

4. Based on interviews with Japanese R&D managers in six of the eight companies listed.

EXHIBIT 1:
U.S. AND JAPANESE ELECTRONICS FIRMS IN THE FORTUNE 200 -- 1990

UNITED STATES		JAPAN	
COMPANY	RANK	COMPANY	RANK
IBM	5	Hitachi	9
GE	7	Matsushita	12
Kodak	50	Toshiba	24
Xerox	54	NEC	32
DEC	78	Mitsubishi Electric	42
Westinghouse	79	Fujitsu	49
3M	88	Sony	57
Hewlett-Packard	89	Sanyo	107
Motorola	128	Canon	118
Raytheon	143	Sharp	121
TRW	174		
Honeywell	179		
Emerson	185		
TI	197		

EXHIBIT 2: U.S. FORTUNE 200 ELECTRONICS FIRMS TECHNOLOGY PRESENCE IN JAPAN

IBM	**3 R&D labs in Japan**
GE	**Licensing offices**
Eastman Kodak	**R&D lab**
Xerox	**JV**
DEC	**R&D Lab**
Westinghouse	**Strategic alliances**
3M	**JV**
H-P	**JV, R&D centre**
Motorola	**Strategic alliances**
Raytheon	**-**
TRW	**Technology Liaison Office**
Honeywell	**JV**
Emerson	**-**
TI	**R&D Lab**

EXHIBIT 3: JAPANESE FORTUNE 200 ELECTRONICS FIRMS' TECHNOLOGY PRESENCE IN U.S.

	Corporate Lab	Divisional Lab	Acquired R&D
Hitachi	X	X	
Matsushita	X	X	
Toshiba		X	X
NEC	X	X	
Mitsubishi Electric	X		
Fujitsu	X	X	X
Sony	X	X	
Sanyo			
Canon	X		
Sharp		X	