"INTERNATIONAL MANUFACTURING: POSITIONING PLANTS FOR SUCCESS"

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ABSTRACT

The paper offers a framework for analysis of international factory networks. On the basis of a) primary strategic reason for establishment of the factory, and b) the extent of technological activities at the site, five generic roles for the international factories are identified: Off Shore, Source, Server, Contributor, and Partner. Eight international companies in the electronics industry were interviewed and provide most of the case examples.

The conclusions are that a) there is a discernible pattern in the changes of the strategic charter of these factories through time, b) for building up a competitive international manufacturing base, it is essential to have certain types of factories (such as Partner and Contributor factories) in the company's international plant network, c) since developing these types of plants take time and usually require long residency and presence at the site, the plans for them should be made at the outset when a new plant is considered, and d) in the design of the organisation for managing an international network of factories, it is useful to go beyond geographical factors and consider grouping the factories according to the similarity of their strategic roles.

I. INTRODUCTION

Globalism of many industries continues to push companies to expand their network of factories worldwide. In light of the rapid changes in economic conditions and technologies, well established multinational corporations are constantly reviewing their existing sites and manufacturing strategies to remain competitive. How should a company go about analyzing its current manufacturing capabilities? What factors are important in deciding where or what type of factory to build, to expand or to remission? Our objective in this paper is to detail to the reader a framework for analysis of international manufacturing strategies and to look at some of the different kinds of movements that are occurring within specific plants today.

In preparing this model, we have interviewed eight international companies in the electronics industry with operations in Europe. This paper first describes the major strategic reasons for internationalization of manufacturing, followed by a model that incorporates these reasons to analyse manufacturing strategies. Examples taken from our interviews help to show how various corporations have positioned themselves within the framework and show the development process that has occurred at various manufacturing sites. Our model will help companies to analyse their current factory network, to see some of the trends that are occurring within manufacturing and to plan for the development of future capabilities needed to meet global competition. This analysis has addressed facilities under the control of headquarters; other important options outside of this framework for meeting operational strategic goals would include joint ventures, technical partnerships or non-integrated subsidiaries.

II. STRATEGIC ROLES FOR INTERNATIONAL FACTORIES

The key for answering the question of <u>how</u> a company should expand its manufacturing base is to determine <u>why</u> it needs to expand. In other words, the reason for expansion determines the way that the company should plan, design, construct and commission a new factory. One must first determine what overriding strategic role the factory will play over time.

In looking at the internationalization of manufacturing, we found that companies have many reasons for expansion. One way to organize and clarify these reasons was to isolate the most important strategic role, the first primary motivation or the main driving force for building a new facility. We have grouped these reasons into three basic categories: access to low cost production input factors, proximity to markets and use of local technological resources.

Access to Low Cost Production Input Factors: Important low cost input factors include labor, local raw materials and energy, depending on the industry. Capital is seldom a factor (due to the availability of local capital in the form of grants or low cost loans in low cost areas). Within high technology industries with minimal input factor cost impact, low corporate taxes on exported output could be a major factor.

Proximity to Market: Davidson (1980), in a study of U.S.-based multinationals, suggested that the two primary reasons for locating manufacturing abroad have been to reduce risks and to serve new markets. Risks include financial risks from foreign exchange fluctuations and trade restriction risks (including tarrifs, quotas and excise taxes). Market support reasons include a greater ability to respond to market needs, increased customer service (including customization and delivery), and enhanced customer confidence in the company. In a limited number of cases (typically in government regulated industries), a country requires domestic manufacturing for a foreign corporation to serve its market.

Use of Local Technological Resources: A manufacturing base can be an effective way to tap into local technological resources. If keeping up-to-date with technology is critical to a company, then proximity to suppliers, competitors and customers assumes strategic importance. Having a manufacturing base not only increases the frequency of interactions with the environment, but may be the most efficient way to distill the available information from these interactions into useful knowledge for the company.

Other reasons: Pre-emption of competition, by being the first in a new market and establishing a defensible base, has played a role in developing countries. Satellite manufacturing facilities in the home environment of strong competitors can help control their margins.

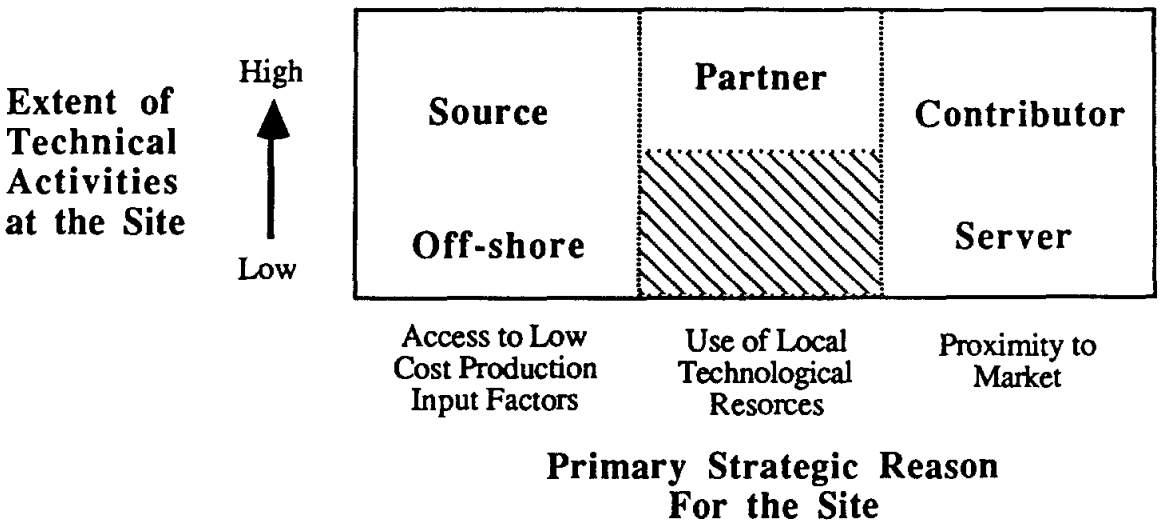
III. FRAMEWORK FOR STRATEGIC ANALYSIS

The following table gives a framework to differentiate among a set of generic roles for factories abroad. The premise here is that this role can be defined by two variables:

- The primary reason for establishment of the factory as outlined above.
- The extent of technical activities planned for that site.

Technical activities include all of the activities other than actually making parts and assembling products: activities such as procurement, process engineering, product engineering, product development, and after-sale service.

GENERIC ROLES FOR A FACTORY



Off-Shore Factories: These are factories which are built essentially to utilize local cheap production input factors and to supply components or final products to the home plant. The basic characteristic of these plants is that managerial investment in the plant is kept to the minimum essential to run the production. Usually no real engineering work (product or process related) goes on at the site; procurement decisions are mainly related to schedule and order release follow up; the primary purpose of accounting and finance is to provide data for the management at the home country; the pattern of shipments out of the plant is kept simple and essentially out of the control of the plant management.

Many factories in the Far East established by American and European "High Tech" companies fall into this category. During the 1970's almost all producers of IC's shipped their wafers to the Far East for assembly. Fairchild's factory in Indonesia, Motorola's in the Philippines and Malaysia are examples. Some of the plants in the Mexican Free Zones fit this category.

Source Factories: The primary reason for establishing these factories, too, is access to cheap production input factors. But they are given a more substantial strategical role than off-shore factories. They become a focal point for a company's efforts, concentrating on specific components, products, or production processes. The factory contains more management and engineering and exercises greater autonomy in procurement, production planning, process changes and distribution.

Apple computer's factory in Singapore is such a factory. For a long time it supplied assembled PC boards to other Apple factories in the U.S. and Ireland. The factory specialized in this; some of the advanced engineering work for the production process (burn in, for example) was performed at the site. Similarly,the Hewlett-Packard memory board plant in Peurto Rico and the Philips plant in Singapore (producing a variety of small electrical appliances such as irons

and dryers) are source plants with strategic roles for the development and production of relatively minor products for the companies for worldwide distribution.

Server Factories: These factories are there to serve specific national or regional markets. Like the Off-Shore category, the investment in managerial talent is kept to a level deemed essential to run the production efficiently. There is, however, more autonomy at the site for managing the flow of material and information between the factory and its suppliers and customers.

Best examples are the soft drink bottling plants and tobacco factories spread over many developing countries. Many of the factories built in the U.S. and Europe by Japanese companies are Servers--at least in the earlier phases before transfer of some engineering skills. Toyota's factory in Indonesia and Nissan's factories in the U.K. are essentially Server factories. Many of the companies trying to enter China are doing so with Server factories. Examples: Volkswagen and Peugeot.

Contributor Factories: They serve specific national or regional markets, but their assigned roles go beyond just supplying products. Like Source factories, they become focal points for certain activities. They can compete with the company's home factories to be the test bed for new process technology, new computer systems, and for the introduction of new products. In short, they are given explicit roles to develop and contribute know-how for the company, going beyond the financial contributions expected from Server factories.

Nestlé's plant in Singapore, Apple Computer's plant in Ireland, Sandoz's chemical plant in the U.S., Volvo in Belgium, Waertsila's (Finnish producer of large Diesel engines) factory in Singapore are all examples of Contributor factories. All have a role which goes beyond just serving their designated markets.

Partner Factories: Serving as a partner of headquarters, a Partner factory builds strategic capabilities in the manufacturing function. They tap into local technological resources not only to collect data for headquarters, but also to use these resources internally. Companies depend on Partner factories for the development of specific manufacturing capabilities. Often they are the sole or major producer of certain products for the company's global markets.

Hewlett-Packard plants in France, Germany and the U.K. are good examples. They are situated in areas with good supplies of engineers and are in close proximity to other high-tech factories. Each plant has responsibility for many of their peripheral production activities as well as being a center for development of certain products for worldwide applications. The same is true for plants of Ford of Europe in the U.K., Germany, Belgium, Spain and France; each has responsibility for the development and production of specific sections of the automobile. Through an intricate and carefully planned system, all of Ford's plants in Europe play

important strategic roles for their manufacturing function, exporting many innovations to Ford's plants worldwide.

Factories of Corning Glass in France, the U.K. and Germany can also be considered Partner factories. The four plants in France specialize in specific products (such as lenses and television screens), and by being in close proximity to Corning's European research center, have pioneered many new products and processes for Corning worldwide. Their two plants in the U.K. have specialized in various products including tableware. The German plant has pioneered most of the fiber optic development. Almost all of these plants play significant roles as Partners in developing manufacturing competence for Corning Europe.

IV. PATTERNS OF DEVELOPMENT WITHIN FACTORIES

The strategic role for a new factory can be determined quickly during the planning phase, but the building of technological capabilities within a factory takes a substantial investment commitment by headquarters and time. Often new sites begin as Off-shore or Server assembly factories with all technology transferred from other sites. Depending on a plant's strategic role for a company, the specific industry environment, and the company's organizational structure, certain plants remain effective in these roles without substantial technical skills. Many global companies have highly centralized organizational structures and chose to keep all technology development near their domestic operations and to continue an Off-shore plant strategy (for low cost production) or Server plant strategy (for serving regional markets). This allows a company to achieve global efficiencies and helps in the integration of technologies.

Philips operates Server factories in its lighting division for markets outside of those supplied by Partner plants in Holland due to the maturity of world lighting markets and technology. All lighting R&D is performed in Philips' Holland labs and first transferred to the Partner factories nearby for process development and validation. Mature products and processes are then transferred to its Server factories worldwide. Economies of scale from having centralized process development in Holland outweigh the benefits from individual market responsiveness for Philips in this industry. Sony, with highly centralized R&D and product development functions in Japan, operates Server plants in the U.S. and in Europe. Its audio cassette plant in France uses products and processes developed in Japan. DEC, while developing the VAX architecture in the late 70's and early 80's, was forced to centralize development at their U.S. headquarters to insure compatibility within the new technology.

One of the difficulties in operating Off-shore and Server factories is in the efficient transfer of technology. Often factories using current, profitable processes are reticent to accept change dictated by domestic plants and labs. Some of the key points noted by Quinn and Mueller that can aid in technology transfers are:

- Give management the incentives to accept technology and insuring that the short-term financial effects are not slowing their acceptance of change. Reward management for their speed and cooperation in the transfer (this was noted at DEC & Philips).
- Keep the number of people involved in the transfer to a minimum to avoid information problems.
- Keep the number of transfer points to a minimum.
- Have a strong coordinating authority, such as multifunctional task-force groups, with specific responsibility and authority for implementation of a given new technology.

As product life cycles decrease, the efficiency of technology transfer increases in importance. One of the reasons for movement away from Off-Shore and Server factory strategies is that companies are trying to reduce the time to market for new product introduction. Time to market involves the speed of product design, the transfer of the product to the global factory network, and the rate at which the production can be built up. Efficient transfer and communication technology exists today, but the organizational issues surrounding its effective use remain as hurdles for many companies. L.M.Ericson, in its telecommunications division, is organized in a way that allows for the efficient building and transferring of core competences amongst its international subsidiaries (Bartlett and Ghoshal, 1987).

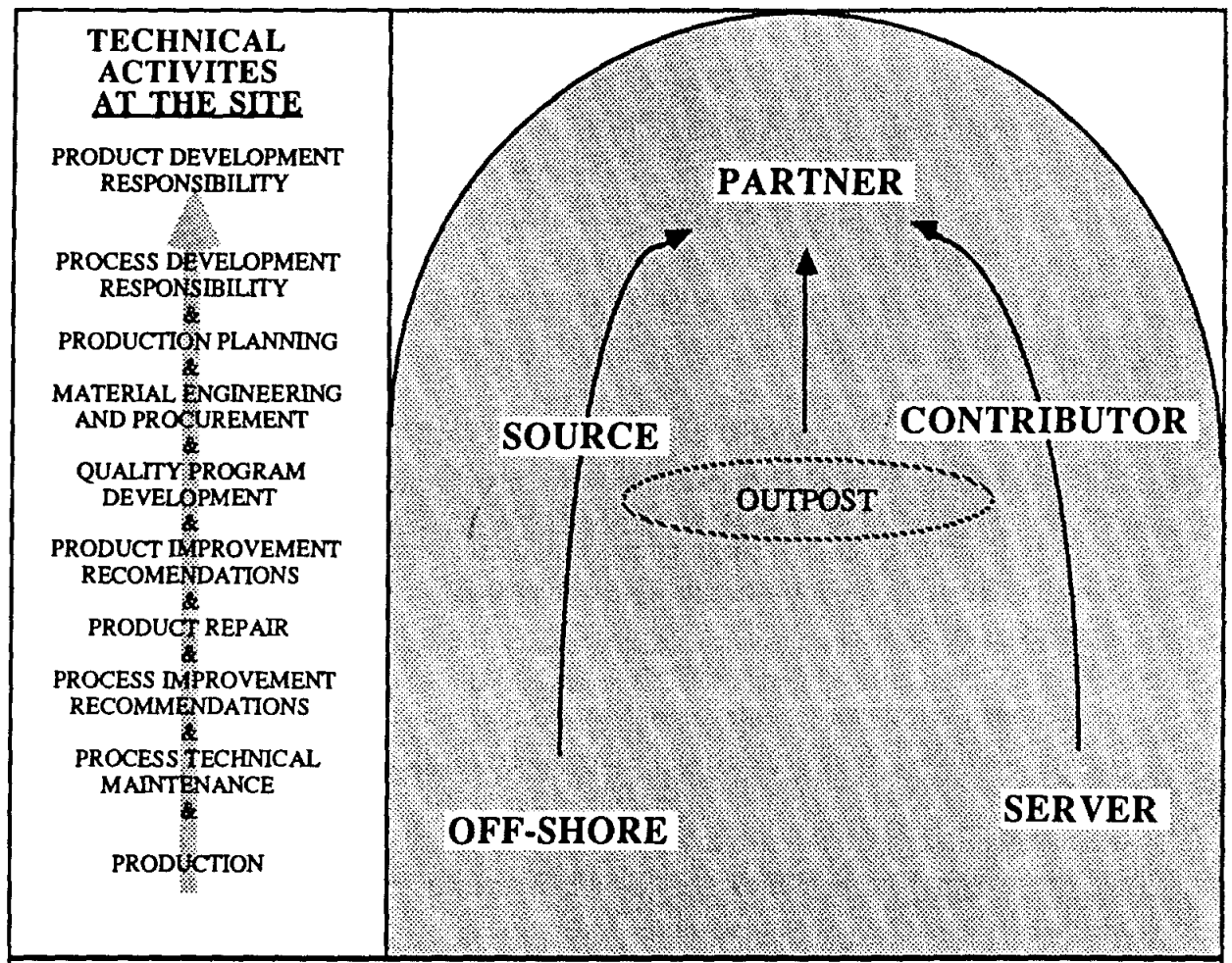
By building technological capabilities within plants, transfers become easier due to the availability of qualified local engineers to aid in process and product introductions. As more development takes place within a plant, the need for technology transfers is also reduced. Philips, in the relatively mature consumer electronics industry characterized by intense global competition and very short product life cycles, has developed its factories in the Far East into Contributor/Partner factories split by product line. R&D and pre-development labs (commercialization of major technological changes like CD technology, liquid crystal display and high definition technologies for televisions) remain in Holland, but the Consumer Products factories have been given product and process development (mainly fashion and cost reduction changes), procurement, production and logistic responsibility to decrease the time to market for their product lines.

Another factor encouraging companies to invest in more technology for Server factories is to give plants the ability to customize products to respond to local market needs. This ability increases in importance as product technology matures, markets begin to segment and local substitution occurs. For sophisticated products, customers start demanding local changes to the product. As volumes increase, governments and local industry infrastructures put pressure on factories to have local development capabilities.

A final reason for movement away from assembly plants noted in our interviews is that for companies to keep successful managers sufficiently motivated over time, they must let successful factories grow in complexity. Corporate technical staffs, sent to new sites to help in their development stages, are replaced by local technical personnel. Additional functions are

added after production becomes routine. Successful plant managers start to fight for new product introductions and development capabilities. When innovative ideas start to flow back to headquarters, additional responsibilities are granted, helping Off-Shore and Server factories to evolve towards Source, Contributor, and Partner sites.

MOVEMENTS WITHIN A SITE



STRATEGIC ROLE OF THE SITE	ACCESS TO LOW COST PRODUCTION INPUT FACTORS	USE OF LOCAL TECHNOLOGICAL RESOURCES	PROXIMITY TO MARKET
DISTRIBUTION FOCUS	*INTERNAL*	*WORLDWIDE*	*REGIONAL*

This type of evolution has occurred for Hewlett-Packard in its Off-Shore factories in Peurto Rico (memory devices) and in Singapore (keyboards). Both sites have moved from their initial assembly responsibility to worldwide product responsibility for the components they produce. They have developed internal product and process development teams which have become competence centers for Hewlett-Packard, developing components for all of the information system plants worldwide.

V. BUILDING PARTNER FACTORIES

Why should a a company build Partner plants as opposed to the more efficient mother/daughter structure with centralized product and process development? Competitive knowledge, skills gained in response to activities within one market and innovative ideas can be crucial to gaining an edge over competitors if they can be diffused quickly throughout the company. The ability to learn from all employees worldwide, to tap centers of excellence and to unite and manage technical skills is becoming increasingly important to respond to shortening product life cycles and a growing emphasis on differentiation of products.

These arguments have been put forth by many, most recently by Bartlett and Ghoshal (1987) who state them eloquently and convincingly. If we were to apply Bartlett and Ghoshal's findings to our framework, the arguments would imply that the roles for international factories of successful multinational corporations would move closer to the Source, Contributor and Partner roles of our model with extensive technical capabilities for the capture of knowledge at all manufacturing sites.

Partner and Contributor factories must have management teams and technical skills capable of learning from their environments and using the knowledge effectively and innovatively in the creation of new products and processes. They must as well be continually striving for efficiencies and flexibility within their plants and be able to respond quickly to the needs of their customers. This requires at the outset a charter sufficiently broad to attract the quality of employees needed to spur innovation and to manage its complexities. Headquarters must allocate enough resources to allow for the development and implementation of ideas. Site location is important and difficult to change with time; the plant must be strategically located at its outset within its environment for meeting a long-term goal of becoming a true Partner plant.

Building greenfield Partner plants is difficult and takes time. Initially, with a mission to absorb and build technical knowledge as well as production yet with minimal development responsibility, an infant Partner plant could be labeled an Outpost. New sites located in centers of excellence often start with Source or Contributor roles for certain product divisions then add product development responsibility for new product lines. We have seen this sort of investment being made at Hewlett-Packard (France) and LSI Logic (England), where each have made conscious decisions to develop Partner plants from the outset. Both began by combining production with small technological teams in large, new sites, transferring manufacturing

processes and existing products from other Partner plants. They have built up their factory management skills and organizational capabilities slowly, hiring local employees, training them, and nurturing the innovative drive to create their own products for world markets. We have not found stable Outpost factories in our research, but have instead seen independent subsidiaries and joint ventures in key technological centers. Examples include Marantz, owned by Philips and Ford's 25% investment in Mazda.

Often a Partner site contains several product divisions, some with assembly responsibilities only, while others with full product development capabilities. DEC originally chose Valbonne, France as a site for a telediagnostic center for Europe. This function has since been decentralized, but DEC has added to the site four separate divisions: technical support for Southern Europe, a Server plant producing the mature PT-11 computer, product development and production responsibility for a new computer product as well as a worldwide competence center for networking/telecom products.

Certain sites begin with Off-shore or Server roles, located in areas far from centers of technical excellence, and with time attract suppliers, competitors and centers for research allowing the initial strategic role to change towards a Partner. IBM, in locating a plant in Northern Scotland far from other technological centers, now finds itself surrounded by a thriving information technology industry. Singapore, originally an area attractive only for its low labor costs, has moved towards a center of excellence in electronics as well.

VI. MAXIMUM PLANT SIZE

What is the maximum size for a site, as usually defined today in terms of the number of employees? The answer to this question depends on several factors. An overriding consideration is the size of the community's work force. Companies often worry about becoming too large of an employer and the implied social responsibility for the welfare of the community. The availability of qualified people can limit growth as well. Philips, with a large percentage of the electronics workforce in Holland, feels limitations in the number of technical employees available for growth within the country.

If the community size is not a limiting factor, at what growth point does it pay to build another facility elsewhere? Sony has built Server factories in France with a maximum number of employees between 400-500, a number where top management can still be on a first name basis with all employees. Other companies in the electronics industry have built much larger sites in Europe, sometimes approaching 4000 employees. These large sites tend to be Partner plants producing a broad product range and often containing several different product divisions. Increasing a plant's size by combining product divisions that are separate organizationally onto one site allows Hewlett-Packard to grow its sites in France from an ideal of 500 to 1500-2000 employees. IBM stresses the need to segregate overhead personnel in

large sites by products, effectively breaking down the organizational structure into more manageable units.

Given that there is an adequate supply of qualified workers within a community, it is not clear what is the optimum number of employees for a site would be. For the electronics industry, the economies of scale do not seem to be as important in due to the highly automated processes and the low number of direct labor. Other industries, such as for automobile and the tire producers, economies of scale require large plants for companies to remain competitive.

VII. COMMUNICATION WITHIN FACTORY NETWORKS

Information in Off-Shore and Server plants flows mostly in one direction. One of the important factors in moving a plant towards Source and Contributor classifications is the development of good two-way communication with other plants. As technical capabilities within a plant grow, the communication from daughter to mother plants of information such as process change recommendations and local component procurement changes increases significantly. With the continued delegation of responsibility to a plant, the worldwide network develops a reliance on information generated from the plant.

Networks containing Source and Contributor plants must have complex yet efficient communication systems, including engineering change release and product documentation. Standard procedures must be established and maintained for the company including accounting guidelines, methods of documentation and technical details such as spare parts numbers. Personal contacts developed within a factory network were as important for the companies interviewed as were the formal channels. De Meyer's comments on formal and informal communication flows between international R&D facilities (1988) summarizes well the communication needs within factory networks:

> The need for excellent communication between sites is critical for the effective transfer of technology. Much of the information that must flow to headquarters and between different sites can be routinized and one can rely on impersonal media, such as electronic mail, reports and global database networks. But for many stages of the innovation cycle, the personal face-to-face communication remains of primordial importance. Personal contacts play a preponderant role in the diffusion of knowledge between sites and in the exploitation of research results. Lateral informational flows must be stimulated. Tools available include:
> - A policy to stimulate travel and constant telephone contacts between managers and technological experts (both DEC and Ford have private planes for shuttling employees daily between their European sites).
> - Regular formal meetings with extensive informal "appendices".
> - Company culture stressing open informational exchange.
> - Organization of international working groups or project teams leading to intense

interaction between employees from different sites.
- An active policy of job rotation between sites.
- Language training.

A final point, succinctly made by Wolff (1985), is that the R&D/Manufacturing interface is healthy only when technology transfers occur in both directions. Partner sites, with development, production and sometimes marketing in close proximity, have the best chance at developing good, two-way communication.

VIII. CONCLUSION

Fierce global competition in an increasingly complex and changing environment demand of multinational corporations the ability to capture and interpret information and to use the resulting knowledge and skills on a global basis. Having a network of Partner plants at key centers of excellence worldwide is a strategy that gives corporations access to foreign technology and stimulates innovative ideas. Contributor plants can also play a key role in this development of a knowledge base. But the building of these types of factories is a large commitment and takes time. Before embarking on the establishment of a new plant abroad, management must agree at the outset on a charter sufficiently broad to attract the quality of employees needed to spur innovation and to manage the growth in complexity of a plant's operations over time.

Since the establishment of a factory is generally a binding and irreversible decision locking the company into certain constraints, it is important to clarify up front a site's charter and strategic role in order to plan its development course carefully. Geographic criteria and the definition of structure, such as communication systems, organizational structures and performance measures, should follow the definition of a site's strategic role. By analyzing manufacturing strategies within our framework, corporations should be better able to examine their current situation to avoid the molding of factories with highly different strategic charters into standard organizational units.

This framework can be used as well to analyse a factory network to help determine its current manufacturing capabilities. It can give a corporation a new perspective for identifying gaps in the network, for discussing the strengths or weaknesses of those gaps, and for mapping out the current and projected movements of plants within the network. In today's environment, the international expansion of a corporation's manufacturing base is often a necessity for survival. With diverse and sometimes conflicting criteria driving this expansion, defining strategic roles and properly planning each factory's development can turn a corporation's network into a significant competitive advantage.

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1987

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