PLANT MISSIONS IN GLOBAL MANUFACTURING NETWORKS: A RESOURCE-BASED PERSPECTIVE WITH EVIDENCE FROM THE GLOBAL COLOR PICTURE TUBE INDUSTRY

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ABSTRACT

The assignment of plant missions typically includes considerations such as plant size, technology choice, and plant focus. In the context of global manufacturing, researchers typically emphasize the importance of location and plant focus in defining the missions of manufacturing facilities. We propose that a richer understanding of plant missions can be obtained by also understanding the plant's manufacturing capabilities. This is consistent with the emergent resource-based view in strategy, which suggests that the traditional industrial organization explanation of competitive performance being driven primarily by product-market positions is inadequate. Our second proposition is that plant missions in global manufacturing networks should be complementary. We use case and survey data from the global color picture tube industry to examine both propositions. We find that plant manufacturing capabilities are an important factor in defining plant missions, along with location criteria and plant focus. We also find that most business units in our study demonstrate complementarity on geography, product, and capabilities dimensions. We conclude with a comparison of traditional and resource-based perspectives on manufacturing strategy and plant missions, managerial implications, and suggestions for future research.

(Keywords: *Global manufacturing; global networks; manufacturing strategy; plant missions; plant capabilities; resource-based view*)

1. Introduction

The global strategy framework of *configuration* and *coordination* of physical and economic resources within multinational corporations (MNCs) has motivated considerable research relevant to manufacturing operations (Porter, 1986)[1]. Of particular interest to this paper is the research on plant missions in global manufacturing networks that has in the past focused largely on the configuration dimension, with an emphasis on location-based criteria (Ferdows, 1997; Vernon, 1966; Ulgado, 1996). Another relevant perspective is the focused factory idea that suggests that a plant should focus on a limited manufacturing task (Skinner, 1986). We argue that such location-based and plant focus perspectives are only part of the picture. The purposes of this paper are to: a) show that deeper insights are possible by examining plant missions through the lens of the resource-based view of the firm and the related organizational capabilities paradigm of the manufacturing strategy literature; b) provide detailed empirical evidence on plant missions from the global color picture tube industry to illustrate these insights; and, c) explore how plant missions are managed within the context of global manufacturing networks.

Two examples from the global color picture tube industry highlight the significance of these issues. In the first case, we observed that Sony has carefully assigned specific *strategic missions* to its picture tube factories around the world, and senior management takes this into consideration when setting performance goals and even deciding on the appropriate management "style" for that factory. In the second instance, Samsung's display division was in the process of evaluating the role that its East Berlin plant would be expected to play in the future to *complement* the roles of Samsung's other display plants (see Appendix 1 for detailed quotes from both Sony and Samsung managers). These two examples suggest that the assignment of plant missions – dynamically - based on the *capabilities* of different subsidiaries, plants, and other organizational units within an MNC, is an important addition to the location-based perspective of global manufacturing, and the plant focus concept from manufacturing strategy. *Second*, the

[1] Configuration includes the choice of location of various MNC facilities and subsidiaries, while coordination refers to the integration of the activities of various subsidiaries, plants, and other organizational units.

Samsung example, in particular, points to the need for creating capabilities that are *complementary*, i.e., making configuration decisions in the context of the existing (or desired) network. In other words, manufacturing capabilities at a plant provide leverage if they add to the competitiveness of the overall business. *This means that plant missions both influence, and are influenced by, the global network of capabilities and resources.* In our case studies we observed that complementarity creates business unit level competitive leverage, and knowledge flows among plants. This article is organized around two core propositions: First, that a richer understanding of plant roles is obtained by focusing on plant manufacturing capabilities, rather than location criteria alone. Second, plant missions in global manufacturing networks should be complementary (mutually and collectively "consistent"), because complementarity leverages the overall business.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature. Theoretical arguments and propositions are presented in Section 3. Section 4 describes our research methodology. Research results are presented in Section 5 (case studies) and Section 6 (survey results). In Section 7 we discuss the results from the case studies and survey data analysis, and use these to evaluate and extend the literature presented in Section 2. We discuss the managerial implications of our research, and make suggestions for future research in Section 8.

2. How Capabilities Define Plant Missions in Global Manufacturing

Addressing the issues raised above requires carefully constructing consistent and logical arguments, evaluating these, and understanding the implications. While there is little research explicitly on these issues, we draw upon several diverse literatures to frame the "problem", and develop our arguments.

2.1 Research Foundations

In order to understand how capabilities define plant missions in global manufacturing, we need to understand the meaning and interrelationships among "capabilities", "plant missions", and "global manufacturing". Three streams of literature are relevant: 1) the resource-based view of the firm and the "organizational capabilities" based paradigm in manufacturing strategy; 2) plant missions and manufacturing strategy; and, 3) global strategy and manufacturing.

The concept of "capabilities" has its origins in the resource-based view (RBV) of strategic management. Whereas traditional industrial organization models view the firm as a collection of input factors seeking various kinds of scale and scope related efficiencies with the intent of achieving leadership with their products for specific markets (Stigler, 1968; Alchian and Demsetz, 1972; Porter, 1980, 1985), the RBV espouses the creation of sustainable competitive advantage through *dynamic organizational capabilities* (Prahalad and Hamel, 1990; Barney, 1991; Conner, 1991; Peteraf, 1993; Collis, 1994)[2]. From a broader perspective, such organizational capabilities fit into an ongoing cycle of *strategy -> competitive priorities -> organizational practices -> reinforce/ create organizational capabilities and core competencies* (Khurana, Lin, Rosenzweig, and Roth, 1999). Table 1 defines the key elements of this cycle.

In addition to physical resources, capabilities also involve intangible, tacit, and evolving resources and skills, such as those that serve as the foundation for new products and new markets (Wernerfelt, 1984)[3]. Further, these capabilities are related to both functional (and building block) skills such as logistics, flexible manufacturing systems, or process innovations, as well as trans-functional processes such as supply chain management, new product development, and integrated manufacturing (see, e.g., Wheelwright and Clark, 1992; Henderson and Cockburn, 1994; Collis, 1994: 145; Lee and Billington, 1995; Dean and Snell, 1996). For a plant, capabilities refer to

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2 The terms "resources", "competencies", "capabilities" are often used interchangeably in the strategic management literature (c.f., Collis, 1994: 143). Throughout this paper, we too use these interchangeably. Stalk, Evans, and Shulman (1992), however, make a distinction by stating that "competencies" are functional and based on individual/ organizational knowledge, while "capabilities" leverage competencies and are delivered to customers and other users through business processes.

3 Compared to product ownership and market share, such resources and dynamic organizational capabilities are valuable, unique, inimitable, and non-substitutable. First, "resources" must be valuable, i.e., they ought to lead to higher efficiencies or effectiveness, and thus create and exploit new opportunities (or negate environmental threats). Second, resources must be physically unique, i.e., they are not simultaneously in use by other firms, and are most valuable in the particular context in which they are used, i.e., asset specificity is key (Teece, 1982; Williamson, 1975). Since they are tacit, and embedded in organizational routines and learning, they cannot be traded, and are thus, inimitable (Teece, 1982; Barney, 1986; Dierickx and Cool, 1989; Prahalad and Hamel, 1990). This means that such resources cannot be acquired, for example, by hiring away management. By the same token, a particular resource is most advantageous if there exist no substitutes for it.

unique skills at the plant, and various activities and practices that serve as the basis for future distinctive achievements by the plant. In Section 4.3, we build upon this understanding of capabilities to list and classify plant-level capabilities.

Table 1: Key Terms in the Strategy Process (a Manufacturing Strategy Perspective)

Strategy Ansoff (1965), Hatten and Hatten (1988), Stalk et al. (1992)	- - ...combination of core competence and capabilities ...... Different strategies described by overall thrust of strategic group. We adopt Miles, Snow et al. (1978) and Miller and Roth (1994)'s clusters.
Manufacturing Strategy Hayes and Wheelwright (1984)	- pattern of choices (structural and infrastructural decisions) - statement of "what the manufacturing function must accomplish" (mfg. Task)
Critical Success Factors/ Competitive Priorities Hayes and Wheelwright (1984), Miller and Roth (1994)	- factors that enable a business unit to successfully compete in its primary markets .. - a statement of relative importance of key manufacturing objectives, such as quality, cost, etc.
Organizational Practices (Miller and Roth, 1994),	- Key manufacturing programs, described by "action programs", e.g., CAD, zero defects (Miller and Roth, 1994) - Procedures and practices used for key parts of manufacturing, generally described by "best practices"
Organizational Capabilities & Core Competencies Prahalad and Hamel (1990), Collis (1994), Khurana and Talbot (1999)	- Operational strengths that are sustainable and defensible. These shape future strategic choices, and at the same time, result from the strategic "intent" - Include both organizational end objectives, e.g., delivery speed and quality, as well as organizational processes, e.g., supply chain and new product development process.

The second definition is that of plant missions[4]. Skinner defines mission as a "description of the manufacturing task(s)" to be undertaken (by the plant). Some relevant considerations for defining plant mission include competitive priorities, plant size, technology choice, and plant focus (Skinner, 1986: Ch. 6). Taking a somewhat different view, Schmenner defines plant "charters" as the assignment of products, processes, markets, and customers to each facility, which, in turn, define the plant's role in the multi-plant strategy (Schmenner, 1982). For this paper, we adopt Skinner's definition, though we use the plant charter and plant focus ideas to

[4] As we mention in section 8, the notion of a *plant* mission may be somewhat inadequate. Today, it is often more appropriate to think of a *facility* mission, which includes the linkages a plant may have with a R&D lab, distribution center, or components supplier (see Bartmess and Cerny, 1993, for a description of the importance of integration of plant-level activities with key functions and activities of the firm).

help define the possible types of complementarity (see Section 3.2)[5]. Thus, a plant's mission – typically assigned by senior management - is a strategic choice that determines the kinds of competitive priorities the plant emphasizes[6]. A multi-plant business unit may assign different missions to each of its plants. For example, in a 1994 presentation, a senior manager of the Copeland Corporation, the company known for the celebrated business case on focused factories (see Garvin and March, 1989), highlighted the differences among some of the plants in his business unit (all plants belong to the compressor industry segment, but make a range of different products). These plant missions included (one of these missions per plant): quality and cost leadership in a standardized product; quality and cost leadership in a differentiated product; encourage product differentiation; low volume specials; prolong life of current products; accelerate learning; and, manage decline of current product line (Ruwe, 1994).

The third set of definitions relate to global manufacturing, and its influence on plant missions. For the MNC, corporate strategy is in part a question of geographical scope: *configuration* (Porter, 1986: 23, 56), i.e., where and how to compete so as to achieve global efficiencies and operating flexibility (Kogut, 1985a,b; Bartlett and Ghoshal, 1989); and, *coordination*, i.e., how to link globally dispersed resources and activities (Flaherty, 1986; Bartlett and Ghoshal, 1989; Galbraith, 1990; Flaherty, 1996). Configuration options range from concentrated to dispersed, and determine the location, size, and responsibilities of various MNC

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5 We do this for two key reasons. *First*, plant charters typically focus on structural (and more visible and apparent) characteristics, while more tacit and intangible capabilities are emerging as more critical. Recent surveys indicate that different plant charters show no significant and consistent differences on structural or strategic dimensions (Schmenner, 1982; Vokurka, 1998). *Second*, plant charters are not positioned to explain much variance, since the dominant plant charter is still the "product plant strategy" (almost unanimously so in the industry for which we have the data, i.e., the picture tube industry), i.e., assigning each plant a specific set of products (Vokurka, 1998). Nevertheless, the question of having a "process plant strategy" is also an important one, especially in the context of vertical integration, i.e., the plant is a stage of a disaggregated vertical value chain (Chandler, 1962; Porter, 1986). For example, should an automobile assembly plant also be responsible for engine assembly? Should wafer fabrication be done in a facility separate from the plant that does wafer cutting? Answers to such questions generally depend on industry parameters such as process technology and logistics costs, although sometimes individual firms consciously make choices different from the rest of the industry.

6 Note that we define mission (and manufacturing task) in terms of the competitive *priorities*, and not the *capabilities*. This is a clearer definition than prior research in manufacturing strategy - e.g., Miller and Roth, 1994, page 285, 286 - where competitive capabilities and priorities have been used interchangeably. Also see Table 1. Note that while plant mission and plant focus (Skinner, 1974) may overlap, they are not identical. A plant mission is a broader description of the manufacturing task for a plant; plant focus describes how a plant may simplify this manufacturing task by re-aligning its resources.

subsidiaries and facilities[7]. *Coordination* choices range from full autonomy to very tight coordination through varying degrees of standardization, rigid management control systems, and centralization of decision-making[8,9].

Figure 1: Generic Roles of International Factories

EXTENT OF TECHNICAL ACTIVITIES AT THE SITE				
	High	**Source**	**Lead**	**Contributor**
	Low	**Off-Shore**	**Outpost**	**Server**
		Access to Low Cost Production Input Factors	Use of Local Technological Resources	Proximity to Market

PRIMARY STRATEGIC REASON FOR THE SITE

(Source : Ferdows, 1989, 1997)

What does the configuration-coordination framework mean for manufacturing strategy and plant missions? While several implications emerge, one that is relevant for this article is how configuration affects plant missions. Ferdows' (1997) description of "international factory networks" focuses mainly on the configuration dimension, and proposes that the strategic missions of international factories can be defined on the basis of two dimensions: location rationale (why locate at a particular foreign site) and the extent of technical activities at the site

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7 The extreme form of concentration is a single location that serves the world, e.g., an Intel Pentium-II chip manufacturing plant in Arizona, a single distribution warehouse for HP laser printers in Scotland, or a central R&D lab in Osaka serving the technology needs of Matsushita. In a dispersed configuration, an activity may be performed in many countries. Typical manufacturing configuration decisions include the location and size of suppliers, and of production and distribution facilities for components and end products. Traditional factors in making such decisions including logistics and production costs, exchange rate uncertainty, and trade liberalization, are well known, and strategic and mathematical models based on location theory and logistics management exist for formulating and solving many such problems (Kogut, 1985b; Hodder and Dincer, 1986; Porter, 1986: 29; Cohen and Lee, 1989; Huchzermeier and Cohen, 1996).

8 As an example, key manufacturing coordination tasks include manufacturing-marketing coordination of global demand, production coordination of dispersed facilities, global sourcing, exchange rate hedging via production coordination, and the transfer of process technology and production know-how among plants (Mascarenhas, 1984; Flaherty, 1986; Cohen and Lee, 1989; Galbraith, 1990; Flaherty, 1996).

9 Traditionally, both operations management and international business researchers have primarily addressed the global manufacturing configuration question from a location theory standpoint. The operations management perspective, reflecting a problem-solving and optimization approach, includes exploring different strategic criteria for choosing a global location, as well as the set of factors described in the preceding two footnotes. The international business view has evolved more dramatically, going from the international product life cycle (Vernon, 1966, 1979) to a more elaborate framework that includes market, resource, and efficiency seeking modes of international production (Dunning, 1988: 13). Dunning suggests that MNCs locate overseas if they can leverage existing resources, achieve greater operating efficiencies, or expand the size of their market.

(Figure 1). Technical activities include process engineering, product modifications, equipment design, etc. Ferdows also suggests that over time, there is an evolution of plant roles, such that with increasing technical activities at a plant, plants aspire to play a "higher" role, such that ultimately every factory aspires to be a *lead* factory.

As with operations strategy itself, the assignment of plant missions involves both "content" and "process" issues (Leong et al., 1990). Having discussed the "content" issues related to global strategy and plant missions, we turn to understanding the "process" of assigning plant missions in global manufacturing. Both the manufacturing strategy and international business literatures prescribe a hierarchical decision-making process. First, global strategy formulation enables MNCs to assign specific roles to their subsidiaries. A subsidiary's role influences its organizational design, the degree of power and autonomy assigned to it, and the functional competence and managerial expertise resident within the subsidiary (Egelhoff, 1988; Doz and Prahalad, 1988; Bartlett and Ghoshal, 1989; Jarillo and Martinez, 1990). It also determines functional strategies, including manufacturing missions (see Leong et al., 1990 for a discussion of manufacturing strategy "process"). Plant missions, in turn, are derived from these functional strategies and the subsidiary's role (Pycke and DeMeyer, 1997).

2.2 Framing the Problem

As the above literature review suggests, plant missions in global manufacturing are currently shaped by two perspectives: a) the concepts of plant focus and explicit plant missions; b) the global strategy framework of configuration-coordination and location rationale. Skinner's focused factory notion has been a central theme in manufacturing strategy. The simple idea that a factory ought to focus on a single manufacturing task is a compelling argument. Yet, it has some shortcomings. First, while one can design the architecture for a factory based on a specific kind of "focus", it is also a fact that a focused factory may find it difficult to respond to the dynamics of changing competition (see, e.g., Mukherjee, 1997). "Focus" itself can become a detriment, just as "core capabilities" can become "core rigidities" (Leonard-Barton, 1992b). Second, the typical manner in which plant focus is defined reflects the "top-down" sentiment inherent in traditional manufacturing strategy, that a plant's strategy is determined by the business strategy. The emergent resource-based view better captures the interaction between business strategy and functional capabilities (see Figure 2).

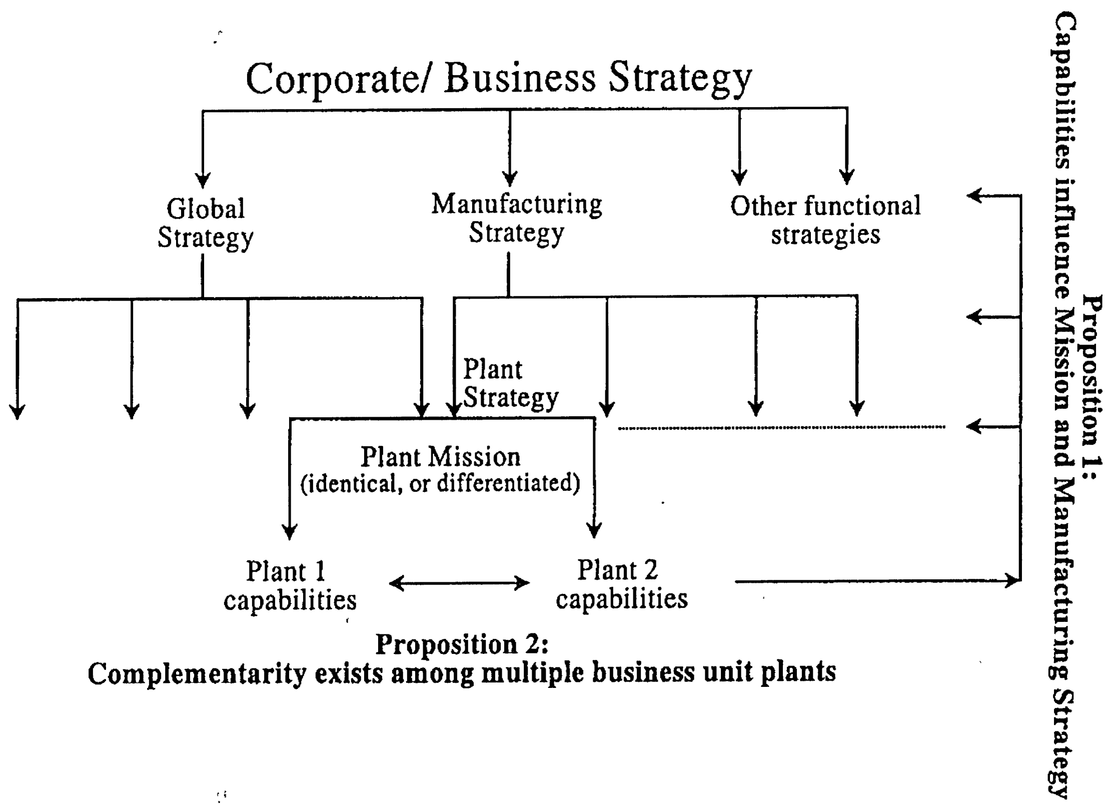

Figure 2: Global Manufacturing Strategy, Plant Missions, and Plant Capabilities

Ferdows' model is a useful starting framework for thinking about plant missions in global manufacturing from a location rationale/ configuration perspective, and it suggests several ways for developing an improved model. *First*, as Ferdows acknowledges, the location rationale itself is likely to change over time: a company locating a plant in Hong Kong twenty years ago to access low cost labor, might not do that today (see MacCormack, Newman, Rosenfeld, 1994; Magretta, 1998)[10]. McDonald suggests that many MNCs of the future will no longer consider their facilities as inert fixed assets, but rather "floating factories" that can be expanded, disassembled, or relocated as the competitive situation demands (McDonald, 1986). *Second*, a mission defined on the basis of the location rationale does not necessarily provide guidelines as

[10] In a previous cross-sectional study, we found that plant location criteria appeared to have dramatically changed – from the time the plant was built - for a substantial majority of the nearly 200 plants we surveyed (Karnani, Talbot et al., 1992).

to *what* the plant can or should do in the future. It is not merely the initial location decision, or the inclusion of plant (technical and other) capabilities, but the ongoing interplay of firm economics, competitive dynamics, organizational capabilities, and inter-functional politics that largely shape the evolving set of objectives and associated activities at a plant. *Third,* given the existence of global "networks" of facilities and other organizational resources, a plant's mission ought to be related in some way with the missions and capabilities of *other* facilities in the network (Starr, 1984; Porter, 1986; Flaherty, 1986; Flaherty, 1996).

We use the above observations about Ferdows' model and the focused factory to re-evaluate the definition and assignment of plant missions in global manufacturing. We argue that plant missions are influenced - in addition to the location (geography) and focus (product, process) drivers - by the plant's (changing) capabilities. Further, plant missions also need to fit into the context of the global network, and are thus influenced by the missions of *other* plants in the network. While these two arguments do not fill all the gaps in the multiple literature streams discussed above, they provide starting evidence and a framework for future research on global manufacturing strategy.

Table 2: Definitions Used in this Article

Concept/ Definition	Perspectives from Prior Research
Plant mission (based on " ... *the kinds of competitive priorities the plant emphasizes*")	" .. choices made with respect to four competitive priorities: cost, quality, delivery, and flexibility. " (Leong, Snyder, Ward, 1990: 113) " ... manufacturing task ... " which the plant must excel at in order to be competitive (Skinner, 1985: Ch. 6, 7) " ... what companies expect from their factories ..." (Ferdows, 1997) " ... plant charters ..." based on physical characteristics of plant (Schemenner, 1982)
Competitive Priorities (*strategic goals emphasized by operations strategy at the business unit/ plant level,* mistakenly called "competitive capabilities" by some)	" demands and constraints on manufacturing " (Skinner, 1985: Ch. 7) those that the manufacturing unit must have to " .. compete given its overall business and marketing strategy .. " , and support the manufacturing task (Miller and Roth, 1994: 285) " .. consistent set of goals ... .. " (Leong, Snyder, Ward, 1990: 114)
Plant capabilities (*those that can provide a distinctive advantage, i.e., activities and practices that matter*; Details in Section 4.3)	" .. organization (plant) with superior resources – technology, production system, knowledge, management, human skills, and finances .... " (Skinner, 1985: Ch. 13)

3. Research Arguments and Propositions

3.1 Plant Missions, Capabilities

Our central argument is that product-market position, location rationale, or a static plant focus dimension, are not enough to explain the business/ manufacturing strategy and the plant's mission. Firm and plant capabilities also contribute to the plant's mission, i.e., these are the building blocks of firm or plant-level competence (Wernerfelt, 1984; Ferdows and DeMeyer, 1990; Hamel and Prahalad, 1990; Collis, 1991). More formally, we evaluate the following proposition on the basis of our case and survey data (also see Figure 2):

Proposition 1: Plant missions in global manufacturing are influenced by plant capabilities as well as location and plant focus criteria.

3.2 Plant Missions in a Global Manufacturing Network

Global organizations exist because they can generate competitive advantages from the ownership and leveraging of their global assets (Hymer, 1976; Dunning, 1988). Further, multinationals face numerous and complex demands with regards to resources, market demands, government and legal pressures, and internal organizational pressures such as competing functional and subsidiary interests (Stopford and Wells, 1972: 18-19; Ghoshal and Nohria, 1989; Nohria and Ghoshal, 1994) [11]. Organization theory suggests that differentiation of organizational subunits – *on the dimensions that describe the diverse set of pressures* - is a logical system response (Lawrence and Lorsch, 1967: 8-13; Pfeffer, 1978: 6-7; Ghoshal and Nohria, 1989). For a manufacturing organization, this suggests that MNCs can be expected to have globally dispersed plants with *differentiated* roles or missions that are collectively expected to be consistent with, and support the overall manufacturing and business unit strategy. This is also consistent with Skinner's (1985) argument that plants in a multi-plant business unit *can* specialize in different tasks, and thus become more focused. That is, we may have one plant that plays the lead in product development, a second that focuses on process development, while a

[11] Martinez and Jarillo suggest that MNCs have evolved from being "multidomestic" (in the 1920-1950 period) to "global" (1950-1980) and now to "transnational integrated networks" (Bartlett and Ghoshal, 1989; Martinez and Jarillo, 1989: 504-505).

third focuses on quality improvement (also see Garvin and March, 1989). Further, the existence, or absence, of a network itself may affect how these plant missions are assigned. This leads to our second proposition:

Proposition 2: A plant's mission within a multi-plant MNC business unit is influenced by the missions of other plants within the business unit, in addition to the manufacturing strategy of the business unit.

Differentiation of organizational subunits typically requires coordination and integration (Lawrence and Lorsch, 1967; Ghoshal and Nohria, 1989)[12]. However, the manufacturing strategy literature, as well as the realization that plant missions are likely to be inter-related suggest an intermediate global network design choice, which we call "complementarity". This form of configuration emerges from the notion of "fit" as complementarity in the strategy and operations strategy literatures (Venkatraman, 1989: 430; Hayes and Wheelwright, 1984). Ferdows also refers to the need to have diverse, *inter-related* "specialist factories", though his definition of the six strategic roles for global factories (Figure 1) does not recognize the possibility of such complementarity (Ferdows, 1997: 76). For our research, we define "complementarity" as the extent of "fit" - on a number of dimensions discussed below - among plants in a multi-plant MNC, such that they also collectively support the overall business unit strategy. It is important to point out that such complementarity is likely to be more relevant for differentiation as opposed to cost-focused business strategies (Porter, 1980). Further, if organizational subunits have differentiated goals that "fit" with each other and with the business unit strategy, the network should be better able to meet overall organizational objectives[13]. Thus:

Proposition 2': Plants within an MNC business unit will have "complementary" missions (which in turn support the overall business strategy).

Our review of prior research revealed little on the issue of definition or dimensions of complementarity. Since this part of the research is exploratory, we venture to describe some

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[12] We suggest that in the global organization, differentiation and integration translate to configuration and coordination (Porter, 1986).

[13] We speculate that even if there is **no** interdependence among plants, such as interplant material flows, complementarity can act as a facilitator (forces plants to coordinate), or even a driver for tight coordination.

relevant dimensions of complementarity (applicable to plants in a manufacturing network), recognizing that these will not necessarily capture *all* types of complementarity (Table 3).

We start with Skinner's "focused factory" notion, and supplement it with the definition of "responsiveness" from international business, and Ferdows' suggestion to use location rationale as the basis for plant roles, and thus, for complementarity. First, Skinner argues that instead of trying to do everything, a plant should be designed to focus on a coherent "manufacturing task", typically determined by products, markets, technologies, and volumes (Skinner, 1985: 72)[14]. This means: having a narrow product mix, focusing on a consistent set of market demands, limiting the number of new and varied technologies being used, and limiting the variability of production volumes to be produced. Second, international business researchers suggest that plants in a global manufacturing network can be differentiated on the basis of global specialization or localization (Ghoshal and Bartlett, 1990: 611). For example, Electrolux's washing machine factory in France produces top-loading washers for all of Europe, while its factory in Italy produces front-loading washers to meet Europe-wide demand. In contrast, Philips' five European factories – focusing on regional responsiveness – produce near-identical television sets, each for a local market. Thus, while Electrolux's manufacturing network emphasizes product-based complementarity, Philips' is dominated by market or geographic complementarity.

The discussion of plant "focus" and plant roles in Table 3 suggests that there are several different ways to interpret complementarity in a multi-plant network. The underlying thesis, however, is that it is desirable to have a multi-plant network with plants complementing each others' capabilities and missions so as to support the overall business/ manufacturing strategy[15]. In order to make this notion of complementarity more explicit and measurable, we will later interpret the above discussion in the context of the global picture tube industry (Section 4).

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14 While this is not an exhaustive list of dimensions for "focus", it does capture the most common dimensions. Skinner (1974) suggests that the key is to identify a dimension that provides the greatest internal consistency for the plant.

15 During informal discussions, we have found support from MNC managers for the complementarity idea, though some managers and academics are concerned about the negative implications of a possible breakdown of inter-plant cooperation when a plant is completely dependent on another (complementary) plant for some of its activities.

However, to complete the set of definitions given in Table 2, we propose the following definition for plant complementarity:

> Having plants in a business unit with different plant focus or manufacturing capabilities, such that they collectively add to the competitiveness of the overall business while being consistent with the business strategy.

Table 3: Types of Complementarity

Complementarity Dimension*	Pressures that Drive Complementarity Dimension	How Complementarity is Implemented	Source
Product	Many products, scale economies	Different plants make different product groups so as to meet strategic objectives of having a full product line	Skinner, Bartlett and Ghoshal
Market/ geography	Different regional needs, logistics costs	Plants focus on different markets/ customers	Skinner, IB literature
Process/ technology	Multiple generations of technologies, scale economies for different production stages.	Different plants focus on different types of technology, or on different stages of the process	Skinner, vertical integration literature
Volume	Production system faces different pressures for different volume demands	Different plants achieve expertise on different product ranges so that customer orders can be allocated on this basis	Skinner, flexibility literature
Location rationale	Plants can be located on the basis of a variety of reasons.	Plant location criteria vary (complementarity idea not explored by Ferdows)	Ferdows
Capabilities	Plants play different roles in a network	Plants have complementary capabilities that collectively relate to the business strategy	THIS PAPER

* As we argue in Section 3.2, differentiation, and thus, complementarity, should be influenced by those dimensions that face diverse pressures and are forced to make tradeoffs, e.g., the need for scale economies motivates the need for product-based complementarity, the fact that a plant cannot be "good at everything" drives capabilities-based complementarity, and so on.

4. Research Methods

Our data come from a larger study of industry practices and competitiveness in the global color picture tube industry (details are given in Appendix 2) (Khurana, 1994). This industry was chosen because it is an important, mature global industry facing major competitive and technological challenges. We focused on a single industry instead of conducting a cross-industry study because we are convinced that plant missions are best understood within the context of a single industry[16]. Further, this is the best manner in which we can understand complementary

[16] While several researchers have hinted at the fact that organizational roles or "missions" may be influenced by industry type (see e.g., Vernon, 1966; Miller and Roth, 1994), almost all prior research on strategic archetypes and manufacturing strategy taxonomies has been cross-industry. We subscribe to the hypothesis that strategic

plant missions within a business unit. However, our research *is* limited by the fact that we have studied in detail only the picture tube segment of the television manufacturing industry. This broader industry has four major segments: glass manufacturing (funnels and panels), tube manufacturing (which we studied), TV set assembly (assembly of tubes and electronics into cabinets), and TV set distribution. Ideally, to better understand plant missions and global manufacturing, we would have liked to study the entire television manufacturing and distribution industry. However, such a massive study was well beyond our resources.

4.1 Research Design

The overall research was conducted in three phases: 1) a single-plant study (1992); 2) exploratory field-based case studies at 16 plants from 8 companies (11 plants in N. America, Europe, and Japan during 1992-93; 6 plants in E. Europe, China, and India in 1994); and, 3) during 1993-95, data collection on strategic and manufacturing issues in the industry using four detailed mail questionnaires (for the plant, production, quality, and engineering manager at each plant). Forty eight of 53 plants in the non-communist countries responded to the questionnaires during 1993-94, giving a 91% population response, thus making it a near-census of the industry. Subsequently, during 1994-95, we obtained data from another six color picture tube factories in Eastern Europe, China, and the ex-USSR. Thus, we now have data from 54 factories worldwide (of a total of 63 color picture tube factories known to exist in 1994)[17]. This article was partly motivated by discussions with several strategic planning managers during the field study phase, and uses both the case study data (1992-94), and the survey data (1993-95) for the analysis.

4.1.1 Analysis of Case Data

Data from only eleven of the sixteen case study sites are relevant for this article; the remaining five picture tube plants belong to single-factory firms. The initial case data collection followed the guidelines suggested by Glaser and Strauss, and Eisenhardt (Glaser and Strauss,

archetypes and plant missions, and organizational capabilities *are* influenced by industry, because strategy is shaped in the context of the current set of competitive and other pressures (also see Collis, 1994: 150).

17 7 new color picture tube factories have been planned or established since this study was conducted, while 2 of the plants in our study have been shut down.

1967; Eisenhardt, 1989). A semi-structured interview protocol was used to elicit responses, among other issues, on location rationale, plant mission, current and future competitive priorities and activities at the plant, relations with headquarters and other plants (see Khurana, 1994: 132-137). These data were recorded in the authors' field notes from the interviews, and later tabulated using categories to help group similar concepts. The results from the analysis of case data were used to formulate the items for the survey questionnaire.

4.1.2 Analysis of Survey Data

We analyze the survey data in three steps. First, we empirically define plant missions based on a cluster analysis of the competitive priorities described by the plants. The cluster analysis derived plant missions are cross-validated with our case studies results. Second, to understand the implications of proposition 1, we analyze if these plant missions are correlated with region of location, with product (e.g., tube size), or with manufacturing capabilities (also see Section 4.3, for a discussion of how the theoretical concepts fit in with the industry context). Third, using these results, we clarify the concept of complementarity of plant missions, and show that it exists for each multi-plant MNC in our population.

4.2 Respondents

We adopted the expert-respondent approach, i.e., we obtained relevant information from plant, production, quality, and engineering managers. All but nine of the 63 picture tube factories worldwide responded to the mail survey. Three of the nine non-responding factories are located in China, one in Russia, two in Europe and three in Asia. The lack of response from the four factories in China and Russia was either due to the fact that the factory had been shut down for several months (as in the case of the Russian factory), or because managers were unwilling or unable to seek permission for participation from government officials. The five non-responding factories in Europe and Asia belong to two Japanese companies and one European company. For these five factories, secondary data on plant size, company size, ownership, location, and product mix for these factories and companies did not reveal any systematic bias, either at the company level, or at the plant level (chi-square test was not significant).

4.3 Operationalization and Empirical Tests

To facilitate the translation from theoretical concepts to measurable variables, we first provide a background for the industry as it pertains to the key concepts, and follow this with an explanation of how we operationalized these concepts. There are some differences in the way in which we operationalize the key concepts for the case studies and the survey, given the differences in the "bandwidth" of the data available from these two data sources.

The first concept of interest is plant mission. For the case studies, we asked managers what their plant's mission and strategy were, and how management expected these to be achieved. In contrast to these detailed descriptions of plant strategy and mission, we adopted a more parsimonious definition of plant missions for the survey data, since it was difficult to measure "plant mission" using a questionnaire. In the questionnaires, we operationalize plant missions based on the competitive priorities emphasized by the plant (see Stobaugh and Telesio, 1983; Miller and Roth, 1994)[18]. Of the various competitive priorities used in manufacturing strategy research, we use low cost, quality (conformance + after-sales service), flexibility (volume + breadth), development speed, and innovation (these five dimensions encompass seven of the eleven capabilities described by Miller and Roth, 1994). A description of the scales used for these selected priorities is given in Appendix 2 (all five were recoded into 1-5 scales for the cluster analysis). The remaining four were either not greatly relevant for the picture tube segment of the industry, e.g., advertising, or were largely outside the scope of the plants' activities, e.g., dependability, speed, and distribution (though these *are* important priorities for TV assembly plants). Data for these were *not* obtained as part of the surveys.

Proposition 1 suggests that the three drivers of plant mission are location rationale, plant focus, and plant capabilities. The location criteria are easy to define for the case studies, since we asked plant managers explicitly during our interviews. We were able to map managers' responses into the three key location criteria suggested by Ferdows. In addition, we capture Skinner's

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18 Leong, Snyder, and Ward (1990) define manufacturing strategy "mission" in terms of the competitive priorities emphasized by the business unit. Researchers have also used a similar definition in empirical work on strategic archetypes and manufacturing strategy taxonomies (e.g., Miller and Roth, 1994).

"focus" dimensions by gathering data on tube sizes produced, and markets served. Process technology and volume based "focus" were found to be fairly homogeneous for the global picture tube industry. The surveys, however, had mixed success. Given the difficulty and complexity of interpreting the location rationale for an established plant, and the fact that these rationale may change frequently, we did not measure location intent in our survey questionnaires[19]. However, we do have survey data on product and market/ region dimensions of "focus".

Plant capabilities are operationalized for the case studies in terms of the kinds of capability-building activities the plant undertakes, and how these have evolved. For the survey data, the operationalization is both more difficult and fuzzier. Prior researchers have measured capabilities in two ways. First, some operations strategy researchers define and measure capabilities as "strengths" on specific competitive priorities such as quality, innovation, delivery, etc. (Kim and Arnold, 1992; Vickery et al., 1993). The problem with this approach is twofold – (i) one can expect extreme response-response bias because the same respondent evaluates the importance and strength of these priorities while also providing data for performance; (ii) this approach is results oriented and provides no insights into *how* organizations acquire these strengths. The second approach, which we adopt for this paper, attempts to first identify and then measure underlying capabilities that matter (see Table 1). Examples of capabilities defined include advanced manufacturing technologies (Clark, 1996), organizational practices such as team skills and empowerment (Dean and Snell, 1992; Black and Boal, 1994), TQM (total quality management) practices (Hayes and Pisano, 1996), and technical/ engineering skills (Dean and Snell, 1992; Ettlie, 1995; Roth and Jackson, 1995). Roth and Jackson (1995) suggest five dimensions of capabilities for services that can be interpreted as capabilities on business processes, human resources, technological skills, market awareness and customer focus, and production efficiency. Based on this assessment of dimensions of capabilities, we identify the following six dimensions (not an exhaustive list) that are relevant for the picture tube industry at

[19] In our previous cross-sectional study, not only did we find that the plant location criteria appeared to have changed dramatically from the time the plant was built, managers also told us that multiple plant location criteria were *simultaneously* important (Karnani, Talbot et al., 1992).

the plant level. Capabilities such as business process and market awareness were dropped because these are not within the general purview of the plants. To the extent possible, we obtained data on specific practices related to these capabilities, rather than seek managers' assessments about their "strengths" on these capabilities (Table 8).

- Technical/ engineering skills and capabilities
- Design and innovation capabilities
- Advanced manufacturing technologies
- Manufacturing process capabilities
- Human resource capabilities
- Quality management practices

Proposition 2 introduces the concept of plant complementarity. This is a difficult concept to operationalize. For the case studies, we asked managers about the key activities at their own plant, what their plant's "strategy" was, and how other plants in the BU fit into the network (Table 4). We then spent several days interpreting the interview notes and obtained clarifications from the interviewees. For the survey data, we needed to be more precise while seeking data on measures related to complementarity. While in Section 3.2, we identified several dimensions of complementarity – product, market/ region, technology, volume, location rationale, and mission – a thorough understanding of the industry context is important to understand the appropriate dimensions of complementarity (Appendix 1). For the global CPT industry, the typical business strategy requires a balance between quality, innovation, and cost. Thus, most competitors find it advantageous to have a range of products, and compete in multiple regions. However, since the manufacturing process is scale intensive, process technology and volume-based complementarity do not provide any advantage. Thus, for the survey data, we define three complementarity dimensions. One is "geographic complementarity", which is based on the number of world regions (e.g., America, Europe, Asia) where the BU has plants (score of 1 if plants in a single region, 2 if in two regions, etc.; Max = 4). Another is "product complementarity", which is based on the variety of product sizes – very small, small, medium, large - collectively produced by the BU, as a proportion of the variety dictated by the business unit strategy (score 0-1). The third is complementarity of "capabilities", which is measured by the number of context-specific capabilities that the BU is collectively "good" at (score 0-6).

A number of performance measures were included (see Table 7). "End-outcomes" include measures such as customer rejects (parts-per-million; CUSTOMER REJECTS), yield (measured as material consumption per 1000 tubes; MAT-QUAL), productivity (tubes per person-hour, uncorrected for automation level; PRODUCTIVITY), and tube durability (hours of tube life; DURABILITY). "Intermediate outcomes" provide another indication of performance that can be useful in assessing plant capabilities and key performance differences; examples include work-in-process (hours of inventory; W-I-P), throughput time (hours; THROUGHPUT TIME), and equipment maintenance performance (number of weekly breakdowns; e.g., SCREENING EQPT. DOWN). Another "intermediate" measure we used to evaluate plant complementarity was inter-plant learning (% of improvement ideas from other business unit plants - %IDEA). Finally, we have limited data on "bottom-line" measures such as % return on sales (ROS).

To test Proposition 1, we will show using our case studies and survey data that plant missions differ not only on the location and plant focus dimensions, but also on plant capabilities at a plant. The test for Proposition 2 is based on showing that, given a business strategy that is not too narrow, MNCs in the picture tube industry attempt to create complementarity on the dimensions of geography, product, and capabilities, and, as a result also on missions.

5. Plant Missions in Practice: Five Company Examples

The eleven selected case study plants belonged to multi-plant business units in five MNCs (see Section 4.1.1). Detailed case studies were written for each of these plants (Khurana, 1994). In this section, we first summarize the data for the eleven case study factories and then discuss the results. We return to the case studies again in Section 7, where the theoretical implications of both the case study and survey results are presented.

5.1 Case Data

The data for our case studies come mainly from our field interviews, and are supplemented wherever necessary with secondary data from the industry. These data on issues such as initial location intent, definition of plant missions, current and future competitive priorities and activities at the plant are summarized in **Tables 4a** and **4b**. In Table 4a, we describe key characteristics for each plant. Due to confidentiality agreements we are unable to provide plant and company names. Most of the data are self-explanatory, but the last two columns require some explanation. The ninth column (second from the last) provides one measure of vertical integration by indicating the % of tube production shipped to external (competitor) TV assembly plants. The last column states the reason for locating the plant in that country or region. Managers from some of the plants indicated that they either did not know why the plant was located where it was because it had been built so long ago, or that the situation had changed dramatically since the plant was originally built. Others gave a combination of reasons – market access, technology capabilities, low cost production, and government-driven need for local content.

In Table 4b, we describe the explicit or implicit plant mission, and elaborate on the strategy adopted by each of the plants, and how this plant-level strategy fits with the rest of the plants in the business unit. We distinguish between plant mission and plant strategy as follows: plant mission describes the longer term expectations that the company has of that plant, while the plant strategy outlines the activities that managers at the business unit/ plant plan to undertake to achieve these goals. This reflects the traditional hierarchical model of strategy as "fit" between different levels of strategy, i.e., corporate, business unit, functional (manufacturing), and plant. Our interviews revealed that while some plants had an explicit (E) plant mission, others did not. In case the mission was not clearly stated, we interpreted the implicit (I) plant mission based on our interviews with the plant manager and other senior managers. The data on plant-level strategy come from our interviews with the plant and functional managers, and indicate the steps they were taking to achieve the plant mission expectations. These plant-level strategic activities are also interpreted in the context of the activities undertaken by other plants in the BU (last column).

Table 4a: Key Characteristics of Case Study Plants

Company	Plant	Plant Age (years) In 1994	No. of plants in BU	Location Home or Away[1]	Tube Sizes (inches)	Tube Size Categories[2]	Other activities at or near plant[3] (business and manufacturing activities)	% sales to *competitor* TV set plants[4]	Location Rationale[5]
Asia-1	Japan	8	6	H	15, 16, 20, 27	S, M	BU HQ and R&D center close by, TV assembly plant not far, extensive engineering resources available. LCD manufacturing undertaken at plant.	20%	U
Asia-1	USA	4	6	A	26, 31	M, L	TV assembly plant also in US; some CRTs also shipped to Japan. Marketing subsidiary.	30%	M
Europe-1	USA	28	8	A	19, 20, 25, 26, 27	S, M	TV assembly plant nearly 500 miles away. Design and engineering lab at country BU HQ 100 miles away. Marketing, admin. functions handled at BU country. Normally these are responsibility of country organization.	60%	U
Europe-1	Europe-A	25	8	A, H^r	20, 23, 26	S, M	TV assembly plant close by. Country marketing subsidiary. WW BU HQ in other country but less than 1000 miles away.	50%	U
Europe-1	Europe-B	27	8	A, H^r	23, 26, 28, 31, 36	M, L	TV assembly plant, glass plant, next door. Country subsidiary marketing, logistics functions located adjacent to plant; good relations but no reporting relationships.	30%	M, T
Europe-1	Europe-C	23	8	A, H^r	20	S	TV assembly plant, glass, components plants close by.	40%	U
Europe-1	China (JV)[6]	4	8	A	16, 20	S	JV with Chinese govt. MNC owned TV assembly plant in same region. Marketing, admin. handled at plant level.	70%	M, C
Asia-2	Europe	10[7]	5	A	20, 21, 26	S, M	TV assembly plants in adjacent European countries. External shipments will go down.	60%	M
Asia-3	USA	20	6	A	19, 20, 26, 32	S, M, L	TV assembly plant, components plant, next door. Country marketing, admin. orgn. in same state.	10%	M
Europe-2	USA	28	9	A/H	25, 26, 27	M	TV assembly plant not far from plant. Two other tube plants in US, but 1000 miles away. Glass, components plants also in US. Worldwide R&D HQ for BU in same region of US.	30%	U
Europe-2	Europe	18[8]	9	A	20, 21, 22	S, M	TV assembly plant next door. Marketing etc. handled by BU HQ.	50%	L, M

Key:
1 - H = Home country; A = Away from home; H^r = Not in home country, but in home *region* (e.g., a British owned plant in Italy); A/H = Away from corporate HQ, but in BU HQ home country
2 - S=Small tubes (<21"); M=Medium tubes (21-27"); L=Large tubes (>27")
3 - TV assembly plant = TV assembly plant belonging to parent MNC (i.e., not a competitor's TV plant)
4 - Measure of vertical integration
5 - U = Location rationale is unknown (managers were not sure); M = Market access, i.e., logistics costs to supply to market; T = Technological capabilities; C = Low cost production;
L= Local content and related issues
6 - JV=Joint venture between Europe 1 and Chinese central and state government agencies.
7 - Plant recently taken over by MNC Asia-2 (past 2 years)
8 - Plant recently taken over by MNC Europe-2

Table 4b: Plant Missions, Plant-level Strategic Activities and Linkages to Other Plants in Business Unit

Company/ Plant	Current Plant Mission (Expectations set by corporate/ business unit)	Mission E or I*	Plant-level Strategy (Steps planned by plant/ business unit managers to achieve plant mission)	Plant Strategic Activities relative to other BU plants
Asia-1 Japan	Design, manufacture and sell high performance tubes with high conformance and low cost.	I	Expand design and manufacturing engineering capabilities to support picture tube plants worldwide. Enhance capabilities for LCD manufacture.	Plays lead role in BU along with another plant in Japan. Produces larger tube sizes; that may change. Hopes to transfer technology/ quality techniques to other plants.
Asia-1 USA	Achieve market share through tube performance, low customer rejects; Improve production of large tubes	E	Stabilize production equipment to ensure consistent conformance. Train new engineers and workers. Establish quality engineering group to work with customer plants. Senior Japanese engineers and managers required to visit customer plants to learn more.	Intends to focus on U.S. market and stay customer focused. Produces large size tubes to ship to Europe and other parts of Western world. Is the most automated plant in world in BU.
Europe-1 USA	Become customer/ quality focused; Increase market share in medium/ large size high-end tubes by enhancing performance. and conformance.	E	Expand capacity & improve quality. Invest in process technology; improve product and process engineering effort; move engineering resources from country BU HQ to plant	Focuses on U.S. market, and quality and cost improvements. Trying to be self-sufficient, but will seek product innovations from other BU plants and HQ. Also responsible for engineering requirements of Europe-1-USA
Europe-1 Europe-A	Achieve customer satisfaction in narrow product line; Make strategic use of technology to provide flexibility; Acquire better design capabilities.	I	Maintain customer focus - conformance, regular customer contact. Implement CIM system to help speed up line and provide added flexibility. Train employees in use of computers and CIM. Develop capability to develop new processes at plant itself. Conduct ongoing benchmarking with BU and other plants.	Is customer driven. Relative to Europe-1-Europe-B, produces fewer tube sizes, but at higher volumes, adapted to customer requirements. Aims to be leader in process tech. development, but product innovations will come from HQ or other plants.
Europe-1 Europe-B	Produce new, high-end, high-performing tubes; Reduce customer rejects. Acquire the ability to produce in small lots to meet demands of multiple customers.	I	Strengthen process and equipment engineering group. Better adapt new product and process designs to factory conditions. Broaden responsibilities of production engineers to include design skills. Develop better, flexible, and "smarter" equipment to deliver new designs at high conformance.	Is designated innovator and test plant for BU. Newest tubes and technology introduced here, then adapted for other plants, consistent with customer demands for innovative products, e.g., flat tubes, 16x9 aspect tubes (for HDTV).
Europe-1 Europe-C	Make simultaneous efforts to improve conformance, cut costs, and satisfy customers. Improve profitability.	I	Institute TQM to improve quality practices, factory layout, equipment maintenance (TPM). Also work with suppliers to improve incoming quality, and cut product and logistics costs. Also work on managerial improvements, e.g., incentive systems, cost accounting, information systems, and share improvements with other BU plants	Is one of two plants in BU focusing on 20" tubes. For 20" tube size - a mature tube - aspires to improve dramatically, and be the leader in the BU.
Europe-1 China	Sell to Chinese market, in addition to exporting low-cost tubes to Asian countries. Improve on every dimension - quality, cost, capacity utilization	E	Train engineers and workers. Tighten process parameters. Set up maintenance system with help of European plant. Seek product/ process technology, and managerial expertise, from other BU plants.	Provides a source of low-cost, high quality tubes so that other plants can continue to improve and experiment with newer and better tubes. Supplies tubes to Europe-1-Asia.
Asia-2 Europe	Increase market share, profitability. Improve performance on quality, cost. Build key manufacturing capabilities at plant.	E	Ramp-up for new tube designs (introduced by new parent Asia-2 after take-over). Train employees to learn Asia-2 technology, management approach. Optimize old and new equipment. Build capabilities for technical skills and quality by hiring skilled engineers. Transfer technology and quality systems from Asia-2 HQ. Send engineers and managers to other Asia-2 plants frequently to understand company.	Is only Asia-2 picture tube plant in western world. Needs to learn from other plants. Also, provide capacity and cost advantage to Asia-2 TV business.
Asia-3 USA	Become center of excellence for technology enhancement and integration, and product/process development. Introduce new products, develop new process technology, export to Japan.	I	Continuously train skilled employees - engineers, supervisors, workers. Experiment with process modifications, new equipment technology. Benchmark extensively to learn from the best. Establish even closer rapport with TV assembly plant (located next to tube plant).	Provides technical expertise and technology for new tubes and processes, even to older, more mature plants. Conveys knowledge of customers to other plants. Shares leadership with other Japanese plant. Three plants in Japan and Europe focus on quality improvement and meeting customer needs.

Europe-2 USA	Acquire expertise in manuf. of large size tubes. Invest in process & equipment. design capabilities. Expand production to meet market needs for E. Europe.	E	Expand capacity and plan for 16x9 HDTV tubes. Install and stabilize new process equipment. Work closely with HQ engineers (in the U.S.). Refine production system to help integrate different parts of total value chain - component suppliers, glass plants, tube plants, TV assembly plants.	Starting from an initial role of providing market access to Asia-3, plant has evolved into a leading plant for Asia-3. Aims to become leader in developing and establishing process for new, larger tubes.
Europe-2 Europe	Improve on every dimension - quality, cost, capacity utilization	E	Hire and retain good engineers (currently losing engineers to better paying MNCs). Learn more from Europe-2-USA and other plants in US.	Aims to continuously learn from other BU plants.

Notes: * - E= Explicit; I= Implicit

5.2 Discussion of Case Data

Our case data confirm the industry characterization presented in Appendix 2. All but one of the eleven tube plants is located close to an internally owned TV assembly plant. In contrast, few of the tube plants have glass plants nearby. These facts, coupled with the large percentage of tubes that are sold to competitor TV assembly plants, reinforce two key observations about the tradeoffs between scale and logistics costs: *First*, logistics costs for tubes appear to dominate plant scale economies (tube plants are close to TV assembly plants), possibly because the relative ease of availability of tubes from competitors mitigates the disadvantages that arise from having limited product variety Rather than require a proximate tube plant to produce all tube sizes, or have another company-owned tube plant ship tubes a large distance, TV assembly plants prefer to purchase tubes from competitor tube plants, to the extent that these plants can make tubes to their designs. At the same time, capacity availability, quality, cost, innovations, and compatibility of standards are important issues that motivate these MNCs to establish their own tube plants rather than source from competitor plants. *Second*, since picture tube plants are rarely in close proximity to glass factories, it appears that scale economies for glass manufacturing dominate the logistics costs of shipping funnels and panels. This holds true even if one considers the location of independent global glass manufacturers such as Corning and Asahi.

The case studies suggest that plant missions are based on the particular tube sizes produced at that plant (product), the geographic region (market) served by the plant (Table 4a), as well as the plant's capabilities (Table 4b). The relationship between plant mission and tube size is driven by the fact that the picture tube industry uses fairly dedicated production equipment, such that the choice of equipment at a plant limits the variety of tube sizes that can be manufactured. The proximity of tube plants to TV assembly suggests that mission – driven by logistics costs - is also defined by the geographic region served by the plant. These two determinants of plant mission are consistent with the location rationale, as well as the traditional view of plant focus: manufacture a limited range of products or serve a well defined market, with emphasis on achieving scale economies and low logistics costs (Skinner, 1974; Hayes and Wheelwright, 1984: 91)[20].

Following our definition of plant mission in section 2.2, we suggest that another interpretation of plant missions is based on the plant's capabilities and critical activities. The case studies demonstrate a range of plant missions on these dimensions. We classify the plant activities and capabilities described in the columns for "Plant-level Strategy" and "Plant Strategic Activities" in Table 4b into four groups:

- Plants Asia-1-Japan, Europe-1-Europe-B, and Europe-2-USA are technologically sophisticated and are leaders on product and process innovation, while Europe-1-Europe-A and Asia-3-USA are gradually moving to such a position.
- Plant Asia-1-USA focuses on process control and conformance, and emphasizes customer service.
- Plants Europe-1-USA and Europe-1-Europe-C are cost-focused, though Europe-1-USA is gradually moving to being quality-focused as Asia-1-USA.
- Finally, plants Europe-1-China, Europe-2-Europe, and Asia-2-Europe appear to follow a traditional definition of plant mission based on location rationale: that is market access and low cost orientation (Ferdows, 1997). Interestingly, all three plants are either new, or have been newly acquired by the MNC. Thus, with the exception of Asia-1-USA, all new or newly acquired plants appear to fall into this category.

The above summary of plant capabilities and mission statements highlights the fact that there are distinct plant capability clusters that differ on key operating parameters. This suggests the existence of a third dimension for plant missions in this industry - plant capabilities. Thus, three dimensions - tube size (product), regional distribution (market/ geography), and plant activities (capabilities) - appear to be important in defining plant missions for picture tube business units. This provides qualitative support for *Proposition 1*.

Table 4b describes how the consideration of the missions of other plants in the BU relate to the mission for a particular plant. In almost all cases, we find that the plant either manufactures a tube size that other BU plants do not, or it has an emphasis different from the other plants. Thus, Proposition 2 is also qualitatively supported, i.e., plant missions in MNCs are

[20] The operations literature offers several approaches to model and solve the plant location problem based on an assessment of demand, capacity, scale advantages, and logistics costs (see, e.g., Cohen and Lee, 1989).

complementary. For example, in the case of MNC Europe-1 (the only MNC for which we have extensive case data on a majority of the BU plants), Europe-1-USA and Europe-1-China are plants with a clear mission pertaining to their geographical location. In addition, Europe-1-USA has the added responsibility of supporting technical and engineering activities for Europe-1-America, a picture tube plant in North America. Europe-1-China has been asked to improve its quality so it can supply tubes to Europe-1-Asia (TV assembly plant), and, at some point, supply 17" color monitor tubes. Europe-1-Europe-A, Europe-1-Europe-B, and Europe-1-Europe-C, along with two other Europe-based plants in the BU, have different missions, although there are similarities in the tubes they produce. Europe-1-Europe-B is a product innovator and almost a test or learning lab (Leonard-Barton, 1991a), while Europe-1-Europe-A is quality and customer focused, with intentions of becoming an innovator plant. The other plants are content to better meet customer and quality needs (Europe-1-Europe-C), or be very cost-focused. The other two Europe-1 plants in Europe which we did not visit for the case are very cost-focused (as revealed by some of the managers we interviewed, and confirmed by the survey data). A similar pattern is repeated for the other MNCs whose plants we visited[21].

Our case studies also point to the impact that proximity to corporate or BU HQ has on plant mission. For example, Asia-1-Japan, Europe-1-USA, Europe-1-Europe-B, and Europe-2-USA are all located near the worldwide HQ or country BU HQ, and all are currently involved in leading the technical and strategic direction of their BU, or have a strong intent to do so. In general, proximity to some center of power appears to influence the plant mission. This is consistent with the international business notion that subsidiary missions, including subsidiary autonomy, are influenced by the nature of the parent-subsidiary relationship (Ghoshal, 1986; Birkenshaw, Hood, and Jonsson, 1996).

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[21] The relative missions for "home" and "away" plants is another possible operationalization for complementarity. However, although it does exist, our case analyses do not suggest a significant difference between "home" and "away" plants. In contrast, the literature on MNC HQ-subsidiary relationships has frequently highlighted the non-symmetry in that dyadic relationship (Ghoshal, 1986; Ghoshal and Nohria, 1989; Birkenshaw, Hood, and Jonsson, 1996).

6. Results of Survey Data Analysis

6.1 Defining Plant Missions

Using the K-means cluster analysis method and measures of the five competitive priorities described in Section 4.3, we obtain a 3-cluster solution (SPSS for Windows, 1994; also see Miller and Roth, 1994). This three-cluster solution is found to be acceptable, since it lends itself to interpretability, and is consistent with prior efforts at using cluster analysis to create strategic groups (Hambrick, 1983; Miller and Roth, 1994). However, as we discuss in Appendix 4, the cluster of plants that we call *multi-focused* actually belong to two groups, *laggards*, and *truly multi-focused.* Thus, we identify four plant mission clusters, which are described in Table 5, in terms of their respective group centroid (mean) scores. Four of the 54 plants could not be assigned a cluster because of missing data. We define these four clusters as "innovators" (34%), "improvers" (34%), "laggards" (10%) and "truly multi-focused" (22%). *Innovators* emphasize development speed for new products and processes, future leadership in innovation, and flexibility, while paying reasonable attention to quality and low cost. *Improvers* focus on quality, while lagging on both development speed and flexibility. *Laggards* are similar to Miles and Snow's "defenders" in that they lag on most factory performance and management practice dimensions. Finally, *multi-focused* facilities are either new factories, or are going through a transition, and hence, are trying to focus on more than one competitive priority. These plants have a surprisingly high emphasis on low cost, while they lag on quality and have average scores on flexibility and innovation. As Skinner (1974) argues, the attempt to balance multiple competitive priorities itself causes poor performance due to lack of "focus".

The foregoing empirical interpretation of plant missions is generally consistent with previous taxonomies developed by Miles and Snow (1978) and Miller and Roth (1994)[23]. Our

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22 In a previous cross-sectional study, managers told us that multiple plant location criteria were simultaneously important. More importantly, the plant location criteria appeared to have dramatically changed – from the time the plant was built - for a substantial majority of the nearly 200 plants we surveyed (Karnani, Talbot et al., 1992).

23 It is important to note that our empirically derived clusters may be different for other industries, though the similarity with the Miles and Snow and Miller and Roth taxonomies suggests that these clusters might be generalizable across industries. Further, our classification scheme applies to plants, while those for Miles and Snow, and Miller and Roth referred to strategic business units and manufacturing business units, respectively.

innovators are not very different from Miller and Roth's *innovators*, or from Miles and Snow's *prospectors*. Our *improvers* are similar to Miller and Roth's *marketers*. Our *laggards* are like Miller and Roth's *caretakers* and Miles and Snow's *defenders*. Finally, the cluster of plants we call *truly multi-focused* do not represent a distinct member of the Miles and Snow taxonomy, and are more like plants in transition.

Table 5: *Observed* Competitive Priorities by Group: Results of Cluster Analysis

***Observed* Competitive Priority**	**Strategic Plant Mission Cluster**				Probability of F-ratio
	Innovator [N=17]	Improver [N=17]	Truly Multi-focused [N=11]	Laggards [N=5]	
QUALITY (1-5 scale)	3.5 (2,3,4)	**4.1** (1,3,4)	1.8 (1,2)	1.4 (1,2)	0.01
FLEXIBILITY (1-5 scale)	**3.9** (2,3,4)	1.75 (1)	2.5 (1)	1.6 (1)	0.01
LOW COST (1-5 scale)	3.0	2.7	**3.3**	2.4	ns
DEV. SPEED (1-5 scale)	3.33 (2,3,4)	2.15 (1)	2.21 (1)	1.73 (1)	0.01
INNOVATION (0-1 scale)*	**0.41**	0.29	0.39	0.20	ns

Notes: Numbers in parentheses indicate cluster numbers from which cluster is significantly different at p=0.05 (Scheffe pairwise test).
ns means not significant. **Bold** numbers indicate highest score for cluster on that particular priority.
* Was recoded to a 5-point scale (Cronbach alpha of 0.72) for the cluster analysis

Table 6: Group Prediction for 16 Field Study Plants

Plant Name	**Survey Based Plant Cluster**	**Cluster Based on Field Visits**	**Agree/ Disagree (1/ 0)**
Asia-1-Japan	Innovator	Innovator	1
Asia-1 –USA	Improver	Improver	1
Asia-2 –Europe	Multi-focused	Multi-focused	1
Asia-3 –USA	Improver	Improver->Innovator?	1
Asia-4-China	**Improver**	**Multi-focused**	**0**
Europe-1-Europe-A	Improver	Improver->Innovator?	1
Europe-1 -Europe-C	Multi-focused	Multi-focused->Improver?	1
Europe-1-USA	**Improver**	**Multi-focused->Improver?**	**0**
Europe-1-Other	Laggard	Laggard	1
Europe-1 –China	Laggard	Laggard	1
Europe-2 -USA	Innovator	Innovator	1
Europe-2 –Europe	Multi-focused	Multi-focused	1
Non-MNC-1	Multi-focused	Multi-focused	1
Non-MNC-2	Multi-focused	Multi-focused	1
Non-MNC-3	Multi-focused	Multi-focused	1
Non-MNC-4	**Improver**	**Multi-focused**	**0**
		Agree on	**13 of 16**

In order to understand and verify the logic behind the cluster classification of plants, we conduct both statistical and qualitative analyses. First, we carry out a canonical discriminant function analysis (the details can be obtained from the first author). Two canonical functions emerge - "*quality improvement*" and "*innovation and customer scope*" – and these correctly predict more than 85% of the cluster membership.

Second, we use the cluster profiles and the loadings for the two canonical functions to independently rate each of the sixteen plants that we visited during our field interviews. Of these 16 plants, our own grouping and the statistical cluster analysis agree on 13, giving a prediction accuracy of 82% (Table 6; also see Tables 4a and 4b).

A comparison of performance measures across the four cluster groups confirms the profiles that one would expect based on Table 5 (remember that the clusters were formed on the basis of stated emphasis on *competitive priorities*). *Innovators* perform well on most operational measures: best on design (tube durability), productivity (tubes/ man-hour), internal quality (# of components used to make 1000 good tubes), and throughput time (hours), and a close second on customer quality (Table 7). They also have the lowest equipment downtimes (# times/ week). *Improvers* do consistently well on all quality-related dimensions (like Miller and Roth's *marketers*). In fact, they have the best customer quality performance (rejects in ppm), though they lag on productivity. This possibly reflects a distinct focus on quality where no compromises are made, and it is possibly an intermediate phase in a transition towards plants that can simultaneously achieve high quality and productivity (c.f., the sandcone model of Ferdows and DeMeyer (1990)[24]. The *truly multi-focused* plants do not display any systematic pattern of performance, as might be expected based on the fact that they are generally in transition to a different mission. Finally, *laggard* plants lag on almost every dimension.

The comparison of factory capabilities by cluster group supports *Proposition 1* (Table 8). The four clusters differ significantly on four of six dimensions of "plant capabilities" identified in section 4.3. For example, there are significant differences on some of the structural elements of plant capabilities (refer to Hayes and Wheelwright, 1984 for a discussion of structure and

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[24] The *sandcone* model suggests that manufacturing capabilities are acquired in a cumulative fashion, starting with quality, and then gradually adding on other capabilities until the business has other capabilities as well, such as delivery, flexibility, and low cost (Ferdows and DeMeyer, 1990).

infrastructure manufacturing strategy decision categories). *Innovators* produce the greatest variety of large size tubes, introduce new designs every year, and have the highest level of automation. *Improver* factories are typically highly automated, but focus on a limited set of customers and tube types. Many of them are new plants. The *truly multi-focused* are clearly aspirants, making fairly large tubes, with moderate variety, serving a reasonably large number of customers, and with a reasonable level of automation. Finally, the *laggards* manufacture a narrower product mix, have a lower technical emphasis (fewer new designs), and have a lower level of process automation.

Table 7: Factory Performance by Cluster Group

Performance Measure	Strategic Plant Mission Cluster 1 *Innovator* [17]	2 *Improver* [17]	3 Truly *Multi-focused* [11]	4 *Laggards* [5]	Probability of F-ratio
END-OUTCOMES					
CUSTOMER REJECTS (ppm)	3930 (4)	**2924** (3, 4)	4454 (1, 2)	5759 (1, 2)	0.04
TUBE DURABILITY (hours of tube life)	**24,689** (3)	19,588	17,125 (1)	14,4006 (1)	0.10
PRODUCTIVITY (Tubes/man-hr)	**1.65** (4)	1.07	1.4	0.57 (1)	0.10
MAT-QUAL (# / 1000 tubes)	**1058** (3)	1094	1095	1129 (1)	0.10
INTERMEDIATE OUTCOMES					
W-I-P (hours)	**33**	43	36	34	ns
THROUGHPUT TIME (hours)	**18.8**	26.7	21.0	23.0	ns
NUMBER OF NEW TUBE DESIGNS/ YR	**9.2** (2,3,4)	2.3 (1)	1.7 (1)	1.0 (1)	0.0007
SCREENING EQPT. DOWN (# / week)	**2.0** (3,4)	3.75 (3,4)	7.2 (1)	7.2 (1)	0.007
EXHAUST EQPT. DOWN (# / week)	**0.7**	1.5	1.6	2.0	ns
BOTTOM-LINE					
ROS (%)	**7.6**	2.5	4.0	5.65	ns
CAP-UTIL. (%)	83.6	87.0	**88.0**	77.5	ns

Notes: The number of plants within each cluster are given in brackets. Numbers in parentheses indicate cluster numbers from which the cluster is different (Scheffe pairwise test). ***ns*** means not significant. **Bold** numbers indicate best performing cluster on that particular performance measure.

A similar pattern is repeated for the infrastructural dimensions, i.e., there are significant differences in capabilities across the four clusters (Hayes and Wheelwright, 1984). Overall, *innovators* are leaders on technological issues and technical skills, while *improvers* are strong on workforce and quality management capabilities. Both *truly multifocused* and *laggard* factories have "poorer" capabilities/ practices compared to *innovators* or *improvers*. The fact that the six dimensions of capabilities differ across plant mission clusters suggests that these are distinct capability clusters. Plant capabilities are indeed an important component in defining a plant's mission, thus providing support for the capabilities-based definition of plant missions in *Proposition 1.*

Table 8: Factory Capabilities by Cluster Group

Factory Capability Dimensions* and Associated Practices	Strategic Plant Mission Cluster: 1 *Innovator* [17]	2 *Improver* [17]	3 *Truly Multi-focused* [11]	4 *Laggard* [5]	Probability of F-ratio
TECHNICAL/ ENGINEERING CAPABILITIES					
No. of production engineers in manufacturing	**71** (3,4)	31	11 (1)	13 (1)	0.05
No. of production engineers in engineering	**48**	31	23	17	ns
% production engineers rotated among depts.	16	12	**30**	10	0.10
OVERALL SCORE (1-5 scale)**	**2.51**	2.38	2.33	1.9	ns
DESIGN AND INNOVATION CAPABILITIES					
Product design changes/ year	**24.8** (2,4)	3.8 (1)	7.7	1.3 (1)	0.03
Process design changes/ year	**13.5**	6.1	5.6	1.8	ns
Number of new tube designs/ year	**9.2** (2,3,4)	2.3 (1)	1.7 (1)	1.0 (1)	0.0007
No. design engineers	**48**	22	33	7	0.10
Commn. bet. design & prodn./quality (1-5 scale)	**4.6**	4.1	3.8	4.0	0.10
Use of design tools (1-5 scale)	**3.2**	2.6	3.0	2.8	ns
OVERALL SCORE (1-5 scale)**	**3.3** (2, 3, 4)	2.6 (1)	2.6 (1)	2.2 (1)	0.003
ADVANCED MANUFACTURING TECHNOLOGIES					
Automation Level - 1 to 5 scale	**3.5** (4)	3.4	3.0	2.1 (1)	0.05
Programmable machines (% machines)	35.1	**37.1**	30.2	28.0	ns
Equipment accuracy – 1-5 scale	**3.55** (3,4)	3.5 (3,4)	2.8 (1,2)	2.8 (1,2)	0.02
OVERALL SCORE (1-5 scale)**	3.45	**3.46**	2.9	2.65	0.006
MANUFACTURING PROCESS CAPABILITIES					
Average Size - cm.	**53**	47.8	49.9	49	0.05
Tube Variety - no. of models	**4.1** (2,3,4)	1.8 (1)	2.6 (1)	1.6 (1)	0.00001
Process "capability" (can meet customer specs.)	3.4	**3.5**	3.2	3.2	ns
Weekly changeovers (#/ week)	0.80	**0.98**	0.80	0.60	ns
Process design capability (% design in-house)	**33.7**	33.3	34.2	23.7	ns
OVERALL SCORE (1-5 scale)**	3.09	**3.35**	3.13	3.1	ns
HUMAN RESOURCE CAPABILITIES					
Worker training (hours)	50	**75**	56	40	ns
High school education (%)	**73**	64	41	46	0.10
Recruitment based on education (1-5 scale)	**4.35**	4.0	3.3	4.2	0.06
OVERALL SCORE (1-5 scale)**	**3.71**	3.54	2.97	3.0	0.098
QUALITY MANAGEMENT PRACTICES/ CAPABILITIES					
Preventive Maintenance by workers (% of time)	**47**	46	40	11	0.10
Setups by workers (%of time)	**56**	45	20	48	ns
Multiskilled workers (%of time)	**45**	44	39	17	ns
% production employees in teams	62	**70**	37	50	0.010
OVERALL SCORE (1-5 scale)**	**3.31**	3.26	2.36	2.5	0.018

Notes: Numbers in parentheses indicate cluster numbers from which the cluster is different (Scheffe pairwise test). ns means not significant. **Bold** numbers indicate best score on that particular practice/ capability.

* Structural elements are aligned to the right, infrastructural elements are aligned to the left.

** The OVERALL SCORE for each capability is calculated by scaling each of the elements of that capability and then creating an additive scale (no reliability measures were calculated since we do not expect the elements to be correlated).

The distribution of plant missions does not show any association with location (chi-square is not significant, though it becomes significant when "laggards" are also included). That is, we did not find any association between particular clusters of plant missions and the regional location of plants in that cluster. We did find that plants located in Japan and newly industrialized countries (NIVs) score highest on innovation, engineering, and quality management practices. However, there is no association between plant missions and capability scores. We are not suggesting that these results disconfirm the notion of location rationale based plant missions; in fact, our analysis does not truly measure "location rationale" because of the difficulties mentioned in section 4.3. Our intent here is to show that the dimension of "plant capabilities" is a significant determinant of plant missions, which in turn are clearly multi-dimensional.

Another relevant chi-square test is for the association between age of plant and plant mission. We use four age ranges for the age of the plant – before 1969, 1969-1977, 1978-1986, and after 1987. The chi-square was not significant, suggesting no association between age and plant mission. However, when we look only at the plant missions of "new" plants (started after 1989), the chi-square statistic is significant. In particular, we find that these "new" plants were either "multi-focused" (consistent with our case-study results) or "improvers". None of these plants are "innovators" or "laggards".

6.2 Plant Missions in the Multiplant MNC: An Analysis of Nine Business Units

Our analysis of plant missions within multi-plant MNCs should be viewed as exploratory because our sample size (43 plants belonging to 9 multi-plant MNCs) is small. From a methodological standpoint, the unit of analysis for this section is *not the plant but the business unit* of MNCs such as NV Philips, Thomson, Hitachi, and Samsung. Though this gives us complete data for only nine firms (the other 11 firms are single plant firms), given that very few researchers have been able to get data from a *complete* industry segment, these are indeed one of the most complete and comprehensive set of results to be published (Table 9).

Table 9 indicates that managers of most of our companies understand the need to have plants with different missions. As illustrated in this table, most of the multiplant MNCs have *multiple* plant missions (the only exception is Japanese MNC # 7), though interestingly, only firm 5 has *all* 4 plant missions. Specifically, there is no Japanese firm which has *multi-focused* or *laggard* plants and most Japanese firms have multiple innovator plants (most of which are in Japan). Of the non-Japanese companies, Firms 1, 6, and 8 are multiplant MNCs in which one of two clusters - innovators and improvers - is missing. Of the two companies that do not have an *innovator* plant (Firms 5 and 7), the European company (Firm 5) has a prototype R&D laboratory at its corporate headquarters. (For this company, we have interview data but not survey data for one of its European plants, Europe-1-Europe-B, which was classified as an *innovator* plant in our case studies). Our interviews reveal that Firm 7 (a Japanese company) has consciously moved from an earlier strategy of having "lead" plants to one where every plant leads on some dimension ("center of excellence"); thus, our analysis classifies these plants as *improvers*[25]. Overall, the results in Table 9 support the existence of plant mission complementarity.

Table 9: Plant Missions in the Multi-plant MNC

Firm	Owner	Regions in which plants located	Strategic Plant Mission Cluster				Total Plants
			Innovator	Improver	Truly Multi-focused	Laggards	
1	NIC	NICs	1	-	3	-	4
2	NIC	NICs	2	2	-	-	4
3	Japan	Japan, NICs, USA, China	2	2	-	-	4
4	Japan	Japan, NICs, USA, China	4	1	-	-	5
5	Europe	Europe, NIC, USA, China/ Other	0 (1)*	3	2	2	7 (8) *
6	NIC	NICs, Europe	1	-	2	-	3
7	Japan	Japan, NICs, USA, Europe	-	5	-	-	5
8	Europe	Europe, USA, Other	2	-	2	1	6
9	Japan	Japan, NICs, USA	3	2	-	-	5

* Europe-1-Europe-B is a plant that was included in our case studies. But, due to a change in management, we could not obtain survey data from it. Our case-based categorization for this plant is indicated in parentheses.

We now explore this notion further by defining and measuring complementarity on a number of relevant dimensions. Earlier, based on our case studies and industry analysis, we defined three relevant complementarity measures: "geographic complementarity", "product

[25] These exceptions point to the need to plan for a *facility* mission, which includes links with R&D labs (corporate and BU), customers, suppliers, and local institutions (academic, government, labs, etc.).

complementarity", and "capability-based complementarity". Our discussions with managers from each of the nine MNCs revealed that most of them had adopted a broad strategy, i.e., one that intended to achieve a balance of quality, innovation, and expanding into new markets. Thus, we expect all nine MNCs to display some degree of complementarity on the three dimensions. Table 10 gives the complementarity scores for these nine firms.

Table 10: Complementarity Scores for the Nine MNCs

MNC	Product complementarity (0-1)	Geographic complementarity (1-4)	Capabilities complementarity BU-GAP (0-6)
1	0.67	1	2
2	0.75	1	0
3	0.625	4	2
4	0.875	3	3
5	0.625	4	4
6	0.75	2	4
7	0.875	4	0
8	0.625	3	4
9	0.875	3	0

- Product complementarity is based on the variety of product sizes – very small (<20"), small (<25"), medium (<28"), large (>28") - collectively produced by the BU – as a fraction of the variety of tube sizes that would be desirable based on its business strategy (0-1)
- Geographic complementarity is based on the number of world regions (e.g., America, Europe, Asia) where the BU has plants (score of 1 if plants in a single region, 2 if in two regions, etc.; Max = 4)
- Capabilities complementarity is measured by BU-GAP, i.e., the number of context-specific capabilities that the BU is collectively NOT "highly competent" at (score of 1 if the BU is "NOT good" on one capability, 2 if "NOT good" on two capabilities, etc., Max = 6)

We explore the association between complementarity and business unit performance by looking at the Spearman (rank) correlations (sample size=9). The only business unit level performance measure we have data for is return on sales (ROS). In addition, we develop a business unit score for several "internal" performance measures by averaging plant-level data on productivity (PRODUCTIVITY), internal conformance quality (MAT-QUAL – lower is better), customer conformance (REJECTS – lower is better), and inter-plant learning (%IDEA - % of improvement ideas from other business unit plants). "Capabilities complementarity" (reverse coded from BU-GAP in Table 10) has correlations in the direction expected (significance level in parentheses): 0.21 (ns) with ROS, 0.31 (ns) with PRODUCTIVITY, -0.29 (ns) with MAT-QUAL, -0.75 (p=0.02) with REJECTS, and –0.42 (ns) with %IDEA. The negative sign for

%IDEA is interesting here, and may point to companies that have low "capabilities complementarity" trying to collectively learn! "Geographic complementarity" has some contradictory correlations: 0.30 (ns) with ROS, -0.11 (ns) with PRODUCTIVITY, 0.57 (p=0.10) with MAT-QUAL, -0.41 (ns) with REJECTS, and 0.01 (ns) with %IDEA. The contradicting correlations (though insignificant, for PRODUCTIVITY, MAT-QUAL) may point to the existence of a tradeoff between operating performance and the challenge of managing a geographically disperse business. Finally, "product complementarity" shows no association with business unit level performance, but does seem to support the focused factory notion of greater efficiency. The correlations are: 0.1 (ns) with ROS, 0.52 (p=0.10) with PRODUCTIVITY, -0.6 (p=0.06) with MAT-QUAL, -0.45 (ns) with REJECTS, and –0.05 (ns) with %IDEA.

7. Discussion of Results and their Managerial Implications

7.1 How to Define Plant Missions?

Our first proposition is that plant missions are determined as much by plant capabilities, as they are by location and other criteria. Our arguments as well as our results suggest that both the traditional industrial organization (product-market position) and core competence (resource-based) perspectives are relevant. Possibly because of the idiosyncrasies of the picture tube industry, especially the high transportation costs and import tariffs for picture tubes, our results provide support for locational advantages, plant focus, *and* plant capabilities. Nevertheless, our case studies do indicate that the *starting* logic of most plants is location-driven: most plant siting decisions *are* based on some locational advantage. In the case of color picture tubes, these happen to be some combination of low labor costs, low transportation costs, and access to protected markets[26]. Subsequently, the mission of the plant is shaped dynamically, by some combination of all three factors, i.e., locational advantages, plant focus, and plant capabilities. However, our survey data, being cross-sectional, are not adequate to test this conjecture.

[26] While Ferdows characterizes the strategic reason for a site as either-or (market, technology, or factor costs), the location rationale for color picture tube plants appears to be some combination of several factors.

The resource-based view provides insights into current plant missions and the dynamics of evolving missions that are not obvious from current IO approaches. Our analysis illustrates that it is possible to develop empirically supported parsimonious models that capture the essence of current plant missions within an industry. Nevertheless, one of the major challenges for the resource-based view of strategy remains: it is difficult to test the superiority of the RBV over alternative hypotheses (Wernerfelt, 1995). Further, a simple characterization of plant missions as "innovators", "improvers", and "multi-focused" (including both "laggards" and "truly multi-focused"), using a cluster analysis, does not capture the full richness of a manufacturing strategy driven assignment of plant missions. Nevertheless, it does highlight the fact that different strategic choices are associated with a different set of practices and manufacturing capabilities. It also enables us to recognize that over time a plant's mission is likely to change as a function of its own capabilities, its "fit" with the rest of the firm's network of plants, and a host of other internal and external factors. This observation adds to the managerial and academic usefulness of Ferdows' model of international plant missions (Ferdows, 1997).

Our arguments and results provide some responses to managers' frustration of having to deal with most managerial problems in a dynamic environment, while academic research is often concerned with the static problem. Specifically, for a manager responsible for managing a global network of plants, location decisions stay constant for only a short period of time. Deciding on plant focus helps, but once that choice is made, few changes are possible. At this stage, a manager may find it useful to describe a plant's current capabilities, and try to map out what future capabilities it may need. An understanding of what skills and resources the plant has, and its strengths/ weaknesses on specific organizational practices and activities, then serve as a roadmap for how these future capabilities can be achieved. This indeed is the reason why plant missions are important.

7.2 Plant Missions, Networks, and Complementarity

Proposition 2 pertains to the assignment of multiple, globally dispersed, and complementary plant missions within a multiplant MNC. Both our case studies and survey results (Tables 4a-b, 9, and 10) confirm the existence of multiple and dispersed plant missions within business units. Our case studies help us understand the manner in which different plant missions co-exist and interact within a single business unit. Our survey results also support this. The results in Table 9 show how every MNC, except for company 7, which has gone to a model of "centers of excellence," has multiple missions. Furthermore, each of these other seven MNCs has at least two of the three plant missions that could be considered as candidates for complementary missions, that is, innovators, improvers, and truly multifocused. These complementary missions enable the picture tube *business unit* to deliver on innovation, quality, and low cost. Table 10 also helps identify and measure other dimensions of complementarity. The Spearman correlations for the complementarity-performance set of variables provide some support for Proposition 2, though clearly, further research on these issues is warranted.

Our results acknowledge the influence of a number of other factors on plant missions and complementarity. For example, our case studies suggest that BU ownership and organizational structure, as well as proximity of a plant to BU or country subsidiary HQ, influence the manner in which plant missions are conceptualized. Other influential factors appear to be distance from R&D centers and competitor plants. While our statistical analysis did not explicitly include these factors due to limitations of the data, they highlight the need to view plant roles and missions broadly.

The concept of global networks has been discussed for more than a decade now, and while MNCs have certainly evolved in their abilities to develop the ability to network, managerial improvements are still possible. The obvious advice to managers is that they should ensure that their organizations do network, and share technology and knowledge (see e.g., Szulanski, 1997). Our results provide managers with another explicit means of creating networks. First, the concept of complementary plant missions suggests how managers may go about designing multi-plant global networks. Further, our informal discussions with managers have suggested that MNCs now feel the need to be efficient in creating their global networks. Thus, organizations need to minimize redundancy in their networks, and creating complementary plant missions is one way to do so. Further, complementarity can also motivate managers and functional groups in far-flung plants and facilities to seek out the locations for the complementary skills, and thus help build stronger global networks.

7.3 Research Shortcomings

We would be remiss not to acknowledge a number of shortcomings, all of which point to future opportunities for researchers. First and foremost, this is a single-industry study, and one where the industry is fairly small in terms of the number of plants and companies. Nevertheless, we believe that plant missions are best understood within the context of a single industry or business unit. Since it is difficult to obtain the kind of industry-wide primary data that we have, our analysis provides insights that would be unattainable through cross-industry studies where the sample response rate is typically very low.

Second, while the rediscovery of the resource-based view (Prahalad and Hamel, 1990) took place almost ten years ago, theoretical development of the capability concept is still in its infancy, and there is a dearth of appropriate definitions and measures for capabilities. Thus, our identification and analysis of the six sets of "capabilities" are exploratory, non-exhaustive, and do not necessarily pass the tests of full content and construct validity. The "complementarity" constructs also suffer from a similar shortcoming.

Third, two of the constructs we use for the statistical analysis - plant missions and location rationale – could be more precise. In both cases, we had to operationalize the constructs in a less-than-ideal manner. Plant missions are multi-dimensional and difficult to measure; location rationale is dynamic and a snapshot is incomplete (Karnani et al., 1992). Hopefully, future research can develop better constructs for these.

Fourth, the business unit level performance measures we use are incomplete – many of the managers did not provide data on these. Thus, our analysis of the complementarity-performance correlations is not as reliable as we would like.

Finally, from a managerial standpoint, most organizations follow a hierarchical process for the assignment of plant missions (Leong et al., 1990). Our research design as well as results do not take this into consideration while analyzing plant missions, or evaluating the implications for managers.

8. Conclusions, and Directions for Future Research

In this article we redefine the notion of a capabilities-based plant mission in the global context, one that goes beyond the use of a location rationale to describe a plant's mission. We partially overcome one of the challenges of the capabilities and resource-based view by providing both case-based and empirical support for the definition of a capabilities-based plant mission. To highlight this, we summarize the major similarities and differences between the traditional and resource-based approaches to describing plant missions in Table 11. We supplement this capabilities-based perspective with the notion of complementary plant missions that describes one way in which plant missions "fit" in a global manufacturing network. Such complementarity enables a business unit to leverage the existence of regionally dispersed semi-autonomous focused factories. In our case studies we observe that complementarity creates firm level competitive leverage, coordination, and knowledge flows among plants.

Table 11: Plant Mission Perspectives Compared

	Traditional Emphasis	**Resource-Based Emphasis**
Business Strategy	Driven by IO models that focus on product-market position. Firms aspire to achieve monopolist advantages. Manufacturing assists by seeking scale efficiencies and high productivity.	Driven by core competencies: acquisition of capabilities that provide competitive advantage that are not easily obtained or replicated. Manufacturing may be a core competence for the business unit.
Global Strategy	Focus on location-specific advantages (input factors, capital, government, market access). Manufacturing assists by seeking global scale efficiencies and market focus.	Global competitive advantage through cross-market learning, and network flows of tangible and intangible resources. Manufacturing may be a core competence for the firm.

Manufacturing Strategy	Missions are based on one of the dimensions of plant focus. Missions are defined top-down, i.e., corporate, business unit, and manufacturing strategy describe plant missions. Missions result from the use of optimization models to configure (facility siting and closure), and to coordinate (through production planning) plant and distribution networks. Criteria are almost exclusively monetary, and physical flows. Some conceptual modeling of roles using location based criteria primarily without much regard to networking effects.	Missions result from a critical balancing of competitive priorities and core competencies with explicit consideration of network effects. Typically diverse but complementary plant missions that don't just focus on cost, quality or delivery. Plant missions are shaped by corporate and business unit strategy, but also provide a feedback loop, i.e., they influence business unit and manufacturing strategy (see Figure 2).

So little research has been done on the topic of plant roles and missions in global networks that research possibilities are plentiful. We will highlight only a few. At the broadest level, no comprehensive theories, and little solid empirical data analysis appear in the literature. Both are badly needed given the extensive globalization of manufacturing today. Neither scholars nor practitioners have well-founded guidelines, theoretical or empirical, for defining, assigning, evaluating or changing plant missions in global networks. In future research, we also see benefit in challenging and testing "common sense" assumptions about plant roles. For example, are plant missions as meaningful in dynamic, turbulent environments and industries as they are in mature, stable settings? Further, while it appears to be logical from both theoretical and empirical perspectives, is complementarity of missions a generally accepted practice? Under what conditions does it work well or poorly? To what extent is it a substitute for, or superior to, interdependent network relationships and missions involving material flows or other forms of direct interdependence? How is complementarity best achieved? Some of these questions could be evaluated through large sample studies across a range of global industries (see Cheng, 1983 for previous evidence on the relationship between interdependence, coordination, and performance).

The resource-based strategy literature points to another potentially fruitful area for research. Ferdows and DeMeyer (1990) proposed a "sandcone" model of manufacturing capabilities, in which quality is the foundation, and other competitive priorities such as flexibility, delivery, innovation, and cost come later. One question for global manufacturing is: How does or should the mission of a plant in a global manufacturing network change to progressively build such a sandcone of capabilities? The second question emerges from the now-common taxonomy of manufacturing and strategic business units: innovators, marketeers, and caretakers (Miller and Friesen, 1977; Miles and Snow, 1978; Miller and Roth, 1994). Once a number of plants have reached the top of the "sandcone", what will be their relative roles in a global manufacturing network?

Finally, our research results indicate the significance of proximity to R&D centers, BU HQ, etc., in shaping plant missions (also see Bartmess and Cerny, 1993). Due to limitations of our data, we could not address this issue in this article. But it leads to a broader set of questions related to establishing the missions not of a single factory, but of clusters of facilities: a factory, an R&D lab, key customers, suppliers, and other resources. In addition, given the emerging significance of a supply chain perspective of operations, the notion of a plant mission needs to be extended to the whole supply chain, i.e., "beyond the factory walls" (Kim, 1994).

References

Alchian, A. and H. Demsetz (1972), "Production, Information Costs, and Economic Organization", *American Economic Review*, Vol. 62: 777-794.

Ansoff, H.I. (1965) *Corporate Strategy.* New York: McGraw-Hill.

Bain, J.S. (1954), "Economies of Scale, Concentration, and the Condition of Entry in Twenty Manufacturing Industries", *American Economic Review*, Vol. 44: 15-39.

Barney, J.B. (1991), "Firm Resources and Sustained Competitive Advantage", *Journal of Management*, Vol. 17: 99-120.

Bartlett, C.A. and S. Ghoshal (1989), *Managing Across Borders*, Harvard Business School Press: Boston, MA.

Bartmess, A. and K. Cerny (1993), "Building Competitive Advantage through a Global Network of Capabilities", *California Management Review*, Vol. 35, No. 2.

Birkenshaw, J., N. Hood, and S. Jonsson (1996), "Building Firm-Specific Advantages in Multinational Corporations: The Role of Subsidiary Initiative", *Presented at the Academy of Management Meeting*, Cincinnati, OH.

Black, J. and K. Boal (1994), "Strategic resources: Trails, configurations and paths to sustainable competitive advantage", *Strategic Management Journal Special Issue*, Vol. 15: 131-148.

Chandler, A.D. Jr. (1962), *Strategy and Structure*, The MIT Press, Cambridge, MA.

Cheng, J.L.C. (1983), "Interdependence and Coordination in Organizations: A Role-System Analysis", *Academy of Management Journal*, Vol. 26, March: 156-162.

Clark, Kim B. and Takahiro Fujimoto (1991), *Product Development Performance*, Harvard Business School Press, Boston, MA.

Cleveland, G., R.G. Schroeder, and J.C. Anderson (1989), "A theory of production competence," *Decision Sciences*, Vol. 20, No. : 655-668.

Cohen, M.A. and H.L. Lee (1989), "Resource Deployment Analysis of Global Manufacturing and Distribution Networks", *Journal of Manufacturing and Operations Management*, Vol. 2: 81-104.

Collis, D.J. (1991), "A Resource-Based Analysis of Global Competition: The Case of the Bearings Industry", *Strategic Management Journal*, Vol. 12: 49-68.

Collis, D.J. (1994), "Research Note: How Valuable are Organizational Capabilities?", *Strategic Management Journal*, Vol. 15: 143-152.

Conner, K.R. (1991), "A Historical Comparison of Resource-Based Theory and Five Schools of Thought within Industrial Organization Economics: Do We Have a New Theory of the Firm?", *Journal of Management*, Vol. 17, No. 1: 121-154.

Corbett, C. and L. Van Wassenhove (1993), "Trade-offs? What trade-offs? Competence and Competitiveness in Manufacturing Strategy," *California Management Review*, Summer : 107-122.

Dean, J.W. and S.A. Snell (1992), "Integrated Manufacturing and Human Resource Management: A Human Capital Perspective", *Academy of Management Journal*, Vol. 35 (3): 776-804.

Dean, J.W. and S.A. Snell (1996), "The Strategic Use of Integrated Manufacturing: An Empirical Examination", *Strategic Management Journal*, Vol. 17, 1996, 459-480

Dierickx, I. and K. Cool (1989), "Asset Stock Accumulation and Sustainability of Competitive Advantage", *Management Science*, vol. 35: 1504-1511.

Doz, Y. and C.K. Prahalad (1988), "Quality of Management: An Emerging Source of Global Competitive Advantage?", In N. Hood and J. Vahlne, editors, *Strategies in Global Competition*. John Wiley & Sons: London.

Dunning, J.H. (1988), "The Eclectic Paradigm of International Production: A Restatement and Some Possible Extensions", *Journal of International Business Studies*, Vol. 19, no. 1, Spring: 1-31.

Egelhoff, W.G. (1988), "Strategy and Structure in Multinational Corporations: A Revision of the Stopford and Wells Model", *Strategic Management Journal*, Vol. 9: 1-14.

Eisenhardt, Kathleen M. (1989), "Building Theory from Case Research", *Academy of Management Review*, Vol. 14, No. 4, 532-550.

Ettlie, J.E. (1995), "Product-process Development Integration in Manufacturing", *Management Science*, Vol. 41, No. 7: 1224-1237.

Ferdows, Kasra (1989), "Mapping International Factory Networks", in Ferdows, K. (Ed.) *Managing International Manufacturing*, North-Holland: Amsterdam & New York.

Ferdows, Kasra (1997), "Making the Most of Foreign Factories", *Harvard Business Review*, March-April, 77-88.

Ferdows, K. and A. DeMeyer (1990), "Lasting Improvements in Manufacturing Performance: In Search of a New Theory", *Journal of Operations Management*, Vol.9, No.2, April: 168-184.

Flaherty, M. T. (1986), "Coordinating International Manufacturing and Technology", in Ed. Michael E. Porter, *Competition in Global Industries*, Harvard Business School Press: Boston, MA.

Flaherty, M. T. (1996), *Global Operations Management*, Harvard Business School Press: Boston, MA.

Flynn, B.B., R.G. Schroeder, and S. Sakakibara (1995), "The Impact of Quality Management Practices on Performance and Competitive Advantage", *Decision Sciences*, Vol. 26, No. 5, Sept.-Oct.: 659-692.

Galbraith, C.S. (1990). Transferring core manufacturing technologies in high-technology firms. *California Management Review*, Summer: 56-70.

Garvin, D.A. and A. March (1989), *Copeland Corporation: Evolution of a Manufacturing Strategy - 1975-82 (A through D)*, Case number 9-686-088 through 9-686-091, Harvard Business School Publishing: Boston, MA.

Ghoshal, S. (1986), *The innovative multinational: A differentiated network of organizational roles and management processes*. Unpublished doctoral dissertation, Harvard Business School: Boston.

Ghoshal, S. (1987), "Global Strategy: An Organizing Framework", *Strategic Management Journal*, Vol. 8: 425-440.

Ghoshal, S. and N. Nohria (1989), "Internal Differentiation Within Multinational Corporations", *Strategic Management Journal*, Vol. 10: 323-337.

Glaser, B. and A. Strauss (1967), *The Discovery of Grounded Theory: Strategies for Qualitative Research*, Aldine Publishers: Chicago, IL.

Hambrick, D. C. (1983), "Some tests of the effectiveness and functional attributes of Miles and Snow's Types", *Academy of Management Journal*, Vol. 26: 5-26.

Hatten, K. J. and Hatten, M. L. (1988). *Effective Strategic Management: Analysis and Action*, Englewood Cliffs NJ: Prentice-Hall.

Hayes, R.H. (1985), "Strategic Planning – Forward in Reverse?" *Harvard Business Review*, November-December: 111-119.

Hayes, R.H. and Kim B. Clark (1986), "Why Some Factories are More Productive Than Others", *Harvard Business Review*, Sept-Oct, 66-73.

Hayes, R.W. and G.P. Pisano (1996), "Manufacturing Strategy: At the Intersection of Two Paradigm Shifts", *Production and Operations Management*, Vol. 5, No. 1, Spring: 25-41.

Hayes, R.H. & S.C. Wheelwright (1984) *Restoring our competitive edge: Competing through manufacturing*. John Wiley & Sons, Ltd.: New York, NY.

Hayes, R.H. and S.C. Wheelwright (1979), "Link Manufacturing Process and Product Life Cycle," *Harvard Business Review*, January-February, 133-140.

Henderson, R. and I. Cockburn (1994), "Measuring Competence: Exploring Firm Effects in Pharmaceutical Research", *Strategic Management Journal*, Vol. 15, Winter Special Issue.

Hodder, J.E. and C.M. Dincer (1986), "A Multifactor Model for International Plant Location and Financing Under Uncertainty", *Computers and Operations Research*, Vol. 13, No. 5: 601-609.

Huchzermeier, A. and M.A. Cohen (1996), "Valuing Operational Flexibility Under Exchange Rate Risks", *Operations Research*, vol. 44, Jan-Feb: 100-113.

Hymer, S. (1976), *The International Operations of National Firms: A Study of Direct Foreign Investment*, The MIT Press: Cambridge, MA.

Industry Week (1994), "Industry Week's 5th Annual Salute", *Industry Week*, October 17, pg. 25-57.

Jarillo, J.C. and J.I. Martinez (1990), "Different roles for subsidiaries: The case of multinational companies", *Strategic Management Journal*, Vol. 11: 501-512.

Karnani, A., F.B. Talbot, W.C. Hubner, A. Khurana, J. Penner-Hahn, V. Ramaswamy, V. Sankaran, C. Siegel, R. Toyama, and M. Yasukawa (1992), "Global Manufacturing Networks Survey: A Preliminary Assessment of Strategic, Operational and Organizational Practices", *Working Paper No. 700*, The University of Michigan, School of Business Administration, Ann Arbor, MI 48109-1234.

Khurana, Anil (1994), *Quality in the Global Color Picture Tube Industry: Managing Complex Industrial Processes*, Ph.D. dissertation, The University of Michigan, University Microfilms: Ann Arbor, MI

Khurana, A. and F.B. Talbot (1998), "The Internationalization Process Model Through the Lens of the Global Color Picture Tube Industry", *Journal of Operations Management*, Vol. 16, Issue 2-3, Special Issue on Empirical Studies of Global Manufacturing: Strategy, Practice and Performance.

Khurana, A., T. Lin, E. Rosenzweig, and A. Roth (1999), "Measuring Manufacturing Strategies of Industrial Suppliers: What Kind of Balanced Scorecard to Use", *Working Paper*, Boston University School of Management, Boston, MA 02215.

Kim, J.S. and P. Arnold (1992), "Manufacturing Competence and Business Performance: A Framework and Empirical Analysis", *International Journal of Operations and Production Management*", Vol. 13, No. 10: 4-25.

Kim, Jay (1994), *Beyond the Factory Walls: Overcoming Competitive Gridlock*, mimeo, Boston University Manufacturing Roundtable, Boston, MA.

Kogut, B. (1985a), "Designing Global Strategies: Comparative and Competitive Value-Added Chains," *Sloan Management Review*, Summer: 15-28.

Kogut, B. (1985b), "Designing Global Strategies: Profiting from Operational Flexibility," *Sloan Management Review*, Fall.

Kogut, B. (1989), "A Note on Global Strategies", *Strategic Management Journal*, Vol. 10: 383-389.

Kotha, S. and D. Orne (1989) "Generic manufacturing strategies: A conceptual synthesis," *Strategic Management Journal*, Vol.10, No.3: 211-231.

Lawrence, P. and J. Lorsch (1969), *Organizations and Environments*, Richard D. Irwin, Homewood, IL.

Lee, H.L. and C. Billington (1995), "The Evolution of Supply Chain Management Models and Practice at Hewlett-Packard", *Interfaces*, Vol. 25, No. 5: 42-63.

Leonard-Barton, Dorothy (1992a), "The Factory as a Learning Laboratory", *Sloan Management Review*, Fall 23-38.

Leonard-Barton, D. (1992b), "Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development", *Strategic Management Journal*, Vol. 13: 111-125.

Leong, G.K., D. Snyder, and P. Ward (1990), "Research in the Process and Content of Manufacturing Strategy", *OMEGA International Journal of Management Science*, Vol. 18, No. 2: 109-122.

MacCormack, A. D., L. J. Newman III, D. B. Rosenfeld (1994), "The new dynamics of global manufacturing site location," *Sloan Management Review*, Summer Issue, 69-80.

Magretta, Joan (1998), "Fast, Global, and Entrepreneurial: Supply Chain Management, Hong Kong Style – An Interview with Victor Fung", *Harvard Business Review*, Sept.-Oct.: 102-114.

Martinez, J.I. and J. Carlos Jarillo (1989), "The Evolution of Research on Coordination Mechanisms in Multinational Corporations", *Journal of International Business Studies*, vol. 20, no. 3, Fall: 489-514.

Mascarenhas, B. (1984), "The Coordination of Manufacturing Interdependence in Multinational Companies", *Journal of International Business Studies*, vol. 15, Winter: 91-106.

McDonald, A. (1986), "Of Floating Factories and Mating Dinosaurs", *Harvard Business Review*, Oct.-Nov.: 82-86.

Miles, R.E. and C.C. Snow (1978), *Organizational Strategy, Structure and Process*, McGraw-Hill, New York.

Miller, D. and P.H. Friesen (1977), "Strategy Making in Context: Ten Empirical Archetypes", *Journal of Management Studies*, 14, : 253-280.

Miller, J.G. and A. Roth (1994), "A Taxonomy of Manufacturing Strategies", *Management Science*, Vol. 40, No. 3: 285-304.

Mintzberg, Henry (1992), "The Fall and Rise of Strategic Planning", *Harvard Business Review*, Vol. 72, January-February: 107-114.

Mukherjee, Ashok (1997), Impact of Product Proliferation on a Focused Factory: The Case of Copeland Hartselle, Ph.D. Dissertation, University of Michigan Business School, Ann Arbor, MI 48109.

Nohria, N. and S. Ghoshal (1994), "Differentiated Fit and Shared Values: Alternatives for Managing Headquarters-Subsidiary Relations," *Strategic Management Journal*, 15, 491-502.

Pfeffer, J. (1978), *Organizational Design*, A.H.M. Publishing: Arlington Heights, IL.

Peteraf, M.A. (1993), "The Cornerstones of Competitive Advantage: A Resource-Based View", *Strategic Management Journal*, Vol. 14, No. 3: 179-191.

Porter, M.E. (1980), *Competitive Strategy*, Free Press: New York, NY.

Porter, M.E. (1985), *Competitive Advantage*, Free Press: New York, NY.

Porter, Michael E. (1986), *Competition in Global Industries*, Harvard Business School Press: Boston, MA.

Prahalad, C.K. and Gary Hamel (1990), "The Core Competence of the Corporation", *Harvard Business Review*, Vol. 68, May-June: 79-87.

Pycke, Bart and Arnoud De Meyer (1997), *Samsung Berlin*, Case study by INSEAD Euro-Asia Centre, Fontainebleau, France.

Richardson, P.R., A.J. Taylor and J.R.M. Gordon (1985), "A Strategic Approach to Evaluating Manufacturing Performance", *Interfaces*, Vol. 15: 15-27.

Root, F. (1994), *Entry Strategies for International Markets*, MacMillan: New York, NY.

Ruwe, D. (1994), "Manufacturing Strategy at the Copeland Corporation", *Presented to the Manufacturing Executive Program*, The University of Michigan Business School, Ann Arbor, MI.

SPSS for Windows (1994).

Schmenner, R.W. (1982), "Multiplant Strategies Among the Fortune 500", *Journal of Operations Management*, Vol. 2, no. 2: 77-86.

Schumpeter, J.A. (1950), *Capitalism, Socialism, and Democracy*, Harper & Row: New York, NY.

Skinner, Wickham (1969), "Manufacturing – Missing Link in Corporate Strategy", *Harvard Business Review*, Vol. 47, No. 3: 136-145.

Skinner, W. (1974), "The Focused Factory," *Harvard Business Review*, May-June: 114-121.

Skinner, Wickham (1985), *Manufacturing: The Formidable Competitive Weapon*, John Wiley and Sons, New York.

Stalk, G., P. Evans, and L.E. Shulman (1992), "Competing on Capabilities: The New Rules of Corporate Strategy", *Harvard Business Review*, Vol. 70, No. 2, March-April: 57-69.

Starr, M. (1984), "Global Production and Operations Strategy", *The Columbia Journal of World Business*, Winter: 17-22.

Stigler, G.J. (1968), *The Organization of Industry*, Irwin: Homewood, IL.

Stopford, J.M. and L.T. Wells (1972), *Managing the Multinational Enterprise*, Basic Books: New York, NY.

Szulanski, Gabriel (1997), "Unpacking Stickiness: An Empirical Investigation of the Barriers to Transfer Best Practice Inside the Firm", *Strategic Management Journal*:

Teece, D.J. (1982), "Towards an Economic Theory of the Multiproduct Firm", *Journal of Economic Behavior and Organization*, Vol. 3: 39-63.

Ulgado, F.M. (1996), "Location Characteristics of Manufacturing Investments in the U.S.: A Comparison of American and Foreign-based Firms", *Management International Review*, Vol. 36, No. 1, January: 7-12.

Vernon, R. (1966), "International investment and international trade in the product cycle", *Quarterly Journal of Economics*, May: 190-207.

Vernon, R. (1979), "The Product Cycle Hypothesis in a New International Environment", *Oxford Bulletin of Economics and Statistics*, Vol. 41, No. 4, November: 255-267.

Vickery, S.K., C. Droge, and R.E. Markland (1993), "Production Competence and Business Strategy: Do They Affect Business Performance?" *Decision Sciences*, Vol. 24, No.2: 435-456.

Vokurka, R.J. (1998), "Operations Strategy and Plant Charters: The Homogeneity of U.S. Manufacturing Plants", *Proceedings of the Decision Sciences Institute Annual Meeting, Las Vegas, Nov. 22-25.*

Wernerfelt, B. (1984) "A Resource-based View of the Firm", *Strategic Management Journal*, Vol. 5: 171-180.

Wernerfelt, B. (1995) "A Resource-based View of the Firm: Ten Years After", *Strategic Management Journal*, Vol. 16: 171-174.

Wheelwright, S.C. (1978), "Reflecting Corporate Strategy in Manufacturing Decisions", *Business Horizons*, Vol. 21, No. 1: 57-66.

Wheelwright, S.C. and K.B. Clark (1992), *Revolutionizing Product Development*, Free Press: New York, NY.

Williamson, O.E. (1975), *Markets and Hierarchies: Analysis and Antitrust Implications*, Free Press: New York, NY.

Womack, James P., Daniel T. Jones, and Daniel Roos (1990), *The Machine That Changed The World*, Maxwell Macmillan International: New York, NY.

Appendix 1: Two examples from the global color picture tube industry

Example 1: Sony

Three years ago, the first author had just finished presenting some striking results that suggested that Sony's San Diego picture tube plant had a higher performance - on virtually every manufacturing measure - than two of Sony's picture tube plants in Japan. While this was counter to our own expectations, the Vice-President of Manufacturing and other managers walked away from the seminar feeling quite pleased, especially since our results confirmed Industry Week's evaluation of the plant being one of America's "Best Plants" (Industry Week, 1994). However, a Japanese strategic planning manager who had just arrived at the San Diego plant from Japan, invited the first author to his office, and explained the Sony "strategy":

> *"Every factory within Sony has a role. For example, our Inazawa (Japan) plant is constantly investigating new picture tubes, new manufacturing processes, and new machines. This (San Diego) plant is assigned the role of producing high-quality tubes for the N. American market. In Europe, before we built the Bridgend (U.K.) plant, we had thought of acquiring the Nokia (Germany) plant, but it did not fit with our intended role for it. There are many other examples like this, but the key point is that the performance of a plant is determined by a combination of its strategic mission, its market competitiveness, and its manufacturing capabilities themselves. And, actually, depending on a plant's assigned mission, we (at Sony HQ) decide what kind of managers to have, how much "power" to give them, and what kinds of workforce policies to have. ......"*

(Source: Author notes, 1995)

Example 2: Samsung

Intriguingly, a similar story was repeated at other picture tube plants we visited, especially those that were not located in their HQ country. For example, our visit to the Samsung, Berlin plant revealed a similar issue, which is best captured in a recent INSEAD case (Pycke and DeMeyer, 1997):

> *"Meanwhile, the globalization of SDD's (Samsung Display Devices) CPT business was gaining momentum. The progression since 1988, when all production was still based in Korea, was very impressive. The Malaysian plant became operational in 1991 with the SEB Berlin plant following in 1992. Since early 1996, Mexico was fully operational, while a Brazilian and two Chinese plants were under construction. SDD was clearly set to realize its goal of a firm presence in five regions with a ten nation based production network in less than a decade. What would be the future role of the Berlin plant within this network of SDD plants?"*

(Source: Pycke and DeMeyer, 1997;
Second author's field notes, 1994)

Appendix 2: Industry Background

Picture tubes or cathode ray tubes (CRTs) are the display devices used for television, computer monitors, radar screens, and medical display screens (such as X-ray or ultrasound screens), and have been in commercial use since the late 1920s. A mature product, picture tubes have passed through the basic technology and product life cycles (see Khurana, 1994: Ch. 4 for an in-depth analysis of the industry).

Today, the main players in this global industry are European, Japanese, and Korean. There are nearly 70 color picture tube factories and fewer than 30 companies in the world that manufacture color picture tubes (7 of the 70 factories have started after 1994 when the data for this study were obtained). Of these, 10 factories are in China and the ex-U.S.S.R. (at the time this study was initiated in 1992, these facilities were explicitly excluded from the study because of political and economic turmoil and the consequent inaccessibility of the plants; during 1993-1995 we were able to obtain data from some of these plants).

The typical manufacturing value chain in the industry consists of three stages: glass and component manufacturing, tube manufacturing, and TV set assembly (followed by the other value chain activities of distribution, retailing, and after-sales service for TV sets). A few of the firms are fully vertically integrated, i.e., they have glass, tube, and TV plants. The minimum economic scale for the three levels is different. Typical plant sizes for glass, picture tubes, and TV set assembly are 3.5M, 1.5M, and 0.5M, respectively. Given worldwide annual sales of slightly over 100M units, it is no surprise that there are approximately 25 glass plants (fewer than 10 companies), 70 tube plants (less than 25 companies), and more than 200 TV set assembly plants (nearly 75 companies) worldwide.

Our analysis of the industry background led us to the following understanding of the types of coordination that are typical in this industry. *First*, physical flows are primarily vertical: they occur between glass and component and tube plants, or tube and TV assembly plants. Given high shipping costs and import duties, materials flows *across* regions are limited, though these do occur (e.g., Sony USA imports 17" tubes from Japan). However, product specialization takes place, especially at the picture tube level, because with high scale economies few picture tube factories have the production equipment to efficiently produce more than 4-6 tube sizes. Thus, there is a clear tradeoff between scale advantages and logistics costs. *Second*, it is common for TV assembly plants to source picture tubes from competitor plants located in the same region (because of the same tradeoffs between scale benefits and logistics costs), though it is limited by issues of quality, technical standards, and tube cost. Such sourcing arrangements are generally handled by country subsidiaries with the approval of BU HQ. But this model varies from firm to firm, and possibly from plant to plant (Ferdows, 1997). *Third*, for the same set of reasons, across-plant production coordination of picture tubes, for example, to support production shifting, is limited (Kogut, 1985b; Cohen and Lee, 1989). Some production coordination does occur at the TV assembly plant level, mainly for smaller (<21") TV sets. *Finally*, coordination of knowledge flows and technology transfer between R&D labs and plants is common, but plant-to-plant technology or best practice transfer is limited.

Appendix 3: Scales Used for Competitive Priorities

The competitive priorities selected for this analysis are overall quality, flexibility, low cost, product/ process innovation, and future leadership in innovation. Additive scales are used for quality (QUALITY), innovation (INNOVATION), and future leadership in innovation (LEAD-INNOVATOR). Single-item scales are used for flexibility (FLEXIBILITY) and low cost (LOW COST).

QUALITY is an aggregate construct measured as the average of 5 items, all 5-point Likert scales with a Cronbach alpha of 0.74:

(i) Top management emphasis on quality as a key priority;
(ii) Emphasis on tube design performance;
(iii) Emphasis on conformance quality;
(iv) Emphasis on factory yields;
and,
(v) Tube performance in comparison to competitors.

FLEXIBILITY is measured as the extent of tube variety possible at the factory (recoded to a 5-point scale from original data).

LOW COST is a single-item measure based on a comparison of the cost relative to competitors.

New product/ process development capability (DEV. SPEED) is measured as the average of the frequency of: (i) New tubes or designs; (ii) Product design changes; and, (iii) Process design changes (the data were converted into two 5-point Likert scales which yielded a Cronbach alpha score of 0.7).

Leadership in innovation (INNOVATION) is measured on the basis of whether the factory general manager had planned or had thought of introducing monitor tubes, LCDs, and/or flat-panel active matrix screens, or tried to understand the impact these new products/ technologies would have on his or her factory (recoded to a 5-point scale with a Cronbach alpha of 0.72).

Appendix 4: Refining the Cluster Analysis

The initial three-cluster solution is presented in Table Ap 1. This table also depicts the probability that one or more of the cluster means differs from another, for each of the five competitive priorities. The clusters differ significantly on three of the five competitive priorities.

Table Ap 1: Original Three Cluster Solution

Observed Competitive Priority	**Strategic Plant Mission Cluster**			Probability of F-ratio
	Innovator [N=17]	Improver [N=17]	Multi-focused [N=16]	
QUALITY	3.5 (2,3)	**4.1** (1,3)	1.5 (1,2)	0.00001
FLEXIBILITY	**3.9** (2,3)	1.75 (1)	2.3 (1)	0.00001
LOW COST	3.0	2.7	**3.06**	ns
INNOVATE	**3.33** (2,3)	2.15 (1)	2.06 (1)	0.0003
LEAD-INNOVATOR	**0.41**	0.29	0.35	ns

Notes: Numbers in parentheses indicate cluster numbers from which cluster is different (Scheffe pairwise test). *ns* means not significant. **Bold** numbers indicate highest score for cluster on that particular priority.

As per the case analysis results in section 5.2, the cluster of plants that we call *multi-focused* actually belong to two groups. In one group, the factories are more like Miles and Snow's "defenders" in that they lag on most factory performance and management practice dimensions. At the same time, there are a few factories that are either new or are going through a transition, and hence, are trying to focus on more than one competitive priority. In other words, amongst our *multi-focused* plants, we expect to see some that are truly multi-focused, and others that are indeed confused and lagging on both effort and performance.

Table Ap 2: Two Types of *Multi-focused* Plants

Observed Competitive Priority	**Multi-focused [16]**	
	Truly Multi-focused [11]	*Laggards* [5]
QUALITY	**1.8**	1.4
FLEXIBILITY	**2.5**	1.6
LOW COST	**3.30**	2.4
INNOVATE	**2.21**	1.73
LEAD-INNOVATOR	**0.42**	0.20

In order to resolve the issue regarding two kinds of *multi-focused* plants, we reexamine the survey data for the *multi-focused* plants that we had identified during our case studies. We classify these *multi-focused* plants into two groups. The plants in the first group place adequate and almost equal emphasis on most competitive dimensions, including low cost, while those in the second group place low emphasis on the development of competitive capabilities (we call these two groups "*truly multi-focused*" and "*laggards*"). We use this criterion to divide the sixteen *multi-focused* plants in our survey data into these two groups: eleven *truly multi-focused* and five *laggards* (Table Ap 2).