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Strategy, uncertainty and the focused factory in international process manufacturing

Mikko Ketokivi [a,*], Mikko Jokinen [b]

[a] Department of Industrial Engineering and Management, Helsinki University of Technology, P.O. Box 5500, FI-02015 Hut, Finland
[b] Consolidated Metals Corporation (pseudonym), Executive School of Industrial Management, Helsinki University of Technology, P.O. Box 5500, FI-02015 Hut, Finland

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Abstract

The extant literature on the focused factory has not explored the contingencies associated with the de facto adoption and use of focused factory principles: Why are some plants focused while others are not? Is focus—or unfocus—a strategic choice, best practice or perhaps a reflection of an environmental constraint? In his pioneering work, Skinner [W. Skinner, 1974. The focused factory. Harvard Business Review 52 (3), 113–121] prescribes companies to ensure that the manufacturing task of their manufacturing units is simple and focused, for instance, by assigning a narrow product mix for each factory or concentrating on a narrow mix of production technologies. Especially in the absence of compelling empirical evidence on the effectiveness of the focused factory approach, we argue that we still do not understand why some plants may remain unfocused.

We observe that in the international process industry case examined in this paper, some factories are unfocused and their manufacturing tasks are all but simple. Yet, some of them appear to be high performers. This presents an opportunity to seek empirical insight on the questions raised above. Specifically, we examine why manufacturing companies in the process industries may or may not follow the focused factory strategy. Our results suggest that in certain operating environments and with certain competitive strategies, choosing not to focus the manufacturing task should be viewed as a viable alternative manufacturing strategy, perhaps even a constraint imposed by the operating environment. We develop four contingency propositions to explain why focused manufacturing strategy may not be desirable or even possible.

Keywords: Manufacturing strategy; International manufacturing; Focused factory; Case study; Process industry

1. Introduction

The contention in this paper is that even though we have talked about the *focused factory* for 35 years (Hayes et al., 2005; Skinner, 1969), we still do not adequately understand its application in the industry (e.g., Skinner, 1996). Our goal is to build through an international case study an understanding of why factories in the process industries may or may not be focused. In so doing, we seek insight that explains the real-life phenomenon, and for this purpose the

* Corresponding author. Tel.: +358 50 376 1095.
E-mail address: mikko.ketokivi@hut.fi (M. Ketokivi).

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case study is the appropriate approach (Meredith, 1998, p. 442). The key question we seek to answer is: ''Under what kinds of business environmental and strategic circumstances are focused manufacturing strategies viable in the process industries?'' Specifically, we examine the effects of competitive business strategy, uncertainty in the operating environment, and production technology and how they affect manufacturing strategies in the process industry.

1.1. Focused factory in the extant literature

Discussion on the focused factory started in 1969, when Skinner (1969, p. 137) described in his seminal paper an electronics manufacturer that served a heterogeneous customer base in three industries. The three customers had different expectations: one emphasized low costs, the second product reliability, and the third fast new product introduction. Yet, the company had decided to serve all markets from a single factory. This, Skinner argued, was an unfocused factory par excellence, which from a normative point of view is bad manufacturing strategy. Skinner (1969, p. 137) further pointed out that the company in his example was trying to reap in economies of scale (or perhaps more appropriately economies of *scope*, see Panzar and Willig, 1981) by serving multiple markets from a single factory. But is this all there is to it? Do companies really make seemingly bad policy decisions in attempts to economize on scale or scope? Is it still the case 35 years later, and in countries other than the U.S.? Is focus unconditionally good manufacturing policy? Instead of assuming this to be the case, we submit it to research as an open empirical question.

Skinner's example is neither an isolated event nor merely an historical anecdote: time and again, we witness that some factories remain unfocused in the sense that they try to achieve multiple goals at the same time (Boyer et al., 1996; Ketokivi and Schroeder, 2004) and produce a wide variety of different products for heterogeneous markets. Indeed, Skinner himself concluded based on empirical evidence from the 1960s and 1970s that ''focused manufacturing plants are surprisingly rare'' (Skinner, 1974, p. 114). In a more recent study, Vokurka and Davis (2000) provide large-sample evidence by observing that 78 of the plants in their sample of 305 plants were unfocused.[1] They also make an interesting observation, which is relevant to this study: the ratio of focused to non-focused plants varies by industry; plants in typical process industries (chemicals, paper, primary metals) tend to be more focused (78% of factories were focused) than discrete-part manufacturers (machinery 58%, electronics 61%). Collins et al. (1998), in turn, observe that there are some country differences in the adoption of their *rigid flexibility model*, a derivative of Skinner's focused factory. Extant theoretical and empirical work on focus does not explain these country and industry effects, or the antecedents of focus in general.

While focused factories have been empirically examined from a content (e.g., Berry et al., 1991; Bozarth, 1993; Pesch, 1996; Pesch and Schroeder, 1996) and especially performance perspectives (Bozarth and Edwards, 1997; Brush and Karnani, 1996; New and Szwejczewski, 1995; Safizadeh et al., 1996), these studies have not sought an understanding of why plants are or are not focused. Also, Vokurka and Davis (2000, p. 44) appropriately point out that ''[l]ittle empirical support has been provided for the focused factory concept''. This observation in particular warrants more theoretical reflection and perhaps alternative theoretical formulations and empirical analyses.

One interpretation of the lack of empirical support for the focused factory is that focused factory is not always the best strategy. Indeed, a careful reading of Skinner's seminal work suggests that focused factories are only possible strategy: ''*One way to compete* is to focus the entire manufacturing system on a limited task precisely defined by the company's competitive strategy . . .'' (Skinner, 1974, p. 119, emphasis added). Other scholars have explicitly argued that factories can be unfocused, but still be high performers (Hayes and Pisano, 1994, p. 81). Apparently, unfocus could be an intentional strategic choice, or perhaps a choice that reflects the specific requirements of the business environment: especially uncertain and fast-changing business environments may require the use of less focused and specialized strategies. Indeed, one of the central arguments in the population ecology literature

[1] Vokurka and Davis (2000) used Skinner's original definition of focused factory, which is also adopted in this paper.

is that so-called *generalist* strategies—where, among other things, the company offers a wide variety of products to its customer base—are more effective in uncertain environments (Freeman and Hannan, 1983). A number of operations strategy scholars have also observed generalist strategies in the manufacturing strategy context, both in terms of emphasizing multiple competitive priorities (Boyer et al., 1996; Ketokivi and Schroeder, 2004) as well as offering a broad line of products (Kekre and Srinivasan, 1990). These observations are clearly at odds with the conventional views of focus (Hayes and Wheelwright, 1984; Skinner, 1969).

The focus–performance studies and theories concentrate primarily on the performance consequences of focus (e.g., Bozarth and Edwards, 1997). However, an examination and theory of the antecedents or determinants of focus is needed to understand the phenomenon at hand. Interestingly, Bozarth and Edwards (1997, p. 178) argue that choosing not to focus may indeed be a conscious strategic move, or that companies may find themselves in a temporary state of non-focus as they make a transition into a new strategy. Also, Schmenner (1983, p. 127) notes, from a descriptive point of view, that older plants tend to be unfocused in the sense that they have, on average, a higher product mix. We submit that these are interesting phenomena that we do not adequately understand.

In sum, although the normative manufacturing strategy literature prescribes factories to focus on one or two dimensions of performance by serving a narrow market niche or by producing a narrow mix of products (Skinner, 1969; Wheelwright and Bowen, 1996), the reality in operations appears to be at times quite different: choosing or not choosing to focus may reflect constraints or opportunities posed by the operating environment. The central question then becomes: ‘‘Why are some factories focused while others are not?’’ Answering this question will enable a better understanding of de facto managerial decision-making, which is at least as important as being able to offer normative guidelines on how to make decisions (Cyert and March, 1992 [1963]). Unfortunately, there is a considerable bias in the conceptual and empirical manufacturing strategy toward the normative, which may well hinder us from understanding what *really* happens in manufacturing companies. We submit that the phenomenon of why some plants are focused while others are not is not adequately understood, which may in part explain Skinner’s (1996, p. 7) observation that not much has happened in the industry in terms of *understanding* and *applying* the tenets of manufacturing strategy in the industry in the 25 years following his seminal research at Harvard in the 1960s and the 1969 landmark article.

1.2. Focused factory in the process industry

The focus in this special issue is the process industry, and the case study presented in this paper is also in a process industry context. Now, neither Skinner nor his followers have claimed that the focused factory is limited to certain types of manufacturing operations. The tenet that the manufacturing task be simple applies, at least in principle, equally to discrete and continuous manufacturing.

We find the concept of the focused factory especially interesting in the process industry context for two interrelated reasons. First, process industries are comparatively more capital-intensive than discrete-part manufacturing (Cox and Blackstone, 2002). One direct implication of this is that the capacity utilization rate becomes more important as it correlates strongly with profitability. Second, product variety is comparatively lower than in discrete manufacturing, because process technology tends to be more dedicated to a narrow range of products (Hayes and Wheelwright, 1979). This makes the achievement of higher capacity utilization rates more challenging: alternative products to fill capacity may not exist during times of low demand. Further, product changeovers in manufacturing may be both time-consuming as well as expensive (Hill et al., 2000).

When these two aspects of the process industry are examined in a contemporary process industry business environment, often characterized by volatile and unpredictable demand (Grant, 2003), the relevance of this discussion in the process industry becomes obvious: What are the manufacturing strategies available to process manufacturers today? Is the focused factory a viable strategy?

At the same time, we do not wish to suggest that the process industry is monolithic and can be discussed and addressed as a single entity. We submit that it would be equally inappropriate to discuss discrete-part manufacturing as a homogeneous entity. Obviously, there are multiple process industries with their own idiosyncrasies. However, there are some general characteristics that process manufacturers share, which will be discussed in detail in this paper.

2. Theoretical foundation

Although inductive case studies such as this one are often regarded as exploratory theory construction exercises, every scientific research endeavor starts with a set of theoretical assumptions and basic constructs. In this paper, we approach the phenomenon mainly from the structural contingency theory perspective (e.g., Lawrence and Lorsch, 1967; Woodward, 1994 [1965]) in that we try to understand the contingencies in the business and task environments that shape manufacturing *structure* and *infrastructure*, to use Hayes and Wheelwright (1984) manufacturing strategy terminology. In addition to *environmental* contingencies central to structural contingency theory, we also examine the *strategic* contingencies, namely the effects of the competitive business strategy (Child, 1972; Donaldson, 2001; Porter, 1980). In consequence, the a priori theoretical constructs are selected based on contingency theory, industrial organization economics as well as theories of manufacturing focus. With regard to theories of focus, we concentrate on Skinner (1969, 1974) original definitions and arguments. Our initial hypothesis is that decisions to stay unfocused or become focused are related to the attempts of the business unit and the plant to adapt or fit to its operating environment and to execute a business strategy that is not served well by focused factories. We also suspect that—especially in the case of older plants—structural inertia (Hannan and Freeman, 1984) may be one of the reasons why the company and the plant may not be able to quickly adapt to its environment (see also Stinchcombe, 1965). Therefore, population ecology and evolutionary perspectives may prove useful as well.

Performance is not of central concern in this paper, rather, the main goal is to further our understanding of managerial decision making. Performance arguments are implicit in our study in that contingency arguments hold that high performance is achieved through proper alignment of the structure and infrastructure with the environmental contingencies (e.g., Donaldson, 2001; Drazin and Van de Ven, 1985), however, testing the fit argument is not the task in this paper. Our main task is to understand why some plants within a company are focused while others are not. We will take a look at operating performance when we discuss the viability of specific manufacturing strategies.

2.1. Defining the focused factory

While there are many different conceptualizations of focus, we choose here Skinner's original definitions and categories. In his pioneering article, Skinner (1974) argues that plants should be given specific and concise tasks with regard to their products, technologies and markets. This leads to three different dimensions of *focus:*

1. Product focus: producing a narrow mix of products.
2. Market focus: serving a carefully and narrowly defined market segment or niche.
3. Process focus: focusing on a certain type of production technology.

Our interpretation of Skinner's original argument and prescription is that these three dimensions are not independent from one another, and they should not be managed separately: each plant must be focused along *all* these dimensions (Skinner, 1974, p. 114). This is an important consideration and we will discuss this in further detail in the context of the empirical study presented in this paper.

On looking at the literature on the focused factory, we notice that the definition of the focused factory concept has become wider and wider as time has progressed, to the point that Harmon and Peterson (1990, pp. 13–14) suggest that focused factories are characterized, among other things, by cross-functional teams, superb communication, lean administrative staff, autonomous maintenance, minimal inventories, and short investment payback time. In this study, we choose to adopt Skinner's (1974) original and narrow definition, which only addresses the product mix focus, market niche focus and production technology focus. We do not view cross-functional teams, for instance, as a necessary characteristic of the focused factory. Cross-functional teams are an important integrative mechanism for functional organizations (Lawrence and Lorsch, 1967) and may thus be useful for functionally organized manufacturing companies as well. However, this has nothing to do with the factory *being focused*, hence, viewing cross-functional teams as a necessary or essential characteristic of the focused factory is in our view inappropriate. Indeed, one might argue that cross-functional cooperation is more valuable for unfocused than focused plants, because being unfocused may well correlate with a high degree of internal differentiation, which in turn would indicate a higher need for integrative mechanisms, such as cross-functional cooperation (Lawrence and Lorsch, 1967).

2.2. Boundary conditions: the process industry context

The context of the empirical study and theory development is the process industry. Some of the general characteristics and tendencies of process manufacturers deserve attention here, because in discussing them we also establish some of the boundary conditions for the emerging theoretical insight (e.g., Bacharach, 1989), which is useful in discussions of the *analytical generalizability* (Yin, 1989 [1984]) of the results. We are in full agreement with Priem and Butler (2001), who argue that explicating the proper domain of application of one's theories is perhaps the greatest limitation and challenge in contemporary management theorizing. This, we submit, is also a shortcoming of the focused factory literature. We will introduce what we think a priori to be the important industry characteristics, but will elaborate on them after the empirical analysis as well once the theoretical insight and specific propositions have emerged.

Definitions of the process industry usually focus on three key idiosyncrasies: (1) either continuous or batch processing, (2) rigid process control, and (3) high capital investment (Cox and Blackstone, 2002). This has direct implications on the production control (Dennis and Meredith, 2000; Fransoo, 1992) as well as performance measurement systems (Berry and Cooper, 1999) applicable in these industries. All these characteristics apply to the context of this study as well; especially the high capital investment characteristic and its implications will become important in this study.

Process industries have traditionally been connoted with commodity products and low product variety (e.g., Hayes and Wheelwright, 1979). However, Taylor et al. (1981) have long since argued that the products in the process industries are indeed heterogeneous in terms of the degree of customization (see also Finch and Cox, 1988; Fransoo and Rutten, 1994). This is the case in this study as well: the company under scrutiny manufactures a wide range of products along the commodity-customization dimension. Directly related to this, the *order penetration point*[2] is not necessarily at the end of the process, it may well be at the very beginning.

3. The case study

We seek empirical insight on focused factories in the process industry by using a *single-embedded-unit case study*, which Yin (1989 [1984], p. 46) labels Type 2 case studies. In this context, Type 2 studies concentrate on observational units (manufacturing plants in this case) embedded within a single company. The advantage of this design is good control of extraneous variables. The drawback, in turn, is lower generalizability to other contexts. The resultant theoretical insight is properly viewed as being of the *mid-range* variety (Bourgeois, 1979).

3.1. The corporation

The corporation under scrutiny is Consolidated Metals Corporation (CMC, a pseudonym), a division

[2] The point at which the product is earmarked to a specific customer (Sharman, 1984). Especially relevant here is one of its variants, the *product differentiation point* (van der Vorst et al., 2001, p. 77), the point at which the product design is fixed to a specific customer specification. Product differentiation may, of course, occur gradually in that, for instance in the production of customized sheet metal strip, the alloy is fixed at the foundry, the thickness at the rolling mill, and the final width of the strip at the slitting stage. Thus, the product becomes ''gradually earmarked'' to a specific customer specification. The order penetration and product differentiation points may or may not coincide (van der Vorst et al., 2001).

Table 1
Sample characteristics

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Location (Asia/Europe/North America)	NA	NA	NA	E	E	A	E	E	NA	A	A	E	E	E	E
Size (number of employees)	300	200	250	400	450	300	50	350	700	200	300	250	50	350	350
Production capacity (million kg/year)	20	14	40	40	45	10	2	50	130	15	10	20	10	50	40
Customer concentration (% accounting for 80% of sales)	20	45	20	30	30	10	30	40	15	40	30	20	60	30	35
Geographic focus (% production serving local markets)	93	88	86	86	32	94	100	24	92	96	100	94	94	92	99
Plant built (decade built)	1970s	1980s	1980s	1950s	1990s	1990s	1970s	1990s	1970s	1990s	1980s	1960s	1980s	1930s	1960s
Age of production technology (years)	10	10	20	30	10	10	20	10	25	10	10	20	15	25	25
Product focus (main product as % of total volume)	52	30	95	76	68	97	72	83	32	60	79	17	8	41	33

of a large multinational ferrous and non-ferrous metals manufacturer. The division examined here specializes in semi-finished non-ferrous metal parts and components for the machinery, electronics, construction and automotive industries, with annual sales of roughly $2 billion in 2003. CMC owns and operates a total of over two dozen manufacturing units in Europe, the Americas and Asia. CMC is selected as the case study company because it has both highly focused as well as unfocused factories, which offers us with an ideally controlled context for developing mid-range insight. The key phenomenon on which we wish to shed light is the observed heterogeneity in the degree of factory focus across CMC's manufacturing units.

3.2. Sampling the manufacturing units

In this study, the most relevant a priori theoretical sampling criterion is the concept of focus. Because there are many different definitions of focus, we look at the whole population of CMC's plants from a variety of perspectives, as suggested by the existing literature. The goal is to pick a sample that gives us the best opportunity to examine focus. Ideally, such sample includes polar types of both strongly focused as well as unfocused plants (Eisenhardt, 1989, p. 537). Fifteen of CMC's manufacturing plants are chosen for analysis in this study. The final sample and the dimensions discussed here are summarized in Table 1. The correlations between selected key variables are given in Table 2.

In sampling the manufacturing units, we first look at the product focus dimension. Product focus is measured by looking at each plant's product catalogue and identifying the main product. After identifying the main product, we calculate its proportion of total production volume. The larger the percentage of the main product of the total production volume, the

Table 2
Correlation matrix of the key demographic variables

	Mean	S.D.	1	2	3	4	5	6	7
1. Number of employees	300	158	1.00						
2. Production capacity (millions kg/year)	33	31	0.87	1.00					
3. % Customers that account for 80% of sales	30	13	−0.51	−0.31	1.00				
4. % Exports out of the continent	16	23	0.30	0.26	0.14	1.00			
5. Plant age	32	17	0.16	0.21	−0.13	−0.30	1.00		
6. Average age of production technology	17	7	0.30	0.46	−0.18	−0.29	0.79	1.00	
7. Share of main product (% of total volume)	56	28	0.07	−0.13	−0.41	0.28	−0.35	−0.22	1.00

higher the degree of product focus. Based on this variable, there are both highly product-focused (e.g., Plants C and F) as well as unfocused (e.g., Plants B and M) plants.

Second, we look at how concentrated the customer base is, because plants with a large number of customers are more likely to be facing more heterogeneous markets and thus be less focused. To operationalize this, we look at the percentage of customer base that accounts for 80% of the plant's demand volume (Bozarth and Edwards, 1997, p. 166). While this widely used measure has some value, we must exercise caution in using it in this context. Caution is needed because the customer may mean something quite different in one plant compared to another. For instance, the main customers for Plant M are large industrial wholesalers that order a wide variety of mostly commodity products. In stark contrast, the main customer for Plant H is another manufacturer, who purchases only a very narrow mix of mostly custom-made products. In this regard, the customer concentration measure is not a good operationalization of product focus. However, it can be used as a proxy for market focus.

Another aspect of market focus is geographic focus, where we have looked at the proportion of plant output serving local markets. We notice that, two exceptions (Plants E and H) aside, CMC's plants are more or less geographically focused.

Finally, because Schmenner (1983, p. 127) argues that plant focus is likely correlated with plant age, we use plant age as the third and final sampling variable. This is not to say that older plants are categorically unfocused, rather, we are simply trying to maximize the heterogeneity in our sample on the relevant theoretical a priori construct. Correlated with plant age are also constructs such as age of production technology and plant size (Table 2), we will show that correlation with especially the former has important implications.

The final product in CMC's manufacturing process is often a discrete unit (such as a sheet of metal or a length of tube), but the production process is continuous until the very end of the process. CMC is best characterized as a process manufacturer, because process-type metalworking operations—foundries, rolling mills, annealing stations and drawing benches—are central to its operations. CMC is also a typical manufacturer in the process industry in that the investment in capital equipment is comparatively large, and roughly 80% of the corporations fixed assets are in the manufacturing units (CMC 2002 Annual Report). Typically 80–90% of total production costs are fixed costs. Also, material costs—as opposed to labor—tend to dominate direct product costs (Rice and Norback, 1987, p. 15).

3.3. Focused factories at CMC

We make two observations regarding the dimensions of focus. First, CMC's production equipment is what transaction-cost economists would call highly *asset-specific* (Williamson, 1985). This means that a given production technology is typically dedicated to producing only a narrow mix of products. Some equipment are also asset-specific in the sense that it has been modified to serve a certain key customer—a relation-specific investment has been made. Now, there is some variance in the degree of asset-specificity across the plants as older equipment tends to be a bit less product-specific than new technology. At the same time, even older technology is highly asset-specific in comparison to, say, job shops with general-purpose equipment. The tube cold-rolling mill at Plant O is a case in point: this comparatively old piece of equipment is less asset-specific than its state-of-the-art counterparts, but can still only be used to cold-roll tube of a specific diameter, specific length and specific material. It does not really have any alternative or second-best use or application. In consequence, we make the important observation that product and process focus in this context are for all practical purposes the same thing. Consequently, we call this type of focus *product-process focus*.

Second, CMC's plants are largely market-focused, that is, they concentrate on serving local markets and generally a relatively small number of niche customers—although some customers may have more diverse needs than others. Many, although not all, of CMC's products compete on price, profit margins are low (the conversion rates are of the magnitude $1/kg), and therefore, transporting the finished goods long distances is simply not economically feasible. Market focus is a given. In sum, the key dimension of focus in

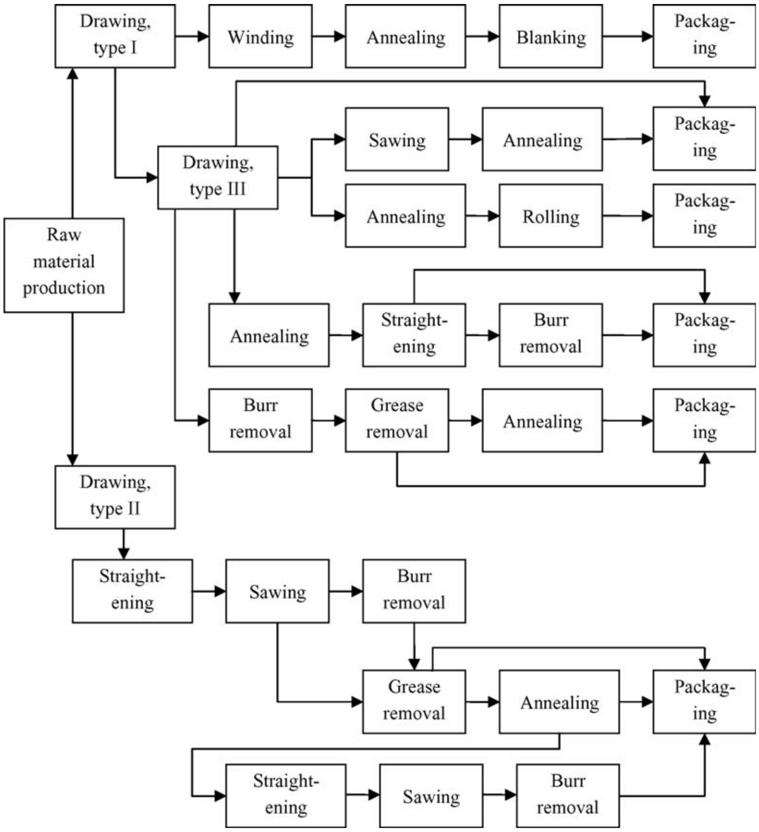

Fig. 1. Process layout of the industrial tubes production at Plant O.

this context is the product-process focus, which will take center stage from here onwards.

3.4. Production systems and plant layout at CMC's plants

Another idiosyncrasy of the process industry that guides and restricts the development of manufacturing strategies is the physical flow of materials through the plant. In a typical process-type manufacturing system, there are a small number of raw materials in comparison with the final products, the production flow is *divergent* (Fransoo and Rutten, 1994, p. 49. See also Fig. 1). This has strong implications to the kinds of manufacturing strategies that are available to these manufacturers.

Figs. 1 and 2 illustrate the process technologies and production systems at CMC. We have intentionally chosen two polar types to highlight the heterogeneity of CMC's operations. Both Plant O (Fig. 1) and Plant H (Fig. 2) descriptions highlight the fact that process-type operations are central to CMC's operations.

Fig. 1 depicts the industrial tubes production operations at Plant O, a comparatively unfocused factory in the sample; Plant O's main product only accounts for 33% of total production volume (see Table 1). Further, the other product groups produced, while homogeneous within, are very different from one another and the main product. The production operations use a wide variety of process technologies

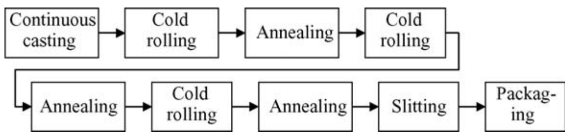

Fig. 2. Process layout Plant H.

and routing options. It should be noted that Fig. 1 shows only one of three production systems in place at Plant O, the industrial tubes production. Two other tube production systems are not depicted. Also, the raw material production phase—which is also performed at the same plant—is only depicted as one step, when in reality it involves multiple steps. Hence, illustrating all of Plant O's operations in one flowchart is downright impossible.

Plant H, in turn, is strongly process-product focused. Fig. 2 shows the whole production system flowchart from raw material production to the finished product. This single flowchart encompasses all of Plant H's products (the main product accounts for 83% of total volume, and the remaining 17%—products quite similar to the main product—are produced using the same equipment).

4. Data collection and analysis

Because the data collection and analysis phases are intimately intertwined in this study (Eisenhardt, 1989), they will both be presented in one section, followed by discussion and theoretical elaboration in the next section. In order to make the discussion in this section easy to follow, the key concepts, why and how they emerged during data collection and analysis, are first summarized in Table 3.[3] The data collection and analysis is described in greater detail in the following. The a priori important concepts and measures were, in turn, reported in Table 2.

Primary data were collected in April 2002–December 2003 using multiple ways of inquiry:

1. *Workshop with CMC's top management (six managers)*: The goal is to understand the corporate strategy and the corporate environment.
2. *Structured survey of business unit managers (27 managers)*: The goal is to understand competitive business strategies and business environment dynamics of individual businesses.
3. *Plant visits and semi-structured interviews with plant managers and production planners (8 plant visits, 40 managers interviewed)*: The goal is to understand the plants' operating environments and how the plants execute the competitive strategy.
4. *Production data (6000 data points spanning 2.5 years)*: The goal is to understand the nature of demand, both in the aggregate as well as by individual product groups.

At the beginning of the endeavor, we did not start with a specific set of structured questions; rather, we explored the topic of manufacturing strategy and the notion of focus at a general level. From these overall concepts, we proceeded inductively to focus on phenomena and concepts that emerged in discussions. In the following, we describe in chronological order the data collection.

4.1. Data collection 1: workshop with corporate management

First, it was relevant for us to develop an understanding of the corporate environment and the business environment as perceived by corporate management. Toward this end, we conducted a 2-day Transformation Diagnostics Workshop (Vollmann, 1996) with CMC's corporate management. Attending the workshop were six CMC managers: three members of the top management team, the corporate supply chain manager, the corporate environment and health manager, and a business intelligence manager (second author of this paper). Two operations management scholars (including the first author of this paper) conducted the workshop that addressed discontinuities of the business environment, strategic intent, strategy implementation and competencies. This workshop gave us an understanding of the strategic issues and challenges at the corporate level: discontinuities, expectations, strategic intent, strategic response, existing competences and competence gaps. In the workshop, *uncertainty* (*unpredictability*) and the related concepts *complexity* and *dynamism* (Table 3) began to emerge as key issues

[3] In an inductive case study the data collection and analysis phases are intimately intertwined (Eisenhardt, 1989): early phases of data collection may guide data collection in later stages and data is analyzed and collected at the simultaneously. The process is thus "highly iterative and tightly linked to data" (Eisenhardt, 1989, p. 532). This is in quite stark contrast with applications of the hypothetico-deductive method, in which theory and hypotheses are developed separately and before the empirical portion. Inductive case studies are found to be especially relevant when the goal is to *understand* phenomena (Meredith, 1998).

Table 3
Key emerging concepts

Concept	Description	Source	Relevance to emerging theory
Complexity	Complexity of product technology, complexity brought about by product variety	TMT workshop, business manager survey	Important in building an understanding of why focus may not be possible
Dynamism	The rate of change in customer expectations, emerging markets, diminishing markets	TMT workshop, business manager survey	Important in building an understanding of why focus may not be possible
Predictability	The degree to which demand for products can be anticipated	TMT workshop, business manager survey, production data	In conjunction with *variability* a central concept in Proposition 2
Variability	Variation in demand volumes for individual product groups	Production data, manufacturing manager interviews	In conjunction with *predictability* a central concept in Proposition 2
Competitive strategies	Classic Porter's (1980) generic strategies	Business manager survey, manufacturing manager interviews	Central to Proposition 2

characterizing the business environment, which according to the workshop attendees affected manufacturing strategy in a fundamental manner. These concepts will take center stage in the empirical investigation as well as theoretical elaboration. These issues, especially uncertainty, have also emerged as important characteristics of the operating environment in other contemporary process industry studies (e.g., van Donk and van der Vaart, 2005; Zaidman, 1994).

4.2. Data collection 2: structured survey of product line managers

The second source of data was a fully structured written survey (see Appendix A) filled out by all CMC's product line managers (a total of 27 surveys), which addressed the market conditions and customer requirements and expectations. A similar study had been conducted 2 years earlier by an independent consulting firm, which gave us the opportunity to address the dynamics of the business environment. Specifically, using the 2000 data as the baseline, we asked each product line manager to describe the changes that have occurred in their specific business environment in the past 2 years. In the survey, we addressed the following issues:

1. Complexity of the product line.
2. Nature of customer relationships (arm's length versus repetitive).
3. Degree of product customization.
4. Order winners and qualifiers (Hill, 1994 [1989]) for the product line's products.

The survey gave us a good understanding of the competitive strategies of the business units, and the requirements these strategies pose on manufacturing operations. What we needed next was the insight of the operational management in individual manufacturing plants on how these challenges are managed.

4.3. Data collection 3: semi-structured interviews with plant management

The third source of data was the operational management within the 15 chosen manufacturing units. We visited 8 of the 15 plants personally and interviewed the remaining 7 using a telephone conference. We interviewed a total of 40 operational managers, including top plant management and production planners. The goal was to develop a further understanding of the issues and specifically elaborate on the concept of focus and its determinants in CMC's context. We presented direct observations to the informants in the form of open-ended questions. For instance, we might start the interview by stating: "Based on our analyses, we have observed quite a broad mix of products manufactured at this plant. Is this indeed the case? What are the implications to managing operations at this plant?" The informants would then be able to correct our interpretations, shed light on the antecedents as well as consequences of their manufacturing policies. In the eight plants visited, we also took a factory tour and made observations regarding the plant layout as well as production planning and control activities.

4.4. Data collection 4: production data

The final source of data is CMC's central production database, which contains the monthly production volumes (in tons) for each product group at each plant. We used this data to examine the nature of the demand in each product group. Data were collected for a total of 194 product groups over a 2.5-year period (January 2001–August 2003), resulting in roughly 6000 data points. This gave us a good empirical grasp of the nature of the demand, especially its variability and predictability. From the production database, we calculated two indexes[4] for each manufacturing plant:

1. The coefficient of variation (CV) in monthly demand volumes.
2. An autocorrelation (AC) index.

The first index (CV) is calculated to estimate demand variability (e.g., de Kok, 2000, p. 236), while the second (AC) addresses demand predictability. These two concepts, variability and predictability, have key roles in the theoretical elaboration that follows. It is further important that they be separated, both conceptually and empirically. Indeed, the two correlate only moderately in the sample ($r = -0.30$): high variability does not necessarily imply low predictability, for instance, there might be high variation (high variability), but it might be highly predictable; this is often the case with highly seasonal demand, for instance, in the construction industry. Both indexes are calculated at the plant level as volume-weighted averages of the individual budget groups within the plant. The plants in the sample are then plotted on the two dimensions (Fig. 3). Three clusters of plants seem to emerge:

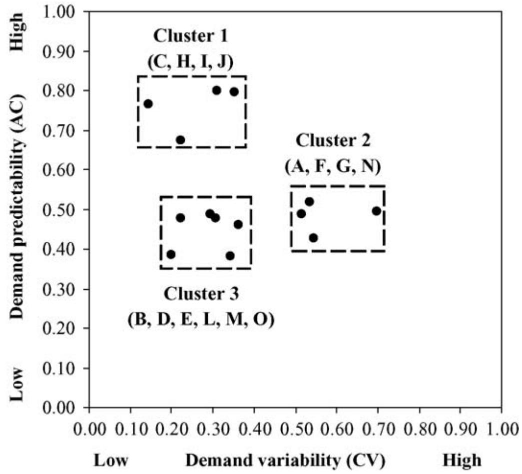

Fig. 3. Demand variability and predictability and the emerging clusters (not enough data was available for Plant K, it is omitted from the graph).

(1) Cluster 1: Comparatively high predictability and low[5] variability of demand.
(2) Cluster 2: Comparatively medium predictability and high variability of demand.
(3) Cluster 3: Comparatively low predictability and low variability of demand.

Now, the interesting question is whether some of these clusters are more suitable for focused manufacturing strategies. We address this and other issues in Section 5.

5. Discussion

In the course of the data collection and analysis, we make the following observations regarding product-process focus (see Tables 4–6; Fig. 4)[6]:

1. Older plants tend to be less focused (Table 6).

[4] The coefficient of variation is calculated using the conventional formula, that is, dividing the standard deviation by the mean. The autocorrelation index is calculated as the maximum value of the Lag 1–12 autocorrelation function. This gives us an indication of how predictable next month's demand is from the demand volumes in the previous 12 months, a high value implying high predictability. The values for the index are to be interpreted simply as correlations.

[5] It should be noted here that *low variability* means *low* only in comparative terms. In absolute terms, volatility is quite high for all plants (Fig. 3): all but one plant have $CV > 0.20$. When the S.D. is 1/5 of the mean ($CV = 0.20$) and we assume normal or at least ''mount-shaped'' distribution of demand (which is reasonable), it means that in any given month the demand may vary between 40% and 160% of average monthly demand, that is, $\pm 3\sigma$.

[6] The measure of association reported in Table 4 is the linear-by-linear measure of association, that is, the Pearson correlation coefficient. While Pearson correlation has simplicity as its main virtue and reporting the associations for many variables is straightforward if Pearson correlations are used, it may not always be the best measure of association, because it only addresses the linear association. The competitive advantage -focus association is a case in point: The Pearson correlation coefficient is only 0.20, but Fig. 4 elaborates on the association, and we see a clear association between the two.

Table 4
Analysis of variance (ANOVA) of the clusters in terms of the other key variables

Cluster number	Number of plants	Mean	Variance explained (%)
Number of employees			
1	4	375	10
2	4	250	
3	6	283	
Production capacity (millions kg/year)			
1	4	59	25
2	4	21	
3	6	28	
Capacity utilization rate in 2003			
1	4	90	10
2	4	86	
3	6	84	
% Customers that account for 80% of sales			
1	4	29	22
2	4	23	
3	6	37	
% Exports out of the continent			
1	4	26	9
2	4	8	
3	6	18	
Plant age			
1	4	23	16
2	4	40	
3	6	35	
Average age of production technology			
1	4	16	2
2	4	16	
3	6	18	
Share of main product (% of total volume)			
1	4	68	25
2	4	65	
3	6	39	
Demand variability			
1	4	0.26	79
2	4	0.57	
3	6	0.29	
Demand predictability			
1	4	0.76	90
2	4	0.48	
3	6	0.45	
Operating profit per kg in 2003			
1	4	[a]	4
2	4	[a]	
3	6	[a]	
Competitive strategy (0 = price, 10 = differentiation)			
1	4	5.0	7
2	4	4.5	
3	6	3.8	
Scope (0 = local, 10 = global)			
1	4	2.5	37
2	4	1.3	
3	6	4.8	

[a] For reasons of confidentiality, we will not disclose the absolute levels of operational performance.

2. Plants with older technology tend to be less focused (Table 6).
3. Plants that serve a differentiation competitive strategy tend to be more focused (Fig. 4).
4. Plants tend to be more focused if demand is predictable (Fig. 4).
5. Asian plants tend to be more focused than European and North American plants (Table 5).
6. Plants serving fewer customers tend to be focused (Table 6).
7. Focused plants tend to achieve higher operating profit (Fig. 4).

In the following, offer a theoretical explanation for each of these observations, and a set of propositions.

5.1. Why does plant age matter?

We make the same observation as Schmenner (1983, p. 127): older plants tend to be less focused. But what explains the phenomenon? We submit that in this context plant age matters only because it happens to correlate with two other important factors. First, plant age correlates, not surprisingly, with average age of production technology (high correlation of 0.79). One theoretical explanation is therefore the asset specificity argument: older plants tend to have older equipment and technology, which is comparatively more general-purpose, and the company is able to seek complementary or ‘‘filler’’ products when the demand for the main products decreases. Such filler products are necessary in order to be efficient. Second, because production equipment age also correlates with overall production capacity in that plants with older equipment tend to have a higher capacity (Table 6),

Table 5
Analysis of variance (ANOVA) of the clusters in terms of geographic location variables

Cluster number	Number of plants	Mean	Variance explained (%)
Number of employees			
North America	4	363	6
Europe	8	281	
Asia	3	267	
Production capacity (millions kg/year)			
North America	4	51	19
Europe	8	32	
Asia	3	12	
Capacity utilization rate in 2003			
North America	4	85	27
Europe	8	85	
Asia	3	95	
% Customers that account for 80% of sales			
North America	4	25	13
Europe	8	34	
Asia	3	27	
% Exports out of the continent			
North America	4	10	14
Europe	8	24	
Asia	3	3	
Plant age			
North America	4	30	23
Europe	8	39	
Asia	3	18	
Average age of production technology			
North America	4	16	26
Europe	8	19	
Asia	3	10	
Share of main product (% of total volume)			
North America	4	52	17
Europe	8	50	
Asia	3	79	
Demand variability			
North America	4	0.41	10
Europe	8	0.32	
Asia	3	0.42	
Demand predictability			
North America	4	0.61	23
Europe	8	0.49	
Asia	2	0.66	
Operating profit per kg in 2003			
North America	4	[a]	9
Europe	8	[a]	
Asia	3	[a]	
Competitive strategy (0 = price, 10 = differentiation)			
North America	4	4.5	1
Europe	8	4.4	
Asia	3	4.0	
Scope (0 = local, 10 = global)			
North America	4	2.3	6
Europe	8	3.6	
Asia	3	3.0	

[a] For reasons of confidentiality, we will not disclose the absolute levels of operational performance.

achieving a high capacity utilization rate in older plants is, *ceteris paribus*, more difficult. This may force the plant to broaden the product mix, which is again possible because of lower asset specificity compared to new-technology plants. We thus offer the following theoretical proposition to explain observations 1 and 2:

P1. *Plant age is negatively related to focus, because older plants tend to have older technology which is less asset-specific, and have more difficulties in achieving high capacity utilization.*

5.2. Competitive strategy and focus

We observe that CMC's focused factories are on average more differentiators than price competitors in Porter's (1980) terminology (80% of plants executing a mainly differentiation strategy are focused, the corresponding proportion for price competitors is only 40%; see Fig. 4). The observation that differentiators tend to be more focused is perhaps the most interesting one, because it seems counterintuitive: one might argue based on the basic tenets of industrial organization economics (e.g., Porter, 1980) that in price competition the most important competitive weapons are the learning curve benefits and economies of scale, therefore, a price competitor, if anyone, should have product-focused plants, not seek economies of scope. Now, this is certainly true, but with one important condition: demand for the one product produced is stable. With variable demand, plant focus in commodity production is simply not feasible because of high fixed costs: during times of low demand the plant would not even be able to cover its

Table 6
Correlations between the key variables

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Number of employees	300	158	1.00												
2. Production capacity (millions kg/year)	33	31	0.87	1.00											
3. Capacity utilization rate in 2003	87	8	−0.37	−0.44	1.00										
4. % Customers that account for 80% of sales	30	13	−0.51	−0.31	0.13	1.00									
5. % Exports out of the continent	16	23	0.30	0.26	0.34	0.14	1.00								
6. Plant age	32	17	0.16	0.21	−0.77	−0.13	−0.30	1.00							
7. Average age of production technology	17	7	0.30	0.46	−0.74	−0.18	−0.29	0.79	1.00						
8. Product focus: share of main product (% of total volume)	56	28	0.07	−0.13	0.59	−0.41	0.28	−0.35	−0.22	1.00					
9. Demand variability	0.36	0.15	−0.25	−0.40	−0.07	−0.42	−0.49	0.28	−0.08	0.21	1.00				
10. Demand predictability	0.55	0.15	0.24	0.33	0.42	−0.19	0.28	−0.40	−0.20	0.47	−0.30	1.00			
11. Operating profit per kg in 2003	[a]	[a]	−0.48	−0.50	0.59	0.10	−0.04	−0.61	−0.66	0.07	0.15	−0.14	1.00		
12. Competitive strategy (0 = price, 10 = differentiation)	4.3	1.9	−0.32	−0.16	0.70	0.33	0.52	−0.58	−0.58	0.20	−0.14	0.20	0.51	1.00	
13. Scope (0 = local, 10 = global)	3.1	2.5	−0.09	−0.11	0.16	0.54	0.32	−0.32	−0.36	−0.42	−0.51	−0.18	0.05	0.28	1.00

[a] For reasons of confidentiality, we will not disclose the absolute levels of operational performance, only its correlation with other variables.

fixed costs, which may be up to 90% of total costs. Also, according to CMC's Senior Vice President of Technology commodity production in non-ferrous metals is comparatively simple. In consequence, learning curve advantages will rapidly be competed away. In a differentiation strategy, in turn, entry barriers are higher, because differentiation advantages are more difficult to compete away. In CMC's case, differentiation advantages are based on proprietary production technology, which enables quality levels that exceed those of competitors'. Also, differentiation strategies are also associated with long-term customer relationships and relation-specific investments, which constitute another entry barrier (e.g., Winter and Szulanski, 2001). This leads to our second theoretical proposition:

P2. *In environments with highly variable demand, product-process focused manufacturing strategies are more feasible when the competitive strategy differentiation-based.*

5.3. Why does predictability matter?

In the preceding section, we established that high demand variability has implications to focus. Here we argue that demand predictability has a similar effect. Based on Fig. 4, we conclude that 75% (3 out of 4) of the high-predictability-cluster plants (Cluster 1) are focused, while in the other two clusters (with comparatively lower predictability), the proportion of highly focused plants is only 44% (4 out of 9). We propose that the explanation for why predictability matters can be uncovered by examining how demand becomes predictable. Demand becomes predictable when customer relationships are long-term, and the number of key customers is small. In arm's length markets, which are often associated with commodity products, the switching costs for CMC's customers are low, customers come and go, and this makes demand for individual products more unpredictable.

P3. *Focused factories are easier to implement and maintain when customer relationships are stable and long-term (as opposed to arm's length markets) and the plant has only a few key customers. All these increase predictability of demand, reduce complexity and create customer lock-in.*

5.4. Why does geography matter?

There are two main reasons why Asian plants tend to be more focused is twofold. First, Asian plants tend

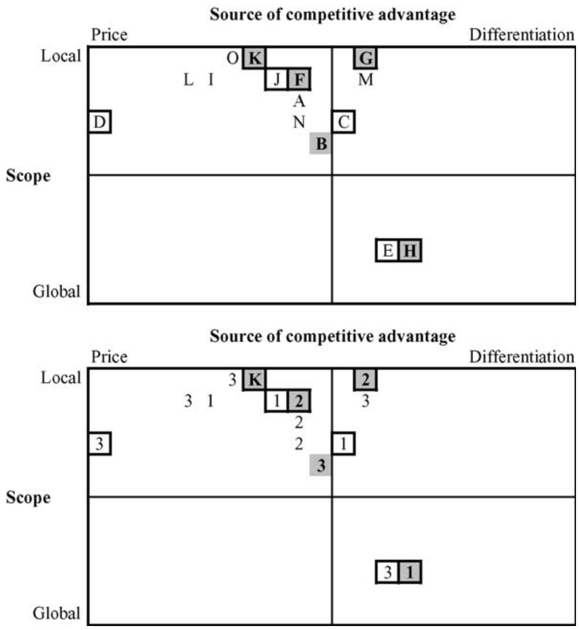

Fig. 4. Generic business strategy, focus and performance (in the top graph, plants are identified by their plant codes, in the bottom graph by cluster membership). Legend: Boxed entries indicate a comparatively focused plant. Entries with shaded backgrounds indicate the five top-performing plants (by operating profit per kg). Plant K does not belong to any cluster, because not enough longitudinal data was available to examine demand variability and predictability.

to be newer and thus have newer, specialized production technology: having a broad product mix is simply not possible, and was never intended. Second, Asian plants tend to be smaller (Table 5), their strategic role is to serve local markets with less capacity—they are *contributors* and *servers* in Ferdows' (1989, p. 8) terminology. Smaller capacity also means smaller capital investment and less risk, which has clearly been a factor in establishing operations in comparatively less-developed countries. Because the Asian markets have been growing in the past 10 years, achieving high utilization rates has been easy compared to, for instance, the North American markets, which have long since plateaued, even declined. This leads to Proposition 4:

P4. *Plants in higher-risk locations tend to be more focused, because they tend to be smaller and their specific strategic role is that of serving local niche markets using the latest available technology.*

5.5. A note on market size and excess capacity

One aspect of the market that is for some reason often neglected in operations management research is the total demand in a given market and its relationship to plant capacity. At the writing of this case study, CMC's industry is best characterized as being in a state of ''chronic overcapacity''. After a period of industry-wide high capital investment in the 1990s the markets are simply too small to fill the plants. This is an important consideration, because large plants may choose not to implement the focused factory approach for the simple reason that no single market can absorb the plant's capacity. The plant is forced to seek so-called ''filler products'', that may or may not fit the manufacturing task, just to fill capacity. Recently, this has been especially crucial in CMC's North American operations. Therefore, seeking products that fit the existing production technologies may not be motivated by a strategic search for economies of scope (Panzar and Willig, 1981; Teece, 1982), it may indeed be a mere necessity from a cost perspective. In such cases, one may end up producing products for which economies of scope do not even exist, because producing something even at a loss is better than producing nothing at all at an even greater loss.

5.6. Strategy, focus and performance

Fig. 4 suggests that CMC's focused plants tend to perform better (in terms of operating margin/kg): of the top five performing plants four are strongly focused. Here, the explanation is straightforward. Focus correlates strongly with capacity utilization rate (Table 6). Because fixed costs are such a high proportion of total costs, the link between capacity utilization and operating profit is trivial. This should not, however, be interpreted as implying that all plants should be focused. Rather, we suggest the following normative interpretation: there is a time and place for a focused manufacturing strategy, one must understand the important contingencies embedded in the four propositions. Focused manufacturing strategy requires a specific business-level strategy (here, differentiation), a specific operating environment (comparatively stable demand) and a specific customer relationship (long-term and stable, with a few large customers). In turbulent business environments, arm's length economic exchange and price competition, focused manufacturing strategy may indeed be the least appropriate alternative. Plant B is a prime example: Plant B is not only profitable, but also by far the most profitable of all of CMC's plants in 2003, despite the gloomy market conditions. It operates in a business environment where demand is highly unpredictable and also highly variable (CV = 0.36, which means that if the average monthly production volume for a product group is 100 tons, the production volume in any given month may vary between 0 and 200 tons, $\pm 3\sigma$). Plant B's main products account for only 30% of total production volume as it serves a fairly large number of carefully selected specialty product markets. Despite this lack of focus the plant has been very efficient and profitable. The key aspect of Plant B's manufacturing strategy is high flexibility—rerouting, volume and product mix flexibility—which enables highly customized products with little extra costs, and some of its products compete exclusively on differentiation (although there are also a number of products competing on price). Plant B employs some of CMC's newest proprietary production technology. Plant B's top management team concurs that in terms of process technology, plant layout and material flow, the plant is quite complex and unfocused, but this complexity is manageable because of the high degree of flexibility: the goal at Plant B is not to make everything simple, rather, it is to make everything manageable.

5.7. Boundary conditions revisited

Dubin (1978) suggests that the key aspects of a management theorizing are (1) specifying the key concepts, (2) describing how the key concepts are related, (3) explaining why the key concepts are related, and (4) specifying the boundary conditions. In the four propositions offered above and the discussion preceding them, we have explicitly addressed the first three. Dubin's fourth criterion for good theory, specifying the boundary conditions, has been partly addressed in describing the context of this study, but requires explicit attention here in light of the propositions that have emerged. This is especially important, because explicating the domain of application of one's theories is perhaps the greatest limitation in today's management theories (e.g., Priem and Butler, 2001), yet it is especially important in mid-range theorizing. In order to avoid repetition of earlier discussion where we discussed the context idiosyncrasies, we approach the boundary conditions by looking at how and why each of the key variables in the emerging propositions is important. Instead of trying to explicate all possible boundary constraints here—an impossible task—we follow Whetten's (1989, p. 492) suggestion to conduct a few ‘‘mental tests of the generalizability of core propositions’’.

First, asset specificity is a key variable as it has strong implications to the nature of focus, and the interdependence between, for instance, process and product focus. It should be fairly obvious that the insight and propositions, especially P1, cannot be extended to low-asset-specificity environments. Or perhaps they can, but they are not very interesting or in any way critical to managing manufacturing in such environments. In plants with general-purpose equipment (e.g., job shops), the managerial challenges associated with focus are rather different, because asset specificity is not an issue. In such environments, product and process focus are separate dimensions to be examined separately.

Second, the industry in which CMC operates is highly capital-intensive. In consequence, the plant managers identified high capacity utilization as their primary goal—a plant operating at a low rate of utilization would not be able to even cover its fixed costs (see also Fransoo, 1992, p. 193). This is apparent in the strong correlation between operating profit and capacity utilization. That operating profit correlates strongly with capacity utilization rate introduces a number of fundamental challenges and restrictions, especially when coupled with asset specificity. In consequence, the results of this study and the propositions are probably not at all applicable to labor-intensive manufacturing operations; especially P2 hinges on the condition of high fixed costs.

Third, manufacturing plants in the metalworking industry have traditionally served local markets because the products are heavy and hence expensive to transport. Although there are exceptions as companies today strive for higher value added, the conversion rates for many of CMC's products are still by and large of the magnitude $1/kg, therefore, producing something in the Far East for European markets is often not feasible. This is in stark contrast with, for instance, the production of consumer electronics, where conversion rates per pound of weight—if one wishes to apply the concept in the electronics consumer products—are several orders of magnitude higher. This is an important context factor, which, for instance, fundamentally restricts the availability of business strategies with a wide (global) scope, which is evident in Fig. 4. The availability of global scope strategies might drastically change the results and Fig. 4, leading to a different formulation of P2 and P4.

Proposition 3, in turn, strongly reflects the fact that CMC operates exclusively in a business-to-business environment. We know that for instance in consumer electronics manufacturing, focused factories are feasible even with a large number of customers and arm's length markets. P3 is therefore also context-dependent.

In sum, we posit that the domain of application of the propositions is everything but universal, we present the process industry contingencies above as key determinants for the domain of application, leading to *mid-range* theorizing and propositions. At the same time, capital-intensive process industries with high asset specificity and mainly industrial clients represent a significant portion of the manufacturing industries. Therefore, investigating phenomena that originate in these industries as well as investigating the applicability of established theories in these contexts serves both the practitioners as well as the academic audience (Berry and Cooper, 1999; Dennis and Meredith, 2000; Rice and Norback, 1987).

5.8. Managerial implications

Our results have strong implications for practice as there are a number of strategies that can be used (and that CMC indeed uses) to adapt and prosper in the dynamic and complex business environment. A number of the key concepts in the theoretical model are also under management control, at least to an extent. A few of the most important ones are discussed in the following.

The primary overall managerial variable of interest is the competitive business strategy. We have argued that decisions regarding product-process focus in CMC's context are highly dependent on the choice of competitive strategy, in a way that is less than obvious (see P2). CMC is competing in different ways in different markets, and it is imperative that both corporate managers as well as business managers understand the implications of competitive business strategy on product-process focus. It is also important to remember and business environmental conditions—specifically, demand variability and predictability—have strong implications to product-process focus.

On a smaller and more practical scale, the order decoupling point is a managerial variable. There is no universal rule for how to manage this, but two main tactics can be pursued. By moving the decoupling point forward the plant can create a cushion for demand variability: the later the product is earmarked to a specific customer, the more flexibility the plant has in managing production orders and customer orders. On the other hand, the plant may be required to move the decoupling point backward to accommodate individual customer needs, as is the case with customer-specific alloys, where the decoupling point is at the foundry. The most effective strategy here would be the "best of both worlds", where the order decoupling point is moved forward, but the degree to which the product functionalities can be tailored to customer needs does not suffer. Plant E, for instance, has successfully exploited this strategy in the past 3 years: by being able to move the decoupling point forward without compromising customer expectations Plant E can improve its efficiency significantly by eliminating setups, which in the process industry are a significant cause of downtime.[7]

The plant, and CMC, may also attempt to integrate forward vertically in order to move closer to the end customer. This is known to enhance demand visibility as well as predictability. However, moving forward in the value chain is again no universal maxim, each plant and business unit has to carefully consider what the key competencies are and not to try to integrate into parts of the value chain it cannot master. A

[7] The plant manager at Plant E had calculated that if he could eliminate one setup per shift (go from six to five setups), the average production order size would increase by 25% and consequently daily production capacity would increase from by at least 10%.

number of CMC's plants are implementing this strategy, although very selectively. As an example, tube manufacturers such as Plant O may offer customers further customization of the tubes. For instance, if the tube has to be bent into a U-shaped form before installation at the original equipment manufacturer (OEM), this operation may be performed at Plant O instead of the OEM's plant. Some plants are also engaging in cooperative product development with the customer (Plant E and H). CMC's product is typically a semi-finished non-ferrous metal part, which serves a specific function in the customer's product. Joint product development has indeed led to cost reductions for Plants E and H, who have convinced a number of key customers that in order to achieve the desired functionality, the part that CMC provides need not be custom-designed and custom-made, because a standard part will achieve the same functionality, provided that a small and comparatively inexpensive design modification be made to the customer's product. At the corporate level, moving closer to the end customer may involve the purchase of one of CMC's clients, especially in cases of high asset specificity (Williamson, 1985). One such major purchase was made in 2002, for instance, when one business division bought one of the main customers of one of its business units.

Finally, dynamic allocation of capacity at the corporate level may also enable companies better to respond to demand variability and unpredictability. This strategy is especially viable for high-value-added products, where transporting the finished goods from a factory in Europe to the North American market is possible, at least from a transportation cost perspective. With low-value-added products the production is necessarily local.

5.9. Limitations

While we have been able to map CMC's internal operations in great detail, especially the empirical treatment of the business and operating environment is somewhat incomplete. Uncertainty, complexity and dynamism have clearly emerged as the main dimensions of the environment that require detailed attention. We have used fairly narrow definitions and operationalizations of these key concepts. Further research should look at alternative definitions and operationalizations so that we could get a more complete understanding of how these affect operations. Our conclusion is that CMC's internal operations are greatly affected by the business and operating environment, which of course is one of the basic arguments of the structural contingency theory as well (Lawrence and Lorsch, 1967).

Another important point regarding these three concepts is the distinction between the subjective and objective dimensions. Bourgeois (1985), among others, makes a distinction between the subjectively perceived environment (what managers think is going on in the environment) and the objective environment (what actually happens in the environment). In order to understand managerial decision-making, we must understand both dimensions. For instance, subjective perceptions often guide decisions and behavior, while the objective environment may be more fruitful when we seek to explain differences in economic performance. Future research should explore these distinctions and their implications.

6. Conclusion

We have taken the first steps toward a *mid-range contingency theory of the focused factory* in the context of the process industry by developing a set of four contingency propositions. The main contribution of this emerging theory is that it addresses one of the remaining gaps in the focused factory literature: Why do some plants remain unfocused? We point to strategic and business environmental contingencies, which have been largely neglected in earlier research on focus. Future research should further elaborate on these contingencies. We have also offered four propositions that can be empirically tested in large samples. This is another potential direction for future research.

This paper has contributed to the manufacturing strategy literature by taking a systematic in-depth look at the determinants of manufacturing focus in a complex and dynamic business environment. In so doing, this study has complemented the extant research on focus has concentrated largely on the content of focus as well as its performance implications. Earlier contributions, while certainly valuable and at the same time important foundations for this paper, are limited in helping us understand the phenomenon that provided the impetus for this paper.

The main propositions arising from our theory is that there is a time and place for product-process focus in the process industries. Or perhaps a better way to express the result is that while focus seems to be associated with higher performance, it is not always the best strategy; there are other viable alternatives. Further, the corporation should not impose a single manufacturing strategy to be executed in all its manufacturing units, because the environmental and strategic contingencies faced by different plants are not identical. We argue that these issues have not received enough attention in the extant literature, and they should further be examined in empirical research. The case company in this study has both very focused as well as unfocused plants; we should not readily assume that staying unfocused is bad strategy. Staying unfocused may indeed be a conscious strategic choice that helps cushion environmental turbulence in times of rapid change, and unfocused strategies may well be more useful in executing specific competitive strategies. We find a great wisdom in the words of Plant B's plant manager: "Our goal is not to make complex issues simple, rather, our goal is to make complexity manageable by building flexibility into our production systems."

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Appendix A. The survey instrument

The respondents were given the year 2000 data and were asked to indicate the changes that have occurred in the past 2 years.

	Year 2000	Year 2002
Transactional complexity of end user business		
Delivery batch size to final customer	High	% Smaller compared to 2000 % Equal with 2000 % Larger compared to 2000
Number of transactions with each customer	Small	% Smaller compared to 2000 % Equal with 2000 % Larger compared to 2000
Market fragmentation (number of customers)	10–15	Number of customers
Product range and service complexity		
Degree of customization	Low	% Lower compared to 2000 % Equal with 2000 % Higher compared to 2000
Order freeze point	Late	% Earlier compared to 2000 % Equal with 2000 % Later compared to 2000
Type of customer relationship		
Order-by-order versus long-term	Long-term	Long-term Order-by-order

Appendix A (*Continued*)

	Year 2000	Year 2002
Main customer requirements		
Price	1	
Quality	2	
On-time delivery	Not identified	
Demand flexibility	Not identified	
Product characteristics	Not identified	
Lead times/fast delivery to customer	Not identified	
Long-term relationships	Not identified	
Availability	Not identified	
Service	Not identified	

The average delivery batch size for a given plant may have been, for instance, ''high'' in the year 2000. In the survey, the informant was asked to estimate what percentage of delivery batch sizes had gotten smaller or larger or stayed the same for the customers that the plant had both in 2000 as well as 2002.

References

Bacharach, S.B., 1989. Organizational theories: some criteria for evaluation. Academy of Management Review 14 (4), 496–515.

Berry, W.L., Bozarth, C.C., Hill, T.J., Klompmaker, J.E., 1991. Factory focus: segmenting markets from an operations perspective. Journal of Operations Management 10 (3), 363–387.

Berry, W.L., Cooper, M.C., 1999. Manufacturing flexibility: methods for measuring the impact of product variety on performance in process industries. Journal of Operations Management 17 (2), 163–178.

Bourgeois III, L.J., 1979. Toward a method of middle-range theorizing. Academy of Management Review 4 (3), 443–447.

Bourgeois III, L.J., 1985. Strategic goals, perceived uncertainty, and economic performance in volatile environments. Academy of Management Journal 28 (3), 548–573.

Boyer, K.K., Ward, P.T., Leong, K.G., 1996. Approaches to the factory of the future: an empirical taxonomy. Journal of Operations Management 14 (4), 297–313.

Bozarth, C.C., 1993. A conceptual model of manufacturing focus. International Journal of Operations and Production Management 13 (1), 81–92.

Bozarth, C.C., Edwards, S., 1997. The impact of market requirements focus and manufacturing characteristics focus on plant performance. Journal of Operations Management 15 (3), 161–180.

Brush, T.H., Karnani, A., 1996. Impact of plant size and focus on productivity: an empirical study. Management Science 42 (7), 1065–1081.

Child, J., 1972. Organization structure, environment and performance: the role of strategic choice. Sociology 6, 1–22.

Collins, R.S., Cordon, C., Julien, D., 1998. An empirical test of the rigid flexibility model. Journal of Operations Management 16 (2–3), 133–146.

Cox, III, J.F., Blackstone, Jr., J.H. (Eds.), 2002. APICS Dictionary. American Production and Inventory Control Society, Falls Church, VA.

Cyert, R.M., March, J.G., 1992 [1963]. A Behavioral Theory of the Firm, second ed. Prentice-Hall, Englewood Cliffs, CA.

de Kok, T.G., 2000. Capacity allocation and outsourcing in a process industry. International Journal of Production Economics 68 (3), 229–239.

Dennis, D.R., Meredith, J.R., 2000. An analysis of process industry production and inventory management systems. Journal of Operations Management 18 (6), 683–699.

Donaldson, L., 2001. The Contingency Theory of Organizations. Sage Publications, Thousand Oaks, CA.

Drazin, R., Van de Ven, A.H., 1985. Alternative forms of fit in contingency theory. Administrative Science Quarterly 30 (4), 514–539.

Dubin, R., 1978. Theory Building. Free Press, New York (Revised ed.).

Eisenhardt, K.M., 1989. Building theories from case study research. Academy of Management Review 14 (4), 532–550.

Ferdows, K., 1989. Mapping international factory networks. In: Ferdows, K. (Ed.), Managing International Manufacturing. Elsevier Science Publishers, Amsterdam, pp. 3–21.

Finch, B.J., Cox, J.F., 1988. Process-oriented production planning and control: Factors that influence system design. Academy of Management Journal 31 (1), 123–153.

Fransoo, J.C., 1992. Demand management and production control in process industries. International Journal of Operations and Production Management 12 (7), 187–196.

Fransoo, J.C., Rutten, W.G.M.M., 1994. A typology of production control situations in process industries. International Journal of Operations and Production Management 14 (12), 47–57.

Freeman, J., Hannan, M.T., 1983. Niche width and the dynamics of organizational populations. American Journal of Sociology 88 (6), 1116–1145.

Grant, R.M., 2003. Strategic planning in a turbulent environment: evidence from the oil majors. Strategic Management Journal 24 (6), 491–517.

Hannan, M.T., Freeman, J., 1984. Structural inertia and organizational change. American Sociological Review 49 (2), 149–164.

Harmon, R.L., Peterson, L.D., 1990. Reinventing the Factory: Productivity Breakthroughs in Manufacturing Today. Free Press, New York.
Hayes, R.H., Pisano, G.P., 1994. Beyond world-class: the new manufacturing strategy. Harvard Business Review 72 (1), 77–84.
Hayes, R.H., Pisano, G.P., Upton, D.M., Wheelwright, S.C., 2005. Operations, Strategy, and Technology: Pursuing the Competitive Edge. Wiley, New York.
Hayes, R.H., Wheelwright, S.C., 1979. Link manufacturing process and product life cycles. Harvard Business Review 57 (1), 133–140.
Hayes, R.H., Wheelwright, S.C., 1984. Restoring Our Competitive Edge: Competing through Manufacturing. Wiley, New York.
Hill, J.A., Berry, W.L., Leong, G.K., Schilling, D.A., 2000. Master production scheduling in capacitated sequence-dependent process industries. International Journal of Production Research 38 (18), 4743–4761.
Hill, T.J., 1994 [1989]. Manufacturing Strategy: Text and Cases, second ed. Irwin, Burr Ridge, IL.
Kekre, S., Srinivasan, K., 1990. Broader product line: a necessity to achieve success? Management Science 36 (10), 1216–1231.
Ketokivi, M.A., Schroeder, R.G., 2004. Strategic, structural contingency and institutional explanations in the adoption of innovative manufacturing practices. Journal of Operations Management 22 (1), 63–89.
Lawrence, P.R., Lorsch, J.W., 1967. Organization and Environment: Managing Differentiation and Integration. Harvard University, Boston, MA.
Meredith, J.R., 1998. Building operations management theory through case and field research. Journal of Operations Management 16 (4), 441–454.
New, C.C., Szwejczewski, M., 1995. Performance measurement and the focused factory: empirical evidence. International Journal of Operations and Production Management 15 (4), 63–79.
Panzar, J.C., Willig, R.D., 1981. Economies of scope. American Economic Review 71 (2), 268–272.
Pesch, M.J., 1996. Defining and understanding the focused factory: a Delphi survey. Production and Inventory Management Journal 38 (2), 32–36.
Pesch, M.J., Schroeder, R.G., 1996. Measuring factory focus: an empirical study. Production and Operations Management 5 (3), 234–254.
Porter, M.E., 1980. Competitive Strategy: Techniques for Analyzing Industries and Competitors. Free Press, New York.
Priem, R.L., Butler, J.E., 2001. Is the resource-based "view" a useful perspective for strategic management research? Academy of Management Review 26 (1), 22–40.
Rice, J.W., Norback, J.P., 1987. Process industries production planning using matrix data structures. Production and Inventory Management Journal 28 (2), 15–23.
Safizadeh, M.H., Ritzman, L.P., Sharma, D., Wood, C., 1996. An empirical analysis of the product-process matrix. Management Science 42 (11), 1576–1591.
Schmenner, R.W., 1983. Every factory has a life cycle. Harvard Business Review 61 (2), 121–129.
Sharman, G., 1984. The rediscovery of logistics. Harvard Business Review 62 (5), 71–79.
Skinner, W., 1969. Manufacturing—missing link in corporate strategy. Harvard Business Review 50 (3), 136–145.
Skinner, W., 1974. The focused factory. Harvard Business Review 52 (3), 113–121.
Skinner, W., 1996. Manufacturing strategy on the "S" curve. Production and Operations Management 5 (1), 3–14.
Stinchcombe, A., 1965. Social structure and organization. In: March, J. (Ed.), Handbook of Organizations. Rand McNally, Chicago, IL, pp. 142–193.
Taylor, S.G., Sewart, S.M., Bolander, S.F., 1981. Why the process industries are different. Production and Inventory Management Journal 22 (4), 9–24.
Teece, D.J., 1982. Towards an economic theory of the multiproduct firm. Journal of Economic Behavior and Organization 3 (1), 39–63.
van der Vorst, J.G.A.J., van Dijk, S.J., Beulens, A.J.M., 2001. Supply chain design in the food industry. International Journal of Logistics Management 12 (2), 73–85.
van Donk, D.P., van der Vaart, D.A., 2005. A case of shared resources, uncertainty and supply chain integration in the process industry. International Journal of Production Economics 96 (1), 97–108.
Vokurka, R.J., Davis, R.A., 2000. Focused factories: empirical study of structural and performance differences. Production and Inventory Management Journal 41 (1), 44–55.
Vollmann, T.E., 1996. The Transformation Imperative. Harvard Business School Press, Boston, MA.
Wheelwright, S.C., Bowen, H.K., 1996. The challenge of manufacturing advantage. Production and Operations Management 5 (1), 59–77.
Whetten, D.A., 1989. What constitutes a theoretical contribution? Academy of Management Review 14 (4), 490–495.
Williamson, O.E., 1985. The Economic Institutions of Capitalism. Free Press, New York.
Winter, S.G., Szulanski, G., 2001. Replication as strategy. Organization Science 12 (6), 730–743.
Woodward, J., 1994 [1965]. Industrial Organization: Theory and Practice, second ed. Oxford University Press, London.
Yin, R.K., 1989 [1984]. Case Study Research: Design and Methods. Sage Publications, Thousand Oaks, CA (Revised ed.).
Zaidman, B., 1994. Market vulnerability in the process industries. International Journal of Production Economics 34 (1), 57–64.