INDUSTRIAL MARKETING AND MASS CUSTOMIZATION: CASE STUDIES FROM THE MANUFACTURING INDUSTRY

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ABSTRACT

The guiding issue of the paper is how industrial marketing practices correlate with flexible manufacturing capabilities, a prerequisite of mass customization (MC). The paper describes a few relationships between marketing practices and flexible manufacturing capabilities in a selected company that competes in the manufacturing industry. Its case study qualitatively describes the observed relationships between selected variables of interest. The paper also offers discussion on the possibility to generalize the observed dependencies in an empirical field verification of hypotheses with the use of questionnaire interview and structural equations modeling.

KEYWORDS

Industrial Marketing, Flexible Manufacturing, Manufacturing Industry.

1. INTRODUCTION

For many decades the manufacturing flexibility (MF) concept has been subject to scientific investigation esp. in Productions Management, and more recently in the domain of Operations Management. Its importance in unquestionable: the higher the levels of MF a company reveals, the more reactive it is to market changes, probably the most important company's ability in turbulent, fast changing industrial markets, driven by demands usually derived from the industrial processes of other purchasing or vending companies. The need to measure the extent of MC practices in a company, given the multi level nature of contemporary MF construct, requires that multiple level respondents be surveyed simultaneously during the field research: at the shop-floor and marketing level. To test this approach we have conducted face-to-face interviews with selected respondents in a manufacturing company and presented the results in the form of case study. This is, we believe, a starting point, where further, larger scale research initiatives, become possible for quantification of the obtained preliminary results. This research should use different methodology from the one here applied, as the case study method is applicable to few research units and mostly for exploratory research purposes.

The case study approach has already been used in previous research papers on the mass customization issues at the MCPC 2004 conference (e.g. by Anisič et al. (2004), Rungtusanatham et al. (2004)) and proved its high usefulness on the small scale of research inquiry.

Following this logic, our integrating knowledge and so far qualitative approach have shown some interrelationships in the domains of industrial activity, both manufacturing and marketing, in companies producing cutting tools, and electro-motors. All of them were investigated for the presence, dimensions and extent of MF that makes viable some form of MC practices. In either case, at the higher – marketing level, we have strived to identify the underlying potentials for marketing flexibility – how far the MC practices, in terms of manufacturing flexibility, customer involvement and made-to-order products a company can practice and enhance its marketing responsiveness, given its resource and organizational constraints experienced at the lower – shop-floor level.

A similar integrating approach has been called for in some earlier works of researchers, who had investigated the marketing-manufacturing interface, and noticed this to be the important missing link in the cross-functional integration of a firm (Hausman et al. (2002), Calantone et al. (2002), O'Leary-Kelly et al. (2002)).

The purposes of this paper were therefore the following:

(i) to identify constructs of key importance to MC and marketing, and means of their reliable measurement in operating enterprises,

(ii) to determine the relevance of measures of these constructs to the selected field(s) of industry by interviewing the key informants in these enterprises,

(iii) to determine, whether a company practises MC, and if so, then which form, and

(iv) to assess the possibilities to use large scale modeling techniques that apply these measures to help companies better integrate their marketing with manufacturing.

The paper starts with the presentation of the state of the art in industrial marketing relevant to the marketing activities found in industrial companies of interest. The following section discusses the corresponding MC literature in which defined are the key variables of our research focus: manufacturing flexibility, product modularity, points of customer involvement. This section is followed by the case study of an industrial company, SEW Eurodrive, an assembly plant for electro-motors. The last two sections discuss the possibilities of large scale research with the use of these measures and offer concluding remarks.

2. INDUSTRIAL MARKETING – THE COMPANY'S LINK WITH LOYAL CUSTOMERS

Industrial marketing is an organizational function used to link the company's abilities to provide goods with its abilities to balance out external systems, be they the general environment in the form of opportunities and threats that challenge the company, or the close environment - the challenges from competition or customer demands. We were interested in how MC and MF practices as well as product modularity correlate with customer loyalty. To establish this link we needed first to diagnose if a company practises MC, and then to find out if product modularity is valued by customers in the form of their increased loyalty. Also, we have inquired about the level of value associated with marketing flexibility measured by the acceptance of an individualized orders, wide product range offered and short lead time. Point(s) of customer involvement in the value creation process served as a diagnostic variable indicative of MC practices by the focal company.

2.1 Industrial marketing communication

Typically, the personal means of communications, rather than mass communication, are applied in customer contacts in industrial marketing. Trade shows, exhibition centers as well as personal selling were extensively used for presenting the product features and to persuade its advantages over other competing product solutions. Higher levels of communication with an order placing customer, we have assumed as indicative of a greater level of customer involvement in the production process. Electronic means of communication, if preferred to paper-based ones, would have signaled the case of customers directly interacting with the production system, without the need of intermediation of company's officers.

2.2 Marketing of systemic products

Systemic products are specific industrial products, that are treated by the customers as bundles of real (material) products and intangible services integrated together by the seller or manufacturer.

Backhaus (2003) describes the specific nature of systemic goods as follows: " *With the initial investment in the system the* ***systemic philosophy*** *or* ***systemic architecture*** *becomes grounded, that is derived from so called "system leaders"(base products).* […] *Because the customer outright constrains his possible future buying activities to this architecture, the point of time of the initial investment is of special importance both to the buyer and supplier. In result, for the suppliers, who sell their products in systemic business, the decision making process leading to the initial investment is in the center of their considerations. If the buyer effects his initial investment without considering his following future investments at that moment, from marketing point of view we can speak only about the introduction of single products to the market, but not about systemic business*.".

These goods can be recognized in that the "*[…] perceived process of successive purchases is not seen [by the industrial customer] as simple repeated purchases, but as a sequence of purchases of a range of interrelated product components […]*. These interrelated product components can be a follow-up product installation (service), if the product is e.g. a bespoke software solution, or training of the personnel (service), but it can also be the future add-ins to the already purchased product the consultancy, training and other prospective systemic products, that use the same modular design as the ones already used by the customer. These prospective products can be purchased without the risk of incompatibility with the already possessed product components, and thereby contain links with the "system leader".

2.3 Sources of customer loyalty in systemic products

Our preliminary research hypotheses concerned the sources of customer loyalty among the surveyed enterprises. For different types of products considered, our conjecture was that technical and organizational dimensions of customer binding effects to particular product will be stronger for systemic products (case supported by Weiber et al. (1994) for computer system products). These effects should be weaker for non-systemic industrial products, where mutual interrelation of components does not exist. To these products consumers should be bound primarily by psychological factors, price and other marketing mix factors apart.

Technical binding of customers is reflected in the interchangeability of product components' uses within the system, and not beyond of it. Outward openness of the system weakens the technical binding effect, whether one-way or both way.
Other sources of loyalty in systemic products can be based on the **organizational dimension** factors, provided by learning effects from the product handling, from experience with the product use, organizational formal and informal knowledge of the system, or committed time investments in the system.

The last sources of loyalty to industrial product Weiber & Beinlich (1994) call **psychological factors**, that include **trust factors** and **satisfaction factors**. The first are based on interaction with the company sales and training personnel, their dependability, competence, sincerity and lack of opportunism. Satisfaction factors are derived from the after-sale services, e.g. from the training of the personnel, (on-site) implementation of the (systemic) product, its value for money, advising.

MC should also give an added value, which is perceived by the customer, if he were given an opportunity to directly interact with the manufacturing system and thereby obtain an unique and individualized product. Therefore, MC itself can be seen as a source of customer satisfaction. We have modified the systemic loyalty scale by adding some indicators of satisfaction from MC.

Another source of customer loyalty can be the utility derived from the exchangeable use of systemic product elements: that can be disassembled, mounted and interchangeably used in alternative product designs. This can be achieved either by the customers themselves, if they have knowledge and necessary skills, or by the sales/service personnel in the course of ongoing systemic product implementation. Product modularity can be the source of customer satisfaction and thereby - loyalty. Appropriate items that measure these aspects of customer satisfaction were added to our questionnaires.

3. MANUFACTURING FLEXIBILITY IN MASS CUSTOMIZATION

The concept of MF has evolved from simple isolated measures derived independently from environment in which the manufacturing systems function, to multidimensional and multivariate complex constructs, often hierarchically structured. A survey of available literature in Ramasesh et al. (1991), give an overview of the dimensions of manufacturing flexibility, although none of them was mentioned to be investigated in the MC context.

An example of the recent treatment of the MF construct can be found in Zhang et al. (2003), where dimensions of the MF construct are one level measurement indices, including machine, labor, material, routing, volume and mix flexibilities, whereas Koste et al. (2004) have investigated the matrix form of manufacturing flexibility dimensions: machine, labor, material handling, mix and modification flexibilities, each modified by four possible elements of flexibility: range-number, range-heterogeneity, mobility and uniformity flexibilities. At lower levels of organizational activity, e.g. shop-floor level, certain flexibility capabilities are necessary in order to achieve the required flexibility at the higher levels, e.g. at marketing or strategic level (Koste et al. (1999)). In practical terms, the marketing director can accept an individualized order, when the production director accepts the responsibility for making such order. The consent of the latter is contingent on the machine, labor and other resource capabilities being at the disposal of the production director, otherwise such an individualized offer should not be made and the order not be accepted.

3.1 Manufacturing flexibility dimensions

To identify such MF capabilities, we have borrowed some of the scales from the previous studies conducted in different organizational contexts, and made some modifications, appropriate for the specific product lines manufactured and assembled in our companies.

3.2 Modularity of production

According to Tu et al. (2004), the **modularity-based manufacturing** is *"[…] the application of unit standardization or substitution principles to create modular components and processes that can be configured into a wide range of end products to meet specific customer needs*"(Tu et al. (2004), p. 147). Further they add that it helps achieve MC *"[…] by creating modular components that can be configured into a wide variety of end products and services*." (Tu et al. (2004), p. 148). Modularity based manufacturing is achieved by a set of practices in product design (product modularity), production process design (process modularity), and organizational design (dynamic teaming). Further in the paper we have focused only on the first variable.

Accordingly, Tu et al. (2004), define the **product modularity** as "*[…] the practice of using standardized product modules so they can be easily reassembled/rearranged into different functional forms, or shared across different product lines* " (p. 151).

Modularity differs with the stage of production process: in **fabrication modularity** "*[…] (1) the components are designed to end-user specifications, (2) components are sized for each* [product] *application, (3) components are altered to end-user specifications, (4) component dimensions are changed for each end-user. A different type of modularity* (standard m.) *exists when: (1) products have interchangeable features and options, (2) options can be added to standard products, (3) components are shared across products, (4) features designed around standard base units, (5) products designed around a common core technology*" (Duray et al. (2004), p. 416).

3.3 Points of customer involvement in the production process

The MC literature proliferates in the accounts of customer information used early in the production stages, so as to minimize the risks of misalignment of what the company produces and offers with what the customer actually wanted. Depending on the point of customer involvement, the company can offer a diversified range of products. If customer preferences are included early in the design stages of the production cycle, the product could be highly customized, and the involvement is at the *design/fabrication* stage. If customer preferences are accounted for in the final assembly stages, this type of customization is at the *assembly/use* stage. This differentiation provides an indicator of the degree of customization of manufactured products (Duray et al. (2004), p. 413).

We can therefore infer MC practices from the level of customer involvement in the **design and fabrication stage** of the production process, when (1) customer's requests are uniquely designed into finished products, (2) each customer order is a unique design, (3) customers can specify new product features, (4) each customer order requires the fabrication of unique components, and (5) customers can specify size of the product. Alternatively, such practices can be inferred from the level of customer involvement in the **assembly and use stage** of production process, if (1) customer orders are assembled from components in stock, (2) customers can select features from listings, (3) customer orders are filled from stock and (4) customer can assemble products from components (Duray et al. (2004), p. 416).

To account for the possible level of customer involvement in the production process, we have followed the lines of making the concept of modularity operational, presented in Duray et al. (2000) and Duray (2004), in which the customer can input the information about desired product into the production process either in the design and fabrication, or assembly and use stages.

4. CASE STUDY OF A MANUFACTURING COMPANY

4.1 SEW Eurodrive

SEW Eurodrive, Łódź is a company that belongs to the chain of Eurodrives, in Europe and worldwide. The company serves primarily Polish market, and its assortment covers among others: brake motors, synchronous motors, servo controllers, gear units, asynchronous servomotors, synchronous servomotors.
The company does not have manufacturing facilities, so that the appropriate manufacturing flexibility measures were nonexistent for us to consider. Instead we have investigated the MC concept applied at the assembly level in this company.

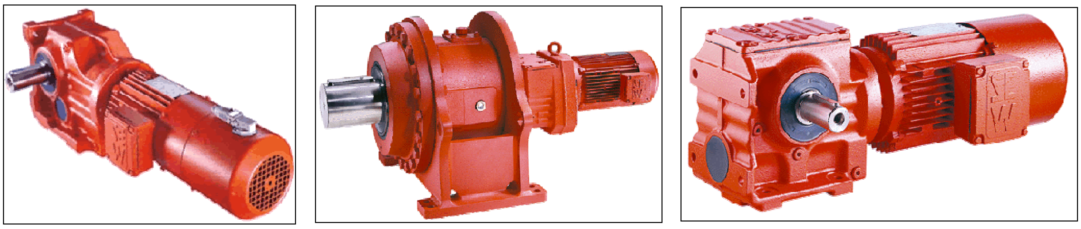

Fig. 1 Examples of products manufactured by SEW Eurodrive (from left to right): asynchronous servomotor, planetary gear unit, and SPIROPLAN® gear unit

4.1.1 Marketing process

The company depends primarily on personal selling techniques. The SEW products are made from modular units and standardized parts. Physical product parts are not, to some extent, unique from the competitors' parts: this feature cannot be the source of loyalty based on technical factors. This feature has its good side though, since it enables the company higher flexibility on the supplier side: it can make purchases of components on the open market, instead of from one source.
To file a successful order, following data must be given:

Table 1

1. Gear unit type R, F, K, W or S	5. Gear unit size
2. Gear unit series R	6. Gear unit size
3. Motor series DR, DT, DV or D	7. Motor size and no. of poles
4. Motor option brake	8. Motor option TF thermistor sensor

Other data can also be required, e.g. mounting position, cable entry, position of terminal box, which altogether increase the required variety of production options.

The company accepts orders filed mainly through fax, and email, although fax was found the most preferred order collection vehicle to other ones. In either case, the data included in orders are manually entered into the expert system, by the SEW workers or by the customer himself, and the final desired products configured in it. There is a possibility to enter orders by specifying the needed product from its parts in the expert system directly (through the dedicated system interface), but few customers routinely do so, making this route relatively infrequently used for order generating purposes as compared to fax and e-mail. We have noted this as an indicator of difficulty on the way of further integration of the external systems with the internal production system.
The dedicated system interface is used by customers mainly for preliminary product configuration, and such usage is not necessarily followed by their order-oriented activities.

The products are not perceived by customers as systemic ones, at least ones that are made of technically bound components. The customers do not have the competence to make amendments to the purchased products, they can be changed only by SEW workers and inside the plant, whenever the customer demands slightly different product specification, from the one he ordered. The old product can be then taken into pieces and new one reassembled, owing to its modular design, within several hours. The company organizes training sessions on how to use purchased products in different applications, and to use other solutions. These services, however, are not seen as bundling of the core products, therefore cannot be the source of customer loyalty.

The sales force is relied upon to win orders and build loyalty among customers – a factor (salesforce) not investigated in depth in our survey. The loyalty of the customers depends mainly on the organisational and psychological factors. Highest scores were found for the sources of customer loyalty based on trust and moderately on satisfaction items. On the other hand, for product modularity, for the possibility of buying fully individualized product and individual configuration of its components high scores were found as well.

The company does not accept orders for completely new products (not decomposable to available components). Such orders, if occur, are outsourced either to the parent company in Germany, or to one of its subsidiaries worldwide. The MC occurs therefore only in the assembly stage (Duray (2004), Duray et al. (2000)).

4.1.2 Assembly process

The most of the orders were found to be ATO (assembled-to-order), practically 100%. Insufficient assembling capacity was overcome mainly by outsourcing the orders to parent/daughter production plants abroad.

Design of the product parts is complex, as they can be put together in about 40m possible optional compositions. The products have a modular design: each function required by its components is pre-specified in the company's expert system, that tells the assembling workers which parts match with one another and make up the required product unit. The system is at the heart of the operating company and has been built owing to its 75 year experience and expertise in the field. The specified component parts are in this way further demanded and collected from the central store, or in certain cases, can be demanded by first class air delivery from the nearest production plant. Interestingly, the assembly plant can itself select own suppliers independently from the original SEW production plants, until the ordered and supplied parts conform to the strict company's requirements.

Because of the modular design of all of the products, their number of parts necessary for production, can be minimized. For a given product group, e.g. asynchronous servomotor, there is a synthetic representative (the base product), from which the specific design is derived by entering dimensions, shaft diameters, torque, power etc. This indicates practices of product modularity (Tu et al. (2004)).

The labor flexibility has been found low, mainly due to low-skilled workers used in the assembly. All workers were said to be able to replace at least one colleague and one additional machine, but not much more. Assembly volume flexibility and mix flexibility scores were found at maximum: the plant is able to serve both unit volumes, as well as long ones (in hundreds) and switch frequently to very different product designs. The main constraint is the limited plant's capacity adjusted to the market size it serves. Therefore we conclude that in the dimensions mentioned above the company has certain assembly flexibilities (Zhang et al. (2003)).

5. THE POSSIBILITY TO USE STRUCTURAL EQUATIONS MODELING

The application of structural equations modeling (SEM) (Jöreskog & Sörbom, (2004), Bollen (1989), Jöreskog et al. (2001)) has a long tradition in the disciplines of marketing and operations management. Its usefulness stems from the incorporation of structural and measurement variables in empirically tested models. In fact the structural model and the measurement model are two complementary ingredients of SEM in its general form. The use of this technique is also natural to the operations, marketing and management sciences, where researchers are continuously challenged with the validity assessment of structures of objectives, and their operationalizations - measurable indices. Multiple forms in which SEM can be used, and in which is actually used in numerous examples of operations management and marketing literature[1], from confirmatory factor analysis to multiple regression models, justify its applicability to investigate the nature of the interface between marketing and manufacturing.

The first and predominant condition however, is to work out valid and reliable scales of the measured constructs and to have sufficiently large base of firms practicing some form of MC. This base can be created with the use of questionnaires adopted from the available literature and adapted to our particular needs. The scales should also satisfy additional condition, in that they should comprise possibly the fullest scope of the MC practices, thus approaching the completeness criterion of the MC concept. These practices also should not overlap on one another. If such a clear picture is created, the accompanying instrument will help us diagnose, if a randomly selected company practices, and if so, then what forms, of MC.

Recent advances in latent growth modeling (Bollen et al. (2004)), also enable the observations of time-dependent interrelations (e.g. in the form of influences of processes) among selected variables in the focal research units (panel studies). Cross-sectional studies that dominate in most contemporary research lack this process-oriented dimension, and could have been extended longitudinally to process models of MC practices.

The conceptual framework here proposed is quite versatile and can bring valuable insights to both industrial marketing and operations management literature. We fall in line with the recommendations of Piller et al. (2004), p.443, about the need of empirical evaluation of MC and its constituent concepts.

6. CONCLUSIONS

6.1 General observations

We have selected the constructs of key importance to the identification of MC practices and used them to diagnose a company, whether it practises MC and to which extent. We have not used the instruments of high power of resolution: rather to illustrate the approach it was lowered to 2-3 points on the scale (from 7-point scales originally available in the subject literature). Being so unspecific helped us to cover much extended spectrum of variables, than the original scales were able to.

The company has operated in relatively stable market conditions, which make it easy to build fairly reliable market forecasts, that reduce operations and order volume uncertainties. This constrains the external pressure on the company to further enhance MC capabilities. As it was already raised in the subject literature, the environmental turbulence and decision uncertainty are positively correlated with company's flexibility abilities (Zhang et al. (2003), p. 173, Chen et al. (1992), p. 436-441, Tu et al. (2004), p. 148), and with marketing/manufacturing integration (O'Leary-Kelly et al. (2002), p. 235).

The relevance of the measures to the field, in which our company has operated, was found satisfactory (objective ii) in the introductory section). A difficulty emerged in the case of the sole assembling activity of the company, which narrowed the scope of our survey . We have found support for our initial suppositions on the differences in sources of customer loyalty dependent on the type of product offered. Where no systemic goods were offered, customers were loyal mainly through psychological and organizational factors to the focal company.

The scope of our inquiry was purposely wide, mainly owed to the proximity of the enterprise included in our analysis. For an attempt to quantify the results, or for model building purposes on a larger scale than the one undertaken, a much narrower focus should be considered.

We have tried to identify with the use of scales the existence and forms of MC practices, and to relate them to the existence and the sources of customer loyalty, depended on the systemic or ordinary industrial

[1] An account of the literature is omitted here because of limited capacity of this paper.

products offered by a company. Given the low number of firms we have surveyed, and the generality of instruments used, our attempts are promising.

One of the weaknesses was to ask manufacturer officers for the possible customer reactions, instead of the customers themselves. We are aware of this deficiency of our approach, and accepted it because of the time constraints and availability of corporate respondents instead of their customer counterparts.

Another one is that our results are not representative. We have treated them as an illustration of our approach, which we intend to continue and propose to undertake on a much wider scale.

6.2 Possible future research agenda

The directions for further research in the marketing-manufacturing interface in the MC context are therefore following: first, the reliable scales measuring the existence of MC practices (industry-specificity must be minimized) through the appropriate application of concepts and measures must be grounded. This has been the focus of this paper (objective i) in the introductory section).

Second, the research base of units (the corporate firms), that practise MC on the territory of Poland should be identified prior to the launch of large scale research studies. This can be done with the already available instruments.

Third, the five-level layered structure of manufacturing flexibility (Koste et al. (1999)) should be verified (and simplified, if possible), to enable further modeling with the use of SEM. Empirical models should give grounds for cross-country comparisons across industries.

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