# Unexpected emergence of a Community of Practice when implementing Product Configuration Systems

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**ABSTRACT**

Customers are increasingly demanding customised products tailored to their specific needs, and many firms are faced with the challenge of delivering such goods. Over time the number of product variants increases with consequences for sales staff, as they must know an increasingly larger number of products. Sales staff copes by specializing in particular products and becomes increasingly fragmented.

Product configuration systems (PCS) are a technology, which is designed to manage product variety by automating parts of the work performed by sales staff. PCS is also seen by management as a tool to lower the skill required for acting as a sales person through division of labour, narrowing the job and automating intellectual tasks.

Consequently, when analysing PCS implementations, we expected to observe lowered job satisfaction and more repetitive work. This expectation has not been met, quite the contrary. Sales staff now has higher job satisfaction, because the PCS has provided a common platform on which a community of practice has emerged. Automation has removed the technical aspects of the job, which interested engineers and not sales staff, who may now focus on what they perceive to be their real job: Providing a good sales experience and good service.

KEYWORDS: product configuration system, community of practice, expert system, sales staff, work design, deskilling,

## 1 Introduction

Delivering customized products is increasingly becoming an important issue for firms, as customers demand products that are tailored to their specific needs. This trend is dubbed "mass customization" and is a production philosophy, which tries to capture the best from mass production and 'one-of-a-kind' production. Mass customization implies that products are produced at near mass production cost and at the same time allowing the customer to be involved in the specification of the product (Duray et al. 2000). This implies that an unlimited number of variants do not constitute mass customization, as the customer is not involved in specifying the product. The idea of mass customization is little over 25 years old, beginning with Davis (1987), and it has been researched extensively since, see Silveira et al. (2000) for a literature review on mass customization.

One of the technologies for delivering customized products is a product configuration system (PCS). A product configuration system is essentially a model of the product to be configured, which contains relevant information and knowledge about the product. A product model of a bicycle would contain information about the available models and constraints

about how the models can be customized. For instance the model contain constraints about what size of colour, handle, gear, number of spokes in a wheel, frames that are allowed to be used with a particular type of wheel, etc. All sorts of constraints between the various parts can be entered into the model allowing a customer to completely customize his product. A customer may want a bicycle with racing saddle, 21 speed gears but a reinforced set of wheels to accommodate the added weight of his son on the child seat. Through a user-interface sales staff interacts with the model and thereby choose (configure) the desired components for the product.

PCS, however, is a technology for automating the work of sales staff, and this paper presents results from a study on the effects of PCS in 12 Danish firms. Before the study it was expected that PCS would negatively impact the quality of work for sales staff due to deskilling, but as we shall see the effect was quite the contrary.

In section 2 we describe PCS in detail, and in section 3 we outline the expected consequences of PCS. Section 4 we briefly outline the methodology and present the unexpected empirical findings exemplified in a case. In section 6 we analyse the findings and attempt to explain the reason for the unexpected findings from a communities of practice perspective.

## 2 Product Configuration Systems

Product configuration systems can be designed with various levels of detail depending on the intended purpose, and we typically distinguish between 1) a quotation configuration system and 2) a production configuration system. A quotation configuration system is a PCS designed to produce a quote for a particular type of projects. Most often quotation configuration systems are found in heavy engineering companies, where the cost of producing a quote is very costly and a significant proportion of the quote contain the development of a product variant not previously developed. In the opposite end of the scale we find the production configuration system, which has complete knowledge regarding the product and its components down to the last spacer. Such systems are often linked to the company ERP system allowing a configured product to be directly produced. The PCS then feed a configuration to the ERP systems thus allowing for automation in the process of creating specifications such as bill of material, routing, inventory etc.

The knowledge contained in a PCS can be represented in basically two ways 1) Structural and 2) Functional. A structural representation is when the PCS operator, in this case sales staff, can choose individual components and the PCS only serves to validate a configuration. In this situation sales staff must be knowledgeable about the product in order to transform a customer's functional requirements into a product. A functional representation implies that the PCS is also to transform functional requirements into product specifications. For instance if one were to configure a cement factory, a few of the important functional characteristics are production capacity pr. day, composition of raw material and elevation above sea level. With just this information it is possible to generate a reasonably precise set of specifications for a cement factory. The sales staff in this situation can be rather unskilled, as only the ability to interact with a computer and ask the right questions are required (see Figure 1 for an example of a structural PCS).

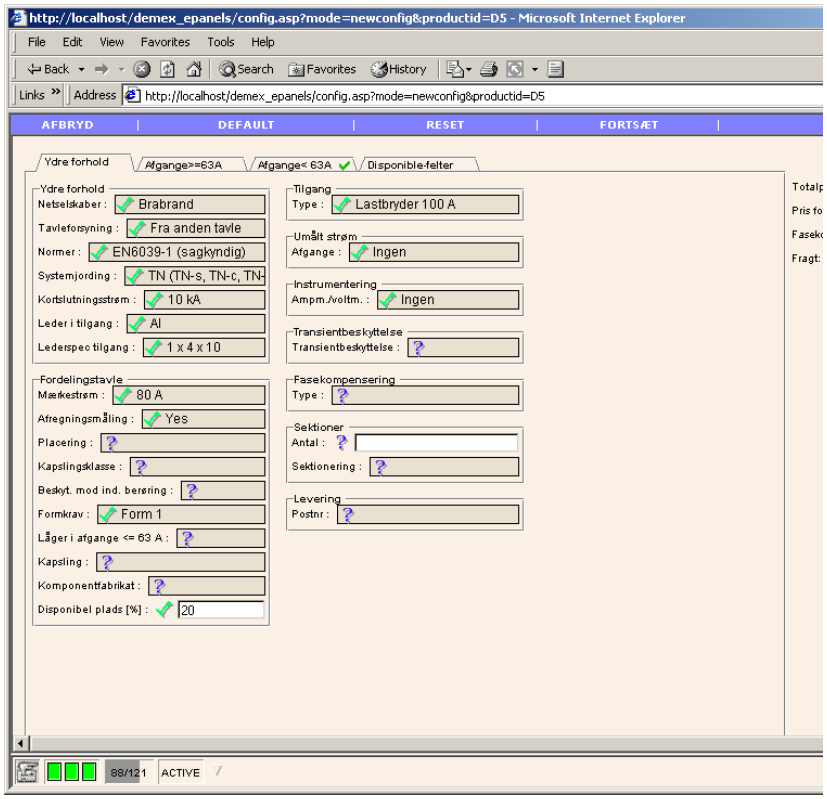


**Figure 1: Example of a PCS with structural knowledge representation when designing electric distribution boards. The user inputs customer preferences, which are validated in real-time.**

Naturally the distinction between functional and structural knowledge representation is more of a spectrum with two extremes, and most product configuration systems will contain some degree of functional knowledge.

### 2.1.1 PCS in the business processes

A firm can be characterised as consisting of three distinct processes: 1) Product development, 2) Order handling and 3) Manufacturing as illustrated in Figure 2. We limit out focus to the development and order handling process and the relation in between.

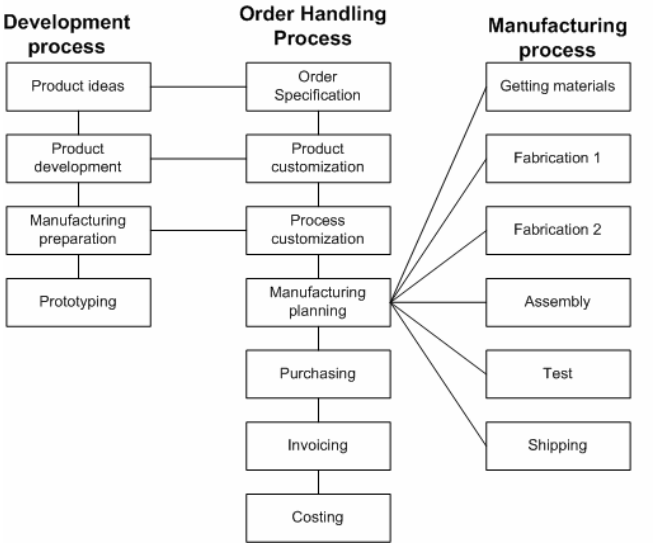


**Figure 2: The process of a firm (Hansen 2003, from Barfod & Hvolby 1997).**

Without PCS a customer enters in the top of the order handling process by contacting the firm. Sales personal and the customer enter into a dialogue with the intent of producing a product specification. If the product specification is outside normal parameters, the product has to be modified to fit the customer's wishes. This is a costly procedure, as the sales person has to contact R&D, production, sales support and/or perhaps other departments such as product management, who will make the proper adjustments. Regardless of how small these modifications are, they have to follow the process of making product modifications. This includes making new drawings, bill of material and specifying the modified production process. All of these activities include approximations by the involved staff as they try, to the best of their abilities, to match the customers need to a specific product. Often the process is a reoccurring iteration between customer, sales, R&D and production. This is complex process, where responsibility is changed back and forth between the involved departments. All too often required information to specify the product was not gathered in the first place resulting in time consuming follow-up questions, which could and should have been avoided. The questions do consume a whole lot of time, but they halt the process of producing a specification and so do all the iterations between development, production etc.

The purpose of a PCS is to automate a substantial amount of these iterations by creating a system that allows a sales person to specify a product in dialogue with the customer. If the desired product can be specified by use of the product configuration system, all the usual back and forth between departments is eliminated and the specified product can be produced, when the customer has accepted the offer made by the firm.

A product configuration system extends the range of standard products and makes it possible to configure these at a low marginal cost. Without PCS, limited experience of sales people result in a limited product variation, as they will only offer the limited number of products, with which they are familiar. With PCS it is possible to support the actual sales process by allowing the PCS to make choices regarding configuration based on functional requirements. For instance, if one was to configure a truck, and the customer required a specific capacity, the PCS would allow only configurations, which satisfy the capacity requirement. Naturally a product configuration system does not support arbitrary configurations, and the firm must choose which products and components to enter into the model. The possible number of configurations offered by the model becomes a subset of the configurations offered by the company, as illustrated in Figure 3.

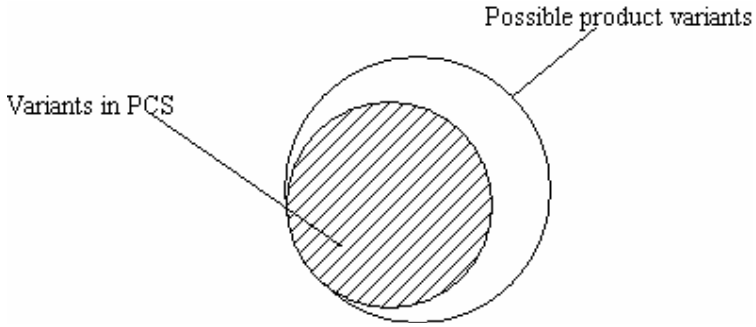


**Figure 3: Possible product variants in a product configuration system are a subset of all product variants offered by the company.**

## 3 Expected consequences of PCS

As product configuration systems are essentially a tool for automating product configuration in the order handling process, it was expected to have negative consequences for sales staff. When automation occurs the consequence is most often that staff will be left with a job with little variation PCS automate some of the knowledge work typically done by sales staff, and in the same process social interaction with other functional groups in the firm is greatly reduced or perhaps even eliminated. It is no longer necessary to confer with R&D to ensure that a particular product can be produced, as the PCS in many instances will be able to validate the product configuration in question.

Firms who implement product configuration systems typically sell complex products with large product variation. This is almost a tautology, as a product configuration system has little use, if the product is simple and sold in only a few different variants. Complex products and large number of variants has implications for the sales staff that is to translate costumer requirements into product specifications. Sales staff must indeed be knowledgeable about the products that they sell and long time experience at a technical level is often required to configure the product correctly. At Demex Electric, a Danish firm producing electric distribution boards, sales staff typically came from production in order to have the required experience specify a product.

Thus it was the hypothesis that sales staff would suffer from deskilling and to a large extent be relegated to just collecting information with little interaction with other departments and consequently a significantly lowered job satisfaction.

## 4 Methodology

This research was conducted in the "The Product Models, Economy, Technology, and Organization Project" (PETO, which was formed with the intention of studying the process and effects of implementing product configuration systems. Most of the literature on product configuration systems deals with technical issues, and only a few recent papers have taken economic and organizational issues (Forza and Salvador 2000 & 2001) into consideration.

Given the fact that no other interdisciplinary studies of product configuration systems, to our knowledge, have been conducted a qualitative and yet hypothetically deductive approach was selected. A questionnaire was developed, which was intended to capture information about the situation before and after PCS as well as details of the development at implementation processes.

The specification process, which is within the order handling process (Figure 2) was drawn in two different process diagrams allowing for easy comparison of the before and after situation. Questions were designed to be both closed and open ended questions, in the latter case leading respondents to elaborate and explain certain positions (Jacobsen 1996:111-113). The open ended questions were used deliberately to allow some degree of exploration in the interview process, and respondents were allowed to pursue their line of thought before being interrupted and directed towards the question. Concluding questions were used to confirm and summarize the meaning of open ended questions.

A number of 20 firms were selected, and 12 firms agreed to participate in the study. The firms were selected from a larger pool of 43 firms with affiliation to the Danish Association for Product Modelling. In order to gain a broad understanding of the impact of PCS the firms were asked to provide respondents in the following categories: 1) Sponsor, 2) Technician/programmer, 3) User, and 4) The project leader. These four roles were chosen, as they were expected to represent the most significant roles in a configuration project (Riis, 2003).

The interviews were intended to be conducted with a single respondent at a time, allowing for a detailed interview with personal opinions being expressed. A basic level of trust was established by presenting respondents with a written and signed statement of confidentiality. In some cases, however, it was not possible to conduct individual interviews, and a group interview was the only option. It must be expected that these interviews to some degree fail to uncover problems with the product configuration system and the development and implementation processes, as group interviews have a tendency of expressing consensus among the respondents. A minimum of two investigators were present in all interviews to ensure the multiple investigators effect (Eisenhardt 1989:538). The combination of multiple investigators and open ended questions was found to be very powerful, as investigators deliberately keep silent to pressure respondents into answering. On many occasions this was the deciding factor for getting a meaningful answer. The interviews were taped for later transcription and this was followed by a procedure for extracting the meaning of the interviews (Kvale 1994:189).

## 5 Empirical Observations

While the PETO project has conducted interviews in 12 Danish firms, we shall limit our selves to focus on a single firm in this paper. The firm will remain anonymous and be referred to as Macron Energy. In the PETO project firms are labelled A through L, see Edwards & Riis 2004 and Edwards & Pedersen 2004 for a description of these firms and firm I is Macron Energy.

The empirical evidence presented here is the result of two interviews with two employees in Macron Energy, who were interviewed separately. Respondent 1, interviewed for 2:20 hrs, was an engineer responsible for building the product configuration system and respondent 2, interviewed for 1:30 hrs, was a sales assistant.

Macron Energy implemented PCS as an integrated part of a new ERP system and needed PCS specifically to establish a clear overview of the product range. Macron Energy had a history of producing tailor made products for individual clients, and produces a product, which is a productive resource for the customer and the yield of this productive resource is directly related to the elevation of a central component above ground. Customers naturally demanded the highest possible version available and often got what they wanted, which sometimes resulted in cost overruns, as production cost dot not correlate with height.

The organisation in Macron Energy has not changed since implementing PCS, and the sales department is organised with a sales manager and a sales assistant responsible for a particular geographical region. The reason for dividing into geographical areas is tied to the nature of the product that is often subject to various degrees of government subsidy and detailed knowledge of the region such as the availability of heavy construction equipment etc is important. When an order is received, a project is initiated with the purpose of coordinating all activities related to delivering the order. Depending on the size of the order, the sales manager is responsible for the project or in larger projects an internal project department becomes leader of the project.

The sales department is primarily responsible for specifying the product to a degree, where it can be produced and delivered. Before implementing PCS the specification process was to a large extent a back and forth between the customer, sales manager, sales assistant, product management and sometimes R&D. Product management is a sort of intermediary department between sales and R&D, which has extensive knowledge regarding products and how they might be customized. Basically the customer would make a preliminary specification together with the sales manager, who would submit the preliminary specification to the sales assistant. The sales assistant would send the preliminary specification to Product

Management, which would analyse the specification and most often ask for further details. If the details are not available the sales assistant would then contact either the sales manager or the customer directly to clarify matters. This process could often go through a number of iterations, and occasionally R&D would have to be included in the process. Despite of this complex process it was often seen that little but none the less important details, specific to a particular region such as specific warning lights were forgotten or remembered very late in the process. These little details could halt the project and sometimes inflict costs on Macron Energy, as the sales could not be concluded before they were fixed.

Following the implementation of PCS the process has changed somewhat, as the PCS now assists the sales assistant, when specifying the product. The product configuration system has been designed to help the assistant by asking a number of questions and the system will then make the proper product specification down to parts list and routing table. The sales manager still contacts the sales assistant, who enters the configuration into the PCS. The difference being that the sales assistant by using the PCS is now able to validate the configuration in real time. Missing information will be detected immediately and the sales assistant can contact the sales manager or the customer directly for clarification. The little details such as the mentioned warning lights has been entered into the PCS and the sales assistant can now choose between different alternatives. The alternatives are presented as a function of the country, where the product is going to be placed and reflects the national law.

If for some reason the desired product is not contained in the system, the preliminary specification must go through Product Management and perhaps R&D. The difference from before PCS is that now the required information is already entered into the system making it much easier for Product Management and R&D to perform their tasks.

Sales assistants are very pleased with the new system. It provides much better support for the assistants, and the system helps the assistant get the correct information in the first encounter. It often happens that the customer does not have all the information ready and will need time to produce the required information. Here the PCS support the process by making it visible, what information is needed before the product is completely specified. With this system it is now possible for assistants to cover for each other, as all orders are handled in a similar way in the PCS. This in particular is a source of much satisfaction, as sales assistants can focus on providing good service for the customers. See also Møldrup and Møller (2004) for an overview of the advantages and disadvantages provided by PCS in relations to sales representatives.

## 6 Analysis and Discussion

It was anticipated that product configuration systems would lead to lower job satisfaction, which was a consequence of deskilling and fewer interactions with other departments in the firm. What we have seen in the case of Macron Energy and indeed all of the other cases analysed in our project, are that PCS in certain situations increase job satisfaction. Particularly in the customer contact situation, PCS appear to make a positive difference as it provide detailed support for the sales person. In this section, however, we focus on analysing and explaining the unexpected observations from Macron Energy.

We have heard several times in the interview that sales assistants were very pleased with the new system, and much of this was because they could now work together as a team. This team, however, is a team which are not working directly together, as they are tied to different sales managers and geographical areas, but they do their job in much the same way using a common set of tools. Naturally there are idiosyncrasies between assistants, but it is possible for one assistant to login on a colleague's computer and use the system to service a customer.

We propose that the new PCS to some degree supported by a new ERP system has changed work practice in the sales department. This change in practice has created an environment in which a community of practice can emerge. The essential change is the new work practice, which dictates a common way of working.

A community of practice (CoP) is defined as a group of people, who share common practices, interests and aims (Brown & Duguid 1991). A CoP is a group of people who collaborate on a shared task (Brown & Grey 1995). It is a group of people in a firm working across organisational boundaries and team structures to do the job and may even transcend the company (Wenger & Snyder 2000). Communities of practice are bound to personal informal relationships revolving around a practice and this is often related to participants' interest in learning (Snyder, 1997).

With the old system it was not possible for sales assistants to share a work practice. The old system was tied to idiosyncratic work practices, where each sales assistant had his or her personal system for storing data, selecting which data to store on the individual customers and projects. While the old system was fine for maintaining a working relationship between the sales managers working in the field, it was not conductive for creating a shared work practice within the group of sales assistants. It is our feeling that focal point for sales assistants, was the sales manager who must be assisted in calculating prices, liaison with other departments, and entering the agreed product specifications in the old system. The relationship has set the framework for the old working practice. The old system in reality only functioned as an interface to the production and thus did not contain other information apart from bill of materials and routing to some extent.

The new system based on PCS and ERP constitute an environment in which employees may actually work together. The new system is now the interface to production but more importantly product configuration system and project management. The system is designed to support every process, which lie between the initial customer contact and final delivery of the product. As such the system has become *the* interface between sales assistant and all other departments of Macron Energy. It has now become close to impossible to service a customer without using the new system. PCS has a central role here, as all products must be specified with this system and large proportions of the sales assistants work is using the PCS, as the customer makes up his mind about the final configuration of the product. Given this common interface and project standardization, sales assistants are able to service each others customers without causing the customer any inconvenience. In fact, sales assistants attribute the benefits of the new system to being able to provide a good service to customers.

The new system thus facilitates a shared practice, and as sales assistants helps each other mutual learning begin to take place. The learning effect is rooted in discussions about how to use the new system, how to handle a customer, and why a particular configuration was chosen for that very customer. As the rest of the company relies strongly on the accuracy of the configurations, the sales assistants are also given more responsibility, which is most appreciated. Also a gradually bigger insight into technical issues and overview of product variants is appreciated, as this knowledge assures sales assistants in sales meetings and when configuring products based on the specifications given by sales managers. The emerged CoP is further strengthened as the sales representatives are perceived as important actors in enhancing the new system and finding bugs. Five of the sales assistants serve as super users, who educate and act as focal points in discussions about improvements and bugs. This further enhances the emerging CoP, as the group receives credibility from the surrounding organisation as well as it provides a legitimate reason for sales assistants to meet and discuss the new system and work practices.

## 7 Conclusion

In this paper we have reported findings from a study of one firm having implemented PCS as part of a larger ERP system. The findings reported here is part of a larger study of 12 Danish firms and their experiences with implementing PCS. It was expected that PCS would result in deskilling and reduced job satisfaction. Our findings points to quite the contrary.

In the study of Macron Energy it has been shown that the old system did not facilitate a common work practice among sales assistants, which was tied exclusively to a sales manager.

The new system supports the actual practice and makes sales assistants work through the system and not adopt idiosyncratic practices. As such a shared practice has emerged allowing sales assistants to support each other and this has constituted a community of practice. A number of the sales assistants serve as super users, which teach other sales assistants in using the PCS. This provides a legitimate forum for discussing and improving the practice in which they are all part.

The findings presented in this paper do not appear specific to just Macron Energy, and we have experienced similar observation in the eleven other firms of our study. The predominant effect on sales assistants are a feeling of being able to serve the customers better, as the PCS provide a clear overview of the possible product configurations. Sales assistants can now focus more on providing a good solution for the customer. The PCS is an important tool here as it provides an easily accessible knowledge base, which makes sales assistants appear knowledgeable, competent and fast responding – as long as the customer stay within the framework of the PCS. Still if the customer falls outside the PCS, the sales assistant will appear professional, as it can instantly be determined that the product is now outside the realm of the sales assistant, and Product Management or R&D must take over from here.

While our expectations, to say the least, was not met this research has shed light on the effects of well designed support tools such as product configuration systems. Why was our expectations not met? Basically we suffered from an imperialistic view of what is a good job and one element of this was technical competence, which we as engineers naturally view as important. Although the sales assistants appreciate that they gradually get to know more about the products, the sales assistants in this case are not engineers and do not prefer technology over being provided with a tool, which helps them transform customer needs into a product. Indeed this is what a product configuration system does and this has resulted in the unexpected emergence of a community of practice.

## 8 Acknowledgement

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