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Configure-to-order (CTO) Product Development Process The Basis for True Customization

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Abstract

The fundamental characteristics of a configure-to-order (CTO) product is illustrated in this research with the view to reduce the time to market and offering more product variants with highest customer satisfaction. In this paper, we have formulated various aspects of configuration process in terms of customer view, designer view and production process view. All these three views are demonstrated separately and integrated within a case product for achieving true customization. The overall outcomes from the case example are critically analyzed in terms of product individualization that offers benign customer value. This research is concluded with several specific future research directions.

Keywords
Mass customization, innovation management, configuration process, order decoupling point (ODP), product individualization

1. Introduction and Motivation
In today's global village customers are much more selective than ever. This creates continuous pressure on manufacturing firms to develop individualized product. In order to suppress such a situation, firms are approaching for the product development strategy termed as configure-to-order (CTO). This CTO approach triggers the true customization process in the business community. True customization can be defined as the product individualization process, where individual customer could participate in the designing process of the desired product from the very early of the developmental processes. This concept differs from mass customization phenomenon, where product features or components are mostly predesigned from where customers make the selection according to their specifications. Although in mass customization certain parts or components also can be designed for individual customers.

The increasing level of product differentiation can be managed successfully through applying CTO strategy. This approach also ensures to meet the functional requirements of diverse customer needs and subsequently the fulfilment of various design parameters of the customized products. The configuration process is generally considered as a way of interacting with the designers and the prospective customers in order to fulfilling specific requirements [1]. Customers' demands or requirements are usually collected through various forms of market research. From the collected data or information, designers are proceed for the concept of the new product or re-design or re-engineering the existing product to match with customers expectations. In case of new product development, designers are also concentrating to make the components as common as possible with the view to achieving economies of scale.

In CTO approach, customers' emotions, aspirations or desires for a product are collected through market research and accommodated within the software tool known as 'configurator'. This can be termed as customer-oriented configurator. When the customers' desires for the specific product are collected the next available step is to make the price quotations in respect to functional features and high level bill of materials (BOM). All the necessary information or data is accommodated within a sales configurator. The detailed design and required engineering for all the components are performed through product configuration process and the data is stored within product configurator [2]. In the final stage of the configuration process, required routing and scheduling are done in order to manufacture the predesigned parts or components. The required resources are planned optimally to fabricate the customized components. The complete data related to component manufacturing process is stored within the production configurator. The procedural steps of the generic configuration process are presented in Figure 1.

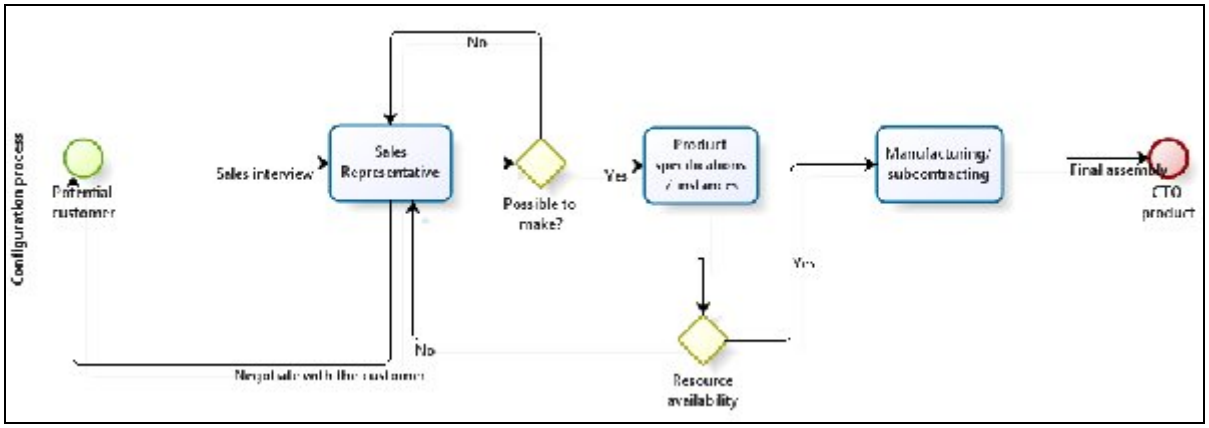

Figure 1: The procedural steps of the configuration process

2. Literature Review

The generic concepts of configuration process are discussed by many researchers and it is nowadays considered as an important step for developing true customized product [3, 4, 5]. The configuration process is basically a combination of customers, sales personnel, designers and process engineers where the main objective is to develop customized product or services. This process also ensures quick response to market needs while achieving high quality and improved product development efficiency [6]. Due to product differentiation, manufacturing firms are facing with the complexities of frequent design changes and operational processes [7]. This complexity can be managed comfortably through configuration process where various design features are accommodated within the configurator. These storage design features facilitate the product proliferation and satisfies the potential customers.

Configuration process initializes product variety management, especially for the development of complex products with low volume and high variety. This process basically propose 'design by customers' approach where firms communicate with their customers about what they can offer, to find out customer needs, to assist customers in decision making and negotiate about their choice of products [8]. The CTO product development strategy help customers to define their needs, visualize their product options and assess available alternatives [9]. The configuration software (configurator) considers the production relevant interdependencies and basically implement to the business to consumer context. The implementation of different configurators reduces the tasks for sales personnel, designers and process engineers and enhances the formation of product platform from which stream of product derivatives can be developed efficiently and economically [10, 11].

Different available configurators namely sales configurator, product configurator, production configuration etc empowers the sales promotion and after sales services with customer satisfactions. Sales configurator used for capturing the price quotation and delivery deadline while product configurator integrates the information related to design and engineering of the customized product [12, 13]. In the production configurator generic operational processes are defined in terms of resource management and production routing [14]. In CTO strategy all the available configurators might be implemented for architectural assessment of the intended product and dimensioning the various aspects of design, engineering and sales. The basic needs for customers order fulfilling process are analyzed by the configuration process in order to achieve the competitive advantages in business network [15, 16,

17]. The mapping among different configuration process describes the primitive routes of product customization process as a whole.

3. Description of Different Configurator

The basic requirement for a configuration process is to develop custom built product or services. In order to fulfil such requirement manufacturing firms need to integrate all the component of the configuration processes. This integration makes the necessary bonding among the customer, designer and process engineer. The required integration exhibits the interdependencies among various configurators as displayed in Figure 2. From Figure 2, it is observed that product customization starts from the customer oriented configurator which is followed by product configurator and production configurator. All these three configurators are the essential need to develop the final customized product. The detailed descriptions of these three configurators are discussed in the following paragraphs.

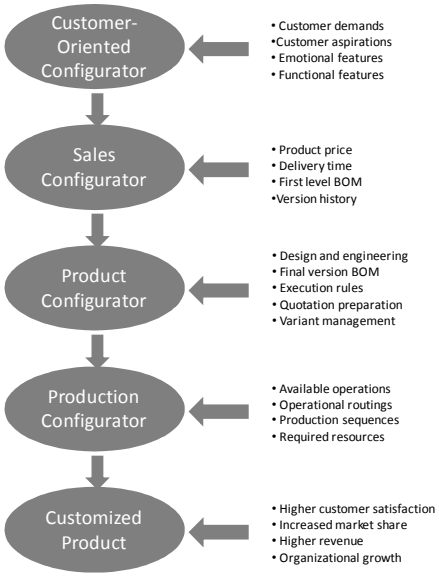

Figure 2: Generic information flow among configuration processes

3.1 Customer Oriented Configurator

The customer-oriented configurator mainly deals with the concept of customer requirements in terms of emotional and functional features in the expected products or services. Both the features are resulted with the aesthetic and aspiration perspectives for the potential customers inside the manufacturing community. The interrelationship among the customers' requirements can be modelled as in Figure 3, from which the specific approaches of product customization are evolved. From Figure 3, it is noticeable that product customization process should be started from three angles of customer preferences as aspiration, emotion and aesthetic. All these three requirements are diluted within the customer-oriented configurator from which customers are interfaced with the designing process of the intended product. This configurator is basically examined how the customer needs and requirements information can be integrated into the product development process.

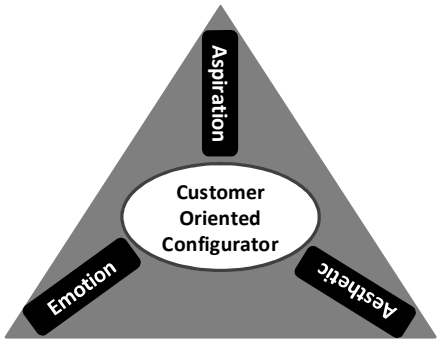

Figure 3: Generic requirements for customer oriented configurator

In this configurator, three customization features (emotional, aspiration and aesthetic) are collected through market surveys such as face to face interviews, written and/or online, arranged workshops etc. The collected data for the expected features are accommodated within the configurator, from which potential customer could choose his/her choice of preference(s) of the expected product. All the features are taken into consideration by the product designers in order to design the necessary components or parts that fulfill the customer's needs. During the designing process various components or parts are designed and accommodated within the configurator in a hierarchical structure. Individual requirement specifications are connected for physical design structure via the predefined rules within the configurator.

3.2 Sales Configurator

The sales configurator provides the necessary mapping between the customer-oriented configurator and the product configurator. The features of the intended product as selected by the potential customer within the customer-oriented configurator are taken into consideration for the necessary input in the sales configurator. This configurator creates the first level of BOM in order to fulfilling the customer's emotions, aspirations and aesthetic views of the desired product. During BOM creation it also maintains the version history of various product alternatives. This product alternative is finalized by the designer according to customer preferences. There exist multiple versions of the same component or part within the configurator with the views to bringing varieties among product alternatives. The general view of the sales configurator is presented in Figure 4.

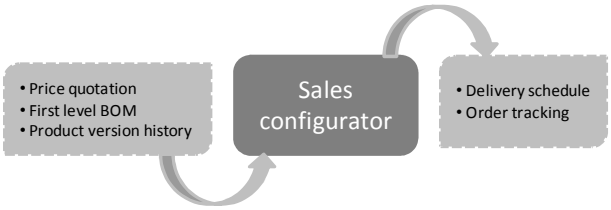

Figure 4: General view of a sales configurator

In sales configurator the price level of each product alternatives are also mentioned from where customer could choose his/her product of choice considering the price of the product. This price level is varied immediately according to the changes of features of the desired product. Along with the product price this configurator also displays the expected delivery time of the product. Based on the price and delivery time it generates the required quotation for the customer which facilitates the component or product selection process as a whole. This sales configurator initiates the sales personnel to maintain the order delivery process and keeping the necessary tracking of the production process. It often maintains the price comparison of the competitor products, where the price of the host company displays the lowest one. This comparative price level promotes the overall sales of the company by attracting the respective customers with offering lower price.

3.3 Product Configurator

The product configurator is basically a list of component hierarchy from which the developer gets necessary guidelines to develop an end product. On the basis of product customization, this configurator provides a general

parametric of product structure that creates a representation for a variety of products. Various parametric features of a custom built product such as component name, component hierarchy, final version of the BOM, etc provide the basic architecture of the product configurator. The general needs and the influential factors of this configurator are displayed in Figure 5. It is noticed from Figure 5 that product configurator needs various pre-defined measures such as confirmed sales order, price quotation, execution rules, item coding etc before developing its architecture.

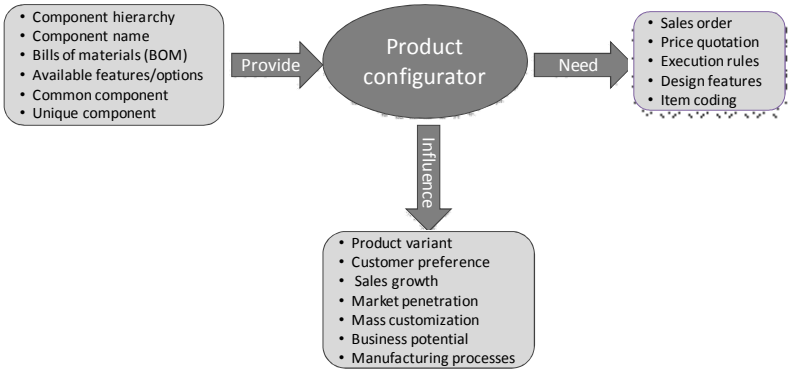

Figure 5: Basic approach for product configurator

This configurator accommodates various components list and functional features such as size, capacity, color, etc of an end product from which customers could select their essential features in order to get the expected functionality of their expected products. A product configurator should be capable of recording the sequences in which product features were chosen. It influences the overall sales growth, market penetration, manufacturing processes and business potential through providing product variant, higher customer satisfaction, etc. Product configurator makes the required integration between the upstream sales configurator and the downstream production configurator. This integration process facilitates the planning of components design and their consequent fabrication processes with the view to reduced product development lead time and increased production rate.

3.4 Production Configurator

Due to the competitive business environment manufacturing firms are nowadays pressing to quick response to the needs of individual customers. Increased level of product proliferation exerts extra pressure on firms in dealing with frequent design changes and recurrent process variations. In such a business situation production configurator can play a vital role for developing customer specific product. Figure 6 displays the basic approach of the production configurator where different production scenarios such as operational timing, production routings, available resources etc are accommodated. Within this configuartor various operational activities are embedded for the required planning and execution of production processes. This configurator calculates the total lead time in terms of set up time, processing time and tear-down time.

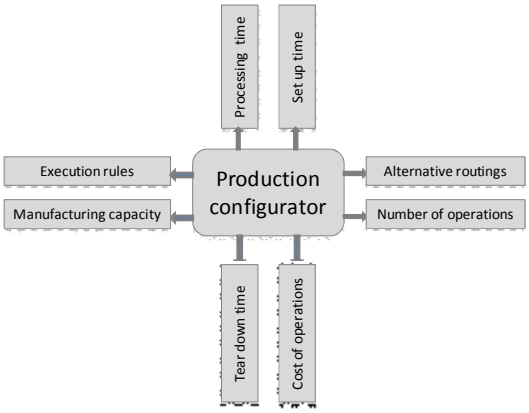

Figure 6: Basic approach for production configurator

This explicit configurator triggers the essential fabrication processes of the customized product according to the data received from product configurator. The selected design features of the specified components or parts from the potential customers are transferred to the production configurator to the necessary operations. The operations are sequenced according the available resources in terms of machines, labor, money etc. It is also required proper capacity management for developing quality products. The functionality of the production configurator is performed through various execution rules that are implemented within its architectural framework. This configuartor executes the operational activities on a real-time information processing. The optimized route and the number of operational processes are determined based on the selection features within the product configurator.

4. An Application Case

With the view to mapping the three configurators within a customized truck development process, we have taken a case example as explain within this section. The basic phenomenon of the product configuration processes are discussed with the case product truck. The generic processes of three configurators as we mapped earlier is implemented in terms of customer, sales, designer and process engineer perspectives. Figure 7 starts with the basic structure of a customer-oriented configurator, where different questions and the following answers of the customized truck are displayed. From these predefined questionnaires customers are able to choose their models of trucks.

Figure 7: Basic structure of a customer-oriented configurator

The generic view of the sales configurator is presented in Figure 8, from where we could observe the different functional features of the case truck. Potential customer could choose according to his/her requirements from these predefined features. The total price and the total throughput time or delivery time is also displayed within the configurator.

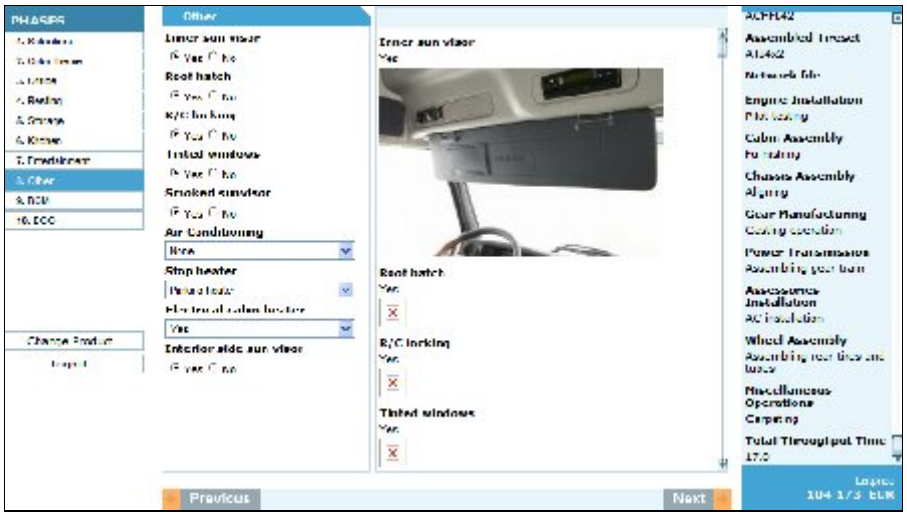

Figure 8: Generic view of sales configurator

After the selection process of different customized features of the expected truck, the designer starts to design the corresponding components or parts and codify them in terms of BOM. A snap shot of the product configurator of

chosen truck model is displayed in Figure 9. Here we could see the various components of the truck and their corresponding identification codes.

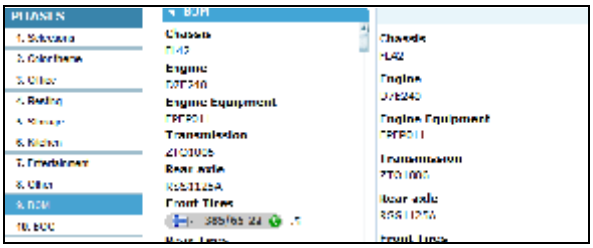

Figure 9: Example of a product configurator

Figure 10 displays the generic view of the production configurator of the customized truck. It shows different operational steps those are required for the fabrication of complete truck. It also presents the total throughput time which is the combination of setup, processing and teardown time of various operations.

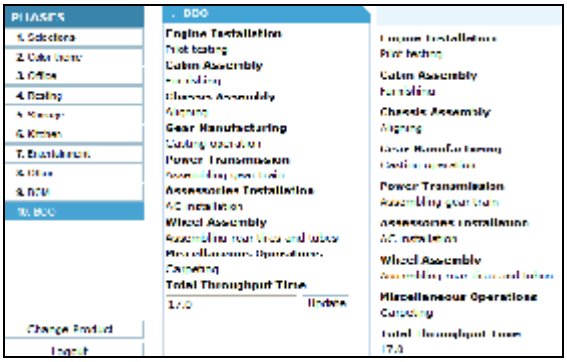

Figure 10: General view of production configurator

5. Discussion and Conclusions

To survive in the competitive business edge manufacturing organizations required to balance between the up-to-date technology and customers demands or expectations. This balance becomes fruitful when the integration among information technology based solution with the product design; engineering and manufacturing processes are successful. The configuration process exhibits such an advanced technique that merges between technology and customer expectations with each other. In such a circumstance, customers' behavioural and emotional needs are fulfilled through the configurators, where the direct communication among the customers, sales personnel, designers and process engineers are established to achieve the custom tailored product. This communication pattern is considered as the basic infrastructure to develop product individualization.

In this research paper, we have articulated different perspectives of the configuration process from customer channel to final production processes. All the required steps of developing true customized product development process are elaborated from order initialization process to order fulfilment process. The generic concept of CTO product development strategy is also presented and discussed about its implementation features. It is noticed from the presented approach that through the CTO strategy it is quite comfortable and efficient for the product developer to the overall planning and execution of the true customization phenomenon. This research theme could be extended with the integration possibilities of supply chain management and logistics with the configuration process. This approach might be useful for tracking the required resources during production process and manage the after sales delivery process.

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