CONCEPTS OF CUSTOMIZED PRODUCTION IN AUTOMOTIVE INDUSTRY

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Abstract
This article deals with the issue of how it is possible to create customized products in automotive industry inexpensively. Most „best in class" manufacturers of customized cars produce them under business models called "build to order", "assemble to order", "configure to order", "make to order", or "engineer to order". The theoretical part provides an overview of fundamental manufacturing principles in automotive. Next part presented model of car production by customized requirements supported with selected ICT tools.

Key words
Automotive industry, mass customization, modularity, build- to- order.

Introduction

The manufacturing industry in general and the automotive industry in particular, is distinguished by rapid globalization, high mass customization, regionalization, value chain restructuring and reduced product as well as innovation life cycles.

The automotive industry is in after-crisis time faced with growing competition from new emerging low-cost countries and needs to redefine its competitive advantage. Global competition in automotive is increasing, with technology and product differentiation becoming the most important sales factors but with continued cost pressure.

Overview of the car production concepts

Historically, mass production started Henry Ford with the concept of dividing work into small simpler parts and then it was easier to automate them. As automation assembly lines were invented to make products, the concept of build-to-stock or build-to-market was developed. Build-to-forecast producers sell products from inventory. As variety increases, it gets harder to keep enough of every variation in stock to satisfy demand. After fifty years, Toyota started with the conception of manufacturing of a product to the buyer's specifications. The process of creating customized product is known as build-to-order, or make-to-order. Customer driving manufacturing is an integrated business methodology designed around the customer, producer and sales. [5] At present, these principles are preferred in manufacturing approach:

Mass customization is [7] a process that enables the production of customized products to users' specification. It is usually done with the use of flexible manufacturing (computer-aided, robotics), which permits the production of large quantities (mass), at a fast speed and at a low unit cost; mass customization is usually done as an assembly process of standard components. Mass customization allows a manufacturer to produce unique customer configurations from a pre-determined set of choices with the same efficiency that it would

take to produce a similar, mass produced product. [2] Mass customization is accomplished by proactively developing product families around a modular product architecture, implementing a flow manufacturing to achieve one-batch-size capability, establishing a spontaneous supply chain around standard materials, creating agile systems to order process based on product configuration and building parametric CAD templates with automatic CAD/CAM linkages to CNC equipment. [8]

Mass customization can be realised in manufacturing practice by [5]:

The concept of *build-to-order* (BTO) - means that a firm starts to make a product only after an order for it is placed. It is also known as demand-driven manufacturing (DDM), customization, and pull technology. This changes not only production planning and control but also the entire supply chain and payment cycle; BTO necessarily involves the outsourcing of different components. [1]

Assemble-to-order (ATO) - refers to a manufacturing strategy in which products are not final assembled until customer order arrives.

Configure-to-order (CTO) - is special case of assemble-to-order, the components are classified into subsets, from which customers select the required components.

In this context, it is possible to mention one of research projects of the Seventh Framework Programme, financed from the EU founds, called "Sustainable Mass Customization – Mass Customization for Sustainability" (S-MC-S). The S-MC-S project aims at supporting European manufacturing to adapt to global competitive pressures by developing methods and innovative enabling technologies towards a customer oriented and eco-efficient manufacturing. To this end, S-MC-S vision is to define and research a new production paradigm, Sustainable Mass-Customization, while also presenting Customization as one of the main driving forces behind the future success of Sustainability. [9]

Customization in automotive production

Traditional car segments are fragmenting variety more and more into niches. The derivations of vehicles models are growing (such as sedans, hatchbacks, vans, and pick-up to minivans, cross- over coupes, roadsters, two-seaters vehicles, SUV, MPV etc.). The complexity of customized models and variants is on the increase, especially with regard to how individual vehicles are equipped. More product variety is causing escalating costs and complexity in the automotive manufacturing system. A potential alternative to manage the variety-induced complexity is to implement a platform strategy. [1]

Key trend in the automotive production is therefore standardisation of modules of car's construction to common platforms [6]. A platform can be described as [4] a basic common module that can be used in several variants of a product family (see fig. 1). This means that vehicles can be adjusted to the individual requirements of customers and delivery schedules enable OEMs (Original Equipment Manufacturer) to produce multiple models (based on varying platforms), at the same manufacturing facility in assembly plant.

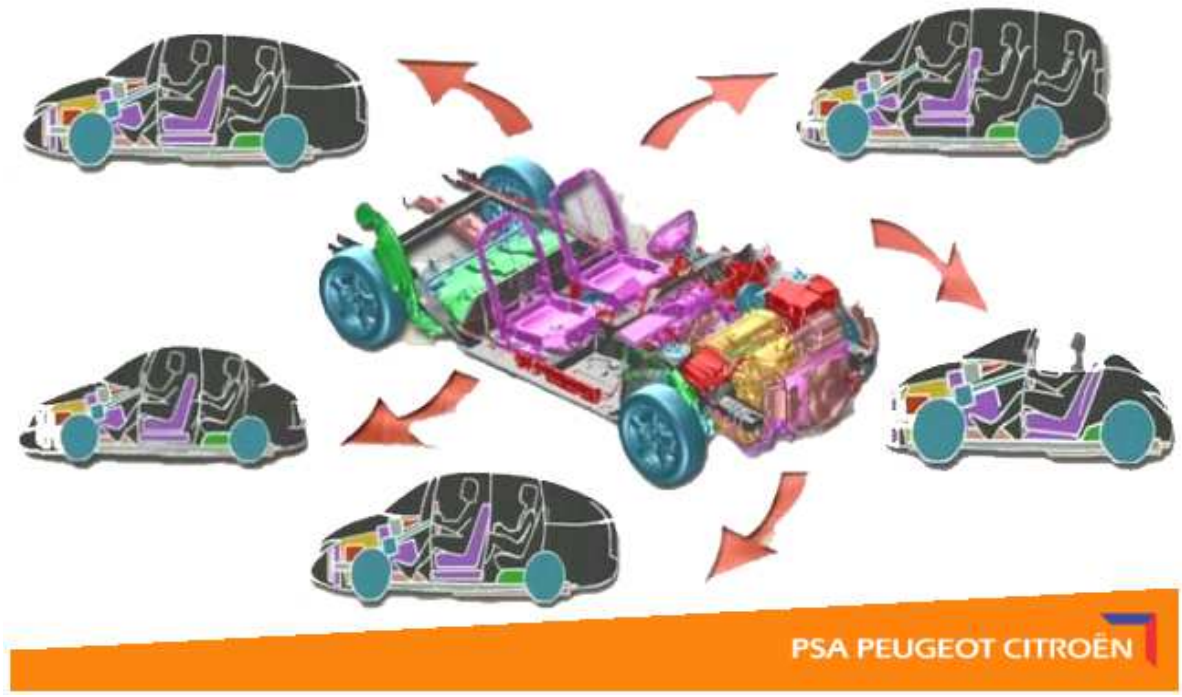

Fig. 1 Example of platform variability in PSA Group; Source: PSA [10]

The model diversity is an important sales argument and order-to-delivery time is the key factor to the automotive market and manufacturing process. Platforms enable OEM companies to cope with the conflict between customization and efficiency.

Platform strategy and commonality may lead to a drastic reduction of the supplier base. Suppliers do not deliver single components, but entire modules. Product modularity can impact the supply chain in that modules are outsourced to first-tier suppliers within the scope of modular sourcing. Modularity is the strategy with the greatest potential to reduce lead times. [8] Furthermore, together with the module supplier, the OEM company can work on developing solutions that aim to shorten lead times.

Build-to-order approach in automotive production

The management fundamentals of customized car production by build to order principle explained simplified in this section of paper (see scheme at fig. 2). Assemble-to-order automotive supply chain is a system consisting of push and a pull parts. In the push part, undifferentiated components and subassemblies are manufactured to forecasts whereas in the pull part, final products are assembled according to customer specifications. This latter part is customer driven and largely determines how long customers wait between order placement and delivery of final products. Customers generally accept this delay because they highly value customized products which naturally require a specific time for assembly and shipment after order placement. [12]

Due to the nature of assemble-to-order supply chains, before receiving the customer order, it is impossible to determine what end products should be assembled. The progress realized in information technology and especially the Internet has enabled automotive companies to operate a direct business to consumer. OEMs use product configuration systems in order to make it possible for customers to configure customized products over the Internet.

These software systems mainly assist customers in the selection of components and only allow the configuration of consistent product variants that can actually be produced on the main assembly line. Whereas product configuration systems are implemented at the interface between the OEM and its customers, other types of information systems are necessary in order to enable the coordination of operations with the network of suppliers, e.g. ERP (Enterprise Resource Planning); Vendor-Managed Inventory (VMI); Electronic Data Interchange (EDI); Radio Frequency Identification (RFID). [4]

Organizing of customized car production

Processes of customized vehicle production is presented at fig. 2, in simplified form. As shown in the schematic picture, customer makes their request e.g. through the dealers and specification is then communicated to carmaker. Orders delivered via phone, fax, or other paper-based order methods can be processed as those received electronically.

The information is captured in a central database and bill allocation is done to determine cost of production and deciding place where the car will be manufactured - is stated the nearest location of customers vehicle model production plant. All parts are supplied, imported and received by logistics ways. Just in time (JIT) or Just in sequence (JIS) supply principles ensure that certain part of the vehicle (the right component) arrive to the right point on the assembly line and at the right time has to be ready for installation on the respective body (to be inserted to the particular vehicle they are made for). Based on a fixed production sequence planned several days in advance (or on the order in which vehicle bodies leave the paint shop), OEMs ask suppliers to deliver components to match the production sequence. [2]

Suppliers can ensure this OEMs requirement of sequence delivery to continue producing components in batch, them they are warehoused, usually at a location in close proximity to the final assembly plant. When sequence orders come from OEMs to the supplier, components at the warehouse are simply repackaged (often aided by information-based tools) in the right sequence and quickly delivered. Once car is assembled, it is transported to the dealers ready for the customer.

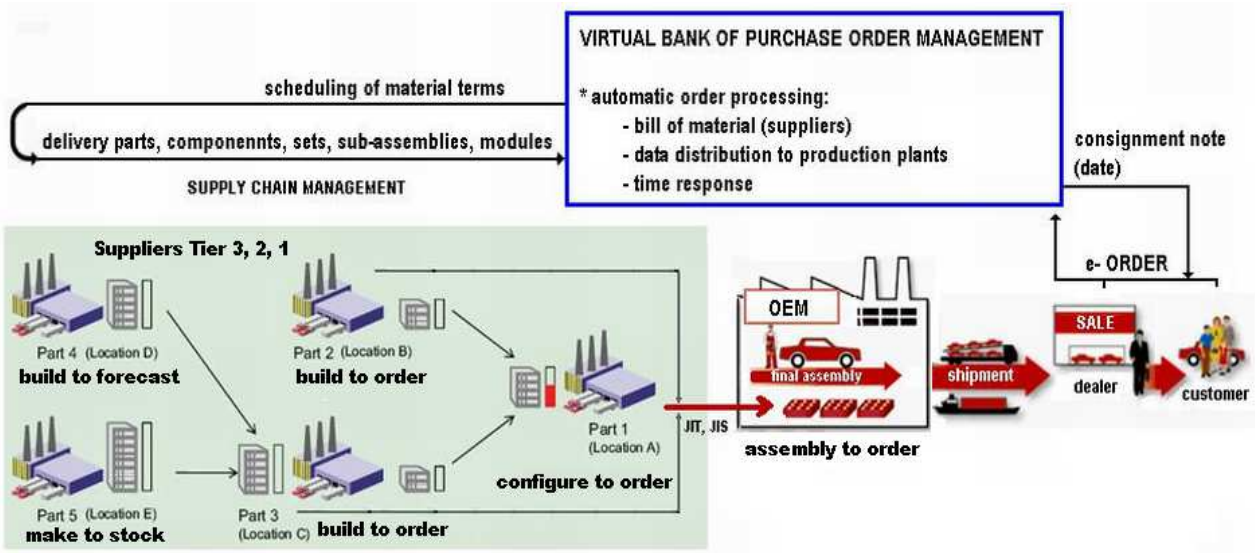

Fig. 2 Model of processes of customized vehicle production, Source: author´s paste-up

Best in class automotive companies used support information technologies tools e.g. mySAP Automotive to monitor production status in real time. This software [3] helps to reduce order-to delivery time, strengthens supply chain activities in the areas of demand planning and tracking and tracing of material deliveries, and improves inventory accuracy across plant – enabling significant reduction time-to-customer. OEM sends the long-horizon forecasts and short-horizon JIT delivery schedules to its suppliers and e.g. larger 1-tier suppliers receive the information via electronic data interchange (so-called EDI order). Other suppliers access the mySAP automotive supplier portal, where OEM posts the requirements to provide up-to-date information on delivery needs.

Conclusion

In automotive industry, one way used to build products to order is to draw parts from forecasted inventory and assemble to order modular products. The factory, supplier or distributor must carry large inventors and be good at forecasting the assembler's demand. In automotive production, with close cooperation of supply chain members, after receiving an order, reactive OEM companies place purchase orders for all the materials, parts, subsystems and wait for all of them to arrive and then assemble them into a vehicle. The ability to deliver parts on time is becoming an increasingly critical success factor among manufacturing plants in automotive industry. One of the actual problems is the simultaneous combination of a large-volume-production requirement with a large variety of small-lot, make-to-order requirement involving a big number of suppliers. Efficient planning of procurement, production and shipment is therefore becoming a more significant complex task throughout the complete supply network. An OEM's most critical measure of a supplier is delivery execution: the right parts in the right quantity, at the right time, delivered to the right point of usage (JIT approach) because missed component deliveries could cause serious disruptions in vehicle production.

Key words

Automobilový priemysel, hromadné prispôsobenie sa požiadavkám zákazníkov, výroba na objednávku.

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