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THE PERSONALIZED PRODUCTS DESIGN USING KNOWLEDGE-BASED ENGINEERING

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Abstract: *Nowadays, the demand for customized products is increasing, forcing companies to look for methods to meet customer requirements. At the same time, the design of these products must be achieved in a way that the balance between advantage and cost is inclined to the advantages of both the company and the customer. To remain competitive, companies need to adopt systems that optimize design processes so that time and resources are not wasted. The article presents an overview of production paradigms, beginning with mass production to mass customization, mass personalization, and mass individualization, and proposes the use of a KBE methodology to design personalized products.*

Key words: *Mass production, Mass customization Mass personalization, Mass individualization, Personalized products, Knowledge-Based Engineering.*

1. INTRODUCTION

Competition between companies aiming to sell similar products to different market segments is increasingly difficult. To compete in terms of competitiveness, companies use systems and organizational methods so that the products offered for sale meet the requirements of the customers and make a profit to ensure the development and well-being of the company.

Over time, there have been several production paradigms, which have emerged due to the changing demands of the market.

The paradigm that totally changed the degree of involvement of the customer in the product design process was mass customization. Once adopted by a company paradigm, the client plays a crucial role in the design process [1].

At the same time, to streamline the design process, companies use up-to-date software tools, this is the only way for companies to maintain their position on the market in which they operate. This paper presents an overview of production paradigms and proposes the use of a KBE methodology when designing customized products.

2. PRODUCTION PARADIGMS

2.1 Mass Production (MP)

One of the models that revolutionized the way of thinking regarding how production is organized was mass production. It was applied at the beginning of the 20th century when Henry Ford used an assembly line that led to a spectacular increase in productivity [2].

The spectacular results of this production organization are presented in Table 1 [2].

Table 1

Productivity from the use of the mobile assembly line

Production year	No. of auto vehicles/day
Before 1912	20-30
1913	100
1914	1000
1915	3000

However, this type of organization, which allowed the impressive increase in car production, proved wrong, because in the idea of making as many products as possible, the quality of the products was neglected, and when products of higher quality appeared, various problems of mass production began to be discovered.

2.2 Mass Customization (MC)

This model of organization was developed in the 1980s. The objective pursued by the companies that applied this organizational model was to make available to customers a wide range of products as much as possible, but at the same time to keep the product price as low as possible [3].

Therefore, the main difference between MP and MC was their purpose: MP is based on the sale of as large volumes of identical products as possible, while MC is based on the sale of a variety of products.

Another difference between the two paradigms is the role of the client: in the case of MP, the customer only has the role of buying mass-produced products, while in the case of MC, the customer also has the role of choosing the desired product from the range of products made available [4].

2.3 Mass Personalization (MPers)

The role of the customer in this production model becomes essential, designers aiming to provide customers with efficient and effective service, who have the mission of providing customers with unique products [1].

One of the differences between MC and MPers is that MC's products are designed to meet the desires of customers at the market segment level. Instead, regarding MPers products, they are made in such a way as to satisfy the needs of the customers at the individual level [5].

Figure 1 shows the differences between the three paradigms presented: MP, MC and MPers.

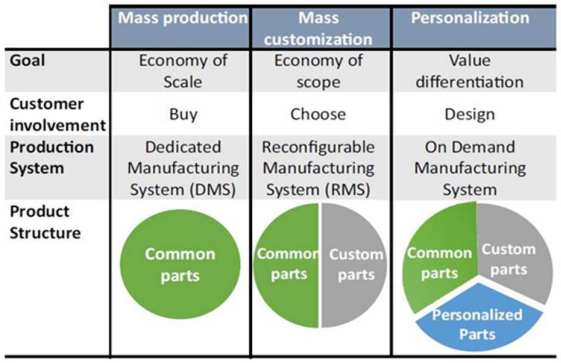

Fig. 1. Differences between MP, MC, and MPers paradigms [4]

Figure 1 shows the complexity of the structure of a product made in the case of MPers, with common, customized, and personalized elements in their structure [4].

The essential elements of MPers are:

- Market-Of-One;
- mass efficiency;
- customer co-creation;
- user experience;

Market-of-One involves making products so that the customer has the impression that he is an exclusive customer of the company. This feature leads to the formation of strong loyalty relationships. The second element of MPers, mass efficiency, indicates that the products produced must bring more value than cost for both the producer and the customer. Customer co-creation represents the idea by which the client is involved in the creative process, its influence being much greater than other paradigms of production. And the fourth element indicates that when designing a product, the designer must consider both cognitive and emotional needs [5].

2.4 Mass Individualization (MI)

This paradigm is characterized by a wide range of products, but unlike the MC, in the case of MI the production of products is not entirely the job of a single producer.

The process of designing a product in this paradigm comprises four stages:

- The main manufacturer produces the basic product and the interface indicates how different modules can be attached, these modules being made by other companies, small or large. In this way, in addition to the development of the main producer, smaller companies can also develop, which is an economic advantage;
- The customer chooses the desired basic product and the modules they want to attach; the customer orders and pays for the basic product and the desired modules;
- The modules ordered by the customer reach the manufacturer of the basic product that serves to assemble the final product and send it to the customer [6].

3. KNOWLEDGE BASED ENGINEERING (KBE)

Due to the need for tools to support the producer to be able to have an efficient design process, systems have been developed to reuse certain knowledge. KBE is exactly a system that retains information from the design phase of products and gives the possibility to reuse that information.

Due to the advantages of using these systems, KBE is used in various industries such as the automotive, civil, or aeronautics industries.

The main advantage of using such a system is that the way in which the design time of a product is allocated is completely changed. If only CAD (Computer Aided Design) software is used, the time allocated to the innovative design is 20 % of the total time, the remaining 80 % being assigned to noncreative, repetitive designs; when a KBE system is used, the data changes in such a way that the percentage allocated to the creative design is much higher than that allocated to the repetitive design, while the entire design process is shortened. [8].

Figure 2 illustrates how time is allocated in the two cases mentioned above, when only CAD software is used and when a KBE system is used. Therefore, the time needed to develop a product decreases considerably, and the process can be fully automatic, so that the time and costs necessary to develop the product can be reduced by up to 90 %.

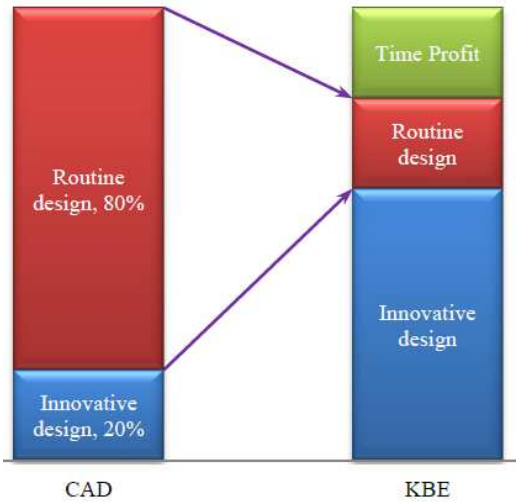

Fig. 2. Design time allocation when using CAD software, as well as when using a KBE system [8]

Another advantage brought about by KBE systems is the influence on product optimization. Since information is stored within the system from the design phase of a product, when some problems encountered in other projects reappear, the solution to overcome these problems is found in the KBE system, which leads to easier product development and the optimal design is easier to choose.

At the same time, the use of such a system allows the manufacturer to focus more on innovation, as the repetitive design process can be achieved automatically [8].

Due to the interest shown by the company and due to its advantages, different methodologies have been developed for those who want to develop such systems.

One of the most important is Methodology and software tools Oriented to Knowledge-Based Engineering Applications, MOKA. This methodology has been developed within the framework of a European research program and is intended to be a standard for the development of KBE systems [9].

The development of KBE systems, according to the MOKA program, is carried out in six stages, which are shown in Figure 3 [9]. MOKA has been developed so that it can be used in two levels: an informal level and a formal level. The existence of the informal level allows to capture knowledge from people who are not familiar with specific technical terms.

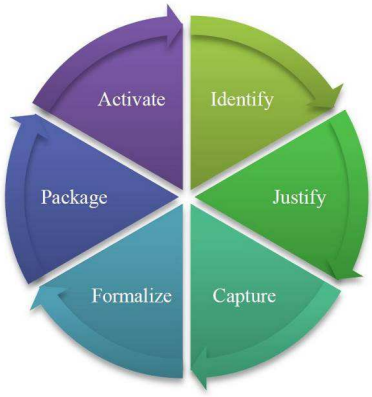

Fig. 3. Steps in the development of KBE systems according to MOKA [9]

The transition from the informal to the formal level is made using a Universal Modeling Language (UML). By using this language, the

knowledge communicated in a common language is transformed into formal models [9].

Another methodology is Knowledge-Oriented Methodology for the Planning and Rapid Engineering of Small-Scale Applications, KOMPRESSA. This methodology is intended to implement KBE at the level of small or medium enterprises [9].

4. CONCLUSION

Nowadays, the demand for customized products is increasing, forcing companies to look for methods to meet customer requirements. At the same time, the design of these products must be achieved in a way that the balance between advantage and cost is inclined to the advantages of both the company and the customer.

To remain competitive, companies need to adopt systems that optimize design processes so that time and resources are not wasted.

KBE-type systems can be used to solve the problem related to the efficiency of the design process, but for the time being the implementation of the system is costly, so there is a reluctance to choose such a system towards CAD software.

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Concepția produselor personalizate folosind ingineria bazată pe cunoștințe

Rezumat: În zilele noastre, cererea de produse personalizate este în creștere, ceea ce obligă companiile să caute metode pentru a satisface cerințele clienților. Lucrarea prezintă o imagine de ansamblu asupra paradigmelor de producție și propune utilizarea unei metodologii KBE la proiectarea produselor personalizate.

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