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PROGRESSIVE METHODS IN DESIGN AND THEIR APPLICATION IN ENGINEERING INDUSTRY

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The problem of a product's life cycle against R&D time has occurred due to changes in the behavior of customers. One possibility how to solve this problem is to use Information technologies and the concept of CIM (Computer Integrated Manufacturing) that considerably reduces R&D time, production time and the time to market. The CIM conception is based on the utilization of single modules (CAx systems) in the Design and Production planning area, manufacturing area (CAD/CAPP/CAM) and others, integrated together into one functional unit.

Key words: *design, product's life cycle, R&D (Research and Development), CIM (Computer Integrated Manufacturing)*

Napredne metode u dizajnu i njihova primjena u strojarstvu. Problem ciklusa radnog vijeka proizvoda prema R&D pojavio se zbog promjena nastalih u ponašanju kupaca. Jedna od mogućnosti za rješavanje tog problema je korištenje informatičke tehnologije i ideje o CIM (proizvodnja u objedinjavanju s kompjuterom) kojom se značajno smanjuje vrijeme proizvodnje kao i vrijeme marketinga. Ideja CIM-a se zasniva na korištenju pojedinih modula (CA-sustava) u području projektiranja i planiranja proizvodnje (CAPP), područje izrade (CAM) kao i drugih, ujedinjenih u jednu funkcionalnu jedinicu.

Ključne riječi: *dizajn, životni ciklus produkta, R&D (Istraživanje i razvoj), CIM (proizvodnja objedinjena s kompjuterom)*

INTRODUCTION

During last 10 years we have seen important changes on the market, the customer's power was increased, customer became the center of attention and interest of manufacturers. The market of today is more flexible and customer guides its progress. Mass produced products don't satisfy the present customers.

The result of this development is consecutive decreasing of the serial production and increasing of the variety of the production programme and elasticity of production. The marketing philosophy of the firm's management is getting forward and it responds very flexibly to the specified customer's needs. The philosophy describes the style how to fill and supply the customer needs. Ability to realize those customer's needs with the minimum huge of power - time, people, energy, material, quality is also not neglected [1].

To create successful product means to handle it in all areas. Construction, technology, processing, surface working are very important criteria, but product is very hardly

supported without design, packing and presentation. Product which doesn't satisfy all criteria is unsuccessful on the market. During standard quality of actual products design is something, that differentiates products from each other.

RESEARCH AND DEVELOPMENT OF NEW PRODUCTS, THEIR DESIGN

Research and development of new products, their design presents the first stage in the life cycle of product that determinates the functional properties, but it influences the production facilities and efficiency of production in the second stage.

Design is very important instrument which creates one part of the price of product for consumers and decides general financial results. The high flexibility and the low costs of the product modification are characteristic [2].

The problem between product life and time of product development appeared due-to the customer behavior. The solution of this problem is to use methodology with the information technologies that secure reduction of development, production and implementation time of the product.

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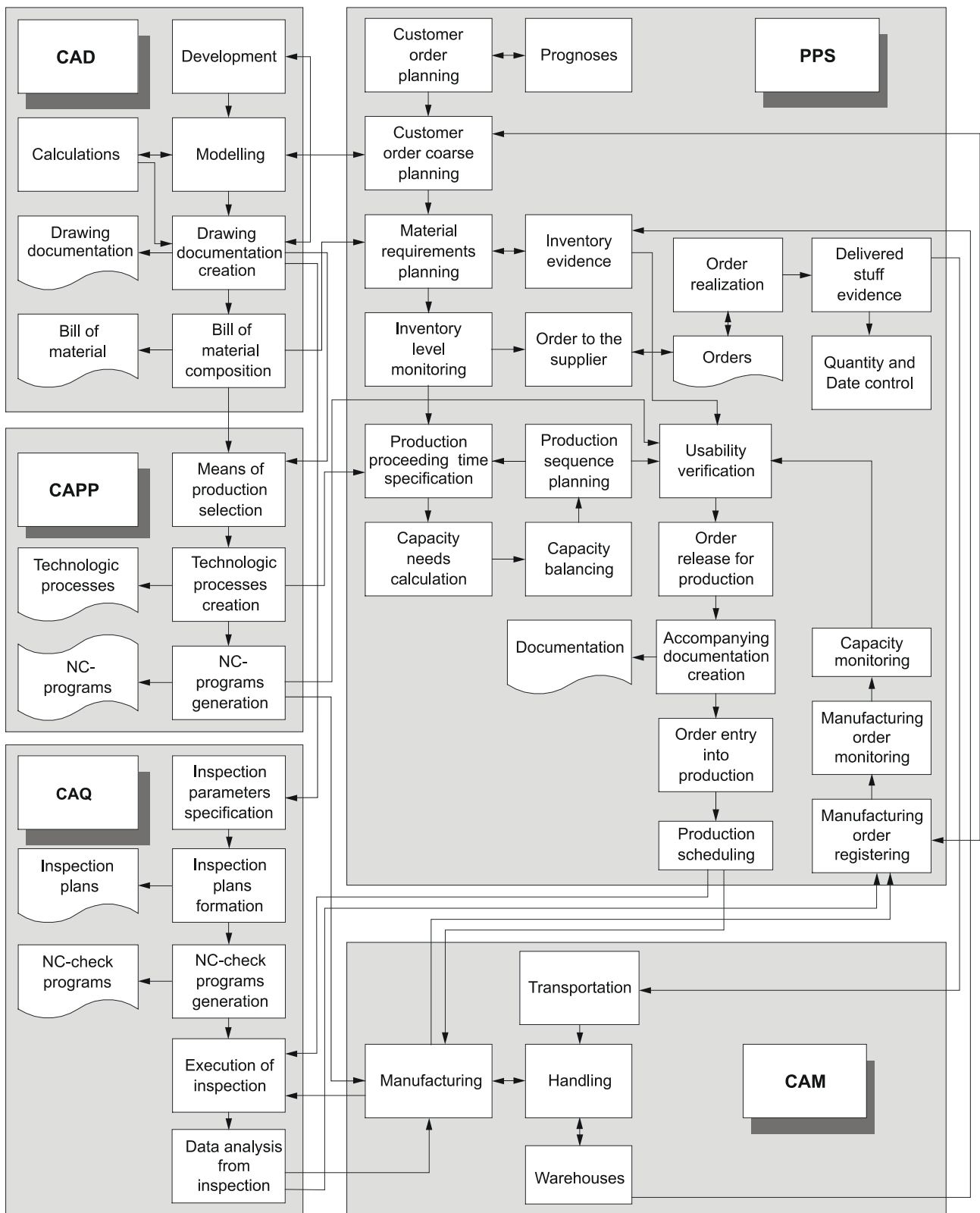


Figure 1. Integration of particular CAx systems and PPS /Production and Planning system/ within the scope of CIM /Computer Integrated Manufacturing/

Slika 1. Objedinjavanje konkretnih CAx-sustava i PPS (sustav proizvodnje i planiranja) unutar područja CIM (izrada objedinjena s kompjuterom)

For the small and middle firms it is not profitable to employ designer for 8 hours per day. Relationship with the external corporations is more economically interesting that are providing complete services for the activity of the firm at the area of design and presentation of problem solution by the outsourcing. Focus of activity to design products and interior was expanded on the graphic design.

From actual analysis of the labor 70 % and 80 % of the total labour content resulted. This valuation is involved in the production preparation, documentation. The project and development of product influences 70 - 85 % of production costs, but these phases create less then 10 % of the product's cost [4].

Today there are used a new instruments of design for example: CAD, CAP, CAM, CIM (Figure 1.).

Simulation and visualization plays significant role in these processes, mainly:

- some technologies,
- activities of the machine, robots, logistic and storage facilities,
- plan and organization of working place, production process, installation.

Using of CIM modul allows reduction of material and energy severity, reduction of storage, abbreviation of the time of production and development, increasing of the time and power of using machines, and quality of product.

The computer support of the firm's activity is solved by the algorithms. There are activities which are very hard to be automatized, they haven't punctual algorithm of their solution.

In these activities there are important long-time experiences of the employers, know-how, intuition about problem, technical intelligence. For computer support artificial intelligence and expert system of the process decision is used.

Application of information technology allows using principle of simultaneous engineering. The nature of SI depends on actual product development and design of production process. The goal of the SI is to minimalize the general time of the implementation of innovation of product, to obtain high standard of quality through the lower costs. From the practical experiences it results, that the SI brings development reduction about 50 - 300 %.

Progressive methods in design and their application in customer marketing presents Figure 2.

Application of the simultaneous engineering is suitable especially for complex products (e.g. a car, a computer, a camera etc.) that have a long development time. Multi professional solution teams participate in product and parts development as well as in production process design. The teams are closely co-operating and working parallel on a certain product part and its mode of production and consist

of designers, ergonomics, technologists, marketing and other experts, solving partial and integral tasks.

Characteristic features are the following [3]:

- working with always actual information through the jointly sharing databases,
- change in certain parts is considered in all other related parts, groups and the whole product,
- simultaneous product design and production process design. Visual monitoring of the whole production process of designed products through the computer allows designers to project satisfactory products in term of technology and to detect and directly possible eliminate difficulties in production already in design stage. It could be also the source of innovation plans in many areas, e.g. change in product shape is less expensive than eventual change in production process.

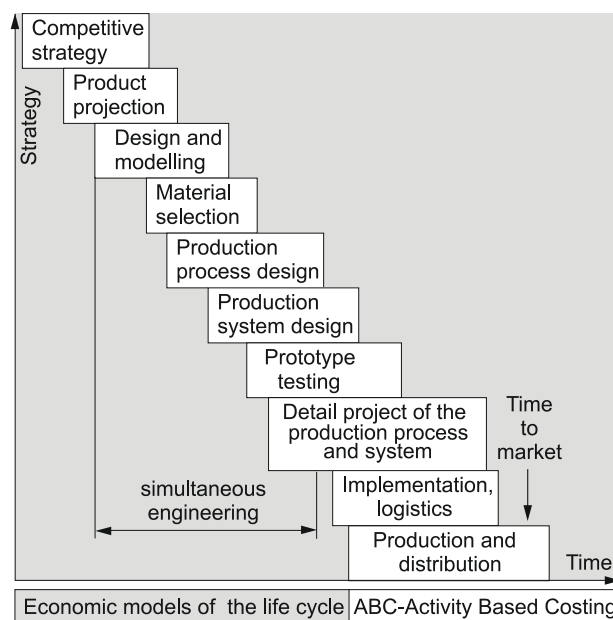


Figure 2. Design cycle reduction of product and production process by using simultaneous engineering

Slika 2. Planiranje skraćivanja ciklusa proizvodnog procesa pomoću simultanog inženjeringa

The progressive tools that could be used in product design are:

- DFM - Design for Manufacturing - Design /construction/ with regard to single /simple/ production of the products and their parts in minimal production costs. [5],
- DFA - Design for Assembly - Design /construction/ with regard to single /simple/ assembly of the product, using the minimal amount/number/ of parts, constructional adaptation of the product to the assembly automation possibility or disassembly in product recycling [6],
- and others: DFC (Design for Cost), DFE (Design for Ecology) [5].

These approaches are based on the idea of constructing the product with regard to the next stages in the product life cycle - production, assembly, recycling, etc.

The other opportunity to increase productivity and flexibility of an enterprise is the FAST PRODUCTION CONCEPTION. It is based on product modular structure which already in design stage allows to achieve short delivery time /time from the customer order to the product delivery to the customer/. The product is composed of pre-manufactured universal and standard, unified parts /modules/, produced and delivered by supplier's /outsourcing/. The emphasis is put upon interconnection and cooperation with suppliers that cover also inventory management in the customer warehouse by JIT conception. This allows eliminating check-in of purchased parts at the consumer.

The philosophy could be used mainly in electronic and car industry, e.g. commission systems - PC configurations. The one advantage is fast and flexible production /product finalization/ exactly according to customer requirements. The other advantage is wide range of many variants, achieved in the final assembly stage of the modular product by the high flexibility and short production /finalization/ and delivery time [6].

The considerable role in new product research & development plays construction of part or product prototype, that represents the first real vision about the object /its model/ and allows to execute different test on it /design, assembly ability, functional options of the product/. It also can be used in marketing activities /starting of marketing canvass before first products manufacturing,, demand of potential customer for future product before manufacturing and modification features of the product according to customer needs/.

Radical time reduction of preparing and prototype manufacturing, increasing number of design variants and manufacturing costs cutting is possible due to RAPID PROTOTYPING /RP/ technologies.

The basic principle of RP is, that object /part/ computer interpretation serves as the primary input for a technological facility that creates physical object with features close to the final object without preliminary phases and special tools. RP technologies infer from 3D CAD models information for segmentation of the volume entity on layers and using of special technique creates the layers. The idea is information generating layers in computer, generating of physical layers and their connection for model /prototype/ creation.

Some of the excellent CAD/CAM/CAE systems are suitable for using of data preparation for rapid prototyping facilities. They are very useful, if the system contains special module for RP technology support /e.g. Unigraphics system by Unigraphics Solutions with UG/Rapid Prototyping module/ [7].

In comparison with conventional production methods prototype manufacturing by using Rapid prototyping methods takes less time - days instead of months. The advantage

of RP methods is not only fast prototype manufacturing in any development phase, but especially possibility to manufacture wide range of modifications and construction layouts of the designed product /prototype functional samples/, which can be then tested and adapted.

The general feature of the RP methods is that work piece formation is not performances by material off take as it is in conventional cutting operation, but by consecutive addition of material in form of powder or melt. A part is created layer by layer. In this way it is possible to manufacture also shape complicated parts with cavities, with sloping and horizontal down sides within very little time.

RP is an universal method for model manufacturing /without using forms, tools/, saving costs, useable in every production sector because of ability to produce any shape. The advantage is fast and exact model processing [3].

RP is for its high economic investment costs suitable especially in major industrial enterprises, e.g. automobile industry or in company's specialized in Research & Development area. Next possible application of RP could be in electronic and electro technical sector, in consumer industry /black and white consumer electronics/, but also in health service /articular substitutes/.

It is possible to assume that RP methods will be used more and more in future. In future parallel with prototype manufacturing the methods could be implicated for fast and budget-priced manufacturing of conceptual models /Rapid Modelling/, for tools and jigs manufacturing /Rapid Tooling/, for piece and small-lot production and service parts production.

CONCLUSION

Productivity is a significant tool for increasing of competitiveness an enterprise on internal and external markets. It is needed to evaluate productivity in the complex way, not only in manufacturing, but also in engineering activities in pre-manufacturing stage. Only shipshape integration of activities of the all stages in product life cycle allows innovation of products and production processes to overshoot in the least time, by the optimal using of enterprise resources considering customer needs. It allows flexible and fast response to changing customer requirements and leads an enterprise to the success and prosperity. Information technologies /IT/ and computers utilization at the all process from product development, design to its packaging, expedition and delivery to the customer is useful in term of the objective.

In spite of intersection of IT into the manufacturing and non-productive /engineering, service/ operations, the main integrating element of the whole enterprise process are and will be qualified, motivated and satisfied staff, that play the key role in transformation of data into information and information into knowledge.

The complex systems implementation lay stress on multifunctional /universal/ staff and communication among people /team work/.

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