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DESIGNING AND DISCRETE PRODUCTION OF OFFICE FURNITURE IN CIM SYSTEMS

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1. Introduction

Ergonomics found its way to offices primarily in the result of investigations on work efficiency. The main objective of those investigations was the improvement of efficiency and cost effectiveness of work stations. Unfortunately, their true consequences included standardisation and de-humanisation and depersonalisation of office space.

Today, the most important characteristic feature of offices is their functionality, flexibility and ease with which they can be adjusted to continually changing needs and requirements of their users. New market requirements necessitate frequent reorganisations of office work and office workspace. This increases the scope of customers' expectations who want to buy universal office furniture adaptable to a wide range of needs and possible to purchase at short notice. Realisation of projects for multifunctional offices entails the need to apply CAD techniques integrated with **M**aterial **R**esource **P**lanning (MRP) systems forming common discrete systems (CIM) [1, 2, 3].

When analysing functionality of software programs for furniture industry currently available on the world market, it is easy to come to the conclusion that there are groups of furniture that have not been well catalogued and parametrised. There is a considerable technological void consisting of non-standard and multifunctional furniture which are more difficult to parametrise and manufacture. Reception, bank, hotel, conference and built-in furniture provide a testing challenge for researchers. This group of furniture generates a great deal of problems but, at the same time, they provide designers with a multitude of wonderful opportunities to create new and novel constructions and space arrangements. Another important challenge for designers of these types of furniture is a very short time allowed for the realisation of orders (Fig.1.) requiring high quality of manufactured products and perfect organisation of work. It is evident from the above chart that both designing and manufacture of office furniture is of discrete nature, which means that the customer ordering furniture can make use both of the catalogue proposal offered by the manufacturer but he may also order the selected piece of furniture to be made to order in accordance with his specific aesthetic or ergonomic requirements.

Therefore, ideas of computer integrated design and manufacture of furniture should take into particular consideration the specificity of the product such as office furniture and use all available CIM environments to disseminate them in the realisation of any processes in furniture factories accepting individual and serial production cycles. CIM systems can easily manage and control production orders, material, production and financial resources and ensure and maintain the assumed quality standards. However, in order to insure proper functioning of all management systems, it was necessary to supply their databases with all information about product structure. This structure can be transferred directly into the management system by exporting data from the CAD/CAM system partly in the form of structure and partly in the form of technological pathways.

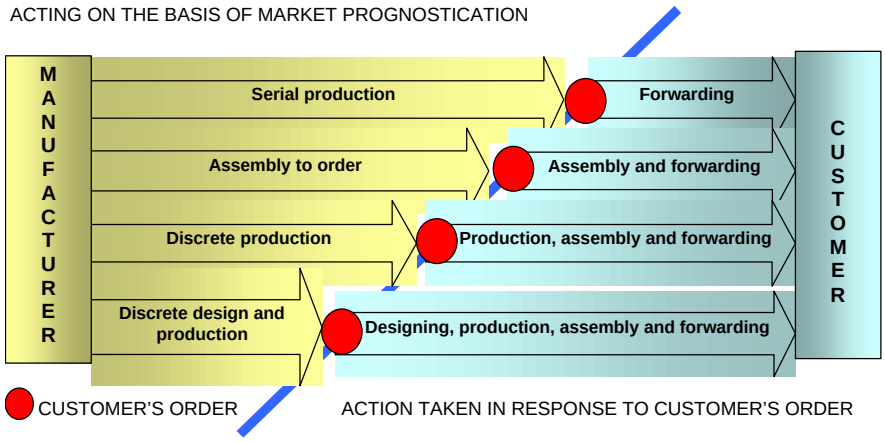

Figure 1. Position of the point separating customer's order

2. Objective of investigations

The aim of this study was to develop an integrated model of a parametric application to be used in the environment of the Mechanical Desktop® together with the MRP class system assisting ergonomic design of constructionally complex office furniture and to propose a way of presentation of production processes of this furniture in the MRP system.

3. CAD parametric model

The first element of the integrated system is a parametric CAD system developed as an application in the AutoLISP language for the Mechanical Desktop® program. When beginning work under this application, for the user's convenience, it is advisable to place the icons of the pieces of furniture which are to be realised in this particular arrangement on to the monitor screen. Next, it is necessary to define the general shape of the room that the customer wishes to be modelled. Once the environment has been defined in this way, it is necessary to introduce its constant elements such as: walls, windows or doors. Having earlier selected the group of furniture to be modelled, we can now begin to arrange the interior. In order to achieve this goal, we can use parametric libraries of desks, additions, cabinet connections and other elements ascribed to a given type of furniture in the icon (Fig.2).

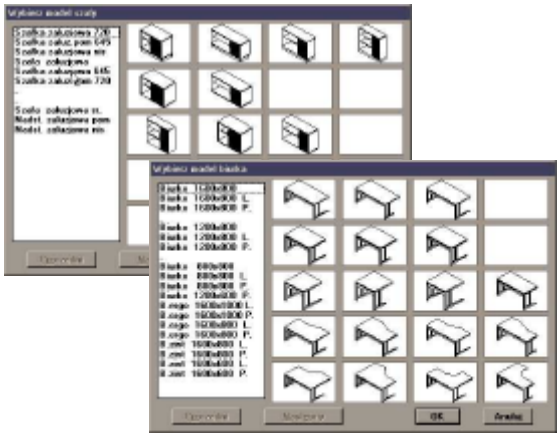

Figure 2. Parametric libraries of office furniture

Next, we can define measured, material and technological elements for the selected types of furniture using shape generators. When we place selected types of furniture on the monitor screen, it is necessary to arrange them into uniform and consistent sets so that it will be easy to perform cost calculations on them (Fig.3).

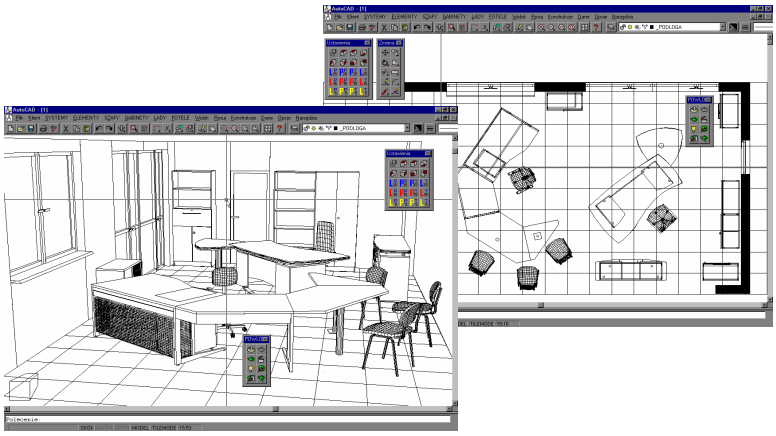

Figure 3. A project of interior design containing parametric objects

Ergonomic multifunctional furniture sets are particularly difficult to design. The main problem here is that one piece of furniture must often reconcile a number of functional and practical requirements often at odds with one another. A good example of such furniture is reception or hotel counters and cash boxes. The main function of this kind of furniture is to facilitate work but it is also used to store documents, office accessories, although sometimes it is also used to have meals at. In addition, this group of furniture, apart from their characteristic functional dimensions associated with anthropometric measurements, often have to take into consideration dimensions of office equipment and allow their mutual interconnections as well as plugging in to sockets.
The developed computer application also allows designing multifunctional office furniture intended for use in any public utility buildings. This means that the program takes into consideration basic functional measurements of office furniture dedicated to work and storage as well as dimension of office work stations. In its assumptions, the program constitutes an expert system indicating users what characteristic measurements of office furniture are optimal and, at the same time, comply with requirements of appropriate standards (Fig.4).

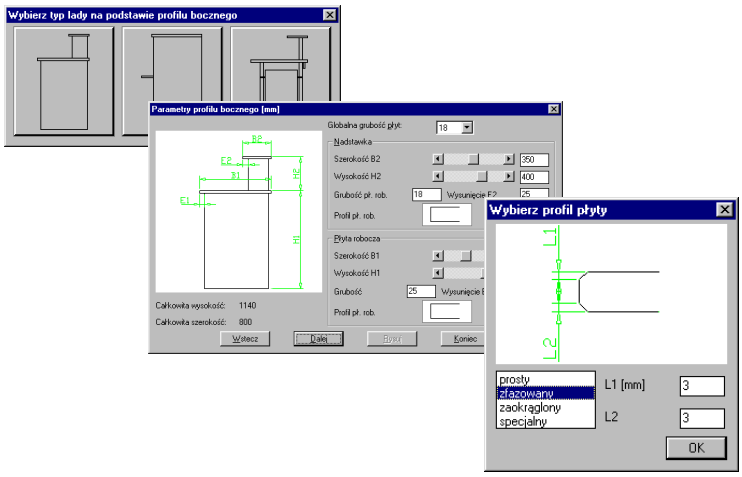

Figure 4. Generator of reception counters

The system suggests correct solutions but it does not necessarily rule out solutions different from standards giving users a considerable room for manoeuvre for creating functional forms and manufacturing reception counters on the basis of a pathway defined by the user (Fig.5).

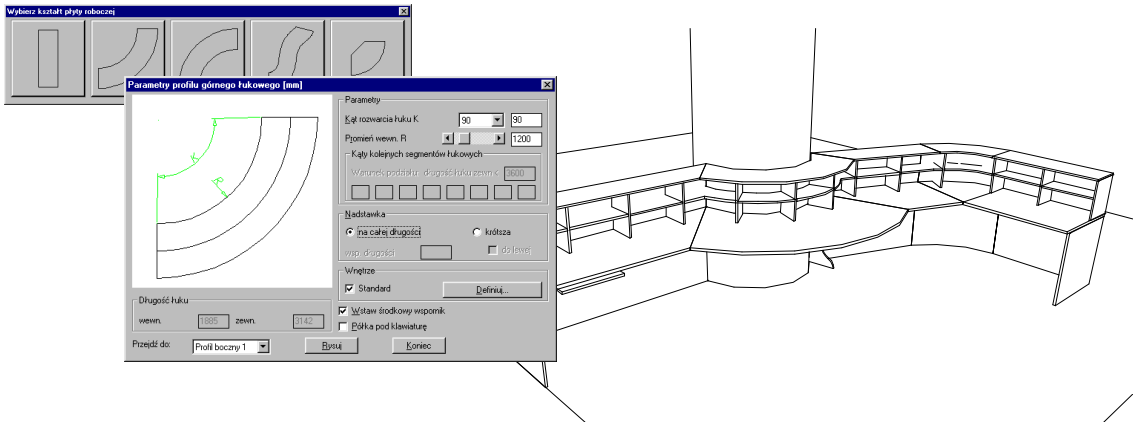

Figure 5. Generator of reception counters

Once the presentation for the orderer is accepted, the user can close the sale order and proceed to generate a production order. To ensure effective control of production, the system can automatically transfer the sale order to the integrated system of company management which can generate production orders, lists of material requirements and production capacities, technological and labour charts etc. for individual positions of sale orders.

4. Control of production processes

The control of production processes of discrete nature requires refurbishment and improvement of all processes which can affect shortening of servicing of customers' orders and improvement of the quality of the offered service. This is associated with the integration of both construction and technological processes as well as marketing, logistic and management undertakings into one consistent system.

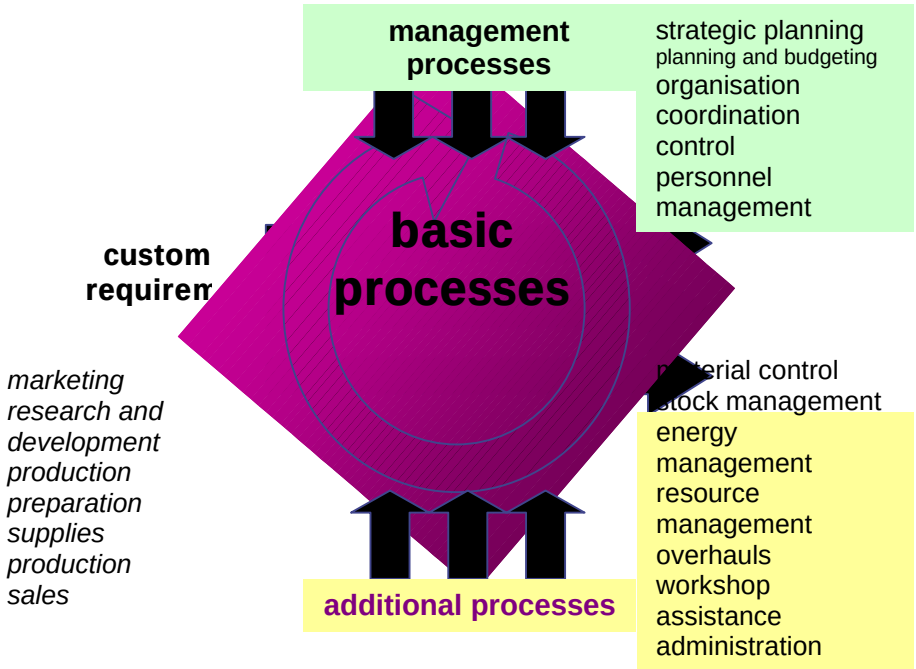

Figure 6. A diagram of processes in an enterprise

The most interesting kind of furniture production respecting individual orders of customers is the design and production to order. The integrated system opens and handles separate production orders and suborders, assigning to them true costs of designs and assigns the time of construction. In the course of the production process, using the documentation prepared earlier, sale orders integrated with construction and technological documentation, shapes, form and mutual connections of individual component parts are mapped. Efficient planning of material requirements and MRP production capacities are possible only if BOM structures of products develop in automatic generators of structures described above. They constitute the basis on which levels of stocks, loads and future business plans are balanced. Figure 7 shows an exaple of BOM chart.

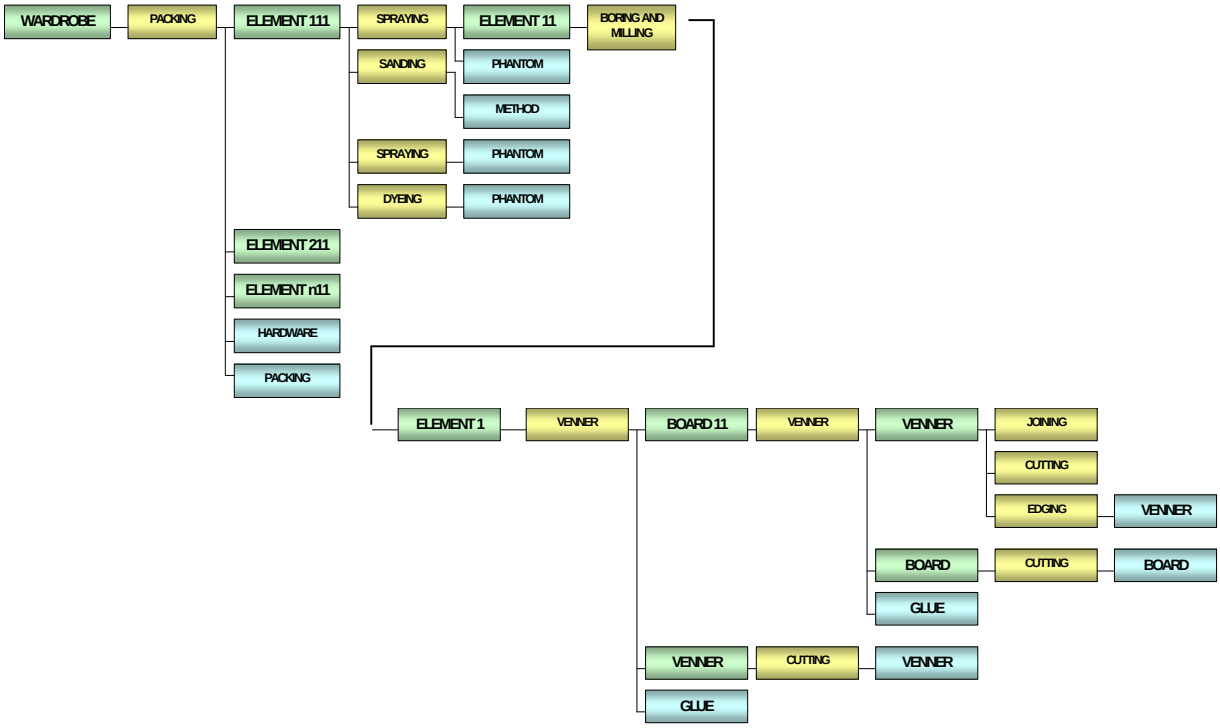

Figure 7. BOM structure of a wardrobe in natural veneer

Product structure indicates the way of realisation of production orders and their mapping in a computer integrated system of enterprise management. Generally speaking, areas of production processes connected with furniture manufacture can be divided into four parts. The first of them entails analysis and control of supply costs as well as the quality of supplies and suppliers. In the second, the level of standard consumption of basic and secondary materials is planned and true costs of material supply to shop floor are calculated. In the third part, by monitoring individual orders for elements, subunits and finished products, it is possible to control the advancement of work and to analyse the progress in the realisation of production orders associated with appropriate sale orders. The last part of production area involves the control of the realisation of sale orders and the analysis of the level of customers' claims or complaints. The realisation of this kind of production stream is particularly enhanced by clearly defined product structure because it forms the basis on which true or virtual stocks used to register individual processes or to control quantitatively and qualitatively product batches transferred from department to department or from one group of machines to another group of machines are mapped.

When realising the most advantageous customer-oriented discrete production, the sales department accepts orders from customers and, by introducing them into the computer system, generates a production order connected directly with a given order. On this basis, the production department

should develop production orders or together with the existing orders prepare the main production plan comprising needs of both discrete and serial production. The introduction of the production plan earmarks all available resources of the enterprise and, in doing so, allows the optimal choice of: the number of workhours of workers and machines, semi-finished products, raw materials and wastes as well as rational planning of purchases of strategic components. A well managed circulation of information shortens the production cycle and allows monitoring the progress of production processes with the aim to notify the customer about the stage of the realisation of his order. The completion of all production tasks allows the product to be transferred to the warehouse and automatically to notify the sales department about the realisation of the customer's order. This, in turn, is the basis to invite the customer to collect the finished product or prepare delivery documents.
The integrated system of computer assisted company management oriented towards realisation of discrete processes should, in the first stage of its implementation, result in dramatic benefits and advantages in the area of customer services. All necessary changes should be introduced rapidly and efficiently allowing to get rid of the old, ineffective methods of organisation. Sales, production and purchase departments should be treated with special care.

5. Summing up

The developed computer program constitutes a virtual tool useful in the process of designing and preparation of production of non-standard or multifunctional furniture which take into account all functional and ergonomic requirements. The spatially generated furniture model constitutes a complete engineer construction with measurement parameters complying with European standard requirements. Moreover, the program enriches the Mechanical Desktop® environment by adding a new designer- and constructor-oriented intelligent tool useful in production of office furniture. It also provides a comprehensive assistance for relational database which is connected with the MRP system. In this case, discrete production catering for individual customers becomes a force driving other types of production. Frequently, enterprises specialised in serial production are unable to overcome their rigid organisational framework and lose valuable long-term orders because they cannot realise non-standard orders. The system presented in this study can and should allow introduction of flexibility in such companies and help them compete for lucrative orders.

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