Use of the Knowledge Base in Computer Aided Planning and Projecting of Assembly Systems.

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Abstract – **Important aspect of methodic in planning and projecting of assembly systems is the analysis of assembled product and realization processes of its assembly. Procedures of the analysis are based on models of the structure of assembled product and models of variants of assembly processes. Application of a systematic analysis allows a connection between the creative and logical techniques into integrated knowledge base. This is being used and verified in the system of automated planning and projecting of assembly processes**

I. INTRODUCTION

Assembly technologies, that are characterized by high degree of automation, flexibility and reliability and that insure the high quality were developed and reworked on the basis of advanced research taking in account systematic approach, integration demands and high degree of knowledge from other interdisciplinary branches.

There is only one possibility how to fully supply and develop the processes of production and projecting of assembly systems and it is only with supplement of advanced methods and techniques having mostly simulation characteristics. Only with the use of simulation it is possible to examine the behaviour of assembly systems, outputs, costs and other project attributes.

The essential step for increasing of the productivity in automated assembly is an analysis of information flows and their optimization and modern technical interpretation. New principles and newly developed types of devices with higher degree of artificial intelligence are being applied. Also new methods of production lines levelling are being applied and developed. In flexible assembly the use of assembly robots is very essential together with an equipment of these. Modern assembly systems demand also new kinds of auxiliary devices that secure supplement for assembly units and devices. Attention is also greatly focused on application of modern systems of control, programming, inspection and identification of production environment.

II. METHODICAL ALGORITHM FOR CUSTOMER BASED ASSEMBLY SYSTEMS PROJECTING

The proposed methodical algorithm of customer based assembly systems projecting issues from the basic model of assembly process, which divides the assembly process into three basic elements: assembled product, assembly process and assembly system. Relations and the three basic hierarchical levels of the model are shown in figure 1. Projecting of assembly systems is considered as a part of a complex file of activities including the strategic analyses, implementation and operation of assembly system. Three elements hierarchical model of automated assembly is source of the proposed methodics of projecting the assembly systems (fig. 2), which consist of three main blocks: analysis of assembled product or products, analysis of the assembly process and of projecting of the assembly systems.

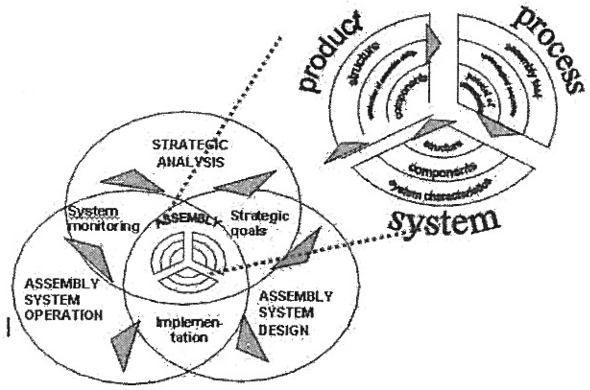


Fig. 1. Three element model of the assembly process

Basic principles applied by creation of the reference methodics of projecting are:

- Systematic approach based on the use of tools of the systems theory allowing the identification of the key elements, their mutual connections and models creation

- Hierarchical segmentation of the process into levels according to the degree of abstraction and detail
- Orientation to divergent and transformation base of projecting, which shows the lowest degree of linearity and highest degree of variance
- Modular principle of building allowing the modification of methodic algorithm according to the exact demands and supporting the innovative an creative approach of the projector.
- Strong orientation to knowledge base, their structure, effective use and continual additions.

III. ASSEMBLED PRODUCT ANALYSIS

Assembled product, or group of products is the key object of research, analyze of which and the resulting conclusion s are directing all following stages of work. In the beginning of assembled product analysis it is necessary to *identify the assembly blocks*, that means those construction parts of the product, assembly of which makes a meaningful unit. Dependant upon the complexity of a product, it is possible to choose the individual level of detail. For the identified set of assembly blocks $M_b = \{B_1, B_2 ... B_n\}$, where n is the count of assembly blocks it is sometimes necessary to process additional data, as for example name, according number, or numbers of technical drawings etc.

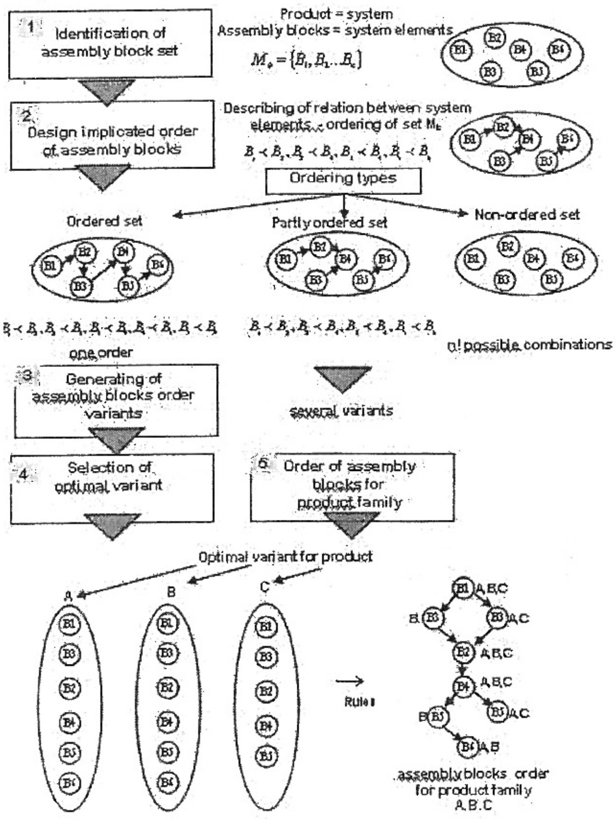
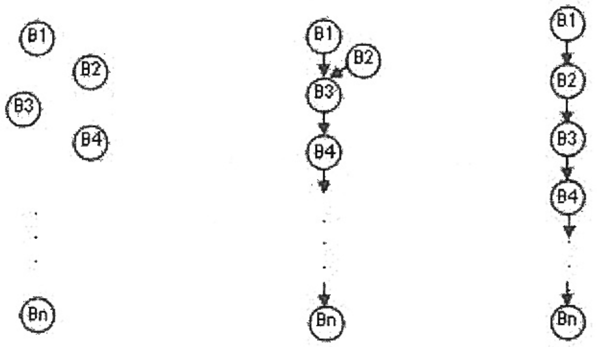


Fig. 2. Procedure of assembly blocks order analysis

III. CONSTRUCTION DEPENDANT SEQUENCE OF ASSEMBLY BLOCKS

Identified assembly blocks can be divided into independent blocks, that means assembly blocks, assembly of which



can be done in any time without the need to look at dependant blocks, that means blocks, assembly of which can be done only by assembling other blocks. This mutual dependence can be expressed and thus allowing the set of assembly blocks to become ordered. Dependant upon the construction of a product it is possible to obtain a set of blocks, which is non-ordered, that means there is no constructional conditioned dependence between the constructed blocks. Type of assembly of such product is

Fig 3. Examples of non-ordered, paritally ordered, and fully ordered assembly blocks

called the surface assembly. Set of blocks can be further partially ordered, that means that the mutual dependence exists only between some blocks and ordered, when we have a product, when there is only one possible sequence of blocks. Absolutely ordered set of assembly operations blocks means, that there exists only one sequence of assembly execution. Such type of assembly process is sometimes called layered assembly. Graphical representation of assembly blocks ordering is an oriented graph, where a block represents a node and relation of order is represented by node connection. For ordering of a set of assembly blocks following rules apply: Ordering relation is defined for every assembly block only once. Figure 3 is showing examples of non-ordered, partially and fully ordered of assembly blocks Most of machinery products belongs to the category of partially ordered assembly blocks. Incidental matrix (Fig 4.) expressing the relations is the base for eventual automated generation of sequence variants of assembly blocks by highly complex products with partially ordered set.

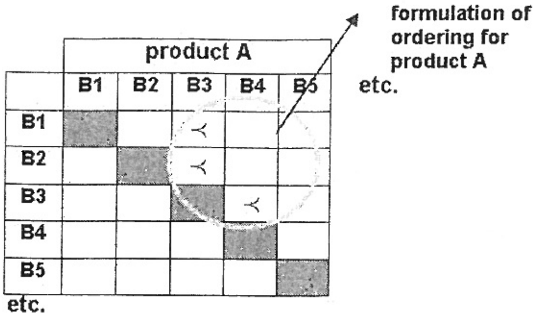


Fig 4. Incidental matrix for formulation of assembly blocks relations of product A

IV. VARIANTS GENERATION FOR ASSEMBLY BLOCKS SEQUENCE

High count of possible variant sequences of assembly blocks can be restricted by additional rules definition of ordering, which aren't conditioned by the construction of a product, but are resulting from the need of abidance of technological recommendations:

- prefer such sequence of blocks, where operations of the same kind are following each other
- prefer such sequence of blocks, which is characterized by minimal count of direction changes of the assembly process
- prefer such sequence of blocks, where there is an assumption of using the lowest count of assembly and leveling tools
- prefer such sequence of blocks, where we can asume the minimal number of stacks, palettes, etc.

Algorithm of variants generations:

1. Identification of the first and the last assembly block.
2. Generation of variants is beginning with the analysis of the last block of assembly, in front of which can't be any other block (a), one block (b), or more blocks (c), as shown in the figure 5.

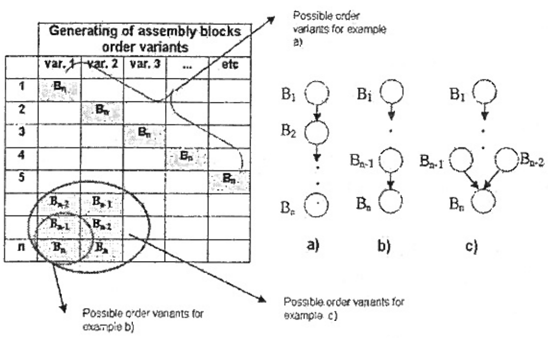


Fig. 5. Principle procedure for generating of assembly blocks order variants

V. SELECTION OF THE OPTIMAL VARIANT

If the technological point of views are considered in the phase of variants generation then we usually, dependant upon the complexity of a product, get 3 or 4 sequence variants of assembly blocks. Optimal variant of assembly blocks sequence can be selected based upon these criteria:

- balance of the estimated assembly time
- possibility of grouping based upon the similarity of connection technology
- minimization of technical devices count

The result is fully ordered set of sequences of the assembly blocks for every analyzed product in the form of oriented graph. Upon this basis it is possible to qualify the identity of individual assembly blocks and to make a model of assembly for a group of products (Fig. 6.).

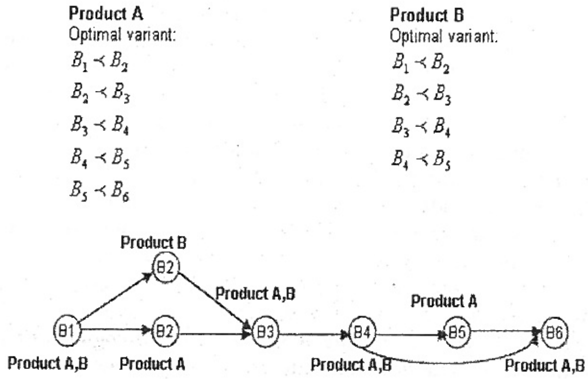


Fig. 6. Principle procedure for generating of assembly blocks order variants

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