The Assembly Technology Process and Part Feeding Model

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Abstract: Analysis procedure as a part of design method enabling a creation of assembly technology process and part-feeding model as a base for planning and design of assembly system is presented in this paper. The model enables a coupling of creative and logical techniques into integrated knowledge oriented system for assembly system design.

Keywords: assembly, assembly operation sequence, part feeding model

1 Introduction

Assembly as a part of production requests a systematic consideration owing to their complexity and lower level of development. One of the important approaches is creation of the theoretical and methodical procedures to assembly process formalisation and exact description. The increased possibility to computer support of the assembly design process required new CA-oriented models for various design tasks.

In the developed integrated methodical procedure for assembly process design was the main goal to create so scope in which the designer can to move in a large knowledge base and to use relatively independent methodical tools.

Assembly system design process incorporating into a complex system illustrates the fig. 1. The input relations are oriented on strategic analysis and goals and the output on the implementation and operation.

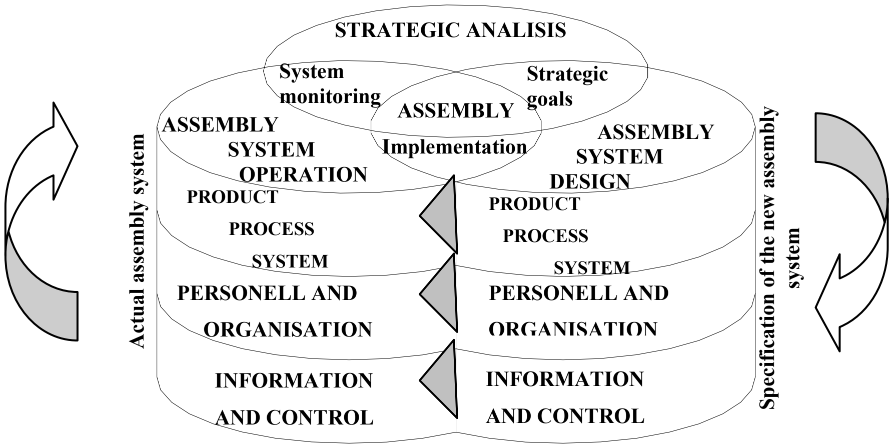


Figure 1
Analysis of joint technology

The methodical procedure (fig. 2) supposes integration of product structure and assembly operation sequences into one unit that represent the process nature i.e. give into relation the objects (assembled products) with the activity (assembly operations).

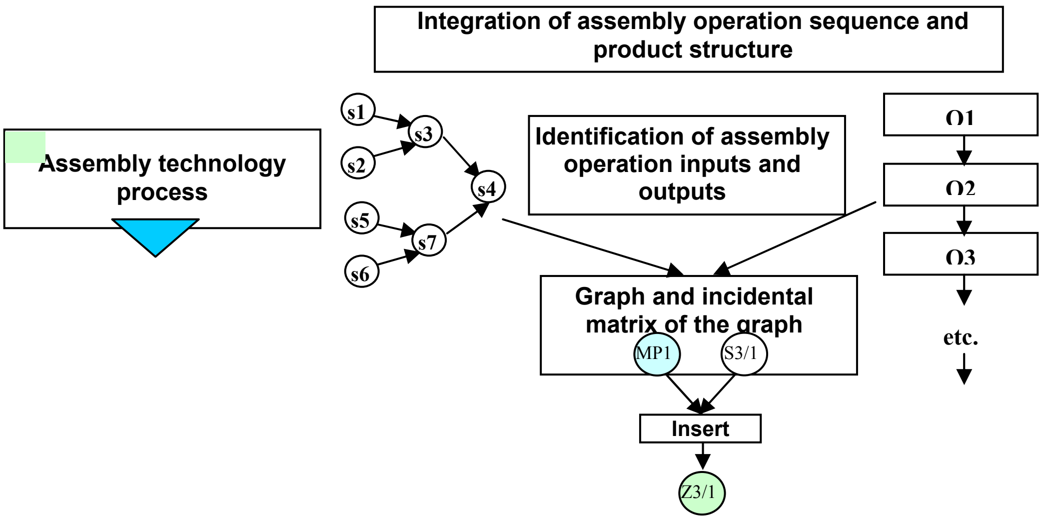


Figure 2
Analysis steps of joint procedure

2 Assembly Technology Process

Identification of assembly operation inputs

The set of assembly operations $M_o = \{O_1, O_2, O_3...\}$ and the set of a product parts $M_S = \{S_1, S_2, S_3...\}$ are in a correlation than can be expressly formalized. The elements of both sets are in graphical representation a graph tops and the relations between them are the graph edges. The elements of the set M_S „put into" the set $M_{o.}$ The main parameters of this relation are input part number and the order of their input.

Identification of assembly operation outputs

After realisation of every assembly operation is arises an assembly point. The set of assembly operation results can be signified $M_{vý} = \{V_1, V_2, V_3 ... V_n\}$, where V_n is the final product and *n* is the number of assembly operations.

Graph of assembly operation sequence

Graphical representation of assembly operation sequence with inputs and outputs and with several parameters is realised after the following conditions are met. The graph tops are the elements of part set M_S and elements of the assembly operation result set $M_{vý}$, e.g. inputs and outputs of assembly operations. The elements of assembly operation set M_o are represented by a rectangle. The relations are represented by an oriented graph edge, which is described as **(i, j),** where **i** is the number of elements put into assembly operation and **j** is the order of their input.

It is possible to describe the graphical representation in the form of incidental matrix. An example of an assembly operation sequence graph for given product is in the fig. 3 and the incidental matrix is in the table 1.

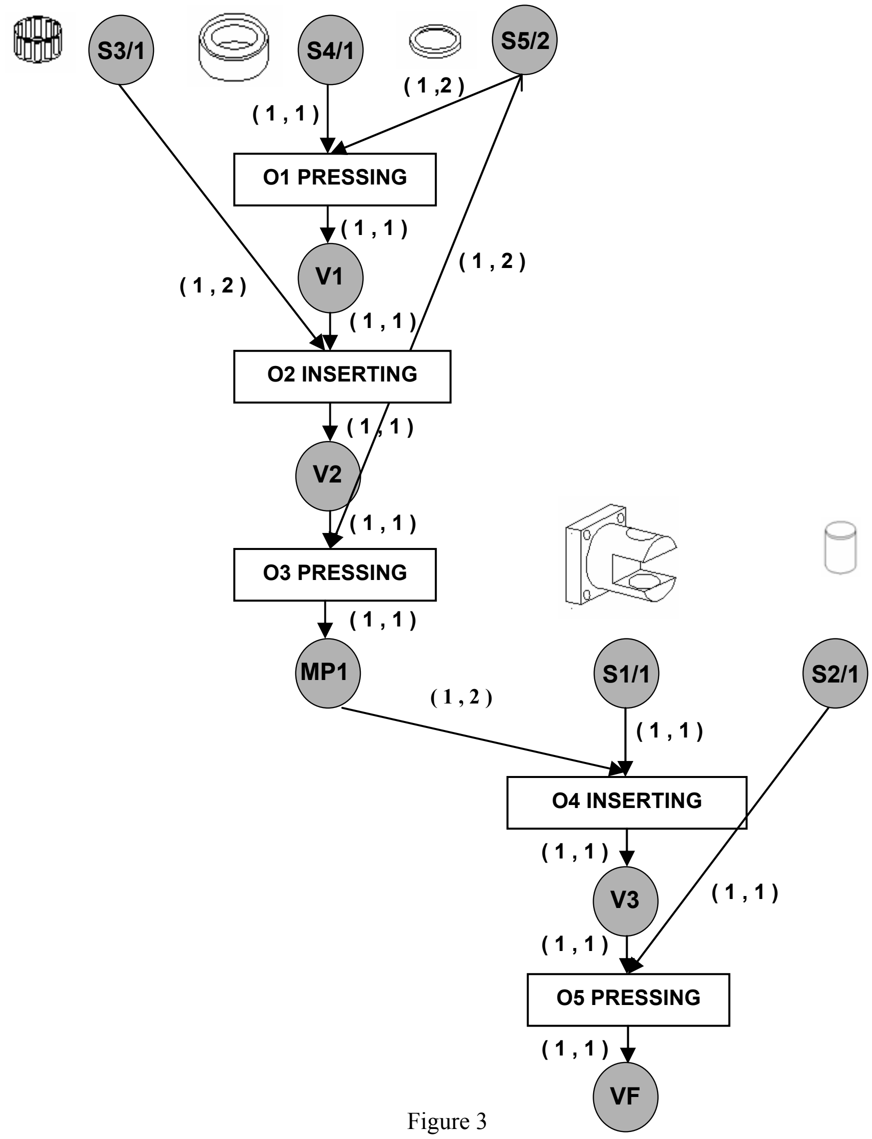


Figure 3
Graph of assembly operation sequence

Operations	S1	S2	S3	S4	S5	MP1	V1	V2	V3	VF
O1 Presssing				1,1	1,2		-1,1			
O2 Inserting			1,2				1,1	-1,1		
O3 Pressing					1,2	-1,1		1,1		
O4 Inserting	1,1					1,2			-1,1	
O5 Pressing		1,1							1,1	-1,1

Table 1
Incidental matrix of the graph

3 Model of Parts Feeding

The manipulation and orientation of the assembled product parts can be characterized as part feeding in space, time and defined orientation. It is complicated task if we consider possible complicated and various geometrical shapes of parts.

The steps of model creation in the fig. 4 related to purpose oriented classification and sorting system. Applied symbol modelling as a base of analysis enables a transparent and expressly interpretation. This model is in the suggested methodical procedure a basis for technical means selection by help of a systemotechnics.

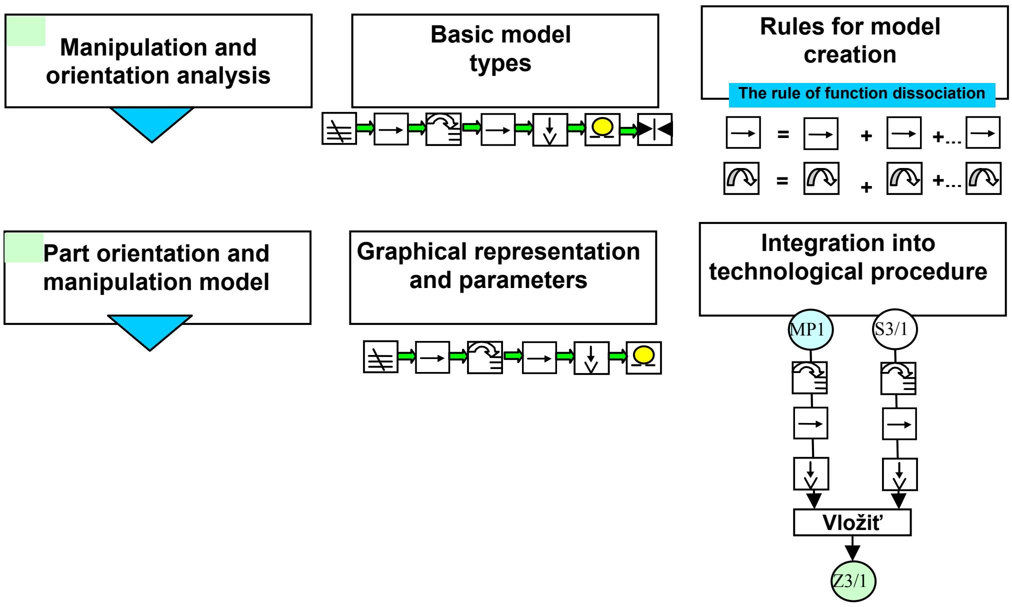


Figure 4
The steps of part model creation

Input identification

The main information about every part:

- Part symmetry characteristics
- Identification of this shape element or elements which are important from the point of view manipulation and orientation
- Characteristics of the part input state

Output identification

The characteristic of the supposed output issued from concrete requirements of every assembly operation. It is related to the part orientation and position as well as required part number per the time unit

Function identification

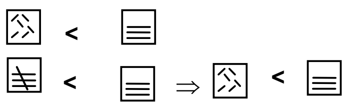
It is necessary find out the function system e.g. manipulation and/or orientation operation which must be realised to ensure the transformation the inputs to the outputs. By this analysis we can start out from the function set (see table 2). They are (table 3) also several basic models. The processing of the particular model can be realised by:

- adaptation of one basic model,
- modification of one basic model by contemporary observance of the rules for the function sequence creation,
- creating an own model

By the creation of the model it is necessary to observance of the following principles and rules:

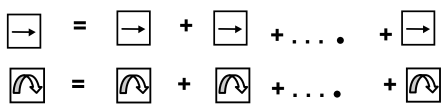
1 *The rule of function sequence*

The functions are following one after the other so, that the already obtained orientation and/or position were not retained in the further process.



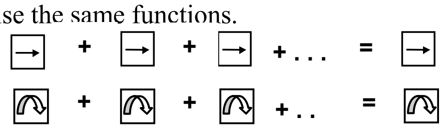
2 *The rule of function fragmentation*

It is possible to fragmentise the every function to in kind n-functions.



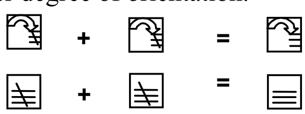
3 *The rules of function synthetisation*

It is possible to synthesise the same functions.



4 *The rule of function summing*

The function expressed higher orientation degree can consist of the sum of several functions with lower degree of orientation.



The rules 2, 3 and 4 are commutative i.e. there are valid also for the reverse process.

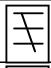
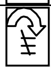
Function	Symbol	Characteristic
1		The supply of non – oriented parts without the exact position.
2		The supply of parts in the exactly position – die orientation is incomplete.
3		The supply of oriented parts in the exactly position.
4		The partial orientation of the parts.
5		The entire part orientation..

Table 2
Basic functions

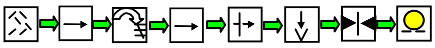
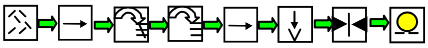
Model number	Symbolic model representation and their characteristic
1	
	Non – oriented supply of assembled parts, their transfer and partial orientation, the transfer of partly oriented part supply, part separation from the stream, inserting into the fixture, fixation and control.
2	
	Non – oriented supply of assembled parts, their transfer and partial orientation, entire orientation, transfer of oriented part supply, inserting into the fixture, fixation and control.
:	

Table 3
Basic function models

4 Graph of Manipulation Operation Sequence

Upon the base of listed rules it is possible to create a function sequence graph, which is necessary to realize for every part. The manipulation and orientation operation graph incorporating into the graph of assembly operation sequence gives a systematic view on several assembly tasks. In the fig. 5 is present an example.

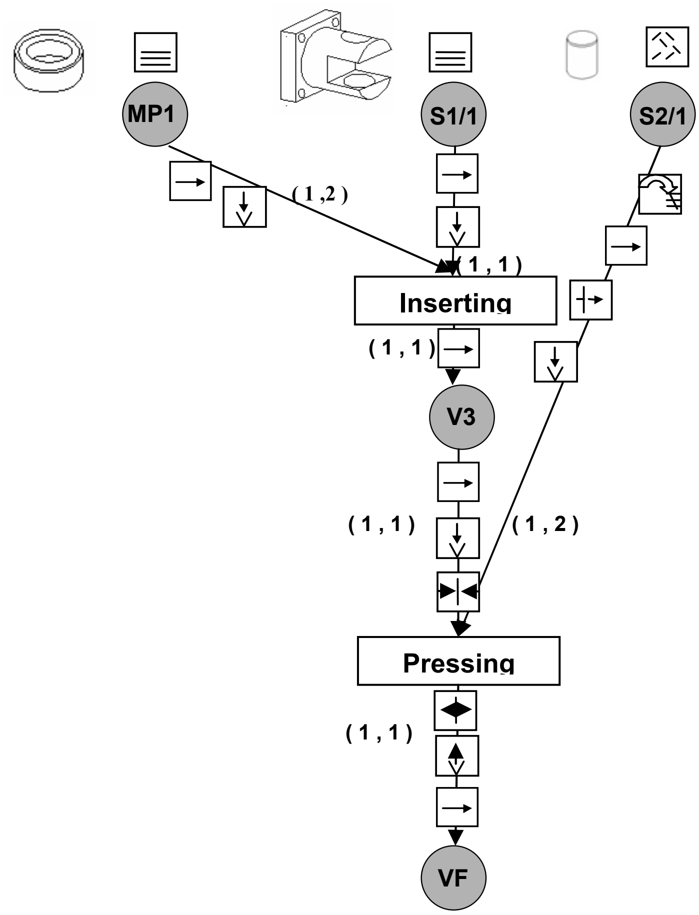


Figure 5
Example of a graph with integrated manipulation, orientation and assembly operation sequence

Conclusion

The presented model was applied on large number of different product types in Slovak firms and proved to be very useful. The great advantage is the possibility to create a model and we obtain a logical linear formal description. Defined model can use computer supporting. Applied results are a part of created knowledge basis of grant project VEGA "Innovation of hybrid assembly of customer oriented production".

References

[1] Kováč J., Svoboda M., Líška O.: Automatizovaná a pružná montáž, Košice Vienala, 2000

[2] Senderská K.: Inovačné metódy a techniky pre projektovanie zákaznícky orientovaných montážnych systémov, Doktorandská dizertačná práca, TU Košice, 2003

[3] Madarász, L.: Inteligentné technológie a ich aplikácie v zložitých systémoch**.** Vydavateľstvo Elfa, s.r.o., TU Košice, 349 pp., ISBN 80 – 89066 – 75 - 5, 2004

[4] Šimšík, D. – Kováč, J. – Madarász, L.: The application of expert systems in the design of robotic assembly, Lines Factory 2000. Churchill College, Cambridge, United Kingdom, 31. August – September 1988, pp. 213-221