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MANAGEMENT OF MANUFACTURING INTERIOR PARTS USING THEORY OF CONSTRAINTS

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Abstract: *The paper is oriented at application of the theory of constrains (TOC) in management of manufacturing interior parts for automobile industry. There is a brief description of technology in manufacturing the interior parts and an analysis of particular technology processes has been carried out to find a narrow point. On the base of the found data, the TOC has been applied consequently, which seems to be a sign of modern management.*

Key words: *Manufacturing management, interior part, analyses of technology processes, narrow point, theory of constrains*

1 INTRODUCTION

Competitive advantage of a company is, among other things, strongly related to the process of continuous improvement. The company is a socially-economical system, which can be observed as relatively closed. Its inner structure is made of components, which are generally employees, company departments etc. Outer environment of the company is represented by suppliers, customers, state, etc. The bonds between components can vary in complexity. While managing the company, it is important to have good knowledge of its inner structure and the bonds between individual components. Provided that only the inputs and outputs are identified, we can compare the company to the so called “black-box”. The transformation of the inputs to the outputs takes place in the company in order to achieve a certain goal.

The company processes can therefore be compared to a chain or a net of chains. A chain is only as strong as its weakest link. Assuming that we perceive the company as a chain of interlinked processes, there is always one process which limits the efficiency of the whole system. It is the weakest link of the chain. According to the theory of constraints (TOC) only strengthening of the weakest link, thus the system constraint, will lead to the increase of the efficiency of the company as a whole. Strengthening of the other links, neither of which are a system constraint, will mean a waste of resources. It will not lead to the increase of the efficiency because only the weakest link determines the maximal efficiency of the whole system. After the removal of the system constraint another link will logically appear and will be the weakest. The process of strengthening the weakest link is therefore an unceasing process.

By comparing the above stated approaches to the management methods applied in the majority of companies, we will learn that managers try to maximize the efficiency of all the processes of the company. Instead of trying to strengthen the chain they strive to increase the efficiency of all the links of the chain. They presume that maximization of the local efficiency will lead to maximization of overall (global) efficiency. They focus on increasing the weight of the chain instead of its strengthening.

2 CONSTRAINT MANAGEMENT

The weakest links of the chain of the company are various constraints which are divided according to their nature to:

- Physical
- Non-physical

Physical constraint can be resources, people, machines or material of a certain kind etc. Non-physical constraint is almost everything of intangible nature. The majority of constraints in the company are non-physical. In general the physical constraints result from the non-physical ones.

Characteristics of physical constraints:

1) Market is usually the most common type of constraint. Market is considered to be a constraint if the demand is lower than the capacity potential of the company.
2) Resources are a constraint if the company is not able to react to the requirements of the demand. For example, company does not have enough qualified employees or production equipment.
3) Material constraint occurs when the company does not have the possibility to buy enough material or material of sufficient quality to run its business.
4) If supplier unreliability or long delivery time cause undesirable delay of production we speak about a constraint in suppliers.
5) We speak about financial constraint if the company does not have enough financial means for purchase of resources for further production.
6) The constraint in knowledge and competency occurs when the company knows what would help to reach a higher profit but it is incapable of achieving it.

Characteristics of non-physical constraint:

7) In the majority of cases these are the particular procedures, habits, attitudes, rules, methods, which are imbedded in written or non-written form. These are procedures, attitudes and rules which were applied earlier when they served they purpose. However in present, they are insufficient for ensuring the competitive advantage of the company and in many cases they are the cause of various constraints, which therefore require change in intercompany policies.

3 BASIC TOC METHODS FOR CHANGES APPLICATION

For the realisation of changes in the company in accordance with the theory of constraints we can apply following methods:

- Application of Socratic method of inquiry

- The principal of five TOC steps (Five Focusing Steps)
- Techniques based on logical bonds

3.1 Socratic method

Socratic method is known as a dialogic method. It is based on the principal of asking questions in a manner which will lead the questioned to their own believe of a necessary change. In this way, the environment which is capable of accepting the necessary changes is created.

3.2 Principal of Five Focusing Steps

Implementation of the theory of Five Focusing Steps (TOC), to find a narrow point and remove it consequently, is realised step by step in five steps:

a)Identification of system constraint
b)Decision how to exploit the system constraint and exploit it to the maximum
c)Subordinate everything to the above stated decision
d)Remove the system constraint
e)If the constraint is removed in the last step, go to the step one.

The principal of Five Focusing Steps is the process of change which should improve the present state of the company. Finding a system constraint is not usually very complicated if the constraint is of the physical character.

3.3 Techniques based on logical bonds

As the principal of Five Focusing Steps is aimed at removal of a constraint in the process of improvement so are the TP techniques aimed at removal of factors which restrain the system from achieving its goal. TP are composed of five logical diagrams:

a)Current Reality Tree – CRT
b)Evaporating Cloud – EC
c)Future Reality Tree – FRT
d)Prerequisite Tree – PRT
e)Transition Tree – TT

These techniques are based on logical principles, so called Categories of Legitimate Reservation (CLR), which are rules stemming from conditions of necessity and sufficiency. Firstly, the negative symptoms are identified through the use of TP, so called UDEs (UnDesired Effects) which describe the present undesirable state of the system. The key problem which stands in the background of the undesirable state is identified based on these symptoms. Afterwards a measure is specified, so called injection, through which is the key problem removed, UDEs are converted to DEs (Desired Effects) and the procedure of their implementation is determined.

4. BRIEF DESCRIPTION OF PRODUCTION TECHNOLOGY

The dashboard is composed of three layers: the bottom plastic part with a portion of glass fibres, the top part which is composed of spatial formation with undevelopable surface prepared by hot-rotation sintering of powder PVC and of an inner polyurethane filling prepared at a robotized workstation by the means of chemical reaction of two components, polyol and isocyante (TDI). All three layers form one unit (sandwich) which is in general equipped with an airbag and is one of the safety parts of every car.

The bottom plastic part is produced by the technology of spraying from granulated PVC on spraying machine. The whole work cycle, from the closure of the mould to the removal of the moulded piece from the mould, is fully automatic. After the production of the moulded piece and its cool down, follows the in hand trimming of possible overflows including removal of inflow system.

The top part of the dash board is produced on a special machine by the means of hot-rotation sintering of powder PVC technology, closable carrier is equipped with a mould that has a cavity which corresponds with the shape of the dash board including the surface design. A certain amount of powder is poured into the mould the carrier is closed and this is followed by the heating up of the inner space up to the temperature which is set by the melting point of the PVC powder. The carrier along with the mould is set to a rotational motion (rotation along the horizontal axis) which contributes to the even filling of the spatial shape of the mould by the melted PVC powder. After the stopping of the rotational motion follows air cooling, opening of the cylindrical mould carrier and withdrawal of the prepared top part which has to be treated by cutting the superfluous rims.

The middle polyurethane layer of the dash board, which connects the bottom carrier layer with the top layer furnished with design produced in required colour of interior, is created by the chemical reaction of polyol and isocyanate. Both of these components are poured in certain proportion through the set trajectory by the robot which works in the fully automated regime. The pouring of both components takes place into an open mould on the underside of the top part. The actual chemical reaction (strengthening) proceeds after the closure of the top part of the mould where the bottom plastic part is gripped.

Apart from the stated basic operations, which are necessary in order to create three-layer sandwich which is the main component of all interior parts, there are other operations which are a part of production process. They are related especially to the customization of the size (milling), the assembly of the safety components (airbag), and the insertion of retainers and the actual assembly of the dash board, which was realised at separated workplaces.

5. ANALYSIS OF THE INITIAL STATE

Before the realisation of the analysis it was necessary to determine its goal, therfore the standpoint from which will be the production process analysed and consequently optimised. The indicator of productivity which was defined as the portion of processed interior parts to the time necessary for their processing was determined as the main criteria. Provided that the number of processed orders is firmly given by the production plan, it is possible to increase the productivity only by lowering the value of time necessary for processing the given number of orders.

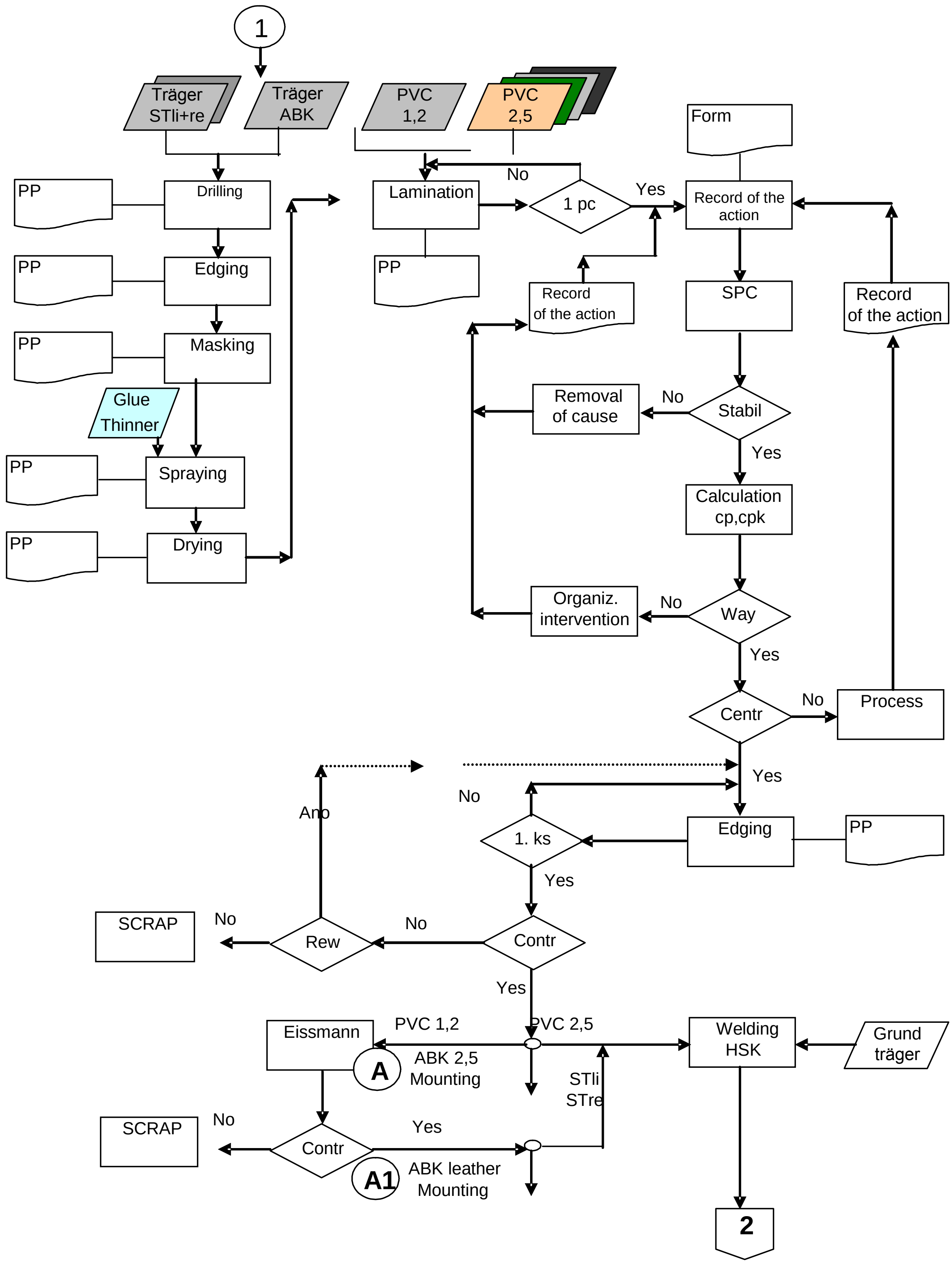

Fig. 1 Flowchart 1

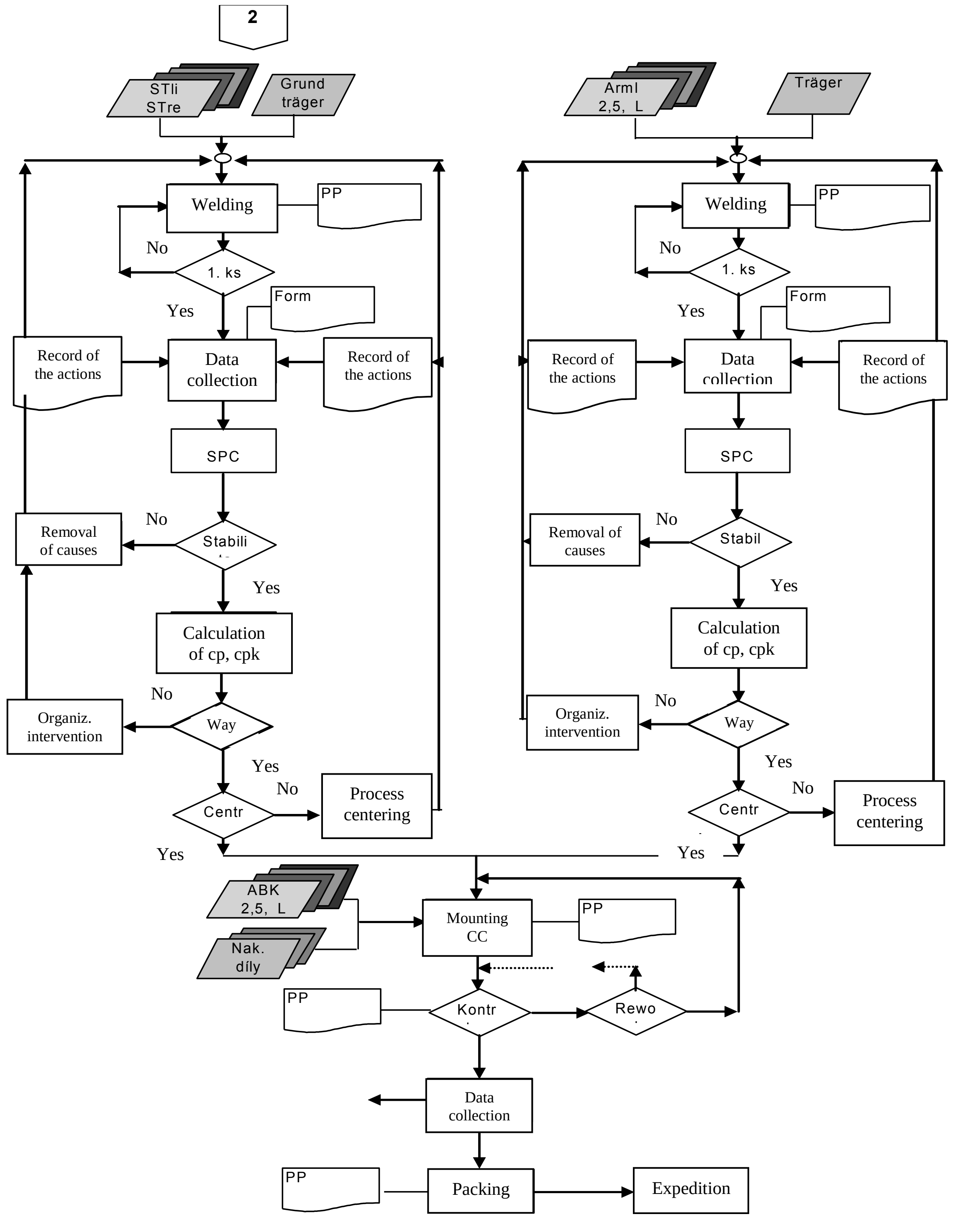

Fig. 2 Flowchart 2

The aim of the analysis is the determination of the most factors as possible, which have an influence on the value of time necessary for processing the orders. After the mapping of various methods, the causal analysis was chosen as the most suitable one. Like the relation analysis it deals with the bonds between the components, phenomena, etc. However, in contrary to the relation analysis, the casual analysis deals only with transversal relations. It tries to discover the causes and their consequences, e.g. what causes which phenomenon, and what is the cause of which phenomenon. It is necessary to take into account that every defined, cause-consequential relation is a certain simplification of the reality.

Through the use of causal analysis it is possible to create a modified tree of the present reality which clearly illustrates individual factors and their cause/consequential relations, by which they influence the value of time necessary for processing the orders in the production process. The tree of present reality is a logical tree which aim is to reveal the problems in the system in complex situations. It expresses the present reality through causal bonds through which it goes deep into the present reality and reveals the key problem, which is responsible for the majority of the present negative symptoms (UDEs). Its assembly helps to the better understanding of the system as a whole, objectively shows the sub-optimal state of the system and indentifies the constraints, at which the change should be aimed.

The base for its creation was observation of the processing method, interviews both with managing workers as well as with ordinary workers and some of the empirically determined values and facts (time analysis).

Four basic areas were determined in the tree to which the attention should be paid while proposing the subsequent optimisation solution:

a)Time depletion while moving from one operation to another
b)Problematic layout and the increased manipulation connected with it
c)Formation of queues at some workplaces
d)Hand writing of dispatch notes by the operators

Table 1

	Operation	Mechanical time [sec]	Hand time [sec]
1	PVC granulate preparation		---
2	Injection production	58	
3	Inflows cutting		55
4	Assembly of airbag frame	59	
5	Preparation of PVC powder for rotational sintering		326
6	Production by slush rotational sintering	122	
7	Removal of the parts and cutting of the rims		155
8	Perforation	60	
9	Insertion into the mould		35
10	Foaming	62	
11	Insertion into the machine		31
12	Milling of the rims	55	
13	Insertion into the machine		30
13	Welding of the airbag frame	61	
14	Final assembly		135

It is obvious from the time analysis and the modified tree of the present reality that the narrow point, which constraints the flow, is the production by slush rotational sintering including the menial works connected with the preparation of the PVC powder: drying, quantity measurement, dosage and filling the mould.

While managing the interior parts production with the use of the tree of present reality, it is obvious that production of a part by the means of rotational sintering of PVC powder is the narrow point which determines how the output of the whole production process will look like. This production equipment is marked as "drum". It determines the "rhythm" of the whole production. Therefore it is necessary to protect it. "Buffers" are used for this purpose. They are placed before the limiting source, in order to prevent its inactivity because of non-delivery of material from the previous source.

6 CONCLUSIONS

Implementation of DBR for certain critical workplace is only a temporary solution, until the five focusing steps are fulfilled. But in respect to the fact that the cycle of five steps is obviously not a question of a short time period, the implementation of DBR (which is the first phase) will take place as well as the subsequent production management according to DBR (the second phase). This state will be stand until the narrow point changes, a new cycle of five steps will occur and the DBR method will be introduced for the newly aroused constraint.

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