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TOOL MANAGEMENT IN THE PRODUCTION SYSTEM

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Abstract. The paper herein puts forth a few introductive notions connected to managing the tool flux within an enterprise. The notion of „tool flux" is defined, enhancing the differences from the material semi-manufactured product flux. Any factory, whatsoever the product it processes and whatsoever the type of material processing, is vulnerable to internal perturbations, among whom the variation of the tool flux is of major importance. Preventing vulnerability is achieved through management in real time, which, for eliminating the penury and the surplus, has to ensure the minimal safety stock, regulated through managerial decision.

The main issue of tool management consists in the fact that "at request, any tool, of any type and dimension, must be available within the right time, at the right place" so as to cast off the tool penury in the system

Keywords: management, school flux, monitoring

1. Introduction

Stock management consists in material management and sets out to substantiate decisions upon optimally employing material resources and upon managing the provisioning/marketing process. Stock management entails fore-knowing the minimal admitted stock level from different sources and pursues avoiding penury/excess through decisions regarding the provisioning/marketing moments in the minimally necessary quantities at optimal costs. The purpose of material management consists in simultaneously synchronization between sales and provisioning [1, 2, 4, 7].

2. Global tool flux

The overall tool number necessary for executing a process, and to a even lesser extent the overall tool number existing within the factory at a given moment does not fulfil both theoretical and practical conditions to constitute in a system.

Therefore, the tools will be deemed as a flux flowing from the central deposit to the factory (central total tool set - SScC = the necessary outfit or general tool level - NSc), towards the departmental zonal deposit (zonal tool set - SScZ), towards the machine local deposits (local tool set - SScL), towards the machines (operation tool set - $SScOT_i$), following the perturbation monitoring track and correcting track (control, selection, re-grinding/sharpening, broken tool elimination, set-up, pre-adjustment). This one will bear the name of tool flux, put down as FlS.

In the fabrication flux, the tools are completely consumed in processing the finite tools (Pf), which makes the tool flux (F_lSc) not to have its own outlet and therefore be open and atypical. The input is connected to the input exoenvironment of the manufacturing system. (SFa) – The market of tool suppliers (PiFzSc) and the outlet – to the fabrication flux (figure 1).

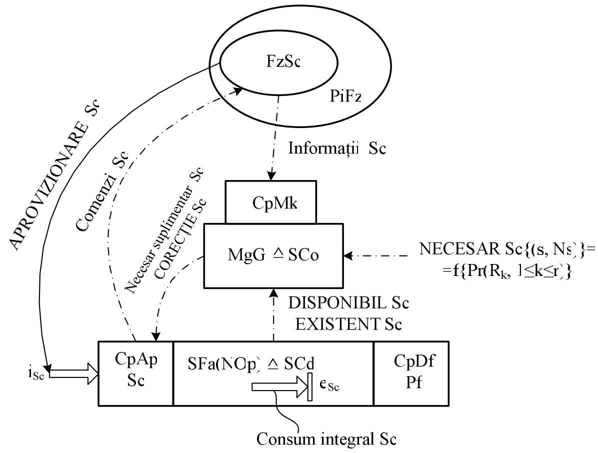

Figure 1. Global tool flux

3. Vulnerability of the tool flux

Any factory, whatsoever the product it processes and the type of material processing, is vulnerable to internal perturbations, among whom the tool flux variation is of major importance. The tool flux varies through the exclusively internal consumption; of the exclusively internal tool flux, during which there may appear **penury and excess**

events. The tool penury blocks the manufacturing flux and the excess – immobilizes important circulating means, both with negative effects upon the financial state of the factory.

The fabrication system has to function so as to wholly eliminate both the penury and the excess of tools. This fact is only possible through managing the tool flux in real time.

Preventing vulnerability is achieved through management in real time, which, so as to eliminate penury and excess, must ensure the minimal safety stock through managerial decision.

4. Paradigm of tool flux

The classical paradigm of production systems cannot be applied to the tool flux, this one requiring a new philosophy in approaching the management strategy. The classical paradigm in managing production systems consists in leading them towards reaching the planned quantitative levels, through regulating the rhythms, through varying the resources and through making efficient use of them in real time. The variation of the **quantitative level of the tool flux** [8] is conveyed by the tool internal consumption, which renders it atypical. **The internal tool consumption is a perturbation as it influences the outlets for stationary inputs**; the consumption is brought about by the causes: break-ups, wear and tear, derangements denominated as follows **tool flaw**. If the wear and tear are predictable and therefore may be foreseen in anticipation, with correction effect, through preventive programs, the breaking up and the deregulations are pre-eminently unpredictable, with decisive influence upon the variation of the quantitative level of the tool flux. **The wear and tear only influences the local hierarchical level** of the tools, in great number and with relatively great frequency. Through preventive programs, the influence of the wear and tear upon the level of the tool flux may be reduced up to zero value. **The breaking up; and the derangements influence all hierarchical levels**: central, zonal and local, bringing along the tool circulation along the entire flux. Although the number of the breaking-ups, of the derangements as well as their frequency is small, comparatively to the wear and tear, their influence upon the variation of the quantitative level of the tool flux is of significance. The tear and wear bring along the tool circulation, exclusively in the endoenvironment, between the local piling up stock – tool dresser for re-grinding/sharpening and zonal piling up stock – local piling up stock for replacement, without affecting the quantitative level of the tool flux. The derangements bring along the tool circulation, exclusively within the endoenvironment, between the local piling up stock – post of pre-adjustment for the adjustment and the zonal piling up stock – local piling up stock for replacement, without affecting the variation of the quantitative level of the tool flux. The breaking ups induce the tool circulation in the endo-exo-environment and its reverse. The endo-exo-environment motion results in eliminating the broken tool, as waste, between the local piling up stock and the post for collecting the waste from the exo-environment and the circulation exo-endo-environment consists in provisioning from the exoenvironment, the central deposit, followed by its motion, set-up and pre-adjusted, through the zonal piling up stock, in the local piling up stock. Consequently, the tool breaking up affects the variation of the quantitative level of the tool flux. The complete utilization of each tool, after a predictable number of re-sharpening operations, influences the quantitative level of the tool flux. Consequently, **the provisioned tool quantity, on the inlet, modifies the quantitative level of the tool flux in the endoenvironment.** Quantity supplied on entry into the central warehouse is the result you want to cancel the disturbance of endoenvironment – breaking and complete exhaustion of tools in manufacturing. The quantity of provisioned tools depending on the breaking up, and likewise tear and wear of the tools, unpredictable and consequently unforeseeable, must be managed (monitored) in real time being unpredictable.

The rhythms of tool flux regulation [8] depend on the hierarchical level, on the tool condition and conditioning, on their type and number, on the breaking up frequency and on the replacement frequency. The regulation rhythm is influenced by the “emergency of tool replacement” (changing time) as well as on the delays (usually of the second order) which appear during the tool manipulation on the flux [3, 6]. **The influence of the regulation rhythms**, on the zonal and local hierarchical levels, upon the quantitative level of the tool flux within the system **is minor, negligible only under the conditions of out-going the tool provisioning through a preventive program,** through whose intermediary there is accepted a **minimum necessary stock** of tools, thereby avoiding any tool penury, a procedure frequently used in any factory. On the local hierarchical level, the rhythm of tool replacement, brought along by whatsoever cause, is high, and greatly influences the tool quantitative level. Therefore, the tool circulation between the zonal piling up stock and the local one is “alert”. In this area of tool replacement, so as to avoid tool penury and the wastage of time, there is a must the existence of a **pre-determined stock** for every type of tool, **reduced replacement time**, **delays in replacement of the first order** (exclusively depending on the logistics type for replacing tools; there are excluded the delays, the waiting lapses brought along by subjective causes). Consequently, the quantitative level of the tool flux within this hierarchical, powerful and rapidly varying level must be quickly regulated, with effects ensuing from here upon the management organization and upon the choice of tool logistics. Consequently, the paradigm of the tool material management differs from the semi-manufactured products / finite product management and consequently, in the real production environments, the tool flux and semi-product flux are separate, functioning independently. The result of this situation consists in **different management strategies for the tools as compared to the semi-products.**

The strategy of tool management includes being acquainted with all events intervening within the process of tool replacement, their control and orderly arrangement, as well as their taking into evidence, monitoring and correction decisions-making, their subsequent evolution into strictly orderly arranged and controlled evidence. The entire strategy is exclusively applied to the endoenvironment. Its effects may be measured in the exoenvironment only as internal perturbations with negative influence.

One of the important issues in the tool management strategy consists in **orderly arranging the selection** of the tool type from the multitude of tools within a piling up stock. This issue is carried out on the basis of the following grounds: in a current moment, there is selected a single tool; through a current manipulation there is transferred a single tool from the supply departure point to a delivery destination point; any manipulation is either aimed at extracting the used tool from the main shaft of the machine, or aimed at feeding it with a new tool; any manipulation takes an auxiliary time which, to the purpose of minimizing the waiting time for the machine, must be as short as possible; during the tool manipulation, the machine is not running; the tool manipulation is preceded by an outrun anticipated selection of the following tool in the local piling up stock; the anticipated selection of the following tool must be superposed over the working stage of the current tool and therefore the selection duration must be shorter or at least equal to the period of the current phase cycle.

Engineering heuristics of material processing orderly arranges processing, according to their duration. Consequently, for a catastrophic perturbation (hypothetical, when all tools within a piling up stock would break), the extraction and the re-provisioning of the piling up stock with tools would have to observe the previous orderly arranged succession, allowing that during a milling cycle – the drills, the reamers, the boring bars, the chamfering bits, the bladders and the taps might be replaced, minimizing thereby the waiting time for the machine. Consequently the order for selecting the tool changing in the stock piling up will be: milling cutters | lathe tools | abrasive blades | boring bars | drills | taps | reamers | counter bores | core drills | chamfering bits | etc.

Supply discipline. Engineering heuristics [5] enhances the fact that, from the flawing standpoint, the tools may be classified in tools characterized by great, medium and reduced flawing liability. The tools with strong flawing liability are, in order: center bits, t, reaming tools and boxed heart checks and splitting cutting tools; the tools medium flawing liability are boring bars, core drills / counter bores / end-mill type gear cutters and the weakly sensitive ones to flawing are generally the cutting mills and the grinding wheels.

In order to avoid the tool penury during the tool flux, there must be a quantitative level of $(1+n_{ScST})$ units for each type of tool, in which 1 stands for the tool in current use and n_{ScST} – for the number of tools on anticipated stock, determined through operative managerial decision, which varies depending on the tool flawing susceptibility. This way $n_{ScST} = 1$ for the tools with small flawing liability, 3-6 units for the tools with medium flawing susceptibility and 10-20 units for the tools with great flawing liability.

As compared to the semi-manufactured products, in the tool flux, there is no supply discipline as the tool does not undergo a process of choice but this tool, once entered in the flux, is non-preferentially used until total wear and tear and replaced.

The principal issue for the **tool managing strategy** in the production system consists in the fact that "**at request, any tool, of any type and dimension, must exist in the right time, at the right place**" in order to eliminate the tool penury from the system. This is only possible through monitoring in real time and through strongly reactive operative-tactical management. The quantitative levels and the regulatory rhythms cannot be provisioned and therefore planned, as they depend on unpredictable random factors. The operative management of the tool management is effectively carried through monitoring their consumption in real time.

Monitoring management tools. Tool monitoring consists in pursuing over the system and in and supervising their consumption almost on every machine throughout system, their spatial circulation on every trajectory of the itinerary transport plan and signalling the penury apparition danger for every tool in the system. Monitoring implies periodically elaborating monitoring reports and sending them over to the tool provisioning department and to the production planning department.

Replacement and up-dating. Any tool existing in one of the three conditions – U, D, R, will be called flawed tool. Any flawed tool must be changed to the purpose of its re-conditioning for re-utilization. During reconditioning, the tool is not used within processing. After reconditioning, the tool is re-introduced in the pre-processing tool flux. Getting the tool out of the flux for re-conditioning and re-introducing it into the flux brings along the variation of the quantitative level of the respective tool in the local piling up stock.

To avoid the penury of any tool in the local piling up stock, there has to be maintained a minimum quantitative level. To this purpose, any reduction in the quantitative level for any tool, brought along by any perturbation in the flux, must be corrected through an up-date re-provisioning of the quantitative level for the considered tool. The up-date is only done at request and effects in correcting the quantitative level only for the local piling up stock. The up-dating consists in correcting the two monitored parameters, which are: the type s of the current tool ($1 \leq s \leq s_t$) and the level N_s of the current tool Sc_s ($N_s = 1 + N_{STL\ Scs}$, where $N_{STL\ Scs}$ is the minimum necessary quantitative level in units, which must be found in the local tool piling up stock). Any up-date provisioning in the local piling up stock compulsorily stirs the tool circulation from the central piling up stock to the zonal piling up stock. Any reconditioned tool will bed re-allotted in the zonal piling up stock.

To come up with a conclusion, any flawed tool imposes its replacement from the local piling up stock and it's up-dating with a new tool of the same type. The flawed tool follows a pre-determined reconditioning or elimination procedure.

5. Conclusions

The overall tool number participating in the execution of a process does not make up a system, only a **conglomerate** which will be named tool flux. The tool flux only has only input into SFa; it has no outlet, it being integrally consumed in the material processing through several times repetitive circulation in the system. The tool re-circulation in the system is either done to the purpose of correcting flawed tools, named **completion** or to the purpose of replacing flawed tools, called **up-dating.** The completion and up-dating are aimed at avoiding penury in local piling up stocks.

The main internal perturbations in the tool management process are the tool penury and excess. Both perturbations make SFa excess vulnerable to the market requirements. The tool management process fits within the global manufacturing process as Integrated Kanban Process.

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