JUST IN TIME CONCEPT AND ACTIONS OF MAINTENANCE

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Abstract. JIT came into focus both in logistic and industrial production and represents the sum up of actions being undertaken by a company in order to provide all components/assemblies to a customer assembly's line without breech of continuity in delivery or stocks. It is being assured running of the assembly line without unexpected interruption. Therefore is mandatory that maintenance activity carries on according to specific strategy. In this paper, the characteristics of some maintenance methods applied by the companies are presented in order to assure fabrication tact and planned deliveries.

Keywords: maintenance, concept Just in Time, equipments, defects, technological system.

1. INTRODUCTION

The quality of products is defined by the performance level that must fulfil customer's expectation. All enterprises activities starting with product and designing, fabrication, homologation to delivery and setting in motion, to maintenance shall be performed based on rules, some of these being standardized.

Maintenance activities restore breakdown equipment/machine to designed operational parameters. Equipment/machine manner and level of use in exploitation and maintenance activities must assure increasing operation period and degradation prevention [5], [7].

The productivity and quality of enterprises products represent fundamental conditions of competitive on a continuously expand market with trends of globalisation. The increase of productivity is obtained by increasing of integrated technological system disponibility. System's disponibility is described by its reliability and maintenance capability.

Maintenance activities structure is based on specific tasks that must be carried on at a given moment [2], [12]. Consequently, reliability, maintenance, operation according to procedure and update will lead to disponibility increasing. This require different types of maintenance.

Thus, from the point of view of maintenance, an upper disponibility is obtained more using preventive and predictive maintenance activities (and another activities part of Total Productive Maintenace-TPM) [3], [6], [12] than corrective maintenace. In brief, TPM represents an equipments management .

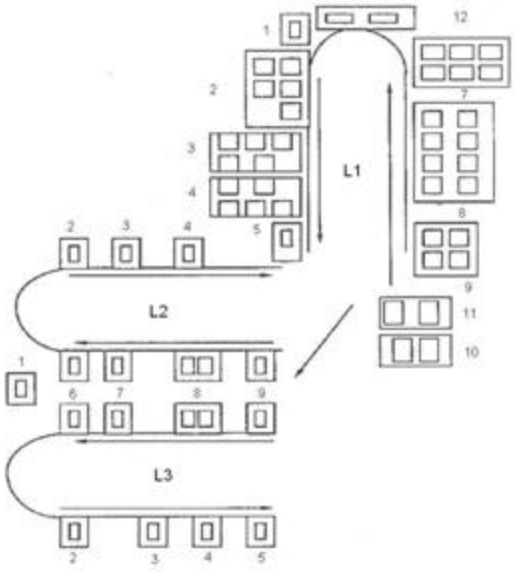
In this paper we intend to bring new elements to support statements [2], [7], [14] like equipments/machines maintenance that is fundamental for a production system that fulfil requirements of Just in Time (JIT).

Every production system is build using production systems, equipments or machines interconected, created to successivelly transform raw materials in final products. Its structure is determined by component subsystems (technologic, logistic, control, auxiliary)

2. JUST IN TIME CHARACTERISTICS

As JIT stated, in a production line or in a production flow the previous step won't produce more parts then the next step requires [14].

Machines and equipments may be set up from „groups" of identical machines to production cells to meet production requirements. Thus it has been created multiprocess production line (fig. 1).



1 – solder;
2 – chipping;
3 – laser control;
4 – electric test;
5 – cure;
6 – sanding;
7 – chip removing process;
8 – chip removing process;
9 – storage;
10 – control post;
11 – adjustement;
12 – fitting;
L1, L2 L3 – multiprocess transfer lines.

Fig. 1. Example of multiprocess cell structure

Hereinafter, it will be showed how the maintenance activity affect Just in Time system.

JIT aims to have a production of components and sub-assemblies at a right time, appropriate quantity and low costs. JIT pursues the goal of one piece flow, batch production with minimal fund in the system. There will not be produced more components then is required by the next step.

Thus, for instance, in JIT assembly line, independent isolated units are linked with conveyor lines conveting many discreete operations into a lean and continuos production line.

From the point of view of the process flow, the four reasons [12] that parts typically stagnate are:

- Equipment breakdown occurence are frequently or the repair requires longer time;
- The change of the product requires longer time for ajustment of the machines, gadgets, tools, control agents and auxiliary ones;
- When the number of quality defects is high in production, arise inevitable stops that have as a result funds with after-affect;
- Unsafe equipment (or behaviour) have a negative effect on production, therefore diagnostic activities (monitoring) are required.

It raised necessity to adopt management equipment concept. This concept represents all activities that prevent quality defects and breakdowns of machines/equipments, reduced set-up times, eliminate the need for equipment adjustement and make the work easier and safer for equipment's operators. An application of equipment management is Total Productive Management –TPM. Tsuchiya has claimed [14] that JIT cannot be established without TPM and other activities. It is therefore valuable to introduce JIT after what TPM has reached a certain level while continuing to develop hereinafter. It is proposed focusing on the effort to eliminate or minimize wastes called „The Six Big Losses", described as follow:

- Loses caused by accidentally machines/equipments breakdown, induced by deterioration of mechanical, hydraulics and electrical components;
- Set-up and adjustement losses at every production requirements changeover(tools, control gadgets);
- Idling and minor stoppages losses. Could be minimized if the equipment/machines are ready to start at any time in response to a production requirement;
- Speed losses caused by bottleneck in production that require improvement of operating rate especially of identified bottleneck machines;
- Defect losses caused by process failure or nonconform parts, accepted as losses and minimized or being eliminated. The focus must be done on maintenance of valuable/quality parts and defect free operating conditions;
- Yield losses. Spending time to start-up machines/equipment is considered a loss. This losses are considered process variables.

An increasing number of companies determined that though productivity has an increasing trend, there are a lot of improving oportunities such as: more efficiency operation of machines/equipment, TPM activities (life-cycle maintenance strategies, machines/equipments effective, improving maintenance activities, involving design, planning maintenance deparments in global operating system of a enterprise)

In table 1 you'll find the main strength points of applying TPM.

Tabel 1

TPM strength			
Productivity - ▪ Losses minimzation	**Quality** - ▪ defects and breakdown minimization	**Costs** – ▪ Losses and other small costs minimzation	**Delivery time** – ▪ Planificated production ▪ Production interruption minimzation

3. MAINTENANCE METHODS

Maintenance methods are established depending on the moment of action against machine/equipments and could be classified as follows:

- Corrective maintenance;
- Preventive maintenance;
- Predictive and proactive maintenance.

Due to the increasing of sensors performance, diagnostics methods [4], [8], [11] and software, companies execute maintenance activities depending on its own needed, equipment's performance, delivery time, inventory etc, that lead to multitude of methods hardly statistic counted.

Every method has strength and weak points and specific way to put in effort.

Standards for different industries have requirements for manintenance. For instance, *ISO TS 16949:2002 Particular requirements for the application of ISO 9001:2000 for automotive production and relevant service part organizations* has a particular demand called preventive and predictive maintenance, where is descried minimum requirements a companiy shall fulfil.

Corrective maintenance. Corrective maintenance is aplicable for restoring machine/equipments working performance when breakdown occurs. In this case, component, subsystem or system is keep on running until failure or breakdown occurs. Component, subsystem or system failure may occur before maintenance activities would have been done.

We highlight two majore strength points: machines are not “overmaintained” and no condition monitoring related costs; and as a weak points we underline high risk of secondary failure and overtime labour affecting production.

Preventive maintenance represents activities of exchanging components at preset intervals depending on exploitation period. Thus, is prevented equipment failure during operation or its deterioration to breakdown. Repairing or service is done at preset intervals by either subcontractors or trained maintenance operators. Preventive maintenance is so-called planned, historical or calendar maintenance.

Proactive and predictive maintenance represents equipment management activities to evaluate, adjust and if necessary exchange equipment components based on its condition [10]. Therewith, is prevented machine/equipment failure. In the predictive maintenance, so-called Condition Based Maintenance (CBM), maintenance activities intervals are determined by assessing component, subsystem or system condition. This is realised by applying various diagnostics methods such as: vibrations analysis, oil analysis, voltages and current variations, etc. In the proactive maintenance, one tries to find a root cause of component, subsystem and system failure and then tries to prevent it to happen again. The result of this effort is obtained by modifing equipment/machine cinematic or constructive structure or by using designing experience. Predictive maintenance gives us an early signal of potential failure or breakdown caused by components deterioraton. Proactive maintenance is so-called Relibility Based Maintenance or Precision Maintenance.

The execution of any these methods require maintenance operators qualified in products reliability and quality [15].

In fig. 2 are presented weak and strength points of the maintenance methods described above [2], [13].

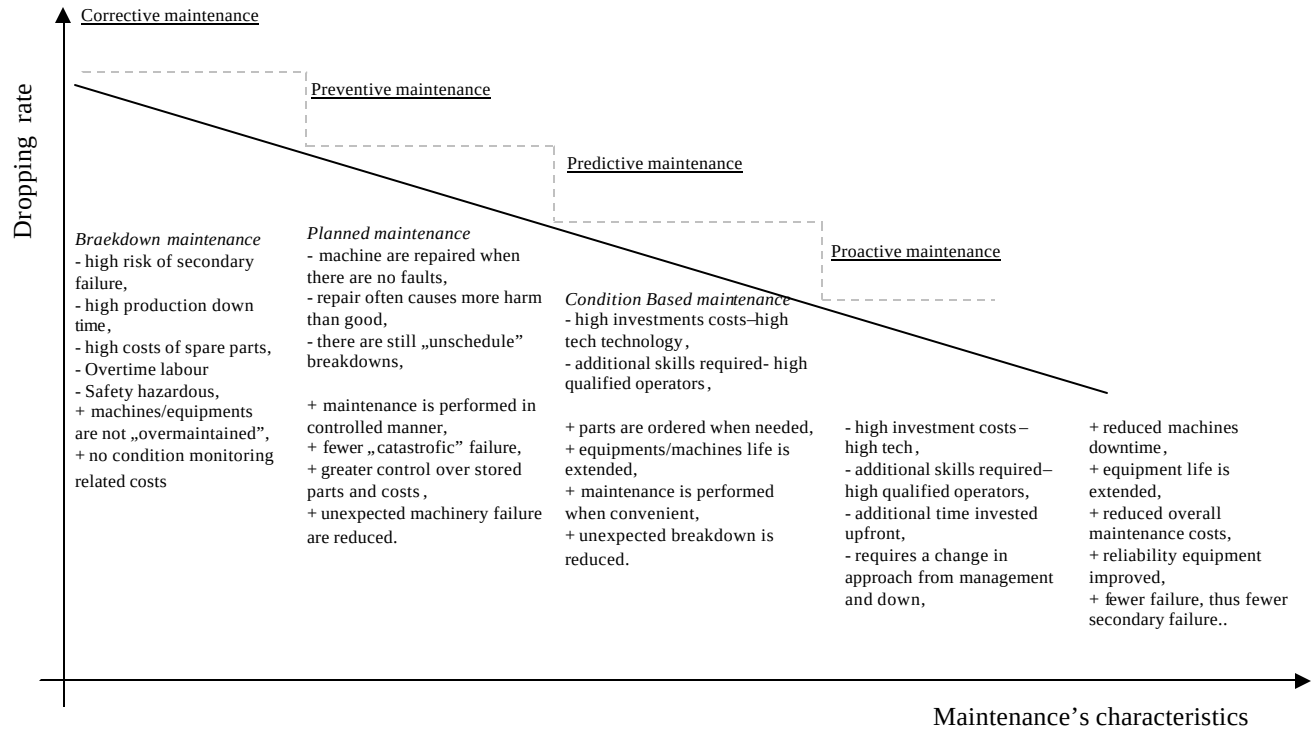


Fig. 2. Maintenance methods, characteristics

Product quality may be defined as meeting customer expectation or conformance to specifications for the product. All the activities carryied out in the company, starting with desining and finishing with equipment maintenance, must be transfomed and orientated in order to assure product quality. Maintenance periodically restores equipment/machine to designed operation parameters from a certain level of deterioration; together production and maintenance seek out ways to delay or eliminate each equipment deterioration.

In addition to maintenance methods showed above, equipment management has a significant function.

Quality maintenance aims to achieve identifying and controlling the relationship between product quality and the deterioration of both processing conditions and equipment conponents; to prevent defects, both are involved maintenance, set-up and exploitation personnel.

Quality assurance is resultant of lots of activities such as: designing (cinematics, machine parts, assembly) and equipment/machine production. The feature of these activities assure a minimum or free-defects exploitation. These features must keep its functional adjustments and hold out against hazardous perturbance defects. It is proved that defects preventive activities require skilled personnel for all steps: designing, production, maintenance.

All these practices, corrective, preventive, predictive and proactive maintenance and quality maintenance and quality assurance are considered to be part of TPM, a system that revolutionizing plant maintenance.

4. MAINTENANCE APPLICATION

Assembly-line equipment maintenance

Assembly-line equipment maintenance [1] is performed with two logistics categories:

- Equipments, devices, systems used for transport-transfer-supply;
- Equipments/machines for assembly.

Moreover, it is mandatory to perform maintenance activities of the other assembly line subsystems as well: control, protection.

♦ *Material handling equipment maintenance*

The equipments for transport-transfer-supply (T-T-S) carry out storage, handling, parts, tools, devices and products (assembly or subassembly) inspection, in a sequential process [16].

As principles of in flow material transfer functions, we may retain:

- The transfer of an amount, quantities and units of a major product, in the next utilization-place before of his separation in smaller units;
- Components and material should move as close as possible to the next point of use;
- Straighten and shorten moves whenever possible, with minimum time and useless way;
- Working and control preset moves of the human operator;
- Use barcodes to identify parts and sequence orders of the flow;
- Avoid parts or products inventory as a result of deterioration disturbance.

Different equipment and systems types are used in configuration of an assembly line, such as:

- Fixed-path handling equipment: conveyors, elevators,

- Mobile materials handling equipments on a preset position and ways: automated guided vehicles, forklift truks,
- Systematic storage and delivery systems: pallets, automated storage, fixed or mobile raks, shelves, etc.

In parts and assembly manufacturing enterprises, problems occur with regard to shippments to the customers, thus, delivery specific managements is required. „In an environment where JIT is practiced and when the work-in-process inventory is kept to minimum, problems in delivery cannot be eliminated unless the standards of plant management are improved". Production equipments and components and assembled products handling equipments must be continuously maintained that on-going parameters will meet production requirements (fig. 3).

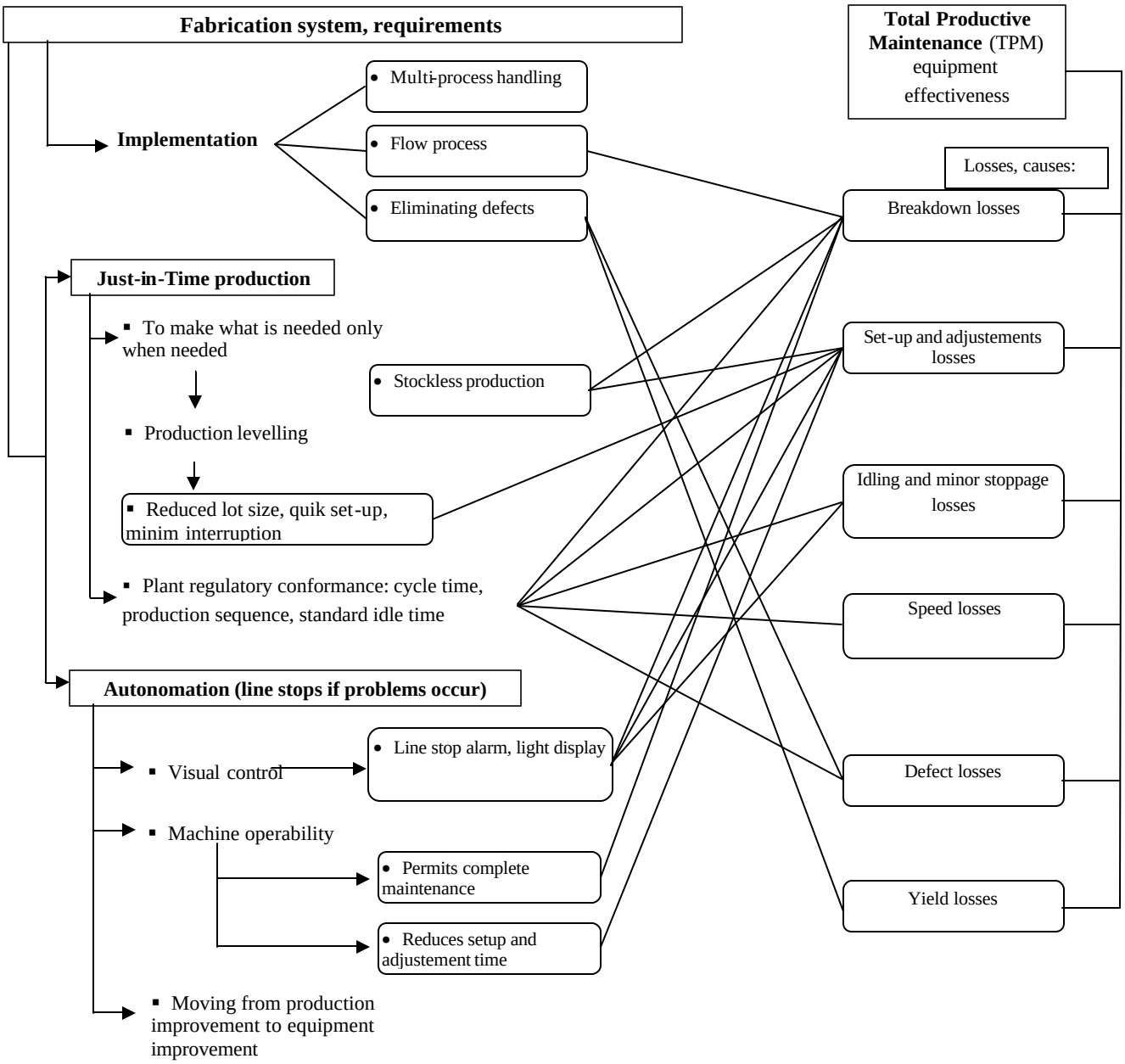


Fig. 3. TPM machines/equipments requirements and losses causes

Every equipments/machine as part of the assembly line must be designed to run in a repetable and specific cycle. T-T-S system configuration is determined by operation and control way, product's feature, types and volume of elements should be stored, transfered, led, fitted, delivered, etc.

Machines/equipments maintenance features eliminates initial causes that lead to deliveriey delay.The fixed-path T-T-S systems in assembly line has the same reliability and maintenability requirements as production equipments. The reason is that the production is in flow, in a single path, with no-back up system. The failure of simple conveyors in such single piece flow can stop production of the entire line. The same effect could be produced by a breakdown of a spot welding robot in a automated body shop. Moreover, the failure of a robot for installation of windshield in a final assembly line could produce assembly line stoppage. As a conclusion, it is utmost important that the auxiliary and support equipment in an assembly line will receive the same maintenance quality as production equipment.

♦ *Assembly equipment maintenance*

The workstations are usually assort as follws:

- Manual assembly workstations – the equipment used by the human operartors may include electrical, hidraulic or pneumatic tools as well as assisst devices or hand tools.
- Special-purpose assembly workstation – the equipment used may include special-purpose tools, hand tools.
- Automated/programmable assembly – robots, modular systems.

The activities in assembly line maintenance are supported on cutting edge technologies and use high tech sensors diagnostics technics and software to interpret the sensor signals. Based on this sensor information, errors due to machines, parts or work instruction or overhauling to the assembly line, can be detected as they occur or even before defect occur. To meet JIT requirements, corrective or preventive actions must be taken immediately.

Record keeping, which is part of all maintenance actions, is critical to equipment uptime. As equipment problems happen and preventive or corrective actions is performed it is very important to have a system in place that will track all the problems with the equipments. The actions that will lead to improvements and appropriate use of predictive maintenance may be identified from record keeping and equipment log.

5. CONCLUSIONS

The maintenance of machines/equipments supports materials flows and proper operation of the production lines. The value of the maintenance programs application is in general higher than in classic production system by highlight avoiding breakdowns or losses of the assembly line. The corrective, preventive, predictive and proactive maintenance activities, as well as quality maintenance and quality assurance are considered part of TPM, a system that is fundamental for maintenance activities. TPM is a systematic approach of understanding machines/equipment operation, a correlation between their quality and breakdown frequence and likely cause. Predictive maintenance gives informations to skilled personnel so their actions to machines/equipment to be done before in planned downtime. Predictive maintenance doesn't guarantee complete eliminate of the unscheduled hazardous, accidentally breakdowns, but was empirically demonstrated that it can be eliminated lots of mechanical parts failure causes.

The reliability and maintenability conditions represents machines/equipments selection criteria that can lead to production flow bottleneck.

If it is assured that machines/equipments are working at designed parameters as well as the high level of confidence in diagnostics capability to identify the occurence possibility of a defect before its occurence, than is accomplished the enterprise's goal to delivery in time, with no stocks, as JIT stated.

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