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PROBLEMS OF MODERN METHODS IMPLEMENTATION OF STOCK OF TECHNOLOGICAL MACHINES MANAGEMENT

Productive management of possessed infrastructure is one of the factors that determine competitiveness of enterprise. Its functioning is aimed at complying with technical requirements of manufactured goods and simultaneously keeping to costs limit, specific efficiency and production ability. In fact, the proper operating of devices in the enterprise is a very important element of system of machine operation management. Proper operating demands specific actions due to having certain production demands, priorities and supervision.
Issues connected with traditional and modern stock of machine tools management were presented in this paper. Methods of technical infrastructure management of enterprise and their advantages and drawbacks were discussed too. Special importance is given to TPM – an innovative approach towards machine operation, the reduction of stoppages and elimination of sources of wastage. Key aspects of TPM implementation process which requires eg. systemic everyday work (5S), were presented. Beside technical and personal problems, the area of fulfilling the rules of safe work with machining devices was discussed. Stages of searching for incompatibilities, generating of necessary documents and establishing essential areas of technical condition of machines conditions were showed.

1. INTRODUCTION

The recent years in many Polish enterprises were the time devoted to maintaining proper position on the market in the face of considerable competition. The high position on the market is shaped first of all, by appropriately high quality of goods, so in order to achieve this position, one must implement proper methods of enterprise management.

Then the realization of production tasks is linked with proper coordination of means and the integration of all functions of the enterprise. The work of every organization section and every worker is aimed at producing goods that come up to customers' expectations.

The one of elements determining high quality of products is a stock of technological machine tools which technical condition has significant influence on the level of received product quality and final enterprise competitiveness. In order to reach maximum effects, the

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process of machines and devices supervision in many enterprises is not always accomplished the way to ensure the minimization of efforts (eg. costs of stoppages, repair work, purchasing of spare parts, wages for repair crew) incurring for necessary operating and service. Various factors have a decisive effect on this:

- elaborate procedures and instructions in the range of planning and completing of service operations,
- lack of economically justified directives on planning service work,
- a wide range of responsibilities and lack of specified duties for services responsible for individual processes,
- low expenditures on service,
- little opportunities to switch off machines and devices in order to carry out service because of their overload.

2. METHODS OF STOCK OF TECHNOLOGICAL MACHINE TOOLS MANAGEMENT

Establishing production system – especially stock of machines and devices – their operation and liquidation or reorganization, is associated with the use of certain operation strategy and implementation of proper management methods. Technical infrastructure can be managed with traditional methods (classic) – eg. accordingly to organization potential, condition, effectiveness, reliability, mixed methods; and modern methods like: Total Productivity Maintenance, Reliability Centered Maintenance or by implementation of process management in maintenance department.

The main indicator in traditional management according to *operation potential* is so called product service life, which is one of the most important indicators of operation quality of mechanical objects in theory and operation practice. Establishing of service interval life values, in other words, the frequency and the range of periodical operation of machines is the crucial problem in proper (optimal) operation of object work.

The strategy *according to condition* consists in monitoring the mechanical condition of machines and working out diagnostic data which allows to make rational decisions in operation system and its surroundings. In practice, on the one hand, one mostly draws upon the stiff plan, but on the other hand – partially upon constant or periodic diagnostic (it is *mixed strategy*).

The strategy *according to effectiveness* concerns events when relative aging of machines comes quicker than their material wear and tear, then those machines fit for usage are withdrawn from stock of technological machine tools due to being in unsatisfactory effectiveness or not fulfilling newly introduced requirements. The decisions are made very often on basis of the results of periodic inspection of reliability level (*according to reliability* strategy) of machines operated until the moment of increased damages intensity. The inspection is carried out when the outcomes of damages do not cause any hazard, do not abuse the rules of industrial safety and do not increase operation costs.

One of the modern strategies is Reliability Centered Maintenance (RCM). This is a process that allows to determine service requirements of technical devices considering

their usage specificity. RCM is often perceived as a platform that interrelates many scientific fields: reliability, IT, statistics and economics. It allows to obtain the effect of synergy, which results in using many different methods within the realization of the one, precisely specified target that is optimization service actions. Applying formal procedure of RCM allows to choosing proper strategy of service individual parts and components and to determine particular and more effective techniques. All these actions are based on environmental, operating and economics factors.

The increasing share of preventive maintenance costs as well as existing competition, force to intensive search for opportunities of reducing costs and outlay on machines and devices preservation. Activities called as Total Productive Maintenance are of great importance too. TPM assumes that activities aimed at maintaining movement should take place in production area, enterprise's repair shop and also in external repair shop. The main goals of TPM are:

- the reduction of costs of unexpected stoppages because of faults,
- the reduction of total investment costs,
- reduction of cost per unit of product thanks to better machine operating,
- the improvement of production process stability – process is under control and guaranties obtaining product of proper quality with lower production costs,
- implementing system of autonomous machine service by operators and system of planned servicing and repair of machines.

The method covers the whole period of machine functioning during production process, is based on prediction - 'anticipation' of failures that could possibly occur. The implementation of TPM takes place gradually and covers next machines in enterprise. The decision about the sequence of machines covered by TPM should be the result of determining their priority in the process. In the context of TPM functioning, the proper operation is not possible without implementation of computer system, which allows to collect considerable data, processing, transferring to certain departments and the proper use of data. There are many applications available on the market that support this area of enterprise activity, however, many times they are expensive, as a result unavailable for small and medium-sized enterprises.

Moreover, apart from properly adjusted operating strategy, crucial is an appropriate organization of service responsible for the supervision process and regeneration of technological machines system.

Many enterprises characterize of implemented quality management system ISO 9000. One of the requirements is *process management*, in which should exist system which uses resources to transform input data into output data. In reference to operating system it is an identification of actions performed by maintenance service and their hierarchy.

Job description of maintenance service depends on factory size, stock of machine tools. The bigger the number of machines and their diversity, the smaller number of processes. In small-sized enterprises where the number of machines is little, the job description is theoretically wider because such services (if they exist) perform bigger number of work and apart from basic processes, they perform activities not connected with the specification of organization unit.

3. PROBLEMS OF IMPLEMENTATION OF METHODS OF TECHNICAL INFRASTRUCTURE ENTERPRISE MANAGEMENT

The condition of possessed technological machines is one of the factors determining the enterprise effectiveness. Despite having a knowledge about possessed infrastructure, traditional supervision system still predominates. Planning and realization of labor which improves the enterprise quality proceeds in an insufficient way.

The large extent of machines use can be an impediment, which prevents from carrying out necessary services. Little outlays are another problem. Surveys carried out in chosen enterprises were the source of neglecting and no effects of implementation of modern strategies of stock of machine tools management. They are:

a) lack of prevention work in maintenance

The repair of damaged equipment requires high costs in order to maintain industrial enterprise. Sudden and unplanned stoppages mark up production costs through: the costs of repair, delays in realization instructions etc. Repair works are or are not replaced by prevention, however techniques of so called maintenance forecasting are being constantly developed and can be easily implemented in great combines all over the world. Prevention instead of sudden repairs means initiation of processes in which non – intervention measurement of chosen parameters which are connected directly or indirectly with machines ability, is carried out. Measurement results are used to indicate certain tendencies of upsetting or wear and tear of a machine, or in case of exceeding established alarm limits – to perform service in order to avoid serious failure of production line.

b) low outlays on repair management

Economic changes in Poland within recent years have influenced the financial condition of Polish enterprises. Most of them in a struggle for existence, give up the financing some areas of enterprise activity e.g. repair management. However such savings are apparent. The growth of faults can be noticed, unexpected stoppages, and delays in instructions realization and higher production costs.

c) lack of time in schedules of machines work intended for service

Customers specific requirements: high quality of products and services especially timeliness of instruction realization which demands constant operating of stock of machine tools in the enterprise. Such actions often prevents from performing service actions. In case of the same types of machines the load is planned to make possible a temporal exclusion of the machine from the production process. The issue gets complicated in the moment of bottleneck occurrence in production process where it is impossible to perform any services, which results in systematic aggravation of machine condition.

d) repetitiveness of problems

In case where there are no prevention activities in the enterprise, the results and causes

of faults are not analyzed. Lack of the data causes that the problems of faults and their reasons are analyzed every time they occur. As a result, the real reason of defects is not detected and eliminated, there are ineffective methods in terms of long period and generates costs.

e) diversity of approaches towards maintenance services in reference to similar or identical machines and devices

In many enterprises with specified production specialization there are installed several the same machines and devices, similar production lines etc. It would be justified to apply similar to each other plans of functioning maintenance services to all of these machines. According to the modern production management philosophy (Lean Manufacturing) one should apply standard procedures in terms of in-service training, spare parts storehouses functioning, location of technical inspections etc. what would bring notable income. Unfortunately, in actual production conditions this assumption not always comes true because of special, constant maintenance services work management. In small-sized enterprises it is mostly one group of workers with different authorities and experiences, where the identification of reason and method of repairing a fault takes place subjectively. In big factories/manufactures, maintenance services functioning within one enterprise, constitute individual units, where different machines operating and protection procedures are used.

f) not obeying established company standard

The crucial element in enterprise functioning is not obeying procedures and as a result making many mistakes by workers. The repetitive failure of the same device comes as a result. While observing, we can notice that cases of such insubordination often happen in manufactures which have great knowledge and experience in operating technological machine field. In theses cases, there is a need to implement of proper workers supervision system.

g) performing unnecessary work, performing work in excess, applying improper management methods

Research results prove that some of activities from maintenance are performed in a wrong way – no reaction to workers signals or activities excess do not improve machines condition. It sometimes happens that despite the correctness, planned actions are, according to conservative strategy – e.g. of too wide range. It may concern excessive spare parts purchases and the necessity of their long-term storage, deterioration of oils or coolants stored in bulks etc.

However in many small-sized enterprises the range of maintenance services (on condition that they exist) covers not only actions connected with machine and devices supervision process, sanitary fittings, transport services etc. This wide range of job description constitutes main problem of ineffectiveness of supervision process.

4. IMPLEMENTATION OF TPM ASSUMPTIONS - A CASE STUDY

4.1. PRACTICAL ASSUMPTIONS OF TPM SYSTEM

Total Productive Maintenance is a way of management involving all workers in maintaining continuity of production. The elimination of losses is based on teamwork, in addition to which, TPM combines all actions undertaken by different departments of a company into one. The basic assumptions are:

- Total Profit – focus on gaining profit;
- Total Prevention – priority of service and maintenance over production plan;
- Total Involvement – teamwork on all levels with the view of eliminating problems.

In comparison to the traditional approach, implementation of TPM involves a certain revolution in the company as well as giving up stereotypes. The basic change that needs to be anticipated while implementation is giving other priorities to the fields of:

I. MACHINE – teamwork on eliminating losses, instead of “if it works, leave it alone”;
II. PRIORITY – prevention, instead of: production plan;
III. TYPICAL ACTIONS – service (inspection), maintenance, modifications in the machines, providing documentation and analysis of data, elimination of possible failure causes, instead of “putting out fire”;
IV. MODIFICATIONS OF MACHINES – every critical in the process, instead of lack of activity due to lacking time, instead of working separately;
V. ORGANIZATION STRUCTURE – Maintenance service integrated with production, instead of working separately.

Success in the implementation of TPM is based chiefly on the interest and participation of machinists in the streamlining process. It is them who have current information to prevent failures. It is important not to load them with new responsibilities who which there is always an opposition, but to transfer the rights to decide about the machine. Their responsibility for operations will lead to skillful detection of defects which could result in serious damage.

In practice, it is important to remember that the preparation stage before the implementation should involve:

1. Training - of all the workers starting from the highest ranks to ordinary workers - raising the awareness of significance and need of the changes implemented;
2. Setting up teams responsible for preventive actions;
3. Reorganization of workstations - introduction of rules resulting from pro-quality philosophies - particularly 5S: Sort, Scrub, Straighten, Standardize, Systematize; analysis of safety (shields used, protections resulting from the specificity of activities) in respect to accordance with obligatory requirements (regulations, norms, recommendations).

4.2. REORGANIZATION OF WORKSPACE

The two initial stages enumerated above do not involve onerous or time-consuming works. While planning the training and composition of the teams one has to realize the need to incur some costs, devote some time for design, planning and teamwork. The preparation of workstations to work in TPM system can prove more difficult.

For instance, in a company's production process an evaluation of the machines' importance was made. The choice of machines was conducted according to the criteria: failure frequency, the frequency of technological operations in a production process, quality and precision of processing. A grinding workstation, situated in the tool section of the company, was qualified for the preventive service. tool grinding machine of an old type is used to a large extent for sharpening machining tools. It is the only machine tool used for this propose in this company. The company is not planning to purchase a new machine assuming that the implementation of TPM session will not only streamline the work in this stand but will also lead the machine to a level of high ability and functionality with no regard to the age of it.

The first stage - panning - is the analysis of the current state of the machine tool. The results of a model analysis are shown in Tab. 1.

In Fig. 1 some identified problems and defects within a grinding work stand are shown.

After a preliminary analysis of the machine, its efficiency, fitness for use, appearance, position in respect to neighboring work stands and transport ways, an analysis of safety of work was conducted.

The analysis of working conditions in regard to the safety of workers operating the machine is the vital issue in carrying out actions that lead it to the point when it fits the formal requirements. In the European Union, the binding documents are the Directives of the Council of Europe as well as the requirements of the National Labor Inspectorate in accordance to the directives of the Minister of Economy on the industrial safety concern the use of machines.

Table 1. TPM session - step I

TPM Session – step I	
Needs	**Decisions**
Analysis of the operation and maintenance manual (DTR) taking into consideration the elements sub-assemblies that are likely to be needing exchange.	To buy new elements in place of the broken or worn-out devices
To evaluate the condition of the machine	To buy materials needed for the repair: paint, finishing putty, insulation tape, warning labels, tools, painter's foil, protective clothing
To plan the supplementation of equipment	To buy new lighting, casings, electric wires, shields
To find equipment on other work stands being there as the result of lack of order, estimate the degree of wear and the need	To buy new connectors, paints etc.

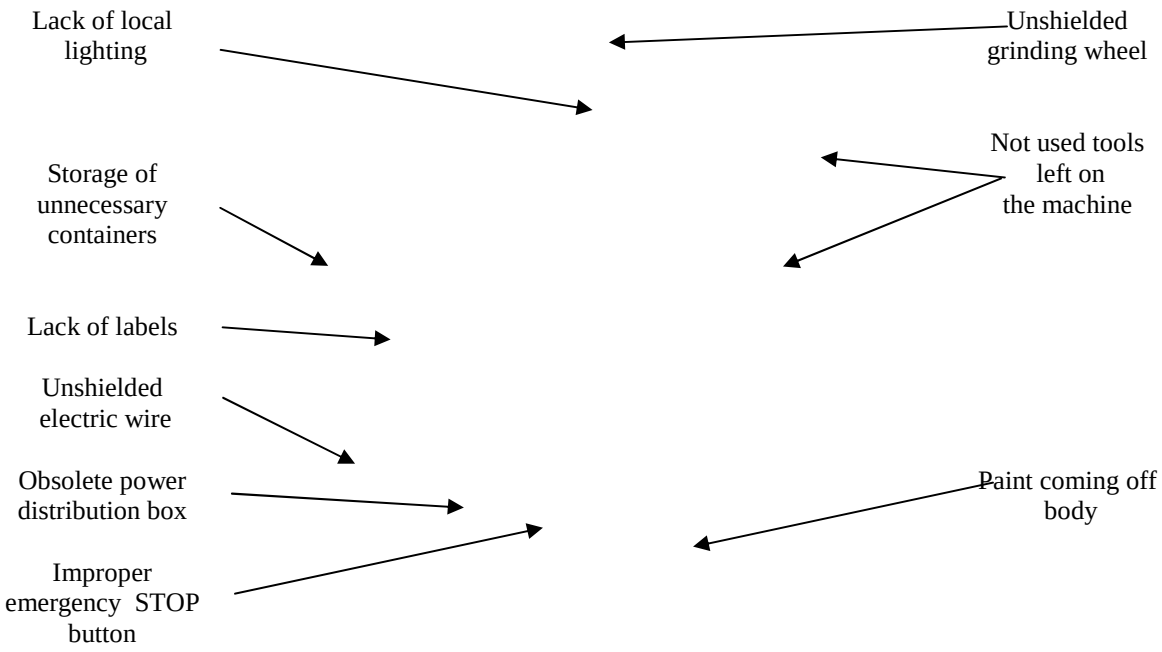


Fig. 1. Problems within a grinding work stand identified before the TPM session

For the reorganization of the work stand an analysis was carries out in accordance to the National Labor Inspectorate's directives, results of which are shown in Tab. 2.

Table 2. The results of the analysis of safety in the grinding work stand

TPM Session – step II			
No.	Problem	Positive results	Negative results
1.	Visibility and ease of identification of control elements	- Control elements are in good working order	- Control elements are improperly labeled
2.	Position of control elements important for safety outside the dangerous area	The machine tool cannot start automatically	
3.	Starting of the machine possible only through intentional performance of the control system	- Starting of the machine tool happens as a result of a deliberate action	
4.	Equipping with a control system designated for complete stop		- lack of elements for complete stop of the spinning elements
5.	Equipping the machine with emergency stop device	- the machine is equipped with an emergency STOP	- the emergency stop button is not distinct in shape and color from the other - it is situated non-ergonomically - lack of grinding wheel guard does not stop the machine

6.	Fitting the shields protecting from dropping or throwing out objects	- the machine tool is equipped with a grinding wheel guard	- the shields are not designed for grinding wheels of different sizes
7.	Fitting of casings or ventilating devices protecting against gas and dust		- lack of ventilation for the accumulating dust
8.	Fastening of the devices and parts to ensure stability	- ensures stability: the machine is fastened with screws to the foundation, parts - with handles or stays	
9.	Fitting of shields against tearing or braking down of the elements or the tool	- as in pt 6 - drive elements secured properly	- the shields are not designed in a way that minimizes the risk of chips being thrown out
10.	Preventing access to contact zone with movable parts of machines	- as in pt 6	- the shields do not minimize the risk of hand injury in contact with the grinding wheel - shields easy to remove
11.	Proper lighting of the workspace		- the stand is not situated on the southern side which causes considerable differences in intensity of light - high brightness of the surroundings and eye fatigue, shadows and no lighting of the work zone.
12.	Protection against the risk of touching hot or extremely cold elements		- risk of eyesight damage caused by hot chips
13.	Fitting of warning devices		- there are no devices warning against the danger in case of excessive noise.
14.	Providing safety while in the zone of the machine tool	- safety of the workers is provided	
15.	The possibility of disconnecting energy sources - safe connection	- energy supply labeled and safe	
16.	Safety against fire, explosion, electric shock		- lack of safety against electric shock - easy access to the distribution box, lack of labeled wire cover (the possibility of tearing it out from the connector), destroyed wire insulation

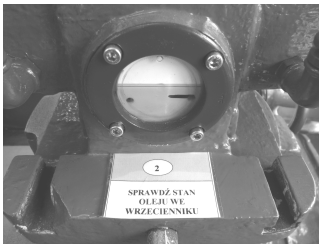
Considering the National Labor Inspectorate's directives on safety, there are difficulties in fulfilling all the requirements. In the case considered, the most significant problem was proper design of the grinding wheel guard. On one hand, a full guard would protect eyes and hands, on the other hand it would make the working zone less visible. If it was produced out of a transparent material, it would cause its quick destruction by hot chips of metal sticking in it. Moreover, it is known theoretically that the guard should be put on during work , but observation shows that the workers make their work easier by dismantling it. In any case when such doubt of a similar character occurs, the solution should be the one that protects health most efficiently. In the model work stand the existing shields stayed in their place, but wearing of safety glasses was ordered.

The next step is devoted entirely to organizing the work stand. The results are shown in Tab. 3.

Table 3. 5S Campaign in TPM session

TPM Session – step III	
Problem	**Characteristics of actions**
Sort	Inspection of everything in the range of grinding stand, selection of necessary and unnecessary items (decision what to throw away, what belongs to other stands), elimination of unnecessary items outside the stand.
Scrub	Washing of the machine tool, disassembly and cleaning of the movable elements, lubricating the transmission. Removal of the old and peeling paint from the main body, painting of the main body. Cleaning, exchange of the worn out and painting of the good valves. Marking of the movable elements Cleaning of the tools, gathering and paining of the handles, joining elements necessary for the processing. Removing of the pieces of rubbish, cleaning of the floor, window sill and the window, cleaning of the panels and cupboards.
Straighten	Organizing the handles and grinding wheels: frequently used objects - close to the machinist, within the reach; less frequently used - in the cupboard or pulpit. Labeling of the storage facility for the parts before and after the processing.
Standardization	Designing of 5S Campaign visualization cards in order to form habits of maintaining order and proper organization of labor.
Systematize	Designing work stand cards for autonomic and preventive service. Markings of the machine tool.

Table 4. An example of a list of activities for autonomic service of the work stand

No.	Markings	Action	Method	How often?
1.		Check the performance of STOP switch	on / off	every day
2.		Check the oil level in the headstock	visually	every day
3.		Check the condition of runners	Turn the lever to the left 5 times, right 10 times, left 5 times	every day

5S practices enable to maintain a good image of the company but above all, to make work easier, the effect of which are good results.

In the TPM system the practice of standardization of work, maintaining cleanliness

and order as well as systematization is mirrored in the work stand documentation. The design of it and putting it within vision is aimed at visualizing the actions of everyday use of the work stand and extorting the performance of preventive actions on the worker in due time and in a designated way.

The examples of notation in an everyday service card are shown in Tab. 4, examples of actions for preventive maintenance in Tab. 5.

Table 5. An example of a list of actions for preventive maintenance of the work stand

No.	Action	Authorized worker	Machine part	How often?
1.	Check the connection	electrician	supply system	once in a year
2.	Check the control elements	mechanic	Off switches	once in a year
3.	Check and adjust the sub-assemblies of the machine tool	mechanic	runners of the table	once in a year

The documentation was placed directly by the machine tool, in the view of the operator.

5. CONCLUSIONS

The implementation of a modern management of machinery stock needs actions to be undertaken in various spheres of a production plant performance. It is more versatile and comprehensive - the whole of machines and appliances constitutes a place of work for people. What is needed is knowledge of not only the machines but also the knowledge principles of organizing work stands, spatial planning, ergonomics, design of processes of work, including the factor of risk to health or life, specific qualities of the surroundings. The effort put brings measurable advantages - after conducting a TPM session an increase efficiency is observed, lower rate of breakdowns, reduction of unforeseen stoppages duration and costs of production. Designing an aesthetic, safe and properly organized work stand lowers the risk of industrial accidents, boost the crew’s morale and triggers creativity - new ideas for streamlining everyday activities appear. Quality of work affects directly the quality of products and lowers the rate of customer complaints.

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