APPROACH TO INCREASE BOTH OPERATORS' SAFETY AND DEVICES' AVAILABILITY UNDER OPERATION

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Abstract

The paper is focusing on increasing both operators' safety and devices' availability under operation. Each process supported by any composition of the man-devices set it is possible to present and described by selected operation (exploitation) parameters, which can be a subject of monitoring. With use process operation parameters set the target-oriented production Key Performance Indicator has been proposed. Base on Key Performance Indicator both operators' safety and devices' availability analysis is possible in practice. Paper composition contains: solution description, good practice examples discussion and conclusions.

Safety of man/ operators and availability of devices are very important for everybody and using preventive one solution we can increase and protect both. Additional process operation parameters monitoring, as well as measuring, are an important factors increases people's awareness. Two different approaches of the same process have been described on examples coming from manufacture. The following approaches have been taken under consideration: traditional one based on reactive maintenance and new approach based on preventive maintenance. The comparison of both scenarios was discussed. For human's safety and dependability of devices, responsibility of all involved employees in practice is equal.

Keywords: *availability, operator, devices*

1. Introduction

Most important thing in every transportation and manufacture activities is human's life and health. These things are priceless and should be protected as good as possible. There are no limits to spending money for that purpose, because in consequence this is not a cost, this is an investment.

Second important thing is availability of all devices included into both transportation and production processes. Possible both transportation and production delays because of unexpected failure always affects for overall costs very negatively. Usually is very hard to estimate time needed for fixing something unexpected and in additional, repairs of broken parts are always very expensive.

The common goal of both transportation and manufacture processes is a focus on increasing both safety of work and availability of devices on transportation and production process. The task is possible to express as follow:

- to minimize time necessary for work close to the dangerous devices; maximize time dedicated for observing and analyze device exploitation and production parameters from a safe place,
- to increase predictability of possible failures: decreasing costs of downtimes and reactive maintenance necessary for fix serious problems.

To meet presented needs the following solution is necessary to establish: to develop virtual system, able to present in a real time, every crucial Key Performance Indicator (KPI) of the process. System should be able to measure KPIs on single device or on dedicated group of devices. System should be flexible to let us choose, which KPI is crucial on particular device or group.

2. Solution description

Developing system should be able to grab selected exploitation parameters describing both device under operation and running manufacture process (example values as: speed, pressure, temperature, energy consumption, noise, etc.) Very important is to establish right standard values for all measured data. If all values for particular process are standardizing, every aberration is a warning for operator that something wrong can happen.

To analyze all KPIs, should be involved experienced operator. According dedicated procedures, operator should know what to do. Thanks that, safety of operator and device is protected. If we summarize all devices included to the process, we can say that safety of operators and whole process is increased. According this philosophy operator is safe, because he is outside dangerous area and from other side dependability of devices is constantly monitored and protected, as well as availability of man - machine set under operation.

Operator’s mistakes should be also treating as process’ parameter. Majority of human influence form operator level can be standardized. System can be set to check also people's input. Easiest way to do that is to let to choose solution from the list, every time when it is possible. Of course human should take last decision, but system can also not to stop the process, system should also enable alarm to let know to operator about not standard situation. This philosophy can be use also to increasing availability of the process. Here most important is to cut maintenance cost.

For sure preventive is better than reactive. If there will be possible to predict more failures before they will happen then cost of downtime and fixing problem will be much less. From historical point of view time spends by operator close to machine is constantly shrinking. On the beginning every operation was manual, after that step-by-step human influence was replacing by automation. The reason was productivity and repeatability but by the way also safety was enriched. Unfortunately we cannot exclude humans fully from the process to protect them in so called 100%. People's influence is limited but danger is still present and accidents and injuries are happen all the time.

To avoid potential danger situation one more thing must be done. If on the area or single device, there is necessary some maintenance, operator should be able to block device and whole process. Everybody around should know about it. This procedure is crucial from safety point of view. It should be visible and understandable for everybody as a red light on the crossroad. The philosophy of checking values algorithm inside the process has been presented on Fig. 1.

3. Good practice examples

To better understanding the presented solution two different approaches of the same process have been described on examples coming from manufacture. The same results is possible to achieve from others both transportation and production processes. Two approaches have been taken under consideration: traditional approach based on reactive maintenance and new approach based on preventive maintenance.

Scenario/ situation A pertains to Rolling Mill with capacity about 700t / 8hrs shift of 12 mm rebar:

A1 - traditional approach based on reactive maintenance. About 1 p.m. there is unexpected stoppage because of broken bearing of the bottom roll on the one of stands of the roughing group. Everybody is surprised because of situation. There was nothing alarming before. According procedure each bearing was checked on the beginning of the shift. Unfortunately there is no spare stand for replace and stand must be rebuilt. 0.5 hour it takes to take off stand and deliver it to the workshop. Temperature of bearing is very high, so disassembly is delayed. At least it takes 2 hours to decrease temperature and disassembly stand. Disassembling takes 1.5 hour. Pin of roll is in bad condition and need to be grind. Another 2 hours. After that time, stand is rebuilt with new bearing: 1.5 hour more. Transport and put into a line 0.5 hour. In total we lost 8 hours. In the same time, maintenance crew found the reason of the problem. There was some leakage on lubrication of the bottom bearing. Replacing the broken pipe takes 15 minutes;

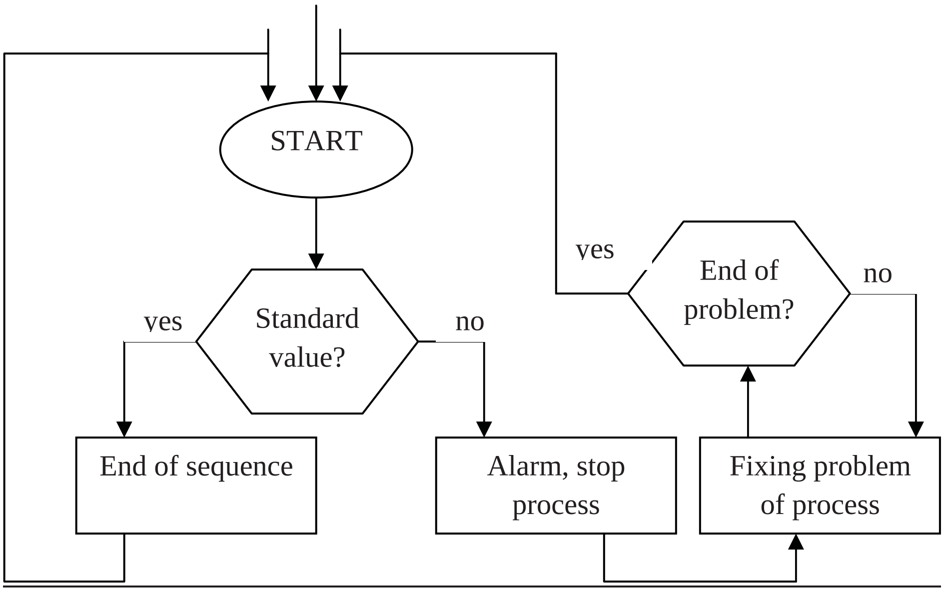

Fig. 1. Checking values algorithm inside the process

A2 - new approach based on preventive maintenance. About 10:30 a.m. on the main pulpit appears alarm. Alarm says that pressure in one of the lubrication's circuit is dropping down. Process operator signalizes this situation to maintenance crew. Maintenance crew stopped production and start checking lubrication 5 minutes after. About 10:45 a.m. they found that there was some leakage on lubrication of the bottom bearing. Replacing the broken pipe takes 15 minutes. 11:00 a.m. production starts again. The 12 mm rebar cost about €550/t, rolling bearing for roughing group cost about €6250. Lubrication pipe cost about €25.

The comparison of both approaches scenario A has been presented in Tab. 1.

Scenario/ situation B pertains maintenance day on the Rolling Mill:

B1 - traditional approach based on reactive maintenance. One of the scheduled jobs was replacement one of the hydraulic hoses, delivers high-pressured fluid to the looper. Maintenance foreman asked pulpit operator by radio to switch off hydraulic system. Pulpit operator reported that he did it and considered area is safe. During taking off the hose, high-pressure liquid, hits operator into his face. In consequence one of employee was injured in his eye. Because of this accident, all works were stopped and all procedures were checked again. It takes 24 hours;

Tab. 1. Compression of scenario A based on reactive maintenance and preventive maintenance

Maintenance type	Lost time [minutes]	Lost production [tons]	Changed parts	Lost money due to lost production [€]	Lost money due to replaced parts [€]	Total loss [€]
Reactive maintenance	480	700	Bearing, lubrication pipe	385000	6275	391275
Preventive maintenance	30	43.75	Lubrication pipe	24062.5	25	24087.5

B2 - new approach based on preventive maintenance. One of the scheduled jobs was replacement one of the hydraulic hoses, delivers high-pressured fluid to the looper. Maintenance foreman asked pulpit operator by radio to switch off hydraulic system. Pulpit operator switched off hydraulic system but independent virtual system reports that in the hydraulic circuit there is still high pressure. Operator reported this information into maintenance foreman. After short investigation maintenance crew found that one valve is not working properly. Problem looks serious, because valve was sending information about proper behaviour. First, maintenance people decrease the high pressure and then they replaced valve and hose. After additional checking they reported finish of work in considered area.

The comparison of both approaches scenario B has been presented in Tab. 2.

Tab. 2. Compression of scenario B based on reactive maintenance and preventive maintenance

Maintenance type	Lost time [h]	Safety
Reactive maintenance	24	Serious accident
Preventive maintenance	0	Safe work

Both solutions show both quality and quantity benefits resulting preventive maintenance strategy with support the dedicated methodology in any operation practice.

4. Conclusions

Both presented examples shows very transparently how decision-making support virtual system (based on dedicated sensors and algorithms) can give in practice very fast and valuable feedback. Described situation can happen in real life and is not so difficult to decide which situation is better for everybody. Of course we can very easily multiply examples from different industries, but the point is that this approach can be use in different production systems.

Safety of employees and availability of devices are very important for everybody and using preventive one solution we can increase and protect both. Additional process operation parameters monitoring, as well as measuring are an important factor increases people's awareness. From psychological point of view, measure of data increases positively employee's state of mind. It means that someone is watching so I have to be safe. From other side everybody must understand the importance of himself, in fact safety and dependability depends on him. To do that it is necessary to prepare dedicated trainings for every group of employees on every level of process, without any exclusion.

Summarizing: all green signals from the process are jointly good accepted during operation solutions. If all are green, we can go. Every device or group of devices jointly operating on particular steps of transportation and production processes should be able to inform everybody around about possible danger situation. If there is some maintenance work on it, or if system detected some malfunction, or aberration from the standard on measured value, system semaphore should say red. It means that process cannot be continued. This kind of signalization is very popular on new transportation devices and production lines. Unfortunately there is still a lot to do on older installations.

Safety hazards in our places of work cost all of us (users). When a co-worker is hurt on the job, this raises the cost of insurance, slows down activity/ production, increases employee anxiety and causes a host of other problems. The same is with devices condition, every outage causes stop of any process/ production cost us a lot and in fact touches everybody from floor workers to owner of company. Human's accidents or devices outages are not accidents. They are caused by lack of attention to good safety procedures and lack of knowledge about device's condition. For human's safety and dependability of devices, responsibility of all involved employees is equal; there are no floor workers, supervisors and managers. If one of them forgot about procedure it can hurts all of them.

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References

[1] Blanchard, B. S., Verma, D., Petersom, E. L., *Maintainability a key to effective serviceability and maintenance management*, Wiley - Inter Science, New York 1995.
[2] Muller, A., Suhner, M. C., Iung, B., *Maintenance alternative integration to prognosis process engineering*, Journal of Quality in Maintenance Engineering, Vol. 13 Iss. 2, pp. 198-211, 2007.
[3] Szpytko, J., *Integrated decision making supporting the exploitation and control of transport devices*, UWND AGH, Kraków 2004.
[4] Szpytko, J., *Operation process reliability centered designing of manufacture transport devices*, Monograph Series of BPE, ITE, Kraków - Radom 2004.
[5] Szpytko, J., Kocerba, A., *Safety and reliability of dispersed transport devices - selected problems*, Monograph Series of BPE, ITE, Kraków - Radom 2008.