Ročník 2019 electroscope Číslo II

Smart sensors – another foundation for Industry 4.0

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Abstract:
Production of electronics gets more and more complex every day. This situation requires all possible information about the production process. Not only information about the components, but also about the machines and their status. New industrial revolution, the so-called Industry 4.0 is very important for all producers that want to be on the peak in electronics production. All today´s machines are driven by electronics, everything starts right here. Also internet of things, internet of services etc. have become a part of this development. Just smart sensor can make real better check of machine's status and makes possible preventive maintenance compared to today's reaction type of service.

INTRODUCTION

Internet of things – smart appliances, using microcontrollers, sensors and software makes it possible to control devices over network (internet). Connectivity between such devices is very important.
Everything begins in production plants, where automation systems take over simple repetitive tasks that had to be performed by humans before. This project of the so-called "Smart Factory" is nowadays being realized by many companies, also in the Czech Republic.
All checking processes are closely connected to production processes and machines (see Fig.1). Downtime is a big barrier for mass production of electronics. We have to find troubles as soon as possible. The best way is to predict these possible troubles. For this we need detailed information about the status of the machines. Then we can react to possible failure before it happens, adapt maintenance to the current status of production and production machines.

Fig. 1: Typical production line for electronics assembly

First steps were done. The so-called MES (Manufacturing Execution System) collects production data and makes the production planning better and more precise. Together with traceability data, the highest possible quality of products is ensured.
We can record all relevant data, all measurements for analysis. We can check process stability on-line. Profiling can be checked instantly, too. This results in stable process and high quality of our products.
Inside of a reflow soldering machine we can check all temperatures, transport speed, O_2 level, exhaust stability etc.
But this is only a reaction onto the real situation. This is not sufficient for the future. For ralisation of predictive maintenance we need to fullfill three main points:

1) Collecting, digitisation and take over of data to a higher control system
2) Data saving, analysis and evaluation of collected data
3) Calculation of probability of needed service intervention

We need information about status of the machines and using of predictive software offers the possibility to plan preventive maintenance, for example. If we just react to failures, we lose very much time, which means also loss of profit. We have to undertake preventive actions. It means to know our processes and machines into the smallest details. We have to be pro-active! We cannot wait till production downtime, because of failure. We need data, check it all, software for predictive control of production machines and processes. How do we do it?
Today we can measure electrical consumption of all parts of the machine, nitrogen and cooling water consumption. We can measure vibration of transport system, too. Based on data about vibrations and current consumption we can calculate status of the mechanical parts of machine (see Fig. 2). If actual values exceed typical values, we can plan preventive maintenance. This can be planned according to the production, use time, when production would be inactive (product change-over etc.). This reaction can improve the

profitability of production line and secure failure-free production, less scrap etc.

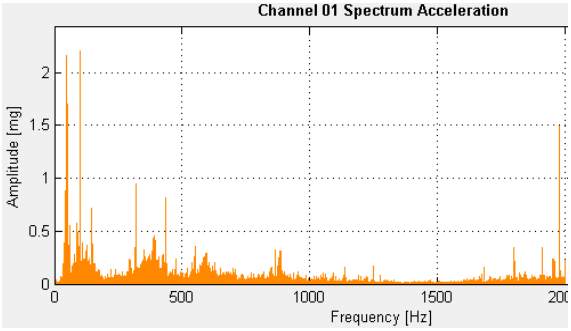

Fig.2 One of first systems, used in machines, are vibration sensors.

Another possibility is using of EC motors (see Fig. 3). It is necessary to drive old AC motors using frequency converters. Efficiency is lower than 50%, sometimes and also higher noise level. Failure information is therefore not directly, it is always just a group of motors and eventually failure is not directly regiseable. Use of EC motors (electronicaly commutated or electronicaly controlled) brings many advantages. Every blower is driven directly, we have information from motor to control system. Efficieńcy of such motors exceed 80%, this means also energy saving potential! You do not need any frequency converter, whole control system is integrated inside of the motor. Data from motor can be used for analysis of the equipment, so we can plan maintenance very well.

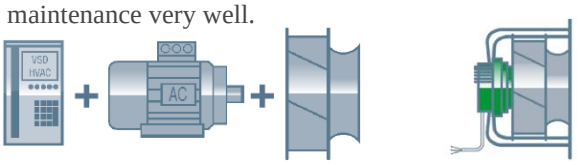

Fig. 3: Use of modern EC motors brings many advantages to us

What does the use of "smart sensors" mean? A smart sensor is every sensor, which can not only measure some values, but also process it and send relevant data to a higher control system. It is very closely connected to IoT (Internet of things). Monitoring of important parts of machine, monitoring of processes makes it possible to get nearer and nearer to our target - the Industry 4.0.
The main question of today is – who will collect and analyse all the collected data?
Of course, people are not able to work with so much data. It is task for artificial inteligency and self-teaching systems. First systems, using so called neuron-network, are allready working. We are on start position and have to do very hard job to bring this systems into real life and our industrial aplications.

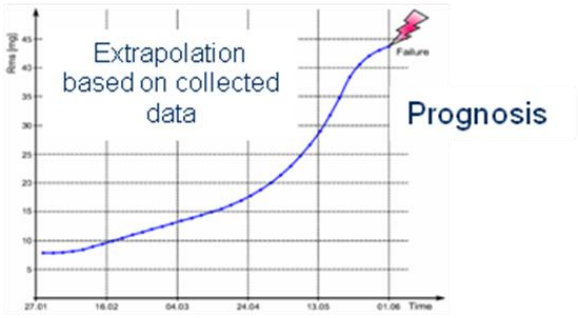

Fig.4 Prognosis of preventive intervention on machine

It is no secret anymore, that some companies have already started implementation of first basic systems of Industry 4.0. Using components, which are able to send on-line data from its run, measuring and prediction of process data, preventive maintenance, use of augmented reality etc. Use of augmented reality, for example, is nowadays tested for education of maintenance personal.

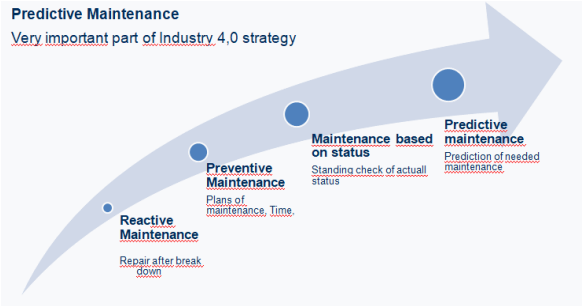

Fig. 5: Future in maintenance

Introduction of first systems is very expensive, instalation of hardware as adjustment of control software is very time consuming.

CONCLUSION

Industry 4.0 is a new way to improve our production and make it more efficient through predictive maintenance (see Fig.5). First it means less people in the production, but later a need of more skilled, educated people will arise. The machines will take over the manual work, mental work will be performed by humans.
European union knows importance of this process for our future and support it by 20 billion of Euros.

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