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Digitalisation and networking in “smart production”

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Abstract:
In this article you will find description of new technological tools for more effective, more accurate and cheaper production of electronic assemblies. Main focus is on to soldering technology. Nowadays, there's a strong focus on digitalization and automation of all areas of our lives. Internet of things, internet of services etc. have become a part of this development. 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. Internet of services – cloud computing. All data can be stored on cloud storage, incl. software, your own PC can be very simple, with no own hard drive. On-line tasks and data sharing is therefore very easy, too. We save costs using this possibilities and make our production more efficient.

INTRODUCTION

We can hear from all sides – we are living in the time of industrial revolution 4.0. What does it mean?
First we should in short form describe history of industrial revolutions. Most of us have heard onlyabout one revolution, today we call it first revolution.
This started in the 18th century in England and ended sometime in the 19th century with switching fully to mass production using machines. Using steam-power for production, origin of private property, a complete change of lifestyle. Progress in traffic is also very important part of the first revolution. Keyword of this time is industrialisation. We call this time period, sometimes, a century of steam.

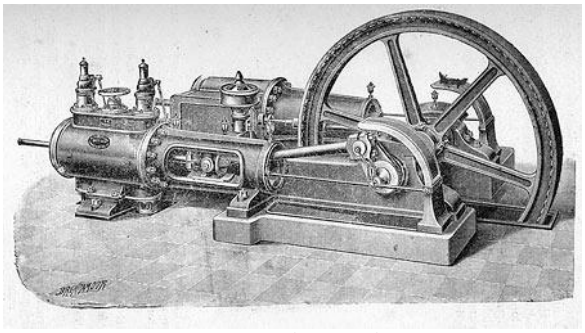

Fig. 1: Steam machine, important for start of industrial revolution in 18th century

Second revolution started with use of electricity and electric-powered machines. Introduction of assembly lines is an essential part of this revolution.
One of most important things was Edison’s invention of light bulb and division of labour, which brought another expansion of industrial production with more machines.
Third revolution is not so significant, it is more an evolution than a revolution. Mostly we start this era in 60s, when first PLC were invented. PLC stands for Programmable Logic Controller, a first industrial computer, working in real time and using so called cycles to run the programme.

Fig.2: PLC – programmable logic controller, in this case control system of an reflow oven

Nowadays we find ourselves in the era of the 4th industrial revolution. This era should take about another 10 up to 30 years. Mass use of internet, its penetration in literally all parts of our lives. Internet connects billions of people and as new issue we start to use connection between machines (so called internet of things), invention of different cyber systems. Artificial intelligence, spreading of artificial intelligence into reality are quite new elements of our everyday life.

Everything begins in the 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 first companies, also in the Czech republic.

One of most important production steps is soldering. How does it look like, from soldering point of view?

ISO norm 13053-1:2011 defines "Six Sigma Process", main values as FPY, RTY, Process-sigma. For description of stability of soldering process we use C_{mk}. Customer will have a proof, that all his products were produced in specification and the producer has to prove it. Companies are using MES, but this is not the only tool for control of failure-free production. More check possibilities, connection between machines etc. is the first step of "Smart Production" or, now called, Industry 4.0.

What does it means for soldering processes? What are main goals of Industry 4.0? Transparency, flexibility and, last but not least, economy!

Transparency in production generally means

smart integration
smart operation
smart products
smart services

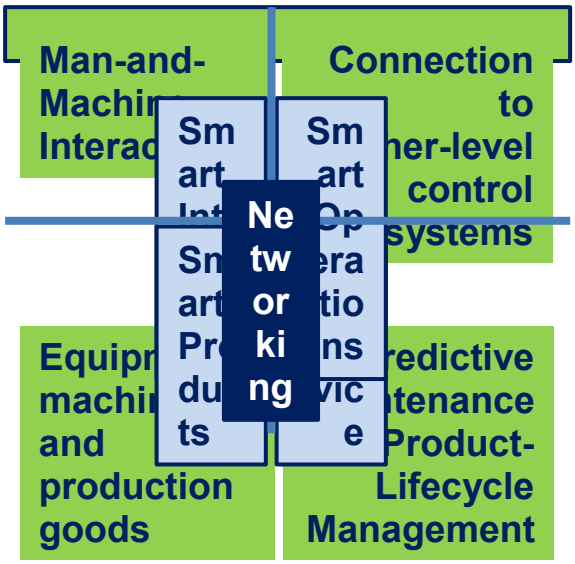

Fig. 3: Digital offers in the electronic industry

What we can do for "Smart Production"? Firstly, it is a monitoring of all processes, permanent check of all important parts of machines, analysis of production, new software tools for better control of production.

We can record all relevant production data, all measurements for analysis. This is one of most important points of "Industry 4.0". We can check process stability on-line. Data analysis offers a very useful overview about process stability and, of course, quality. On-line checking of profiling makes it possible to have a more stabile process, because all instabilities can be found very soon and software stops the production, if something is out of specification.

Inside of a reflow soldering machine we check all important parameters, e.g. temperatures, speed of transport, oxygen level and/or exhaust. But not only these values. Monitoring of transport vibrations, use of EC blowers can make the control of an oven easier. If you have the possibility to measure vibration of transport system, you can plan the maintenance work better. EC motors are smart products, which can be driven over network and send back data about their status. Of course, limit of vibration level has to be safe for production. If measuring system is sensitive, it is not a problem. Automatic lubrication uses this data, too. The machine is more environmentally friendly and can help to optimize the lubrication for just necessary level.

Connection over network, using of smart devices like smart watches, makes control of production much easier, too. Automatic refilling of components for placement machines, predictive maintenance based on data collection from the machine (or line, if possible) – the best way to more efficient production (cost saving, better quality etc.).

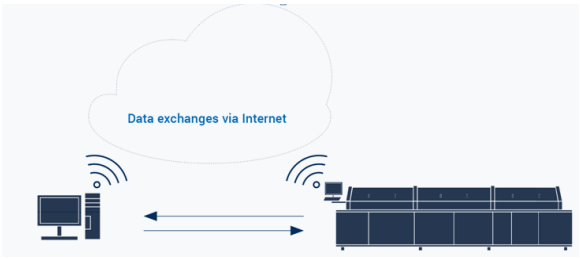

Fig.4 : Remote control of production machine shorts time without production

Operators have smart watches or tablets, connected to the network of the production line. The whole system are independent on the platform Filtering of messages brings to the operator just necessary data, operator from the oven is not interested in messages from placement machines and when yes, then in information about idle time of the line. He can use this time for maintenance or other activities, related to the production.

Remote control of the line is another significant help for high quality production. It saves travel time from producer to customer, reaction time is shorter, service intervention in minutes, instead of hours or, in the worst case, days. Reduced service costs is a big benefit

of this control. All SW troubles (not only) can be solved very fast, effeiciently. Analysis of other troubles can be done very quickly and can save production time and, as already known, time is money. Speaking of money, the next point is very closely connected to it. ROI – Return on Investment. The lower costs of ownerships, the shorter ROI is. Again – time is money!

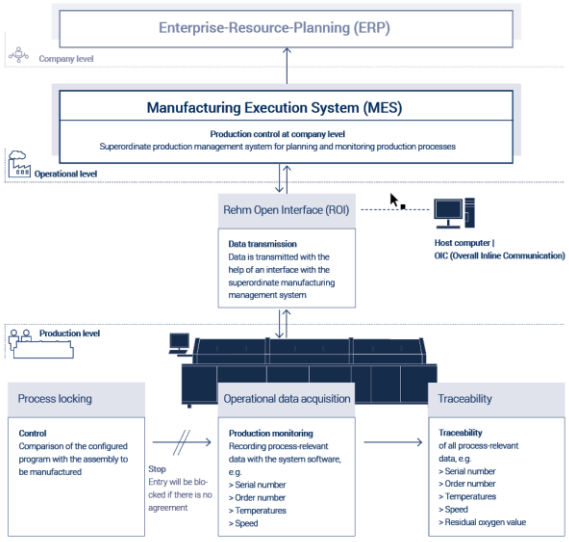

Fig. 5: Production control via a master computer

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

Continuous data collection and check of all relevant programme values serves to qualitatively perfect production. If some of the preselected parameters is out of specification, inlet interface of machine will be blocked and intervention of operator (technician) is needed. Parameters to check are mostly serial number (barcode, 2D code etc.), order or lot number, temperatures an/or speed of transport system, residual oxygen level. This data will be transferred to a higher system (using Puls etc.) over opened interface. This allows control or planning of production from company level.

Every machine needs to be maintained regularly and on the right place. Maintenance has to be precisely oriented, should take short time and, if possible, be oriented on specific parts, selected using data collection from real production till the break. This is not always simple issue. Of course, employees have to be trained and skilled.

Training takes some days, one up to 5, mostly. But this is just the first step for a good maintenance. Experience is a question of time, mostly 6 months or longer, up to 1 year. But people make mistakes in their job. How to improve it? This is a task for augmented reality. Shorter time between failures is very desirable from today's production.

Fig. 6: Glasses for augmented reality

It started some years ago as a game, now it is a challenge for future production and its control systems. Use of augmented reality for maintenance works has already started. If producer of machine prepares manuals in augmented reality, 3D, it can make repairs and maintenance very easy. Time for training of operator can be shorter, influence of people's fluctuation can be eliminated.

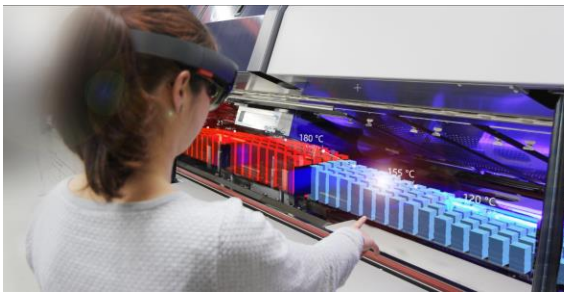

Fig. 7: Operator can see mixture of reality and virtual reality – augmented reality

CONCLUSION

Industry 4.0 is a new way to improve our production and make it more efficient. First it means less people in the production, but later need of more skilled, educated people will come. Machines take over the hard job, people will do more mental job.

Some companies, in the Czech republic too, start with this matter and first experience is adaptation of smart systems for real production. Development of communication protocols, filtering of data for every level, included in system etc.

First steps were done!

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