SPOTLIGHT

FROM THE STEAM ENGINE TO THE

SMART FACTORY

THE INTERNET OF THINGS IN AUTOMATION

The 'Internet of Things' and 'Industry 4.0' are two terms that are increasingly used in discussions, in specialist publications and even in the daily press. New buzzwords? Or a concise description of the future of automated production? Whatever you think, the two visions are much closer to implementation than many realize.

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WE ARE NOW FACING THE FOURTH REVOLUTION: CYBER-PHYSICAL SYSTEMS (CPS), WHICH NETWORK MACHINES AND COMPONENTS, AND VERY FLEXIBLE AND INTELLIGENT SOFTWARE, WILL PAVE THE WAY TO THE SMART FACTORY.

THE INTERNET OF THINGS – often abbreviated to IoT – is not a completely new invention. And the ideas for further automation of production are also part of a logical progression. Everybody is, in principle, speaking about the same future: that of flexible communication, flexible interaction and flexible production. Of horizontal networking factory to factory. Of vertical communication from automation through to the ERP. From embedded systems and global industrial networking. And this provides many new perspectives and opportunities. Not just for production lines and products, but also for employees. However, there are also new security questions that need to be considered.

THE INTERNET OF THINGS AND CYBER-PHYSICAL SYSTEMS

On April 1, 1998 the Hyper Text Coffee Pot Control Protocol (HTCPCP)[1] , for the control and monitoring of networked coffee machines, was published as RFC 2324 – a successful April Fool's joke. At the time. It was a joke back then but, from today's perspective, this was one of the first implementations of the IoT.

The IoT describes how the conventional computer is being replaced by "smart" objects. Kevin Ashton coined the term in 1999, but the approach had already been pursued by Mark Weiser in 1991 in his essay entitled "The Computer for the 21st Century". The IoT became more widely known through Auto-ID Labs[2] and their involvement with automatic identification by means of RFID. Today, in the automotive industry, for example, we have production-ready implementation with vehicles which can establish connections to the Internet, communicate with one another and with other road users, react to changing traffic situations, and automatically seek help in the event of an accident – with the next step being navigating through traffic without a driver.

The possibility of having things communicate with one another changes not just our everyday lives. It will also change how we produce things. Slowly but surely; because industry tends to undergo evolution rather than revolution. Long machine lifecycles and proven processes are just two good examples of this. Over one hundred years passed between the first Industrial Revolution, powered by the steam engine, and the second, which brought us mass production by means of a production line. At the start of the seventies, automation followed with the introduction of electronic controllers and thus began the third industrial revolution. We are now facing the fourth: cyber-physical systems (CPS), which network machines and components, and very flexible and intelligent software, will pave the way to the Smart Factory.

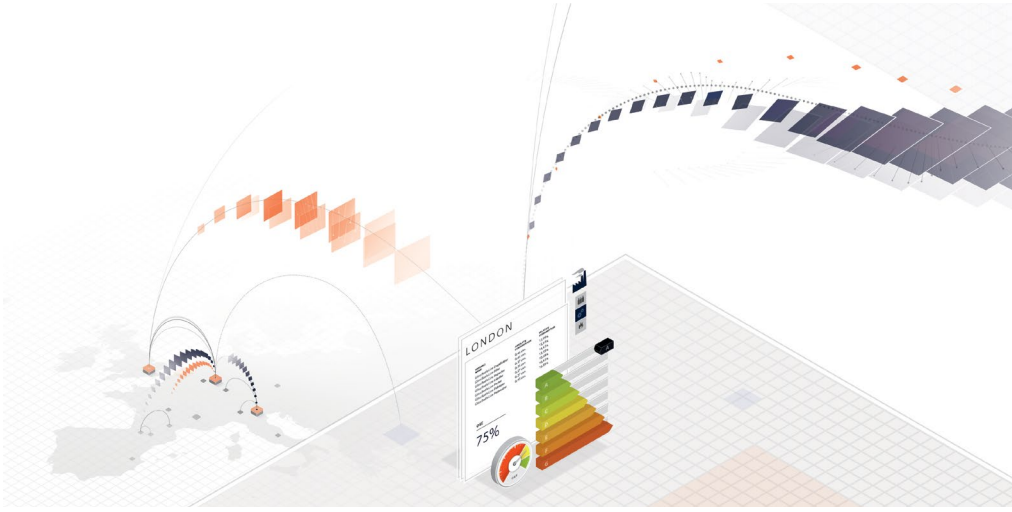
Cyber-physical systems arise from the linking of embedded systems to digital networks of machines or product components. They can log and process data from the natural environment independently – and in turn influence their environment with the results. If CPSs have IP addresses, they can be controlled online – and there are now enough addresses thanks to IPv6. With sensors, actuators and small embedded computers, CPSs organize production autonomously and can thus overcome barriers between companies, such as between suppliers and producers.

THE NEXT STEP: THE SMART FACTORY

The future belongs to the Smart Factory. Many corporate processes are controlled and coordinated in real-time depending on the requirements, even over long distances. This means that individual steps must be standardized as modules and made addressable. Robust networks ensure the necessary continuous exchange of data that is needed for the automatic adaptation of the processes.

Process control is now no longer necessarily central; it can also be taken over directly by components in some cases, thanks to CPS. Embedded systems can be used to interpret environmental data and deduce control commands. Production as a whole becomes more flexible. Machines also

[1] Source: http://en.wikipedia.org/wiki/Hyper_Text_Coffee_Pot_Control_Protocol
[2] Source: http://en.wikipedia.org/wiki/Auto-ID_Labs



contribute to this new flexibility because they are designed to be open for different applications. They are in a position to complete different tasks in a colorful sequence and to employ different tools. The software for process control and visualization must also be designed accordingly to be open and flexible.

The German Fraunhofer Institutes have conceived a type of DNA of the factory. A triple helix symbolizes the intertwining of information technology, product and production. In the future, products will be so intelligent that they can organize their configuration themselves, coordinating with the company's production equipment and planning software. The factory DNA is present in each individual part and in each machine component; together they organize themselves into an autonomous "organism".
What does the Smart Factory mean, then, in practical terms? It could mean the flexible production of small batch sizes without major retooling costs. If components require processing, the machine selects the appropriate tool. Maintenance is organized by the machine itself. The ordering of materials and consumables is also automated. Industrial robots are becoming lighter and more agile. They are breaking free from their limitations and taking on a variety of tasks. Festo, for example, won the Deutscher Zukunftspreis (German Future Prize) in 2010 for its innovative elephant key with grabbing fingers.

Energy management can also develop flexibly: machines organize themselves independently and organize cost-effective energy procurement. You can read more about this in the article entitled "Energy Experience Day UK: Insights into the future of our energy supply" starting on page 46.
Higher-level modules for planning and control will be cloud-based in part and will change the previous, familiar automation pyramid. The automation level will increasingly provide administration and analytical tasks; the planning of manufacturing will already start in the ERP. In order to be able to act as flexibly as this, complex computing tasks must be achievable at the different control levels in a company. Starting with the processing of the order, through planning and manufacturing to logistics and resource management. The process of connecting different levels in the company will further establish itself and continue to accelerate. It will push beyond company limits. However, all processes will have to be permanently coordinated with one another.

The implementation of the Smart Factory requires greater harmonization of interfaces and languages. Joint data pools and equal access to this is also required. Nevertheless programs must increasingly work independently of certain hardware and obtain data from different sources, process this and be able to output it in different formats. Only in this way will new opportunities prevail such as: the evaluation of manufacturing processes according to effectiveness and efficiency, the ergonomics of workspaces, and the problem-free supply of material. Correctly implemented, companies will benefit from considerably increased flexibility with production costs being reduced at the same time.

EVOLUTION

The requirements of a Smart Factory have, in part, already been realized – or are now being created. This means that the procurement of new machines and new software, the forging of new alliances and the purchase of professional services must already be orientated to future ways of working. It is not a matter of being the first to produce goods in a Smart Factory. It is a matter of using new possibilities effectively. This means, for example:

- Targeted preparation for flexible production – in extreme cases down to a batch size of 1.
- Readiness to incorporate suppliers and consumers more closely in the company's own processes and to also share information with them in an automated manner.
- New machines for IPv6 and communication with components, as well as flexible production.
- New software for planning, control, visualization or analysis must adapt flexibly and individually, and be operated ergonomically.

- The networking must allow communication beyond corporate limits – and nevertheless remain secure.

However, new thinking is required. The people involved must get themselves acquainted with the new concepts. This is because – in order for comprehensive networking to work – supervisors and other employees must recognize and accept its benefits. Initial cross-company and interdisciplinary cooperation makes the Smart Factory a successful concept.

The change does not need to be a revolution, but must – as is common in industry for good reason – come at the right pace. Machines have long lifecycles; functioning concepts should be changed as little as possible and the engineers and operators should use what has been tried and tested. In their study entitled "Automation 2020", the Association of German Engineers raised the issue of what we already have many necessary tools; others are on the way to completion. Phillip Werr explains what we have already achieved, what the Smart Factory means for our thinking and what steps will get us to the destination in the article entitled "On the Road to the Smart Factory" starting on page 12.

Research and development will also remain the key to innovative products in the future. COPA-DATA has traditionally been very heavily involved in partnerships with universities and technical educational institutions, research institutes and innovative companies. This always leads to exciting results. In the article entitled "Does the Thought of Industry 4.0 Intimidate You?" by Johannes Petrowisch on page 14 onwards, you can read what this has to do with multi-site analyzes and seamless, manufacturer-independent integration – and what this means for your company.

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their members need to deal with in industry. Complexity was one of the most significant limiting factors. In light of upcoming technologies such as CPS, we should also see that as a warning: if the IoT and the Smart Factory are to be successful, we should not think solely about technical requirements and implementations but, most of all, we must prepare engineers, automation experts, business administrators and IT experts for it – and improve their tools accordingly.

What will be required in the future, more than ever before, is software that can analyze quickly, provide data in an intelligible format and, most of all, can be operated easily and safely. This is because, despite all the progress in mechanical engineering, humans remain the decisive factor. We must interpret events correctly, and react and make decisions quickly. Therefore we also require people who adapt to the quicker pace of change, update their knowledge constantly and are open to new technology.

Humans thus continue to play an important and decisive role in the Smart Factory. They will, however, increasingly need to be highly qualified, to have more competencies and be in a position to analyze diverse information meaningfully to make use of it.

READY TO GO

Where do we actually stand today on the journey to the Smart Factory? As some of the articles in this *IU* will show,

In this vein, Werner Reuss, who is intensively involved with the IoT and smart factories, also reports on the challenges he expects to come – and how Microsoft is supporting its partners – in "Combining Two Previously Separate Worlds" starting on page 15.

With Eco.On, Köhl AG is providing its customers with a comprehensive, process-orientated solution for energy management. In addition to the pure consumption data, actual production data flows into the analysis, which allows a valuable evaluation of the efficiency of a facility or a production line. You can read what this has to do with COPA-DATA and its energy management in the interview with Thomas Winter starting on page 19: "Energy Management for the Smart Factory of Tomorrow".

The fight against insular knowledge silos and overcoming the barriers that form communication islands will become an important arena for engineers and software. Both impair effectiveness and efficiency. You can read how COPA-DATA already supports teams to think and act on an interdisciplinary basis with effective communication between machines and smart information management from the sensor through MES and ERP to the cloud in a report by Phillip Werr in "Horizontal and Vertical Integration with zenon" starting on page 22.

Networking and diverse communication from machine to machine – what does that actually mean for security? We cover this interesting question in our interview with the

Italian security expert Marco Ramilli. You can find answers starting on page 24 in the article entitled "Security for the Smart Factory".

OUTLOOK

The Smart Factory will change automated production significantly. Individual customer requests will be able to be met more easily. Open and closed production networks will exist in parallel, machines will communicate throughout the company and thus further automate maintenance and material supplies. To the same extent that smart assistance systems change work, the working conditions for engineers, operators and control-room staff must also be adapted. This includes a clear focus on ergonomics as well as new operational concepts. Multi-Touch will become the standard and gesture control may be a further simplification in the relationship between humans and machines.

The Smart Factory creates new business opportunities: for manufacturers as a result of individualized products, but also for mechanical engineers and security experts. How far are you, your company, your customers and your suppliers along the way to the Smart Factory?

And, finally, a quick update: the RFC 2324 coffee protocol was enhanced on April 1, 2014 with RFC 7168: it can now also be used for the making of tea.

RECOMMENDED READING

BITKOM - Bundesverband Informationswirtschaft, Telekommunikation und neue Medien e.V. [German Federal Association for the Information Economy, Telecommunication and New Media]: The Platform of Industry 4.0 - The Fourth Industrial Revolution

http://www.plattform-i40.de/finalreport2013