IO-Link –
an integral part in the next industrial revolution known as Industry 4.0
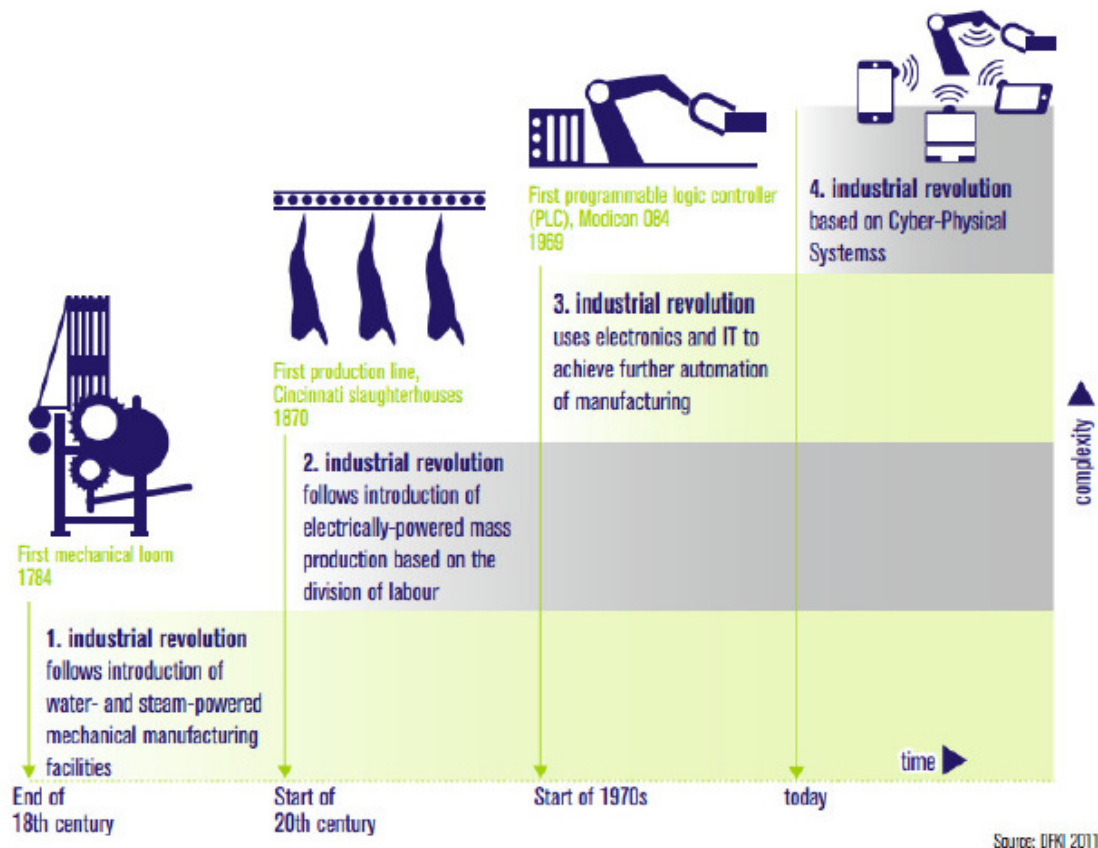
IO-Link – an integral part in the next industrial revolution known as Industry 4.0

The manufacturing industry is on the verge of entering into the next industrial revolution called Industry 4.0 and it is going to change control systems architecture, system connectivity and sensors as we know it today. Sensors are going to have to provide a lot more data than just a 4 to 20 mA or digital signal to the control system and/or system optimization software (MES). In addition to the amount of data required from the sensor will be the ability to set the parameters of the sensor from the control system and/or system optimization software. Industry 4.0 will lead to the development of Smart Factories. Smart Factories of the future are going to need smart sensors and smart connectivity solutions to these smart sensors.

The next industrial revolution – Industry 4.0
The term "Industrie 4.0" refers to the fourth industrial revolution. It originates from a project in the high-tech strategy of the German government, which promotes the computerization of manufacturing. The first industrial revolution was the mechanization of production using water and steam power. The second industrial revolution then introduced mass production with the help of electric power, followed by the third digital revolution and the use of electronics and IT to further automate production.

Industry 4.0 is a collective term for technologies and concepts of value chain organization. Based on the technological concepts of cyber-physical systems, the Internet of Things (IoT) and the Internet of Services (IoS), it facilitates the vision of the Smart Factory. Within the modular structured Smart Factories of Industry 4.0, cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. Over the Internet of Things, cyber-physical systems communicate and cooperate with each other and humans in real time. Via the Internet of Services, both internal and cross-organizational services are offered and utilized by participants of the value chain.

First mechanical loom
1784

First production line,
Cincinnati slaughterhouses
1870

First programmable logic controller
(PLC), Modicon 084
1969

4. industrial revolution
based on Cyber-Physical
Systemss

3. industrial revolution
uses electronics and IT to
achieve further automation
of manufacturing

2. industrial revolution
follows introduction of
electrically-powered mass
production based on the
division of labour

1. industrial revolution
follows introduction of
water- and steam-powered
mechanical manufacturing
facilities

complexity

time

End of
18th century

Start of
20th century

Start of 1970s

today

Source: DFKI 2011

What is Industry 4.0?

There are six design principles in Industry 4.0. These principles support companies in identifying and implementing Industry 4.0 scenarios.

- Interoperability: the ability of cyber-physical systems (i.e. workpiece carriers, assembly stations and products), humans and Smart Factories to connect and communicate with each other via the Internet of Things and the Internet of Services
- Virtualization: a virtual copy of the Smart Factory which is created by linking sensor data (from monitoring physical processes) with virtual plant models and simulation models
- Decentralization: the ability of cyber-physical systems within Smart Factories to make decisions on their own
- Real-Time Capability: the capability to collect and analyse data and provide the derived insights immediately
- Service Orientation: offering of services (of cyber-physical systems, humans or Smart Factories) via the Internet of Services
- Modularity: flexible adaptation of Smart Factories to changing requirements by replacing or expanding individual modules

Microsoft predicts that in 2020, the worldwide market for Internet of Things solutions will amount to US$7.2 trillion with 25 billion "things" connected.

In this article I will be concentrating on the collection and distribution of the relevant data from the Smart Factory's sensors. In order to be able to provide all the necessary data required to connect cyber-physical systems, humans and Smart Factories together and have

the ability to create virtual plant and simulation models - smart connectivity to smart sensors is needed.

One of these smart connectivity solutions is IO-Link.

What is IO-Link?
IO-Link is the first standardized IO technology worldwide (IEC 61131-9) for the communication with sensors and also actuators. The powerful point-to-point communication is based on the long established 3-wire sensor and actuator connection without additional requirements regarding the cable material. So, IO-Link is no fieldbus but the further development of the existing, tried-and-tested connection technology for sensors and actuators.

Easy and compatible (universal)
The connection between the IO-Link master and device is established via a max. 20 m long, unscreened 3-wire cable. The wiring is standardized on the basis of M5, M8 and M12 or any terminal connector. The vast majority of IO-Link devices is equipped with M12 connectors which can be used without any restrictions for IO-Link's switching mode and communication mode. Each port of an IO-Link master is capable of processing binary switching signals and analogue values (e.g. 8 bits, 12 bits, 16 bits). Serial IO-Link communication takes place via the same port. Easy wiring, automated parameter setting and extended diagnosis are but a few advantages of IO-Link.

High functionality (smart)
As a standard, 2 bytes of process data are available per cycle. The transmission between the IO-Link master and device with COM3-interface takes 400 μs at a speed of 230 kBaud and COM2-interface with 38.4 kBaud and 2.3 ms. The user can also choose larger frame types. Therefore, greater process data with up to 32 bytes in length can also be transmitted at a correspondingly cycle time. To ensure that the parameter data of a device is not lost when replacing a device, they can be automatically stored directly in the IO-Link master. If a new, identical substitution device is connected, the parameters of the previous device are automatically transferred onto the new device.

Easy handling
Each IO-Link device has an IODD (IO Device Description). This is a device description file which contains information about the manufacturer, article number, functionality etc. This information can be easily read and processed by the user. Each device can be unambiguously identified via the IODD as well as via an internal device ID.

Smart „IO-Link enabled" sensors
For a sensor to be able to communicate to an IO-Link master the sensor must have an IO-Link communication stack embedded. I can anticipate the first question that has just entered your mind – „do these sensors exist in the marketplace?". Well believe it or not there are a large number of these sensors readily available. In fact you have probably already got IO-Link enabled sensors in your factory. In anticipation of this new revolution, ifm efector has been producing sensors with embedded IO-Link for a number of years now so the chances you have in your plant is high. These IO-Link sensors have the same price tags and part numbers as the previous sensors without IO-Link.

Picture: Pressure sensor with embedded IO-Link

Integrating IO-Link

Of course to introduce IO-Link into a new plant is simple as it becomes part of the initial design concept. But what does it take to introduce IO-Link into an existing plant that already has its system architecture installed. The upgrade is a lot simpler than what one would imagine. With the simple introduction of an IO-Link master between the smart sensor and the fieldbus/PLC layer will do the trick. Again companies like ifm efector have a range of IO-Link masters to suit most applications and system architectures.

Picture: IO-Link master 8 ports IP67 for different fieldbuses: Profinet, Ethernet/IP

Putting data directly into SAP

Some of these IO-Link masters available from ifm efector are masters that have a Y-junction connection, commonly referred to as "Y-Path". This means that the sensors can talk directly to the PLC and directly to a server data base, such as SAP. These masters are the first of its

kind and at the time of writing this article, ifm efector is the only company able to offer this solution. ifm efector partnered with SAP to develop an Industry 4.0 – connectivity port as a solution based on the fact that SAP is arguably the largest ERP software solution available and has one of the largest cloud based solutions – SAP HANA. With the large amount of data expected to be transferred it is imperative to ensure that one is backed by a structure that can handle it. In 2013, 4 zettabytes (10^{21}) of digital data was created.

Picture: IO-Link Industry 4.0 gateway with 8 ports and 12 I/O's for cabinet mounting.

In conclusion

The next industrial revolution is here and unavoidable. Factories either need to adapt or die a slow death as their factories with its existing technologies slip away into the dark ages as they become uncompetitive with its newer technology rivals. Factory owners and engineers need to embrace the next industrial revolution and start doing something about it now – not wait until it is too late.

Ifm efector is a company that is able to assist in getting your factory "Industry 4.0 enabled" with their diverse range of products. From its smart sensors, smart connectivity systems, LineRecorder MES software and SAP connectivity solutions – they are in the perfect position to assist and partner with you through what is going to be a very interesting time ahead.

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