SICK AG WHITEPAPER

INTELLIGENT PRODUCTION LOGISTICS FOR THE CONSUMER GOODS INDUSTRY

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Summary

Production and intralogistics in the consumer goods industry are currently undergoing significant changes. This is the result of rising cost pressures and the need for greater automation as well as increasing product variants and customization. The changes that are taking place also relate to the goal of digitization: Every sensor, every machine, and all people involved in the production and intralogistics processes should be able to communicate with each other at all times. The vertical and, in the next step, horizontal networking of sensors, machines and factories is the systematic further development of this digitalization.

In today‘s market environment, companies in the consumer goods industry are confronted with a continuous overstimulation of consumers and an increasing homogenization of products and services. That is why it is especially important for these companies to position themselves well within the market. The brand plays a significant role in differentiating a company from the competition. It is very relevant to consumer buying behavior. The brand, in particular, is essential for companies in the consumer goods industry, as in many cases a brand represents more than half of the company‘s total value. Consequently, large companies in this industry are constantly faced with the challenge of adapting their brand management to the fast-moving environment.

A factory that meets the production logistics requirements with regards to automation and digitization is called a smart factory.

It is characterized by the following features in terms of production logistics:
- Lean and optimal processes
- Short production times
- Production of individual products at mass-produced product prices
- Increase in productivity
- Transparent supply chain
- Automated, efficient ordering processes
- High flexibility in production
- Quick adaptation to new or changing product requirements
- Consumption-driven supply of production
- High delivery reliability

This requires a variety of solutions from SICK throughout all areas of production logistics: Intelligent sensors for protecting, detecting, identifying, localizing, measuring, and controlling.für das Absichern, Detektieren, Identifizieren, Lokalisieren, Messen und Kontrollieren.

1. Consumer expectations are changing – including in the consumer goods industry

For consumer goods manufacturers and suppliers, the focus is on consumers. Their expectations are constantly changing. Products alone are not enough to succeed in this competitive environment. New business models are rapidly being developed – with profound effects on companies. They are preparing today for tomorrow‘s competition by harnessing the power of data and state-of-the-art technologies.

Markets and consumer demands are becoming more fast-paced and diversified. The pressure on companies to shorten their innovation cycles is increasing. Greater product variety, smaller batch sizes, fluctuating quantities, and shorter product life cycles are the result. At the same time, the Internet gives consumers full price transparency across global markets, further increasing competition and cost pressure.

In line with these requirements, the demands of manufacturing companies on their suppliers are also changing. Machine and system manufacturers must therefore develop new machine concepts that enable their customers to manufacture much more efficiently, flexibly and quickly.

New business models – the challenges of the market:
- Consistently focusing on consumers
- Differentiating products and services – including through innovations
- Exploiting opportunities for increasing efficiency
- Managing the company in a data-focused and forward-looking manner
- Creating competitive advantages

Industry-specific solution approach – effectively exploiting opportunities
- Aligning the business model with the future
- Enabling digitization of the product offerings and processes
- Adapting purchasing and the supply chain to new requirements
- Optimizing corporate governance and making the company fit for the future
- Realizing opportunities for increasing efficiency

2. Production processes: From manual to fully-automated manufacturing

Figure 1 illustrates manufacturing concepts in a factory using four different production lines: If, for example, a product is to be manufactured in large quantities, modular production cells or fully interlinked production lines are good solutions. Manual manufacturing is suitable for the production of small quantities. Conventional machines can be loaded flexibly and automatically with robot support, combined with manual loading if required.

Logistics areas such as goods receiving and dispatch are located upstream and downstream of the production lines. Depending on the type of manufacturing, the degree of automation in material handling and other areas of production logistics varies greatly.

Selection of the appropriate manufacturing concept also depends on the volume and variance of the product to be manufactured. Fully linked production lines are generally preferred when manufacturing few variants and high quantities, while modular production cells are preferred when producing many variants.

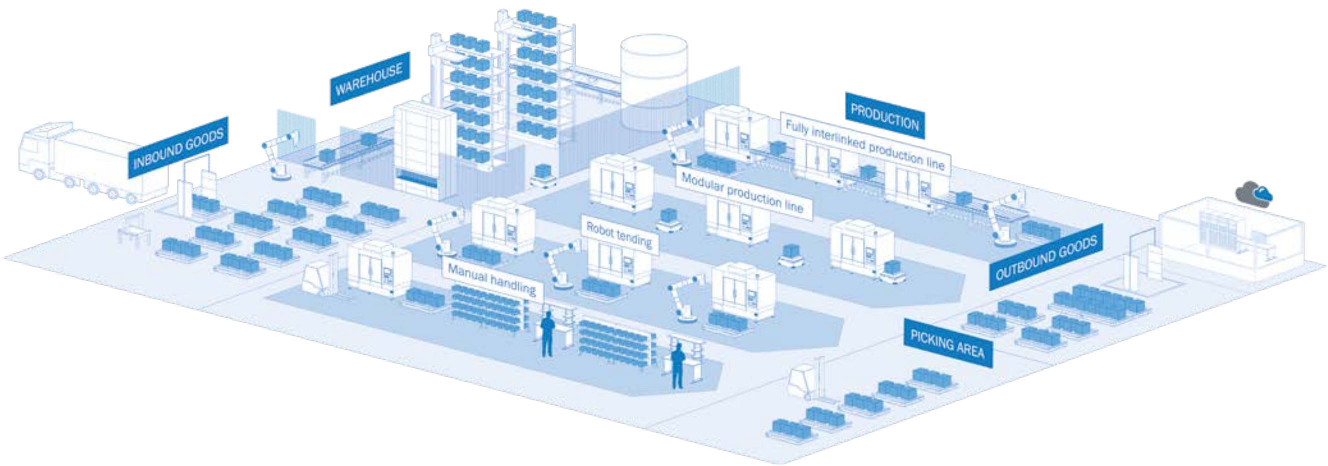

Fig. 1: Manufacturing concepts in a factory based on four different production lines.

If you consider the entire value-adding chain of the consumer goods industry, you will find that all four manufacturing concepts are used there. Depending on the type of manufacturing, the levels of automation in material handling and other areas of production logistics vary greatly.

The reason for this is the great differences between companies in different sectors of the consumer goods industry: Food and beverage producers have different requirements than cigarette manufacturers or producers for drugstore and perfume products. The companies can be divided into more than 20 sectors (e.g., food industry, tobacco industry), which in turn can be subdivided into further subsectors. A subsector is a group of companies that produce a similar type of product or product group. For example, the meat industry is a subsector of the food industry, and the dairy industry is a subsector of the beverage industry. The food industry alone has more than 20 subsectors.

3. Production and intralogistics: Two disciplines merge

Production logistics encompasses all the processes between purchasing and distribution logistics that ensure that the machines and workstations are supplied with the right materials or products at the right time and in the right quantity and quality. The progressive automation and digitalization of manufacturing can help make the material flow from the delivery of materials to the shipping of the finished product fully transparent. This is where the sensor solutions from SICK come into play. The areas affected by this are shown in the graphic and described below.

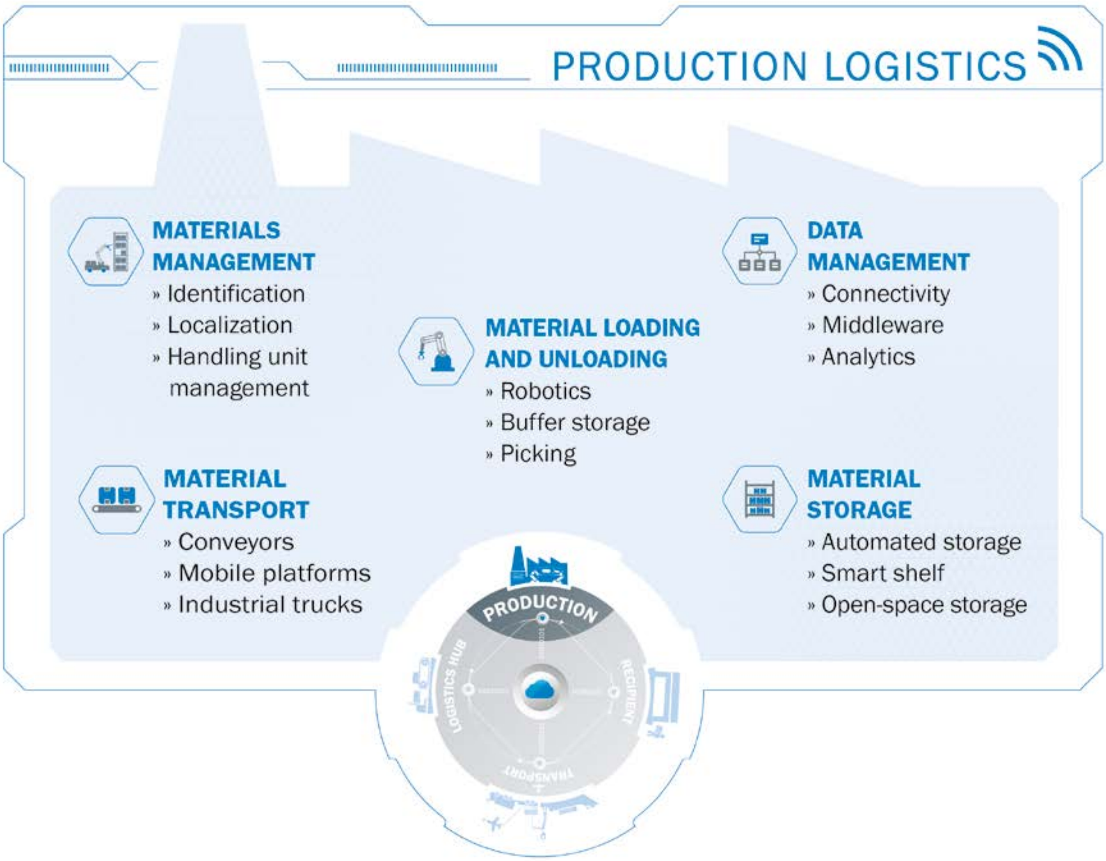

Fig. 2: Areas of production logistics.

Material management
When is which part where? The issues of localization and identification of products and materials provide the foundation for better material handling in production. Container management also helps to ensure problem-free production processes and lower storage costs.

Material transport
Conveyor belts, mobile platforms, tugger trains and industrial trucks are used to achieve a highly efficient and flexible supply of new components to production and for returning empty containers.

Material loading and unloading
Current automation technologies not only master the tasks of supplying and returning materials, but are also finding application throughout the entire material flow in production, including in manual picking processes, robotics, and in buffer stores. This smooths out fluctuations in the production process, increases transparency, and reduces downtime.

Materiallagerung
Modern storage concepts ensure automated replenishment and thereby actively support the production flow. For example, in open-space storage with pallets, with intelligent rack systems, or in fully automated warehouses.

Data management
With the help of connectivity technologies and suitable middleware, data can be integrated into higher level systems such as ERP systems and MES. By bridging the boundaries between networks or software systems, production logistics can create a transparent material flow, provide the basis for the use of analysis software, and facilitate automated logistics processes.

4. Requirements and solutions for interlinked production lines

The implementation of concepts for interlinked production linesalso poses new challenges for machine builders. The machines must be flexible and able to be adapted to the product variants to be manufactured. The product often controls the process. This means that the machine automatically detects to which variant the intermediate product currently on hand corresponds and automatically starts the associated process. SICK offers the necessary identification solutions for this. They can be adapted to very wide range of application requirements.

To implement these concepts, manufacturers of packaging machines, for example, need flexible solutions to be able to respond to different packaging variants. To be able to technically implement the automatic identification of these variants, SICK provides solutions that are tailored to the specific requirements.

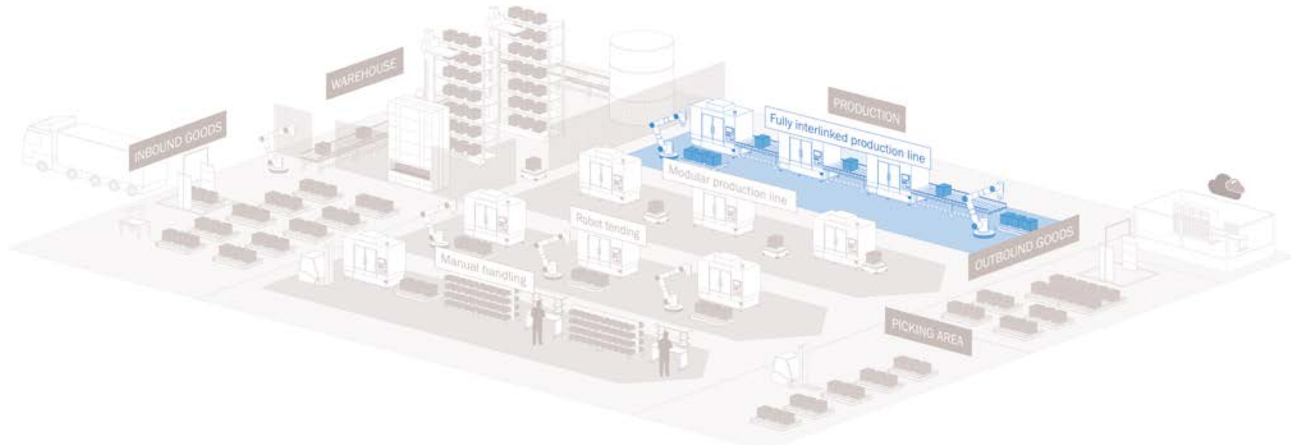

Fig. 3: Modular manufacturing concept.

4.1 Identification solutions: Three solutions for efficient identification

The specifications of an application intended for object identification must be precisely defined in advance. Only in this way will it be possible to ensure that the application fulfills the requirements and is neither undersized nor oversized. The specifications must also take into account the desired degree of automation and the type and security of data storage.

After defining the specifications, a suitable identification technology can be selected. Figure 5 identifies the three most common identification technologies: RFID read/write devices, laser-based fixed mount bar code scanners, and image-based code readers. All three technologies can be combined into the one system, if required.

	RFID	Laser	Image line scan/matrix
1D bar code	–	✓	✓
2D code	–	–	✓
Transponders	✓	–	–
Line of sight	not required	required	required
Costs of a label	> 0.05 €	< 0.005 € (label)	< 0.005 € (label)
Procuring the label	Purchase	Purchase, label printing on standard printer	Purchase, label printing on standard printer
Maximum storage capacity of the label	high	low	medium
Maximum reading field width	very large	large	large | average
Depth of field*	N.A.	high	low | average
Omnidirectional reading	very well suited	min. 2 devices needed	well suited
Maximum object speed	2 m/s to 20 m/s, depending on application	5 m/s	6 m/s
Sensitivity to external light	no influence	very low	low
Impairment due to dirt and wear	low	medium	medium
Metals / liquids in the surroundings	have an influence	no influence	no influence

Fig. 4: Overview of the features of the different identification technologies in industrial use.

The advantages of RFID read/write devices:
- Identification of even hidden or dirty objects
- Suitable for large objects with imprecise transponder position
- Reading and writing of data
- High level of protection against falsification
- Strong data protection

The advantages of fixed mount bar code scanners:
- Also suitable for different distances and object sizes
- Coverage of large reading areas with only one device
- High read stability, even in varying ambient light
- Low commissioning costs

The advantages of image-based code readers:
- Reading of different code types possible
- Independent of code alignment
- Monitoring of code qualities for process optimization
- Subsequent image analysis possible
- Also suitable for heavily damaged codes

4.2 Robot Vision – packaging more productively using image-based sensors

Product cycles are shortening, and the focus is increasingly on resource and energy efficiency. Especially in the consumer goods industry, we are dealing with a very dynamic and fast-moving market. Flexible production solutions using robots are in demand here. They make it easy, for example, to implement seasonal packaging.

Image-based solutions increase the field of vision of robots. SICK offers an comprehensive range of camera technologies and technologies for industrial image processing. Using these, the robot localizes and identifies predefined objects and decides itself how to grip the respective part. There is therefore no need for mechanical attachments such as object guides.

2D part localization using the PLOC2D robot guidance system:
Easy-to-use sensor system for 2D part localization that requires no vision expertise and is ready for operation right away.

3D vision system with 3D Belt Pick for robot guidance:
The easy-to-integrate 3D vision solution for robot guidance applications avoids collisions and product damage in picking processes. The robot guidance system with specialized 3D SensorApp locates objects on a conveyor belt and orients itself to the shape of each individual product.

Bin picking using the PLB robot guidance system:
The flexible robot guidance system for bin picking is used to precisely determine the position of components in boxes or on pallets, regardless of the shape and alignment of the parts. The robot guidance system is available with different 3D cameras.

Robot guidance when palletizing and depalletizing parcels:
The Visionary-S 3D vision sensor determines the position and dimensions of packages on a conveyor belt or pallet and transmits the exact positions and dimensions of the packages to the robot controller. This allows the robot to adopt the correct gripping position in each case and palletize and depalletize objects of different sizes. The 3D vision sensor checks the packing format during palletizing by comparing it with the data stored in the controller.

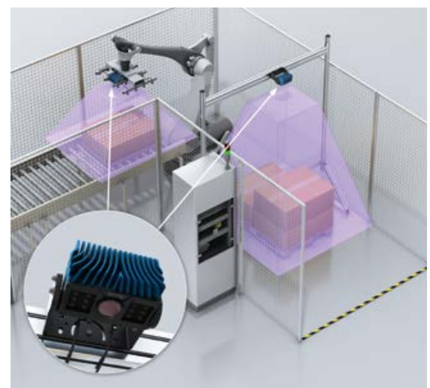

Fig. 5: Robot guidance when palletizing and depalletizing parcels.

Flexible and efficient hazardous area protection for robots
The Safe Robotics Area Protection safety system from SICK provides process-based protection for collaborative robot applications. It gives machine operators unrestricted yet safe access to a robot's work area by adapting the operating conditions to the position of the person. This eliminates the risk of accidents occurring while at the same time improving productivity by reducing downtimes and optimizing both the ergonomic and process aspects of operator workflows. Safe Robotics Area Protection is a complete solution and quickly ready to use: The safety system can be easily integrated into the controllers of standard industrial robots thanks to the precompiled and tested software function block.

Fig. 6: Flexible and efficient hazardous area protection for robots.

4.3 Smart Sensors: Intelligent data collectors

Networked production and control processes in complex machine environments will determine the industrial future. Smart Sensors already support dynamic, real-time-optimized, and self-organized industry processes. These sensors record real operational statuses, turn these into digital data, and automatically share them with the process controller. The added value of sensor communication depends significantly on the quality of the delivered data.

SICK has developed Smart Sensors for this purpose that use the globally standardized IO-Link communication protocol. In this way, the sensors collect data far beyond classic switching signals or measured process variables. The speed at which Smart Sensors receive new parameter sets is a great advantage, especially for flexible batch sizes up to batch size 1. The parameters used can be automatically transmitted to a replacement sensor should a device fail. Smart Sensors automatically detect faults during operation and actively troubleshoot problems that may arise, which ensures smooth processes. To prevent unplanned system downtime, the sensors are equipped with diagnostic functions, thereby enabling predictive maintenance. And last but not least, smart sensors increase process efficiency by providing system processes with the right information at the right time.

For example, a smart sensor from SICK can be used to determine the object speed regardless of any slippage. This ensures accurate measurement results. Furthermore, the sensor makes it easy to sort and classify objects based on their length and independent of the conveyor speed.

Fig. 7: Smart sensors as intelligent data collectors.

5. Automated material transport through mobile platforms

One challenge of production logistics is the provision and supply of the individual machines as well as the removal of the packaged goods. Mobile platforms are often used here: Industrial automated guided vehicles (AGVs or AGCs), service robots and automated guided vehicle systems (AGV systems or AGVs).

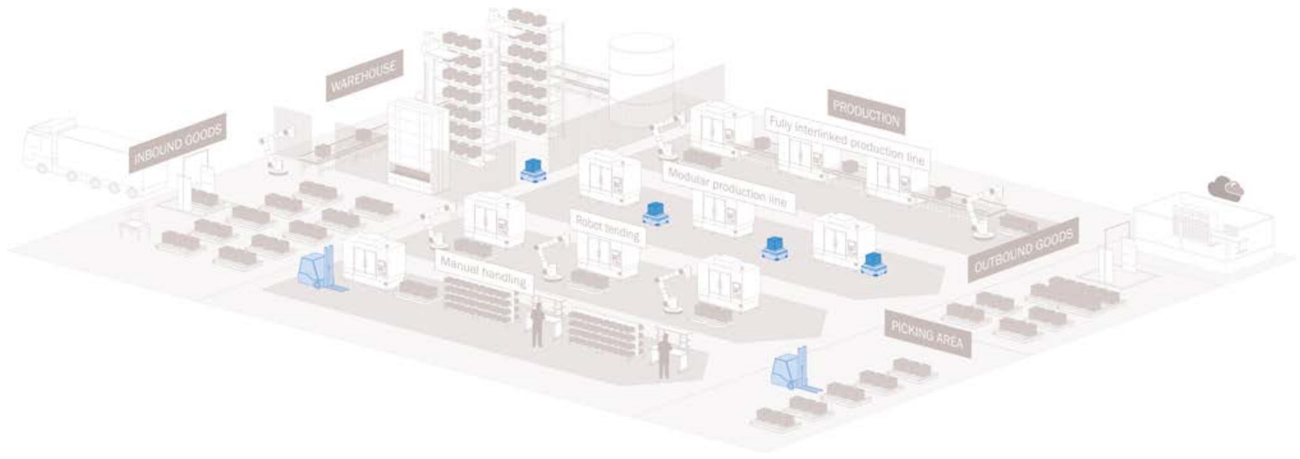

Fig. 8: Mobile platforms in a manufacturing facility.

5.1 Navigation for dynamically adaptable logistics and production processes

Various laser scanners from SICK support automated guided vehicles (AGVs) and AGCs in their autonomous transport operations. The vehicles also provide data for their own software to respond to ever-changing industrial environments. For example, AGVs and AGCs constantly synchronize the floor plan of a room to their route environment. This allows the vehicles to recognize their position at all times and find the route to their destination. With the help of a visual display of relevant measuring points, the routes of the automated guided vehicle systems and vehicles can be traced and controlled.

LiDAR-LOC localization solution:

The LiDAR-LOC modular localization solution precisely determines vehicle positions. The localization is based on natural surrounding contours: LiDAR sensors mounted on a vehicle scan the surroundings and the LiDAR-LOC software creates a digital map of the surroundings from the measurement data obtained. The LiDAR-LOC masters changes in the vehicle environment and the processing of measurement data from multiple LiDAR sensors. Additional artificial landmarks and external odometry are not required for vehicle navigation. The LiDAR-LOC is therefore ideally suited for its development.

5.2 Docking of AGVs and AGCs: Safety for man, material and machine

The area where a mobile platform docks and undocks from a machine is a hazardous point. There are three ways to secure these areas while distinguishing humans from materials. The first is a combination of light grid and muting sensors: The light grid reliably protects the hazardous point, but allows an AGV or AGC to pass with the help of the muting sensors (Figure 9, left).

Three ways to protect an area where a mobile platform docks or undocks from a machine

Hazardous area protection during AGV docking with the Safe Entry Exit safety system

Hazardous area protection during AGV docking with the Safe Portal safety system

Fig. 9: Three ways to protect an area where a mobile platform docks or undocks from a machine.

The second option for human-material differentiation and protection of the hazardous point is the implementation of a muting function with the Safe Entry Exit function. Any type 4 electro-sensitive protective device from SICK can be used here. Depending on requirements, this protection is combined with the Flexi Soft safety controller from SICK or a Siemens S7 control. Muting arms as signal generators are therefore not necessary. This reduces sources of error and increases machine availability (Figure 9, center).

The third option for hazardous point protection is a combination of safety laser scanner and safety software. This solution is based on one or more intelligent safety laser scanners. They ensure humans are distinguished from materials. Safe Portal makes it possible to connect safety laser scanners such as microScan3 to both the Flexi Soft safety controller and third-party controllers such as those from Siemens or Allen-Bradley. Through intelligent protective field programming, the safety laser scanner detects predefined objects, such as AGVs, and lets them pass. External muting sensors are not needed. Safe Portal combines a very high availability with a particularly small footprint, ensuring maximum safety thanks to the permanently active protective fields (Figure 9, right).

6. Digitalization for more transparency and efficiency

A production line – possibly with mobile platforms – requires not only technical implementation at machine level, but also a complex planning process for the individual systems and subsystems. For flexible and dynamic planning and control of manufacturing, the systems and subsystems need feedback as well as information from the field as directly as possible.

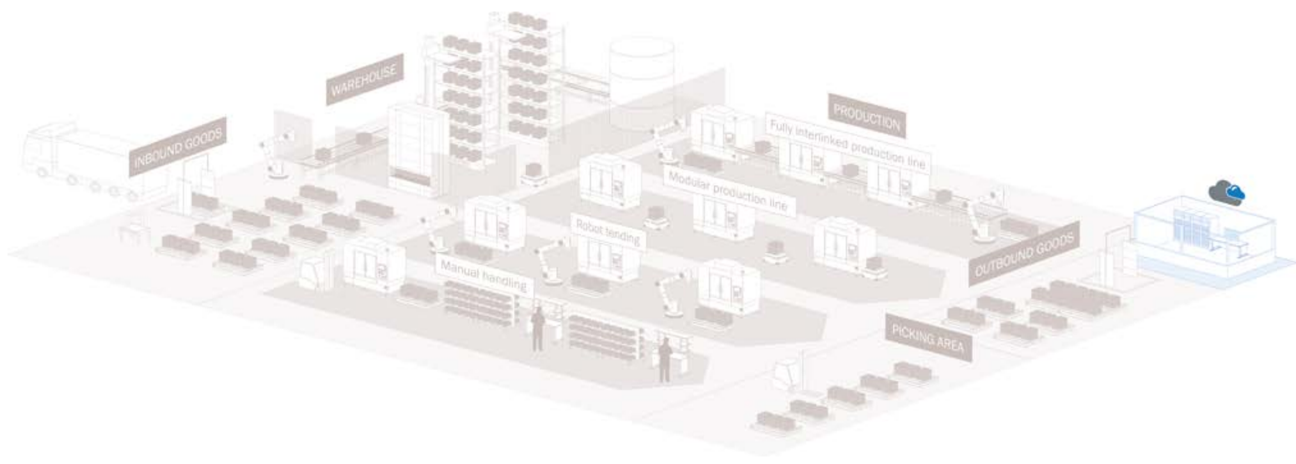

Fig. 10: The role of data in manufacturing.

Figure 11 below from the German National Academy of Science and Engineering (acatech) shows a simplified maturity model that allows a generally valid assessment of the stages of a company's development toward Industry 4.0. Computerization and connectivity are therefore also the first stages in manufacturing.

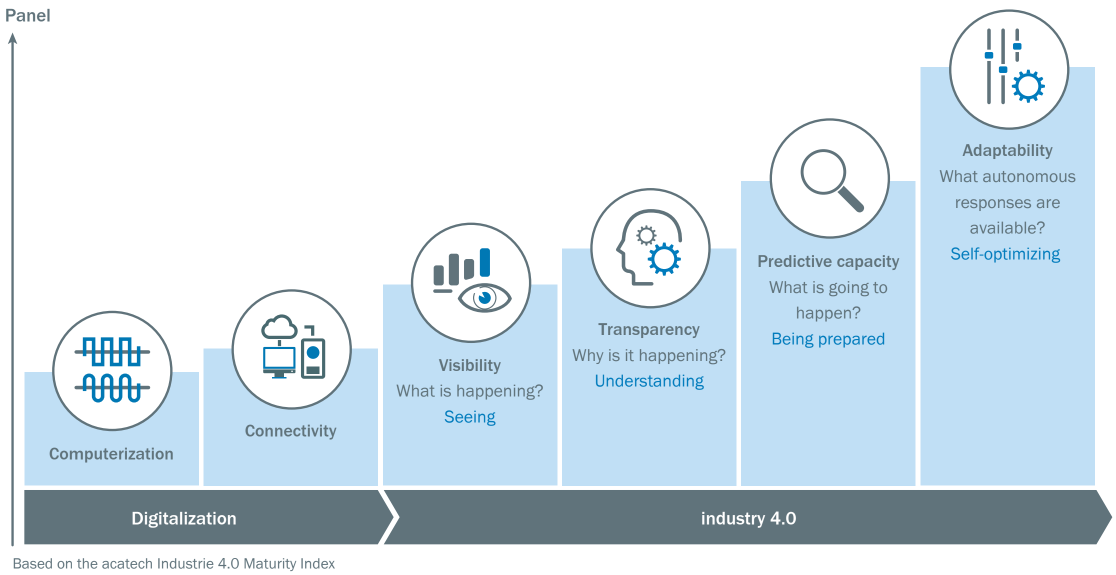

Fig. 11: "acatech Industry 4.0 Maturity Index" maturity model, German National Academy of Science and Engineering (acatech).

6.1 Smart gateways and middleware: The vertical integration of sensor data

Classic information of the first stage – computerization – is the current assignment of the production cells and the processing statuses of the orders. Identification solutions at the machine or processing station often record this information. However, the data is not processed in the machine, but in an IT system on an on-site server or in a cloud.

Access to sensor data is usually only possible from the control, meaning via the existing automation infrastructure, also known as operational technology (OT). Company-level computers, on the other hand, are usually located at higher levels of the automation pyramid. These computers work with other operating systems and protocols. If the data cannot be pre-processed directly where it originates, a gap is created: The IT-OT gap.

Accordingly, the second stage – connectivity – or making the data available is a crucial but surmountable hurdle.

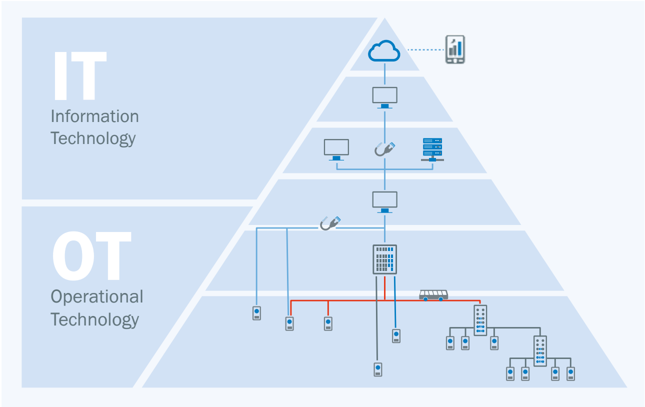

Fig. 12: The vertical integration of sensor data.

Sensor Integration Gateways
The point is to transmit sensor networks to the Internet. Dual-talk gateways are available tobridge the gap from the sensor to the PLC system, e.g., the SIG200 Sensor Integration Gateway from SICK for integrating sensor data into common PLC environments and enterprise-level systems. The SIG200 acts as an IO-Link master: It can be used to acquire, combine, evaluate and transmit digital input signals, digital output signals or IO-Link data from several devices via various fieldbus protocols. A REST-API provides a second data channel for higher-level processing. Due to its prioritization, this type of fieldbus communication is also called fast loop.

Sensor Integration Machines
Sensor Integration Machines (SIMs) offer particularly flexible and intelligent paths to application solutions. Sensor and camera data can thereby be merged, evaluated, archived and transmitted. Only relevant data is then sent to the higher-level systems via an interface. Especially for complex sensor tasks such as machine vision, this is the appropriate approach. SIMs are available in a scalable portfolio and are based on the SICK AppSpace eco-system.

Fig. 13: Sensor Integration Machines (left) and TDC Gateways (right).

6.2 Automated processes through localization Precise order localization

For production planning, it is often crucial to know which machine is currently processing which order and where certain objects are located at the moment. This is because this enables automated analyses of the material flow and avoids unnecessary searches for orders.

UWB systems:

A relatively new key technology for order location is based on ultra-wideband (UWB). UWB transmits the exact position of an object several times a second, providing a high level of transparency and understanding of all production-related assets, load carriers and loading equipment. Tag-based localization in indoor areas uses the LOCU1xx and LOCU2xx localization solutions from SICK, UWB radio systems in the frequency band of short-range communication. These solutions consist of UWB tags and antennas based on ultra-wideband technology for receiving and analyzing telemetry data. The LOCU1xx and LOCU2xx achieve localization accuracy of less than a meter here. A time stamp for each position value makes position, object type and time completely transparent.

Data fusion:

However, for high-volume goods, direct localization using UWB technology is not profitable. The solution here is data fusion. This means that in an IT system, the data from identification technologies (e.g., RFID read/write devices or fixed mount bar code scanners) are linked with the position data from a container or industrial truck obtained via UWB. In this way, it is possible to deduce the position of the container from the position of the industrial truck.

Fig. 14: Automated processes through localization: Precise order location.

A localization solution can also store defined actions. For example, if an object enters a previously defined geozone, it triggers a command in a connected IT system. For example, a shipping order can be triggered automatically for the products on a located pallet as soon as the pallet is in goods receiving. Other possible applications include automated completeness checks of intermediate products for an order before the machine is set up, or checking whether the right tools are in front of the right machine.

7. Conclusion

A Smart Factory, or digital factory, is the further development of our modern factories into intelligent environments where the gap between the real world and digital world is becoming smaller and smaller. Digitization in this context means that all systems, products and processes within the Smart Factory are networked. The Smart Factory is therefore the long-term goal that all Industry 4.0 developments are working towards, today and in the future. The digital factory affects many production industries, such as packaging machine manufacturing.

The digital factory is supported by smart sensor solutions for complete automation of manufacturing and logistics. It enables low production costs, end-to-end transparency, and high flexibility. Networking and controlling machines and processes ensures significantly greater time and cost efficiency in production and logistics processes.

FURTHER INFORMATION

1. Production logistics gets smart
➜ www.sick.com/production-logistics

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3. Hygienic solutions for the food and beverage, and pharmaceutical industries
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