FROM SILICONE TO THE SMARTPHONE: INTELLIGENT PRODUCTION LOGISTICS FOR THE ELECTRONICS INDUSTRY

Creating transparent and dynamic material and information flows for a smart and networked production logistics environment

SICK
Sensor Intelligence.

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Introduction

Production and intralogistics in the electronics industry are currently undergoing significant changes. This is caused primarily by rising cost pressures, the need for greater automation, and increasing product variants and customization. Added to this, there are new requirements arising from digitalization in dynamic markets with ever shortening development cycles.

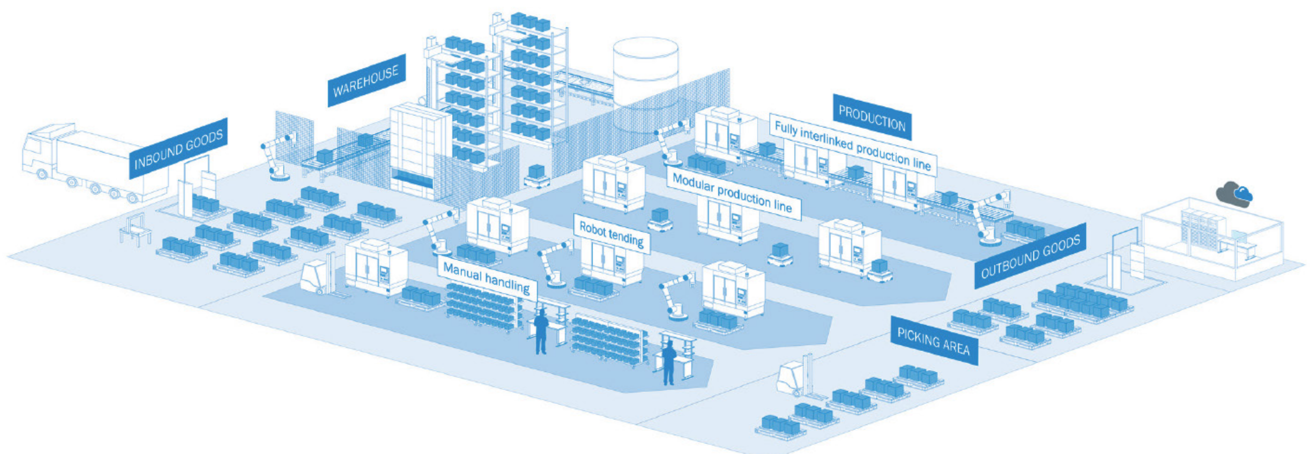
This white paper describes the value chain in the electronics industry. The value chain encompasses the manufacturing of semiconductor chips based on silicon wafers and electronic components like connectors and capacitors, their placement on printed circuit boards, and the mounting of subassemblies and electronic devices.

Previously, the ongoing move toward automation and digitalization focused on individual processes and ma¬chines. The emphasis these days is increasingly on production logistics solutions between machines as well as between production and purchasing or distribution logistics.

The various affected industry sectors are seeking to achieve more transparency and efficiency in the flow of materials and information. Whether it be by fully linking production lines or with the help of modular manufacturing cells: intelligent sensor solutions allow new logistics concepts or extend existing ones in the electronics industry.

Four Production Processes in the Factory: From Manual to Fully Automated Manufacturing

The following graphic illustrates various manufacturing concepts based on four different production lines in a factory: manual handling, robot tending, modular production line, and fully interlinked production line. Depending on whether numerous variants or high quantities are being produced, you can use either modular manufacturing cells or fully linked production lines.



Manual manufacturing is suitable for the production of small quantities or a large number of product variants. Robot assistance allows machines to be loaded automatically, for example in machine parks. Logistics areas such as goods receiving and dispatch are located either upstream or downstream of the manufacturing lines.

If you consider the entire value chain of the electronics industry, you will find that all four manufacturing concepts are used in this industry. The particular level of automation in material transport as well as in other areas of production logistics can vary greatly depending on the type of manufacturing.

For many decades, the semiconductor industry has been characterized by a high level of automation and productivity. Fully auto¬mated material transport to the process machines has been standard practice in the industry, especially in the manufacturing of semiconductor chips based on silicon wafers. When using surface-mount technology (SMT), these semiconductor chips and other components are placed on printed circuit boards. This is done on linear manufacturing lines. From loading to unloading, the process machines in these lines are connected by conveyor belts.

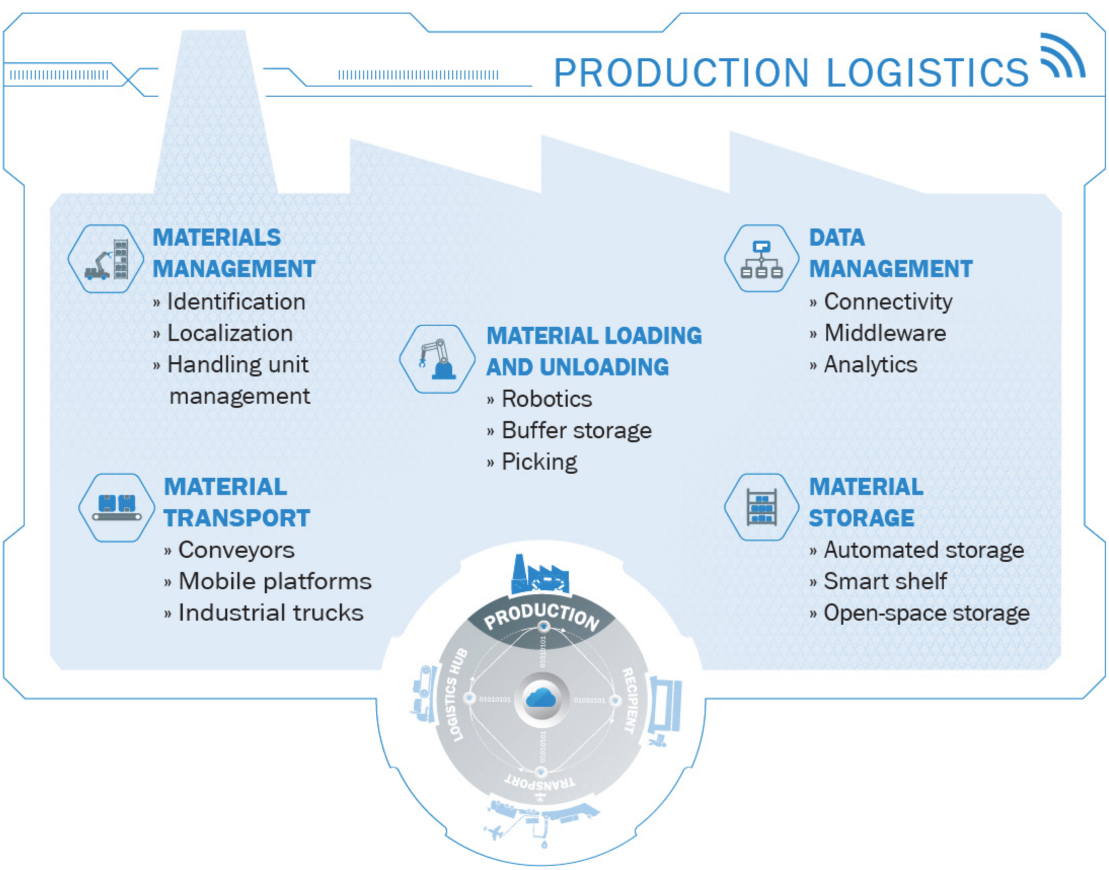
An extremely diverse manufacturing landscape exists in the production of electronic devices and components. In this case, partial processes like in mounting, continue to be performed by manual or semi-automated means. On the path to fully automating the production of electronic assemblies and devices, manufacturers are choosing either fully linked manufacturing lines or modular manufacturing cells.

The manufacturing concept chosen depends on the volume and number of variants of the product being manufactured. Fully linked manufacturing lines are generally preferred when producing few variants and high quantities, while modular manufacturing cells are preferred when producing many variants.

Production and Logistics: Two Disciplines Merge Together

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 makes the material flow fully transparent, from the delivery of materials to the shipping of the finished product. This is where sensor solutions from SICK come into play. The areas affected by this are shown in the following graphic and described below.



Material management

Where is each part and when did it get there? The issues of localization and identification of products and materials provide the foundation for bet¬ter 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 downtimes.

Material storage

Modern storage concepts ensure automated replenishment and actively support the production flow. For example, in open-space storage with pallets, with smart shelf 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 an ERP or 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.

Intelligent Production Logistics for the Challenges in Electronic Manufacturing

Shorter innovation cycles, increasing expectations for product variants, and custom manufactured items are just some of the great challenges facing electronics manufacturers. A further decisive factor is the increase in digitalization coupled with the exist¬ing cost pressures in production.

These issues impact not only automation and the design of machines, but also logistics processes. Production and its logistical processes – while continuing to be highly automated – need to be (re)designed to be as flexible as possible so that even small batch sizes can be produced economically.

Despite the automation of assembly or process equipment, however, a lot of tasks in logistics are still accomplished by manual effort. For example, material postings or material searches in production.

A digitalized production logistics creates transparency, reduces time-consuming manual activities, and reduces the risk of human error. Furthermore, state-of-the-art production concepts reduce the lead times for manufacturing orders. This, in turn, leads to faster response times in manufacturing.

Ensuring the transparency and availability of data in relation to material storage and transport also allows the use of analysis software. Data-based analyses optimize not only processes but also the materials provisioned for them. This enables companies to minimize their work-in-progress and thereby bind less capital.

Intelligent production logistics with tailored sensor solutions allow better identification and localization, optimized handling, and efficient data utilization. This results in:

Lower batch sizes and a greater number of variants with full automation

Reduction in manual work

Less work-in-progress

Ability to respond more quickly to orders

Cost reduction

Use Cases in the Electronics Industry

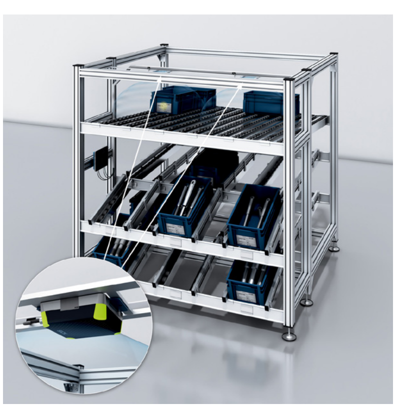
Smart shelf

The digitalization of shelf systems, frequently referred to as “smart shelf,” is becoming commonplace in various areas of the value chain. Sensors, identification solutions, and status indicators are increasingly being used. For example, in SMT manufacturing for the storage of printed circuit board magazines or for the provision of production materials for the assembly of electronic devices.

For the automated demand notification in a Kanban system, the empty container is either identified by a worker with the help of codes or the identification occurs automatically using an RFID transponder as the container is returned. A further possibility is to monitor the quantity of the containers using sensors mounted directly on the shelf. When the level falls below a predefined value, a replenishment is triggered automatically.

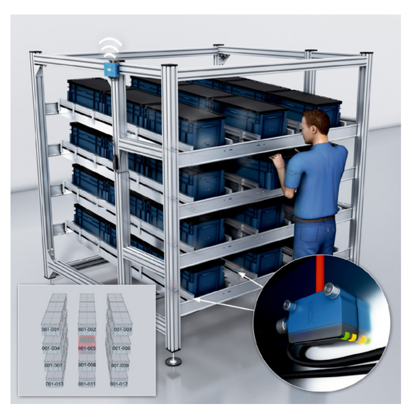
SICK is responding to these application requirements with image-based code readers and RFID read/write devices. It also has detection solutions for monitoring stock levels that can easily be scaled up to meet manufacturing needs.

SICK offers 2D LiDAR sensors for checking withdrawals from the shelf and comparing them to the production order. These sen¬sors can be programmed for the customer-specific application with the help of the SICK AppSpace ecosystem. The same applies to programmable Sensor Integration Machines (SIMs) such as the SIM1004, which are suitable for combining, evaluating, archiv¬ing, and transferring data from multi-sensor systems. The SIMs collect sensor data, for example the shelf contents detected by the FlexChain automation light grid, or the container identification number identified by UHF write/read devices. SICK AppSpace can be used to process the data, communicate with higher-level shelf management systems or an MES, and control external sta¬tus indicators. The latter use visual indicators to tell the worker from which shelf compartments they need to withdraw materials, or where to replenish materials.

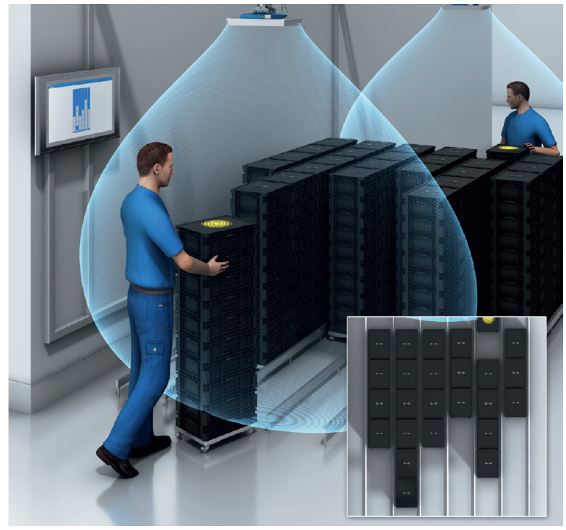


Automated material reorder with RFID at Kanban rack

2D-LiDAR-based shelf monitoring at the smart shelf



Automated matieral reordering at e-Kanban racks



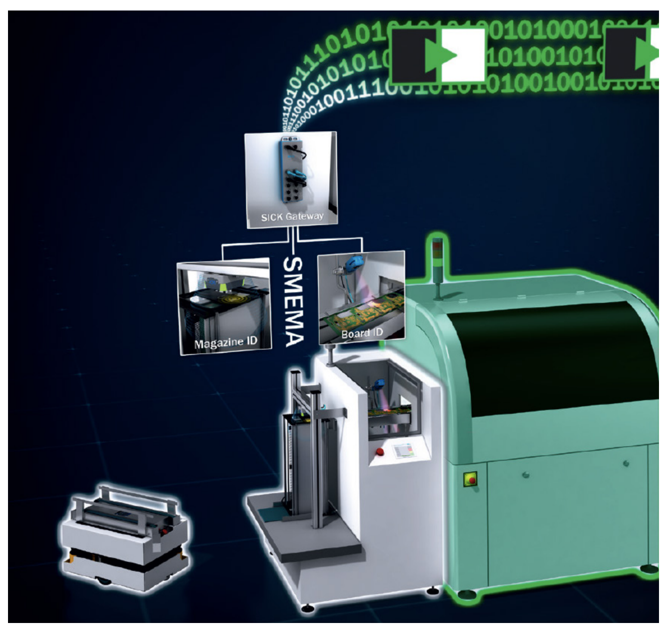
Digitalized supermarket

In electronics manufacturing, after withdrawing material it is necessary to refill the material stock. Employees pick mate¬rials for production from the containers in the so-called FIFO lines based on the “first in first out” (FIFO) principle. Or they replenish the FIFO lines with material containers. Digitalization also of¬fers potential opportunities for optimization in this area to improve transparency and optimize space utilization by using RFID-based identification and line allocation.

The RFU65x RFID read/write device identifies RFID tags on material containers and at the same time detects their loca¬tion in the reading field. The device transmits the respective data to a warehouse management system, so you always know which container is pushed into or removed from which FIFO line. The number of containers in the FIFO line is always also transparent.

Hermes Standard

The prerequisite for intelligent production concepts in electronics manufacturing is open standards. As the high-performance successor to the previous standard interface IPC-SMEMA-9851, the Hermes Standard machine-to-machine communication pro-tocol (IPC-HERMES-9852) has been specifically designed for communication between different process machines and handling units in SMT lines. A seamless implementation of the Hermes Standard ensures greater automation of the line control as well as consistent traceability, which are essential elements on the path to Industry 4.0.



When acquiring brand new PCB assembly lines, it is easier to achieve a consistent application of the Hermes standard. It can, however, also be retrofitted when existing machines with a SMEMA interface and new machines with the Hermes interface need to operate together in an SMT line. Compa¬nies that implement the Hermes Standard benefit from a universally transparent flow of data in their electronics manufacturing facilities.

The Hermes Standard Retrofit SensorApp is based on the SIM1012 and enables different devices to be integrated into a Hermes network, for example a loading unit with a SMEMA interface. When extended with an image-based code reader or RFID read/write device, the SensorApp can also read board and magazine IDs and forward these data via the Hermes interface. A modular and readily expandable solution that can also be vertically integrated into higher level production systems via the IPC CFX standard.

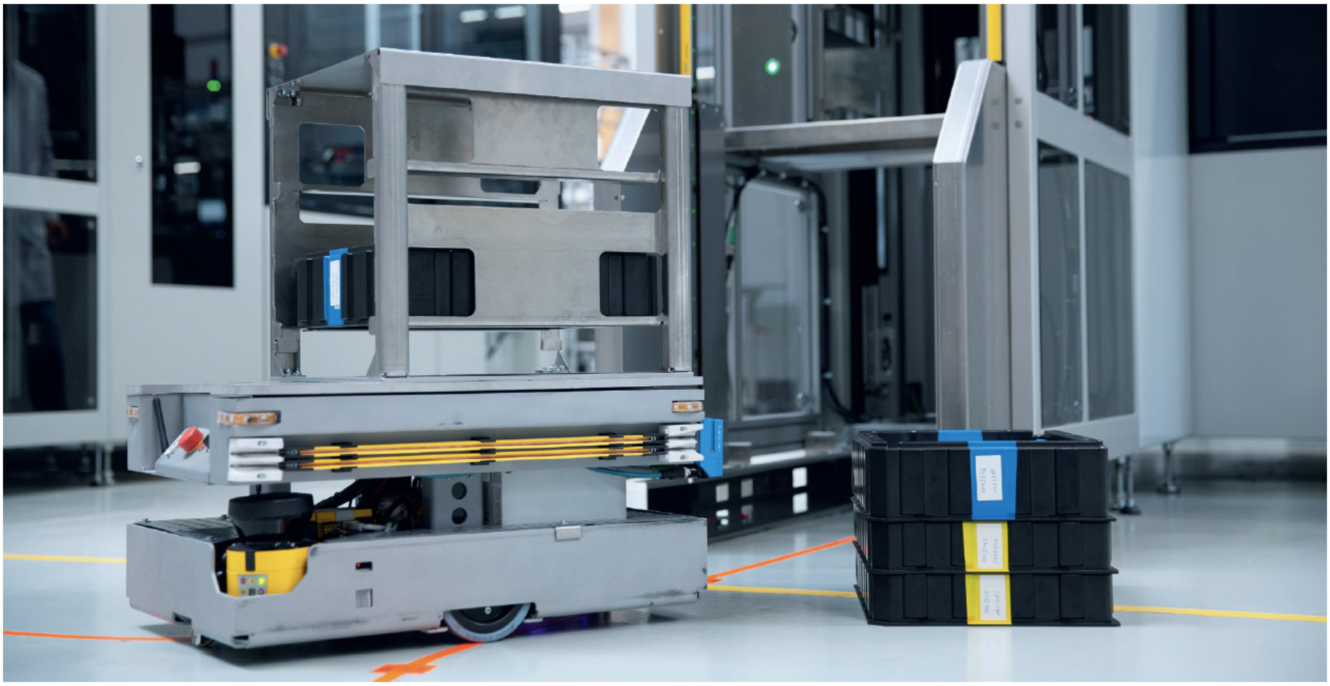
Automated material transport

Mobile platforms in the electronics industry provide a highly efficient, safe, and flexible means of supplying production with new components and returning empty containers. These range from line guided vehicles in the semiconductor industry, small automated guid¬ed vehicle systems (AGVs) for transporting PCB magazines in an SMT manufacturing facility, and large tugger trains for supplying materials to production and for transporting them between different production buildings.

This involves three aspects. First, intelligent navigation and positioning are required for the mobile platforms to move automatically or autonomously between different workstations and individual points in the logistics and production environment. To enable the vehi¬cles to find their way, it is necessary to implement a variety of sensor solutions – right through to integrated contour localization – and these need to be adaptable to the specific application of the automated guided vehicle system in a scalable and modular manner.

Second, environmental perception and safety play a role when the mobile platforms need to be able to recognize their environment during the transport process. 2D and 3D LiDAR sensors, solutions for machine vision, or radar sensors make autonomous, semi-autonomous, or manned vehicles in production safer. With the help of sensors and sensor solutions, the vehicles can quickly detect and safely navigate around obstacles on their route, avoiding collisions with obstacles and persons.

Finally, load handling or the transporting of loads is a core function of mobile platforms. A wide range of solutions for de¬tecting, positioning, and identifying goods are available for this purpose. Thanks to the latest RFID and code-reading technologies, the data acquisition processes during loading and unloading can be carried out quickly and flexibly for almost all types of goods.

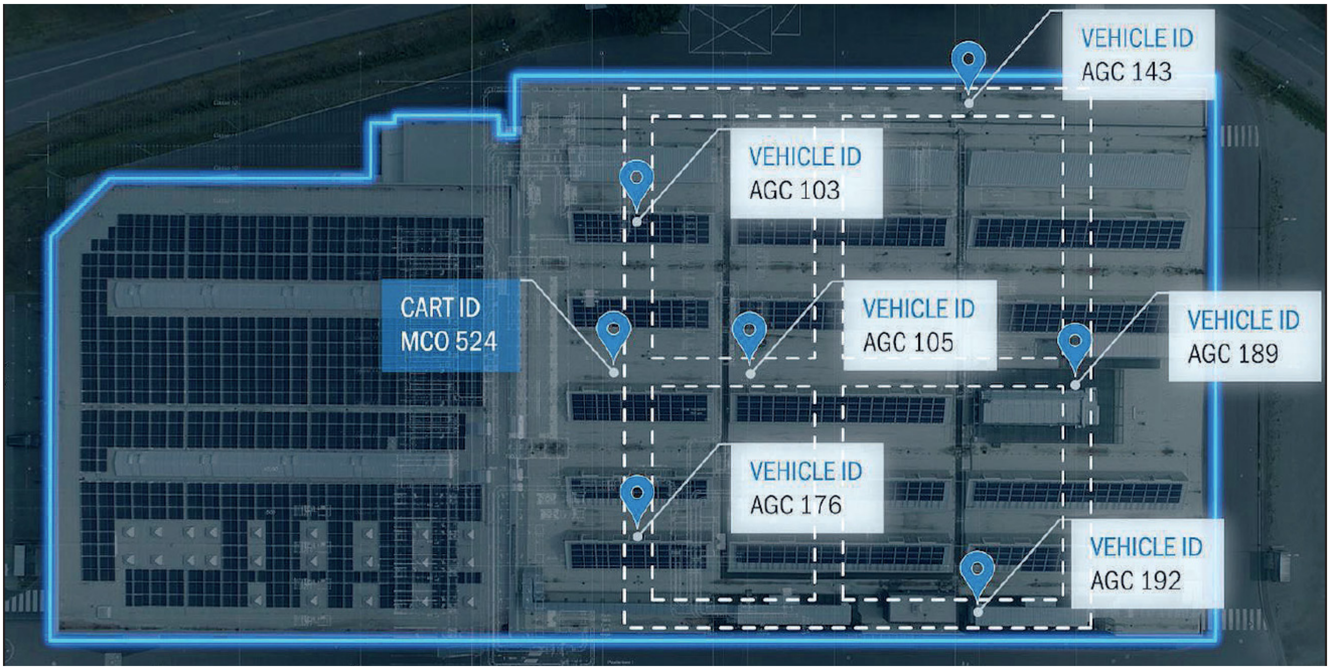


Localization

An intelligent asset localization system helps to ensure reliable, repeatable, and predictable processes throughout the entire material flow – at any time and at any place. It ensures continuous resource planning with no system discontinuities in production, assembly, in the warehouse, or during picking.

There is, of course, not only fixed transport equipment. Objects leave production, an assembly line, or stationary conveying equipment to be transported further by lift trucks, manned forklift trucks, or tugger trains. Here, too, identification and locali¬zation of objects is of great advantage on the path through the halls of the company because it enables losses, delays, incorrect deliveries, and other errors to be minimized.

Using localization data, it is possible to locate all productive assets, load carriers, and loading equipment. Routes can be optimized and dynamically adjusted, setup times prepared or scheduled flexibly, the material flow planned and con¬trolled, goods movements monitored, and storage places managed without manual posting processes.



Thanks to harmonized sensor systems for identification, positioning, and condition monitoring as well as tools for analysis and visualization, large quantities of data can be acquired and evaluated in a targeted manner. By interpreting the data with the help of analysis software, it is possible to identify and display the temporal aspects of the incoming and outgoing material flow, to track the movement of mobile assets on the shop floor, and to understand complex logistical networks.

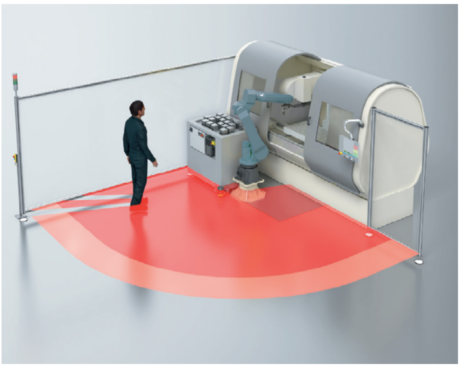
A variety of sensor technologies are available depending on the required positioning accuracy and refresh rate: 2D laser scan¬ners, 3D solutions for machine vision, line guidance and infrastructure sensors, and other solutions.

A relatively new key technology is the ultra-wideband (UWB) technology. This is a radio system operating in the wide frequency band of 3.1 GHz to 10.6 GHz, which allows near-range communication at very high transmission rates. Sensor technologies such as the LOCU UWB system for tag-based localization provide the foundation on which solutions for asset localization can generate added value. To do so, the localization and time data of all concerned localization systems must be fused using suita¬ble software algorithms and powerful middleware and interpreted as information. SICK developed the Asset Analytics visuali¬zation and analysis platform for this purpose.

In addition to its built-in visualization and analysis functions, Asset Analytics also offers open interfaces. These enable raw data and pre-processed data to be used in company-wide supply chain and asset management systems as well in as in cloud applications. Thanks to this connectivity, the localization data can also be used on the ERP and MES level to gain a better understanding of material flows, for example to evaluate the incoming and outgoing material flow and intervene in the supply chain to optimize it.

Machine tending

The interface between material transport and assembly or production processes is material loading and unloading. These tasks are increasingly being performed by robots to load automated testing machines or injection molding machines.



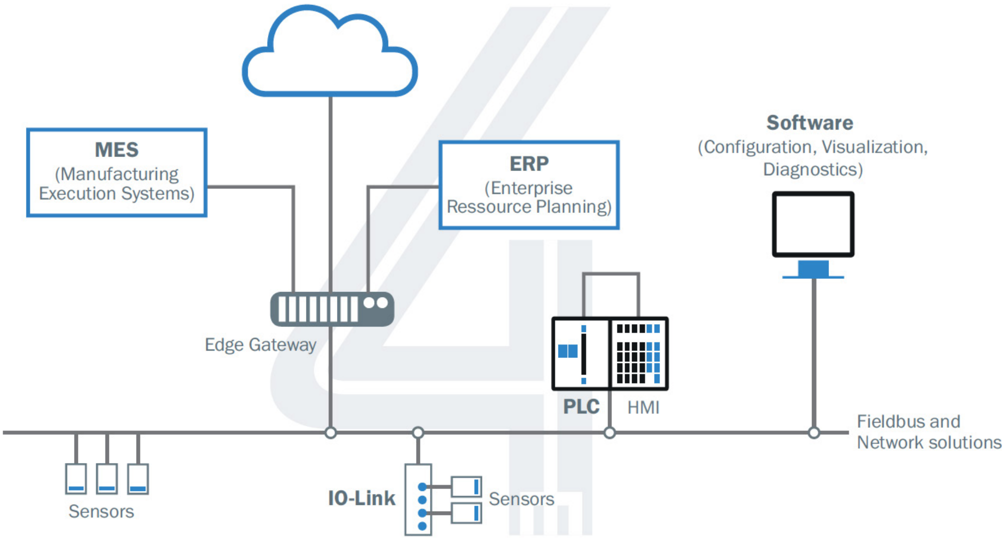
There are two key requirements for this. First, robot vision like optical and image-based systems that turn the robot into a seeing participant and allow it to identify where something is located. Second, safe robotics solutions that ensure the safety of people, and include all measures neces¬sary to turn the critical zone in the vicinity of the robot into a safe workspace.

The PLB500 from SICK is a robot guidance system that enables CNC lathes, assembly equipment, and feed systems to be loaded fully automatically, which optimizes process costs and efficiency.

The safety solutions from SICK, comprising for example the microScan3 safety laser scanner and the software-programmable Flexi Soft safety controller, guarantee a safe collaboration.

Integration

Whether it be for identifying parts or for ensuring the traceability of transport containers, SICK offers programmable devices such as the RFU6xx RFID read/write device that are easy to integrate into higher level systems. Thanks to the intelligent process logic integrat¬ed into these devices, they can communicate directly with higher level systems via modern protocols such as OPC-UA and MQTT.



For digitalized shelf systems or supermarkets in manufacturing, this enables the containers identified by RFID read/ write devices to be reported directly to MES and ERP systems.

Sensor Integration Machines offer intelligent and flexible solutions for all Industry 4.0 related applications. They allow data to be merged, evaluated, archived, and transferred and thereby pre-processed for a wide variety of sensor applications and for communication to higher level systems. Sensor Integration Displays can be used to visualize the data.

Sensor Integration Machines

TDC Gateways

Both Sensor Integration Machines and TDC-E gateways are employed in applications such as smart shelves (see Section 4.2). These applications collect and, if necessary, merge the data collected by a variety of sensors, for example identification solu¬tions for identifying containers right through to LiDAR sensors for validating the actions of workers. External status indicators, for example for pick-to-light systems, can also be connected to Sensor Integration Machines or TDC gateways.

Gateways such as TDC-E collect and process data, and can also communicate via wireless communication channels such as WLAN or GSM.

Integration is therefore the basis for all use cases: logistic processes can be digitalized, and the data made available where it is needed.

Intelligent sensor solutions provide the basis for future-proof production logistics in the electronics industry. Where production and logistics interact in a smart network, highly dynamic material and information flows become fully transparent.

Contact Us

For more information about the electronic industry, contact SICK at info@sick.com or visit our website at www.sick.com.