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How Industry 4.0 Design Principles Are Shaping the Future of Intralogistics

YOU ARE NOW ENTERING THE FOURTH INDUSTRIAL REVOLUTION

The first industrial revolution was powered by mechanization; the second by the assembly line and mass production; and the third by computerization and automation. All three sparked incredible improvements in productivity.

Now, the convergence of connectivity, low cost sensors, big data and advanced robotics are powering the next industrial revolution, Industry 4.0.

While similar in important ways to the Internet of Things, Industry 4.0 provides a more comprehensive roadmap to the future because it encompasses cyber-physical systems, the Industrial Internet of Things and the Internet of Services. In doing so, it helps organizations plan for and create a future in which cyber-physical systems communicate over the IoT and cooperate with each other and humans in real time, supported by an Internet of Services in which both internal and cross-organizational services are leveraged across the value chain.

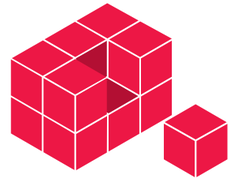
See how Swisslog's people are helping integrate Industry 4.0 into the next generation of material handling equipment.

> *"Industry 4.0 is changing the interactions between humans and machines and between machines and other machines. This will have a huge impact on the warehouse. With decentralized, networked intelligence, advanced robotics and self-organizing processes, the warehouse of the future will take a giant step forward in productivity, flexibility and efficiency.*
>
> **DR. KERSTIN HÖFLE** / Head of Digital Products / Swisslog Logistics Automation

In the supply chain, that means SKUs, machines, people and warehouse and business systems are all connected in a way that enables equipment and processes to continuously reconfigure themselves to optimize throughput, productivity and efficiency as conditions change.

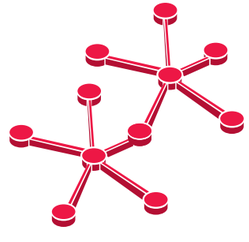
Like the industrial revolutions that came before, Industry 4.0 will be more process than event: most organizations will build Industry 4.0 capabilities over time as they integrate the six core design principles outlined in the following chapters:

INTEROPERABILITY



MODULARITY

REAL-TIME CAPABILITIES



DECENTRALIZATION

VIRTUALIZATION

SERVICE ORIENTATION

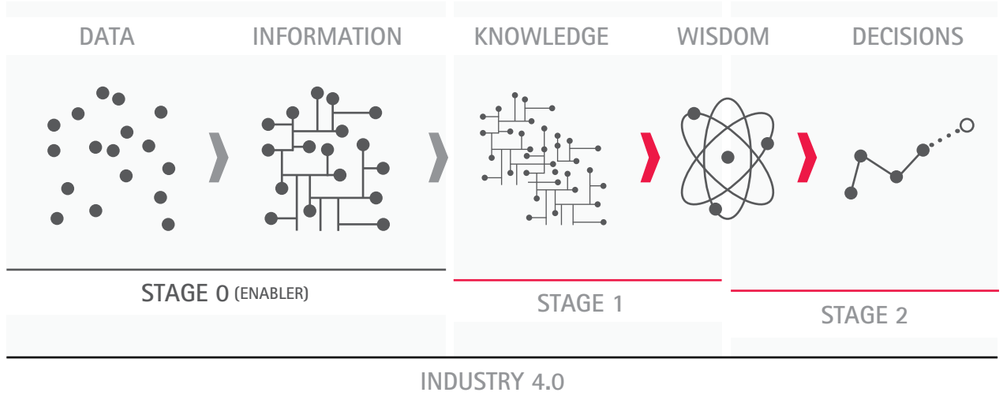
INTEROPERABILITY: THE FIRST STEP IN TRANSFORMING DATA INTO WISDOM

Interoperability is the ability of systems to transact with other systems to exchange data and coordinate activities. Industry 4.0 can't happen without it.

Interoperability unleashes the power to use real-time data to make better, faster decisions—for both machines and humans. A wealth of data is being generated in today's warehouse, but without interoperability this data remains trapped within those devices, or isolated within one of multiple warehouse software systems.

This is where Industry 4.0 intersects with the industrial IoT.

When warehouse devices are connected through the IoT, the data they generate can be collected and aggregated to increase visibility and create opportunities for collaboration across machines and between humans and machines. At the same time, software integration across WMS, LMS, ERP and other warehouse systems, allows data to be consolidated and analyzed at a lower transaction cost.



> *Every organization should be working today to break down the barriers that exist between the various systems and equipment that operate in today's warehouse. Warehouse management software can play a huge role in this evolution. Today's warehouse management systems must be flexible, data smart and future ready to support the promise of Industry 4.0.*

ANDREAS COMPEER / Manager of Software & Controls Product Management / Swisslog Logistics Automation

By consolidating data across devices and systems, data can be transformed into knowledge, and knowledge can be transformed into the wisdom that leads to better decisions.

THE PATH TO INTEROPERABILITY

Here are three things you can do today to increase interoperability:

1. Audit existing systems and processes to identify systems that have proprietary protocols and those that use standard protocols and offer open APIs. Move away from proprietary systems as they can lock you into a single-vendor strategy or require expensive custom coding.

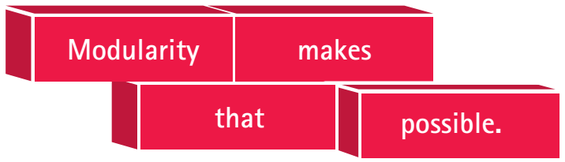
2. Prioritize the business issues where interoperability can deliver the most value in your organization. Speed, cost, accuracy, productivity, and uptime are all important, to some degree, to every fulfillment operation. Choose a project with a compelling business case, such as achieving a desired improvement in fulfillment times. Then, focus on interoperability across those systems that directly impact that metric.

3. Create a long-term roadmap: Establish a vision for the future of your operation optimized for collaboration and real-time decision-making. This vision will help ensure the investments you make in the coming years will support, rather than impede, future adoption of Industry 4.0 technologies.

MODULARITY: THE KEY TO THE FUTURE-READY WAREHOUSE

One thing material handling organizations can't afford today is to be paralyzed by the uncertainty that lies ahead.

To remain competitive they must embrace new technologies, such as automation, that have proven their ability to enhance productivity and efficiency. But, they must do so with an eye to the future.



Consider automated sortation systems. They were once the state-of-the-art in warehouse automation. But, now, organizations that invested in these systems find themselves locked into an inflexible technology that can't adapt to the disruptive changes that are occurring across industries.

> *The pace of change in the warehouse today is unprecedented. Material handling organizations must respond to the changes occurring today without limiting their ability to innovate and change in the future. Modular solutions provide the flexibility to do that.*
>
> **JOHN DILLON** / Vice President, E-Commerce/Retail / Swisslog Logistics Automation Americas

Modular systems are inherently scalable, allowing them, for example, to react to rapid changes in demand without abandoning the initial investment. You only purchase what you need today while maintaining the flexibility to add modules in the future. The following are three examples:

With more than 12 million SKUs and a growing business, Radwell International needed high-density storage that could reduce pick time and position the business for the future. Automated, modular storage proved to be the solution.

Automated storage

Moving from traditional shelf-based storage to an automated storage system, such as Swisslog's AutoStore, reduces the space required to support inventory while automating product retrieval. The three-dimensional storage grid can be expanded—or contracted—as needs change and can even be disassembled and moved to a new location if required.

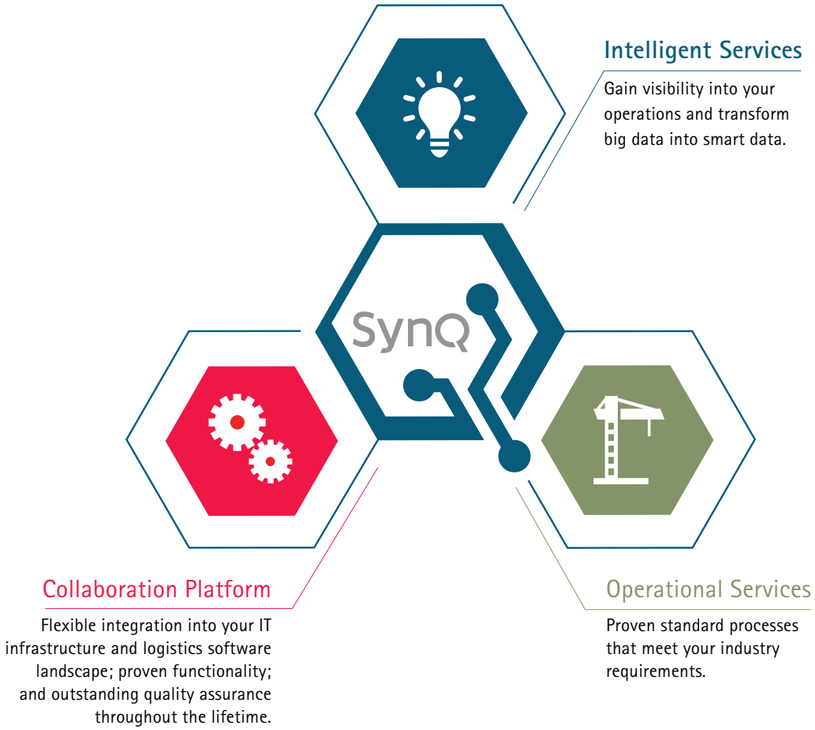
Mobile robots

The shift from person-to-goods to goods-to-person picking dramatically improves pick speeds and productivity in most warehouses. Mobile goods-to-person robotic solutions, such as CarryPick, adapt quickly to changes in demand and enable a pay-as-you-grow approach in which additional robots and pick stations are added as needed.

Integrated software platforms

The traditional warehouse software stack created a monolithic architecture that added complexity whenever new automation equipment was deployed. Flattening the stack and integrating all of the functionality required in a single, modular platform, as with Swisslog's SynQ platform, provides the ability to easily tailor software to the exact equipment in the warehouse without limiting future flexibility.

These solutions, and others that embrace Industry 4.0 design principles, allow warehouse operators to make investments today that will continue to pay dividends in the future.



VIRTUALIZATION: HOW THE PHYSICAL BECOMES DIGITAL

We can do things in the digital world that simply aren't possible in the physical. Need to see inside a piece of equipment while it's operating? Data can tell the story. Want to know how new equipment will impact existing processes? You can spend weeks creating physical models or evaluate multiple scenarios digitally in hours.

Virtualization allows a "digital shadow" of the warehouse to be created digitally by merging sensor data acquired from monitoring physical processes and equipment with virtual warehouse models and simulation models. The virtualized view of operations helps to monitor physical processes and allows warehouse operators and managers to better manage growing complexity, reduce equipment downtime and optimize processes.

Powered by the transition from 2D to 3D visualization in WMS platforms like SynQ, virtualization presents a more realistic and meaningful view of what's happening in the warehouse as well as providing a powerful tool for modeling change. Here's just a taste of what virtualization makes possible.

> *Virtualization is one of the most exciting principles of Industry 4.0 because it allows us to see and do things that have not been possible in the past.*
>
> **DR. KERSTIN HÖFLE** / Head of Digital Products / Swisslog Logistics Automation

Material flow monitoring

Visibility of products in the warehouse has become essential to efficient material handling. But, until recently, this has been limited to knowing the location of a product in inventory. Virtualization technology allows you to monitor products as they move through the process to improve accuracy and identify opportunities for optimization.

Condition monitoring

Real-time data from material handling equipment can enable warehouse staff to accurately predict when maintenance is required to prevent failure. Instead of scheduling regular “preventive” maintenance at pre-set intervals, or waiting until equipment fails before conducting repairs, virtualization enables a smarter approach to maintenance in which service is performed only when it is needed and before failures occur.

Remote Service

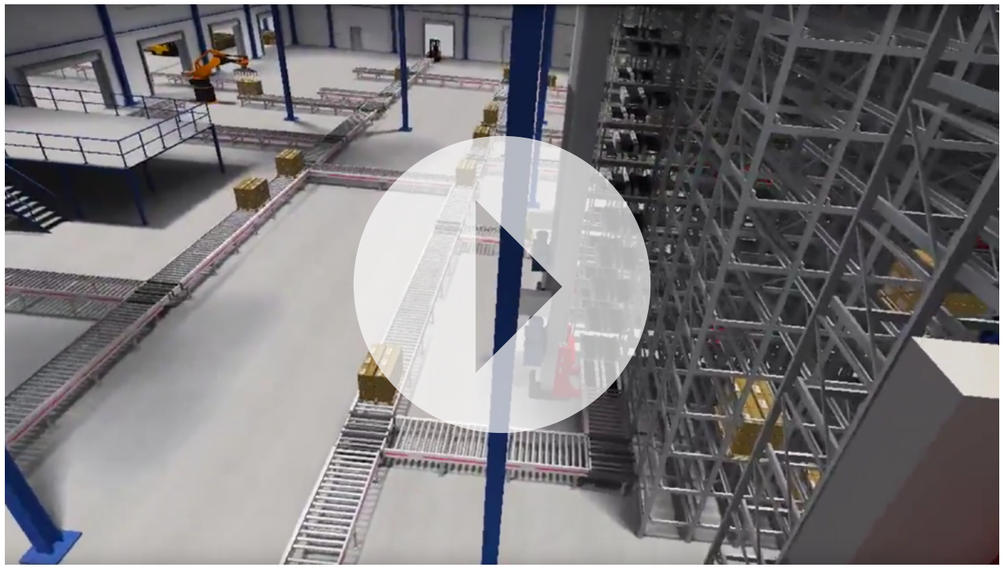
Using augmented reality, made possible by devices like the Microsoft Hololens, service engineers in a centralized service center can connect with on-site engineers and perform diagnostics and troubleshooting through the eyes of the on-site personnel. These solutions, and others that embrace Industry 4.0 design principles, allow warehouse operators to make investments today that will continue to pay dividends in the future.

Watch the video to see how augmented reality is enabling remote service of material handling equipment.

Virtual Design

One of the challenges many organizations face in deploying new automation systems is getting a full understanding of the impact of new equipment on existing process flows before the equipment is installed. With virtualization, you can see exactly how the warehouse will operate, including how pickers and operators interact with the machines, and how walkways, access routes, cabinets and conduits can be optimally positioned.

The rapid improvement in the usability of augmented and virtual reality devices, combined with the advances in mobile robotics, will open even more applications for virtual and augmented reality in the future.



Virtualization is creating new possibilities for warehouse design and management. This video gives you a look inside a virtualized warehouse.

REAL-TIME CAPABILITIES: OPERATING AT THE SPEED OF NOW

To be considered "smart"—the ultimate objective of Industry 4.0 design principles—devices, systems and entire warehouses must know what is happening now. Real-time capabilities—enabled by Interoperability and visualized through Virtualization—make that possible.

Real-time data from across the supply chain is what makes, to a large degree, the whole concept of intelligent cyber-physical systems possible.

Digital devices, such as RFID, sensors, and scanners are now on everything from individual products and cartons to material handling equipment, forklifts, and robots. When connected through IoT networks, these devices not only provide visibility. They provide the fuel for real-time, data-driven decision making by machines and humans.

We're generating massive amounts of data within the warehouse. It's time to start using that data to improve operations. Real-time capabilities do exactly that.

To achieve their speed and productivity objectives, Trinchero Family Estates implemented an automated storage system that manages product inventory with 100 percent accuracy.

> *Real-time data, when collected across the supply chain, not only provides visibility into warehouse operations but provides smart systems with the ability to autonomously react to changes as they occur.*
>
> **TJ FANNING** / Vice President, Consumer Goods / Swisslog Logistics Automation Americas

DECENTRALIZATION: PUTTING INTELLIGENCE WHERE IT CAN DELIVER THE MOST VALUE

Centralized system architectures, in which business logic is contained in a central computer system that supports or controls the operation of various subsystems, have been the norm in material handling for years.

But, centralized systems have limitations in areas that are critical to Industry 4.0.

Most notably, they offer limited scalability. A centralized system has a certain capacity and once that capacity is reached, the system can no longer expand to meet growing requirements. They also suffer in the area of fault tolerance: a single failure can take down the whole system.

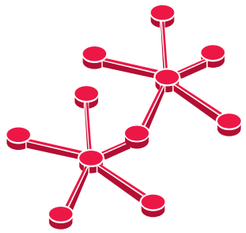
The solution is the move to distributed or fully decentralized architectures.

In a distributed architecture, logic is contained in nodes that support or control remote components or subsystems. It adapts to its surroundings, propagates data through peer-to-peer communication and forms its functionality and intelligence by combining the capabilities of each node.

In a fully decentralized architecture, all business logic is embedded in the subsystem or component so that it has all of the intelligence it needs to perform its function, coordinating its activities with other subsystems to handle complex tasks. While intelligence is decentralized, these systems still rely on a central system for component handling, communication and data accumulation.

A fully decentralized system is easy to scale—you simply add more subsystems—but will, at some point, reach a limit as the system grows beyond the point where subsystems can effectively communicate with each other.

Mobile robots will increasingly rely on distributed or decentralized architectures to optimize performance.



A distributed system offers unlimited scalability. To grow the system, you add more nodes, which only have to communicate with a limited number of related nodes to connect to the entire system.

These decentralized systems also offer the ability to evolve over time and adapt to change.

Consider the Swisslog CarryPick system, which uses small, mobile robots that feature many of advantages of a decentralized system: it is easy to scale the system by adding more robots and it can adapt to changes in warehouse design or even a new facility.

However, CarryPick still depends on the central intelligence and control logic provided by SynQ, the Swisslog WMS. As it evolves, that intelligence will increasingly be migrated to the robots themselves, enabling greater machine-to-machine communication and allowing a "swarm" of CarryPick robots to operate with greater autonomy from the WMS—while still providing the WMS with real-time data on product location.

> *The more we can decentralize intelligence in warehouse systems, the faster those systems can make decisions about how best to perform their tasks.*
>
> **SAMUEL SCHÄRER** / Controls Development Manager / Swisslog Logistics Automation

The vision of Industry 4.0, in which cyber-physical systems cooperate with each other and with the humans that work around them, can only be realized when intelligence and control logic is decentralized or distributed across those cyber physical systems.

SERVICE ORIENTATION: INCREASING AGILITY AND RESOURCE UTILIZATION

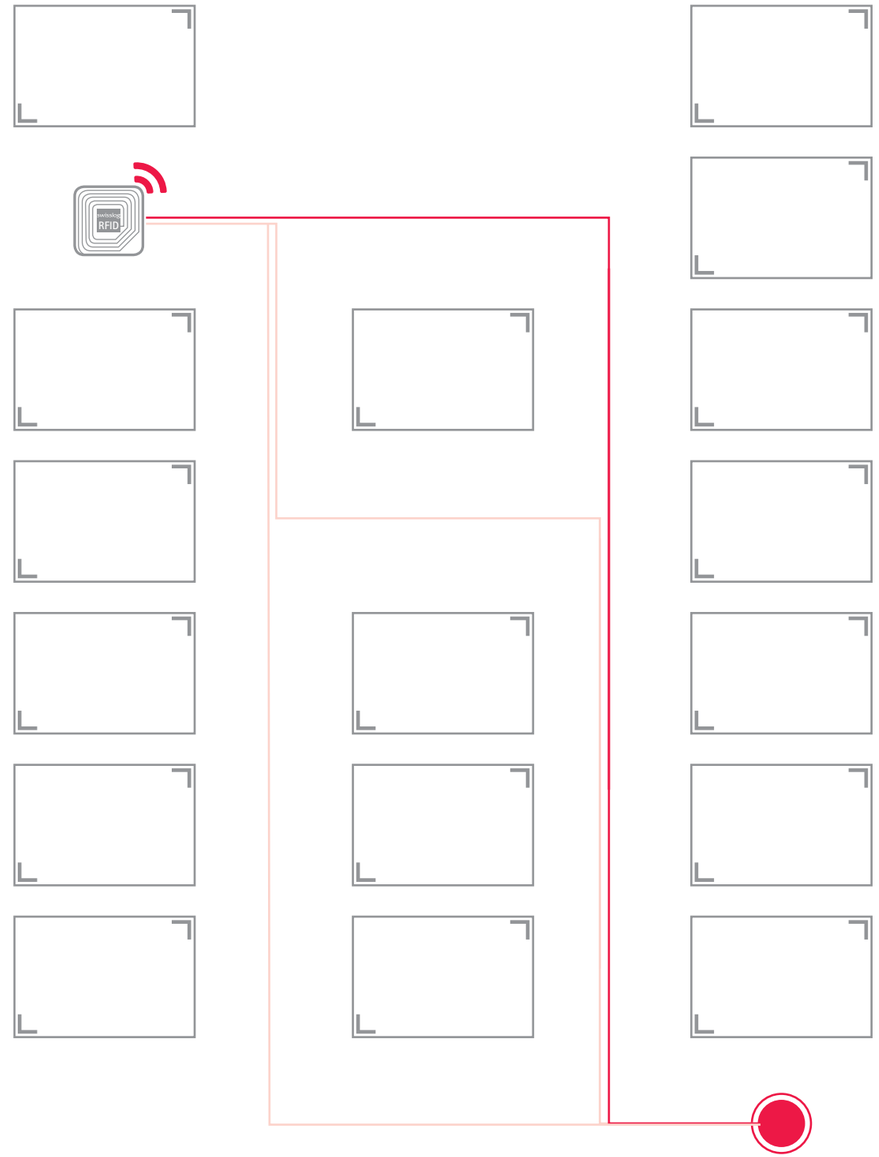
In addition to the six design principles discussed in this book, Industry 4.0 has three core components: cyber-physical systems, the Internet of Things and the Internet of Services.

The first two have already been discussed. Now, let's look at the Internet of Services and the Service Orientation it enables.

The Internet of Services operates similar to the Internet of Things but connects services—both within and outside an organization, and provided by both humans and intelligent systems—to enable services to be offered more efficiently and combined to enhance their value. In this case, "services" is interpreted broadly to include everything from the movement of goods from one location to the next to data analytics services designed to solve a particular business problem.

SERVICE ORIENTATION IN ACTION

When a service-oriented approach is applied to modular assembly stations and the transportation between them by AGVs, both the assembly stations and AGVs offer their services through the Internet of Services. The products themselves carry the knowledge of their specific configurations through RFID tags and can decide autonomously which working steps are needed for their configuration. They then compose the required process and navigate that process in the most efficient way accessing production and transportation resources as needed.



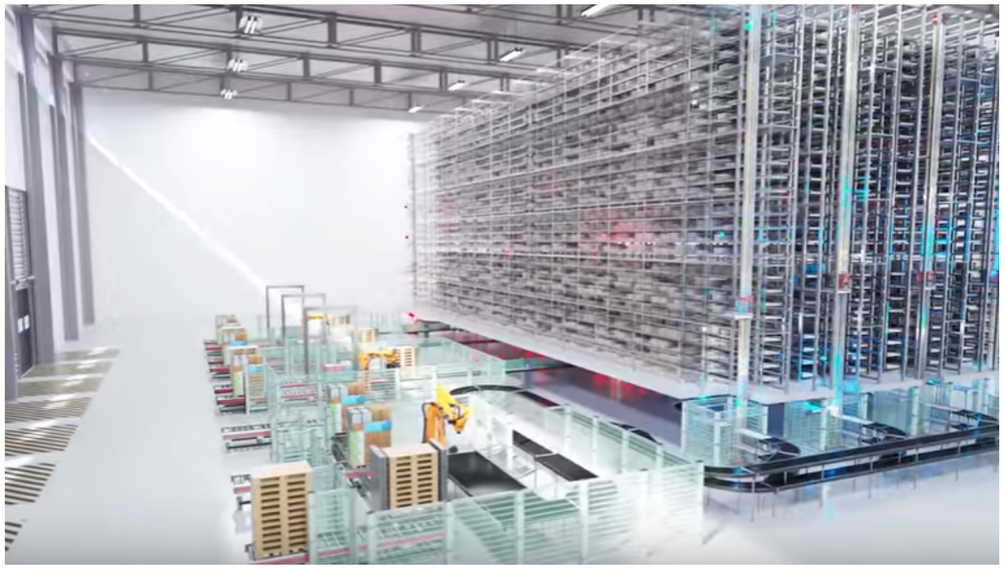
> *Designing equipment, processes and software around a service-oriented model increases information flow across the warehouse and enhances the flexibility of systems and processes.*
>
> SAMUEL SCHÄRER / Controls Development Manager / Swisslog Logistics Automation

THIS SERVICE ORIENTATION APPROACH PROVIDES A NUMBER OF BENEFITS:

1. In contrast to the use of large applications, which tend to be "information silos" that cannot readily exchange information with each other, service orientation enables freer information flow within and between enterprises.

2. Organizing internal software as services makes it easier to expose its functionality externally, increasing its value. As an example, product tracking through shipping benefits the shipper but when made available to the end customer has even greater value.focus on interoperability across those systems that directly impact that metric.

3. Business processes are often dependent on their supporting software. Service orientation offers greater flexibility and is easier to change.

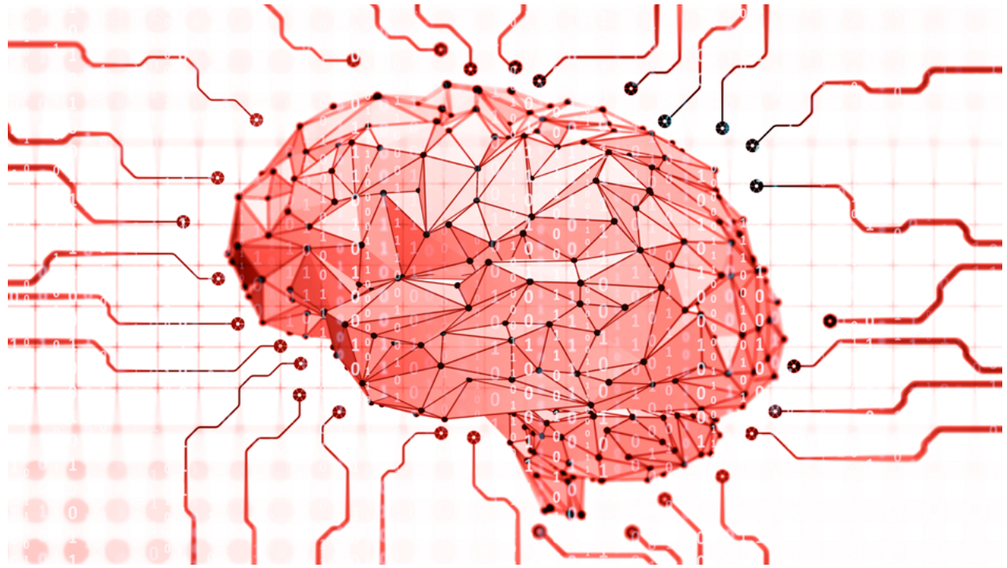


Service orientation allows products and equipment in the warehouse to quickly exchange data and respond to requests to enable greater efficiency and flexibility.

BUILDING THE FOUNDATION FOR INDUSTRY 4.0

The first step in the evolution to Industry 4.0 that material-handling organizations must manage is developing the infrastructure to collect and convert data into insights.

This is the key to better predicting demand, especially from unstructured data such as that found on social media. These insights are what will enable organizations to configure and adapt its equipment, robots and labor to fulfill ever-changing and complex orders.



HERE ARE FOUR STEPS TO DEVELOP THIS CAPABILITY:

1. Establish data science capabilities. With the intense competition for data scientists today, many organizations will find it difficult to build in-house capabilities; however, partnering with a data science consultant may prove to be an even better solution as you have immediate access to established supply chain experience. Partnering with a consultant can also provide more flexibility in dealing with peaks in demand for data analysis services associated with a warehouse redesign or quarterly reporting.

2. Simultaneously, build a data repository capable of aggregating business information from multiple sources, including ERP, WMS, web analytics and social signals. The rapid development of big data technologies provides a variety of "off-the-shelf" solutions that can be configured to your needs.

3. Audit devices within the warehouse to determine where you can collect IoT data to augment business data.

4. Finally, ensure you can visualize your data in a way that delivers timely, actionable insights to internal stakeholders.

BUILDING THE FOUNDATION FOR INDUSTRY 4.0

Once you master these initiatives, you can begin using artificial intelligence to create feedback loops with prescriptive algorithm to adjust distribution processes on the fly based on demand or conditions within the distribution center.

Business leaders need to understand Industry 4.0 technologies and possibilities today and begin planning how their companies will grow them tomorrow. But technology is only part of the picture. In addition to the steps presented here, supply chain leaders must commit to managing change within their organization to ensure people, processes and technology are prepared to embrace Industry 4.0 design principles.

At Swisslog, we're actively working with forward-thinking organizations to help them develop the infrastructure and processes to support the evolution to Industry 4.0.