# INDUSTRY 4.0 AND MACHINE VISION

The Promise of the Smart Factory and the Industrial Internet of Things

**COGNEX**

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## THE PROMISE OF THE SMART FACTORY AND THE INDUSTRIAL INTERNET OF THINGS



One of the most hotly discussed topics in the manufacturing world today is Industry 4.0. A broadly defined group of emerging innovations in industrial automation and data exchange, Industry 4.0 demonstrates tremendous potential to bolster productivity, reduce waste, refine product quality, enhance manufacturing flexibility, decrease operating costs and deliver myriad other benefits to the factory floor.

Points of view differ among producers and distributors about what this "Industrial Internet of Things" will mean to them. Given the highly diverse operations of global manufacturers and variations in region, industry, size, and competitive environment, the full potential of Industry 4.0 continues to take active shape. While the space continues to evolve, one thing is clear: Industry 4.0 will influence the direction of manufacturing for the next several years.
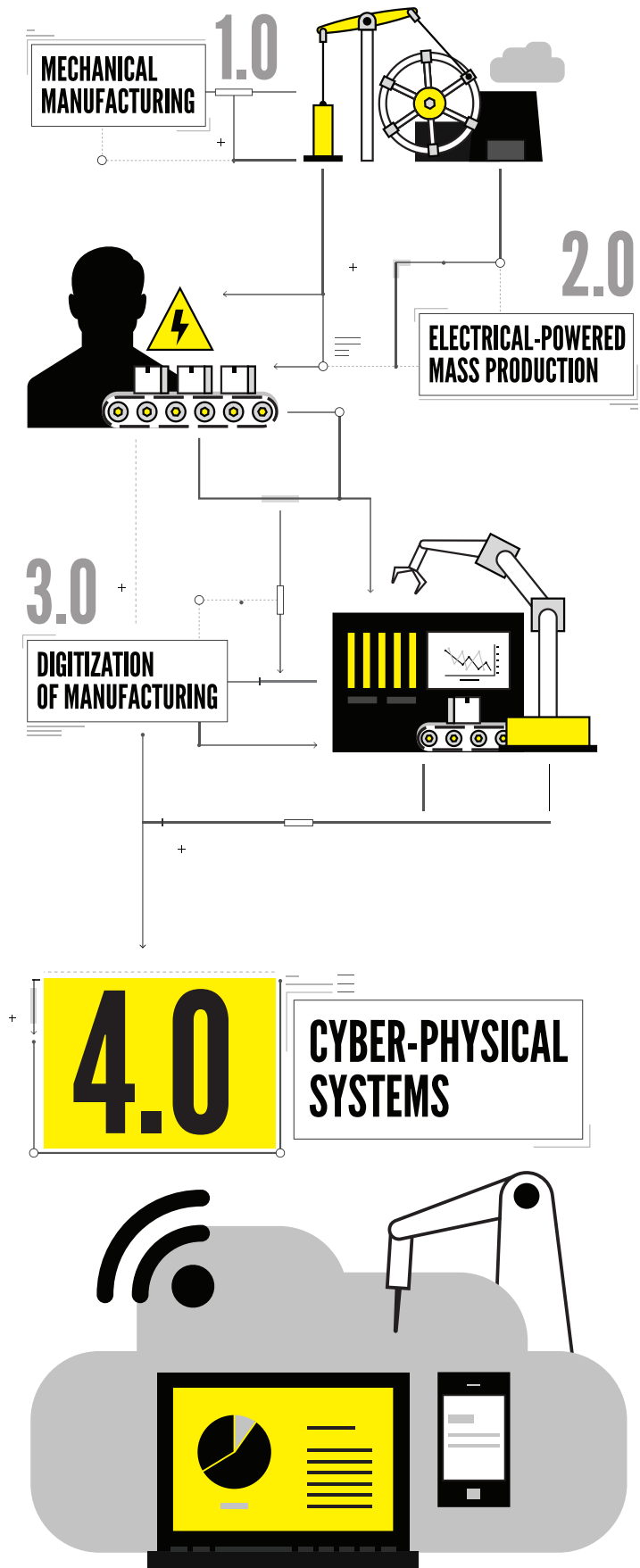
This whitepaper will discuss the current thinking on Industry 4.0. In addition, it will outline several of the key opportunities for producers and distributors, as well as the powerful role that vision technologies—one of the largest producers of data in any factory—can play for their enterprises.
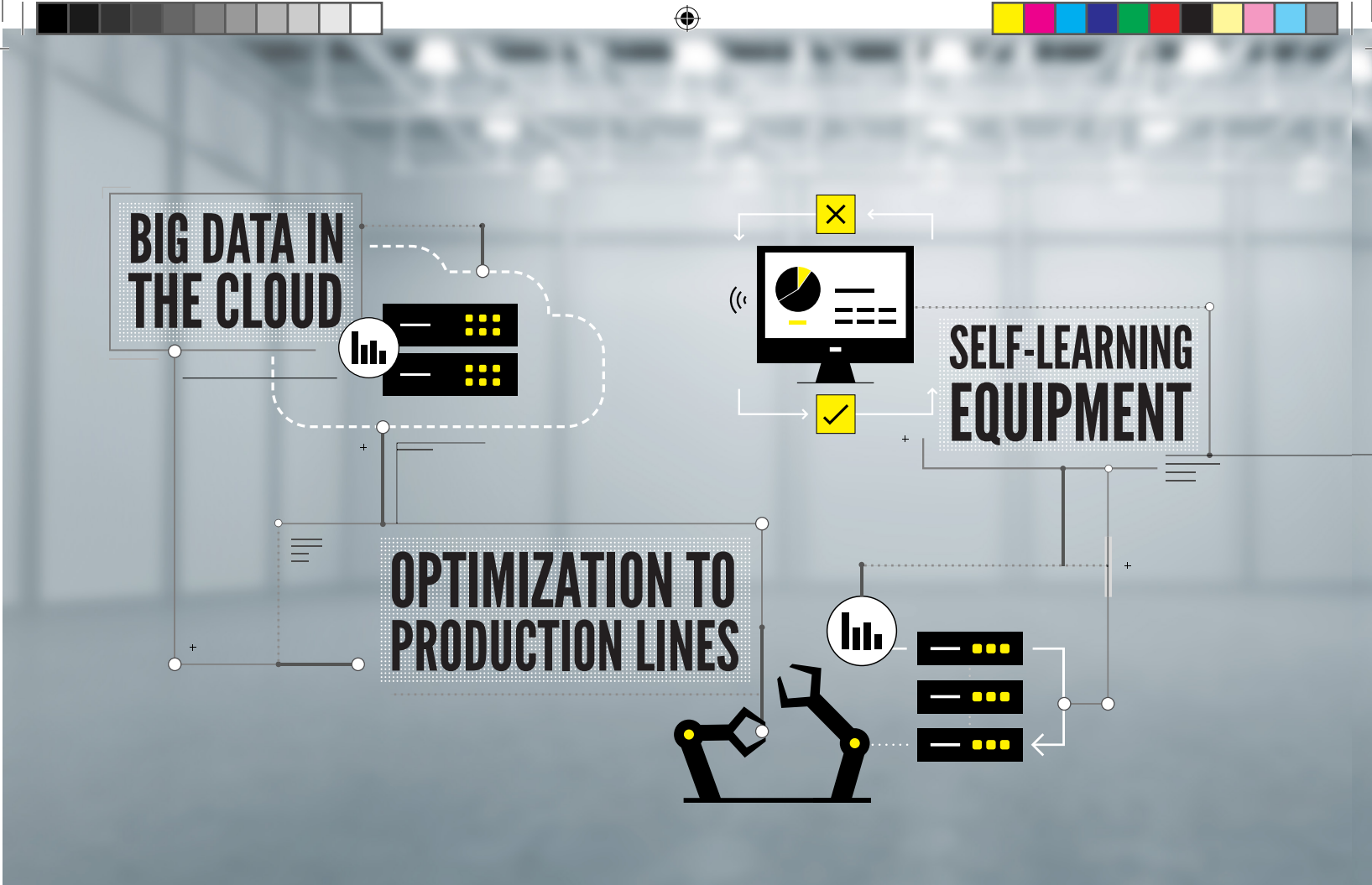
# WHAT IS INDUSTRY 4.0?

The term itself is elusive and originates from the identification of three prior "industrial revolutions," the most recent of which relates to the adaptation of computers, programmable tools and digitization of manufacturing environments in the 1970s. References to "Industry 4.0" are common, as are references to the German "Industrie 4.0," where the concept was originally championed. In the United States, it is sometimes called the "Industrial Internet of Things" and considered a subset of the "Internet of Things." This is sometimes truncated as "Industry of Things."

The fourth Industrial Revolution—or Industry 4.0—is associated generally with advancements in Big Data, cloud computing and deep learning and specifically with a profound increase in the use of cyber-physical systems (CPS)--such as sensors--which have the ability to collect data for manufacturers and producers to identify and trace parts and subassemblies. This data collection process enables devices to autonomously exchange information, as well as control and interact with each other independently, creating operations far more automation-driven. As with the transitions from previous "revolutions," the emergence of Industry 4.0 will occur gradually and decisively over a period of time.

Industry 4.0 began as an initiative of the German government's "High-Tech Strategy 2020 Action Plan" to boost the country's manufacturing. The German government continues to invest hundreds of millions of dollars to encourage research across academia, business and government. While the earliest, strongest interest in Industry 4.0 developments has come from German companies and their neighbors, interest in this emerging concept is now increasing amongst companies all around the world.

**1.0** MECHANICAL MANUFACTURING

**2.0** ELECTRICAL-POWERED MASS PRODUCTION

**3.0** DIGITIZATION OF MANUFACTURING

**4.0** CYBER-PHYSICAL SYSTEMS

# INDUSTRY 4.0 PROMISE AND BENEFITS

Cognex's analysis of the marketplace reveals a number of exciting developments in automation and process improvement associated with Industry 4.0:

- Industry 4.0 capabilities will transform raw data into actionable information and insights that can drive real, measurable performance improvements. It will do this through the analysis of "Big Data" acquired during the manufacturing process and enabled by cloud computing and deep learning methods to uncover trends for process improvement. In many cases today, data may be collected but remain disconnected and siloed. In the future, this data will be shared and used proactively, often led by data-rich technologies such as machine vision.

- Manufacturing systems' communication networks will scan for input from the marketplace and use this information to fine-tune production parameters. For example, a pharmaceutical company's systems—alerted by higher than expected allergy cases reported in a particular region—could trigger manufacturing lines to increase production and place additional orders of raw materials.

- Automation line equipment will provide increasing levels of self-learning, self-controlling and self-optimizing capabilities to quickly and accurately complete complex tasks with minimal intervention. This type of capability is available today in some innovative devices in conjunction with operator guidance but will become far more autonomous with the advent of Industry 4.0.

- Manufacturers will enjoy greater flexibility as robots, machine vision systems, raw materials inputs and other aspects of the production line are able to communicate with each other directly. Benefits may include the ability to produce a wider range of component types on a single line, or manufacture smaller lots of particular products—even customized products—more cost effectively.

COMMUNICATION
OF PRODUCTION DATA

ACCESS TO DATA FROM
ANYWHERE

BEST PRACTICES ACROSS
DIFFERENT FACTORIES

- Similarly, instant access to data and operations information via the cloud and mobile devices will connect workers to critical and time-sensitive information like downtime notifications, details on out-of-spec production abnormalities, maintenance needs and other critical issues requiring on-site intervention. This will allow personnel to monitor trends, analyze data and intercede from anywhere.

  Manufacturers will also be able to export information about the performance of their most successful production lines across their operations via the cloud, equalizing all lines at "best practice" levels.

Industry 4.0 is poised to improve processes in the factory, offering lower production costs, decreased waste, increased flexibility and higher quality throughout the production and distribution cycle.

## UNIVERSAL INTERCONNECTIVITY— A MAJOR HURDLE TO INDUSTRY 4.0

It is likely that manufacturers will demand more investment from their suppliers in Industry 4.0 innovations. This pressure, already evident in pockets of industry, suggests great business opportunities for suppliers of robots, human-machine interfaces (HMI) and other areas of automation. For suppliers, capitalizing on these opportunities and reaping the benefits for themselves and their manufacturer customers will present challenges.

Currently, the typical plant environment includes an assortment of communications protocols—many invented, originated or championed by individual manufacturers—that hamper the delivery of vital data. For a plant to realize the full benefits of Industry 4.0, it must establish instant, automatic and universal communications protocols among all its devices and locations. Plants must therefore be willing to consider new modalities that challenge established, oftentimes successful, protocols in order to enjoy Industry 4.0 benefits.

To employ remote access to the production line from virtual private networks, plants will need to establish consistent procedures for user login and authentication, privilege setting, activity recording and linking between protocols and appropriate IT directories and databases. Protocols will likely need to be configured and disseminated according to universal standards that can be "spoken" by all products, regardless of manufacturer or function. Universal protocols currently being promoted or in development include:

- OPC Unified Architecture (OPC UA), or "The Industrial Interoperability Standard,™" established by the independent OPC Foundation (of which Cognex is a member) and championed by the German Industrie 4.0 Committee. In 2016, in conjunction with the European automation engineering organization VDMA, OPC Foundation started a Vision subcommittee to create an "OPC UA Machine Vision Companion Specification."

- The Open DeviceNet Vendor Association (ODVA) (of which Cognex is a member) owns and is advancing the specifications for Ethernet/IP and DeviceNet towards universal interoperability.

- One of the more recent entrants, the Intelligent Edge Link and Drive (FIELD) system, is being developed in a private industry collaboration among FANUC Corporation, (a Japan-based global supplier of robotics and factory automation); Cisco Systems; Rockwell Automation; and Preferred Networks, a provider of Artificial Intelligence solutions.

# MACHINE VISION IN THE SMART FACTORY

Machine vision is an essential element of the automation system. No other aspect of the production line captures more information or is more valuable in assessing products and finding defects, as well as in collecting data to direct the operation and optimize the productivity of robots and other equipment. Unlike simple sensors, vision sensors generate large amounts of image data, intensifying their utility in an Industry 4.0 environment.

As data analytics capabilities progress, the high volumes of data accessible through vision equipment will be used to identify and flag defective products, understand their deficiencies and enable fast and effective intervention in the Industry 4.0 factory.
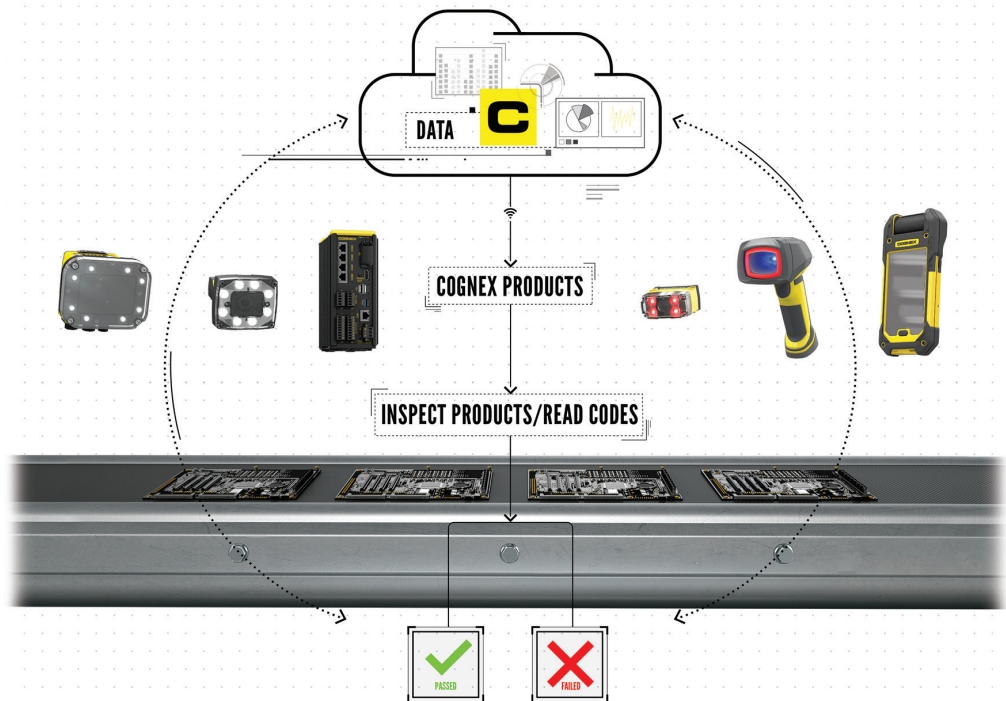
# COGNEX INNOVATIONS

The implementation and expansion of Industry 4.0 will create challenges and opportunities for machine vision suppliers. Cognex expects the application of machine vision systems to accelerate throughout the supply chain and in the operations of both new and existing vision users. Cognex is investing in products that deliver many of the productivity benefits associated with Industry 4.0 described above. Current innovations to be released in late 2017 and beyond include:

**Cognex Connect for universal communications compatibility**
Unlike nearly all the major automation suppliers, Cognex is focused solely on vision—inspection, guidance, measurement and identification—without a vested interest in promoting any specific communication infrastructure. Cognex Connect™ supports a wide range of protocols including EtherNet/IP, PROFINET, Modbus/TCP, SLMP, CC-Link, POWERLINK, OPC-DA, TCP/IP, SMTP and FTP. Cognex's business model and success is based upon the ability to provide and maintain connectivity to multiple protocols immediately and without intervention. Cognex makes significant investments each year in programming support to ensure that it is able to support the majority of communications platforms used by its customers.

**Real Time Monitoring (RTM) System for performance feedback**
This innovative system offers manufacturers some of the Big Data benefits of Industry 4.0. Cognex Real Time Monitoring helps customers monitor performance and diagnose and resolve barcode issues in real time to achieve greater throughput. It also collects and grades the quality of barcode images and provides valuable process control metrics over time across an entire facility. RTM works in conjunction with a network of Cognex DataMan image-based readers that use powerful algorithms to read almost any barcode—even those which are damaged, angled, wrinkled, or occluded by glare. RTM's performance and code quality overview dashboards give the user the ability to track and analyze data such as read rates, 1-D and 2-D barcode image quality and positional heat maps in order to achieve higher read rates and peak productivity.

**Cognex DataMan barcode readers for tracking and routing product**
DataMan® barcode readers use state-of-the art, image-based decoding algorithms to read even the most difficult 1-D, 2-D and direct part mark (DPM) barcodes at industry leading speeds. DataMan automates and simplifies identification and data capture across a wide variety of complex industrial and business processes at every step, from fulfillment to delivery.

**In-Sight vision system architecture with "self-learning" capabilities**
Cognex In-Sight® vision systems have built-in algorithms, eliminating the need for a separate PC, and can do all processing onboard for easier integration and greater stability. In-Sight architecture lets users direct the system to "learn" variations in printed characters and set up parameters automatically to accommodate them.

## Web-based interface for mobile, platform-independent visualization

Cognex solutions allow users to display vision information concerning machine status and historical performance through a web browser on tablets, phones, PCs or other devices at any time. Preferred ranges can be programmed and alerts transmitted anywhere in the world. These "smart," connected devices reflect the promise of the Internet of Things by collecting and readily exchanging data across networks.
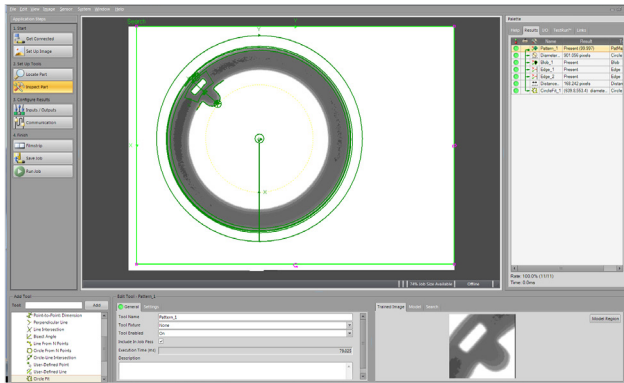




## EasyBuilder interface for fast and intuitive application creation

Industry 4.0 engineers will be called upon to configure vision sensors in order to achieve system-level objectives. In-Sight EasyBuilder® provides step-by-step guidance and suggestions for the non-expert to quickly and easily configure Cognex vision systems for accurate vision inspection and measurement using an intuitive point-and-click environment. A spreadsheet-driven interface is also available, giving power users the tools suitable for their experience level as well.

## PatMax patented geometric pattern matching technology for accuracy and repeatability

Cognex PatMax® is the industry's gold standard for part and feature location. PatMax learns an object's geometry using a set of boundary curves that are not tied to a pixel grid, then looks for similar shapes in the image without relying on specific gray levels. The result is a revolutionary improvement in the ability to accurately find objects despite changes in angle, size, and shading.
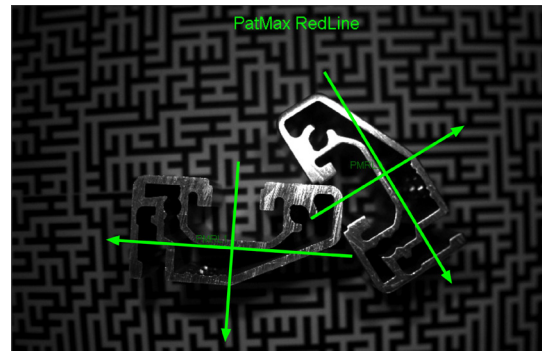


# SUMMARY

With these solutions already available, and many others in development, Cognex is prepared to meet the Industry 4.0 needs of its customers. More than one billion products are inspected, evaluated, tracked and traced using Cognex systems every day. With a wide range of vision solutions already delivering exceptional quality, flexibility and profitability to global manufacturers, Cognex is inherently prepared to usher factory automation into an Industry 4.0 world.

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## COGNEX

Companies around the world rely on Cognex vision and barcode reading solutions to optimize quality, drive down costs and control traceability.

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