

Industry 4.0: Manufacturing's Digital (R)evolution



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What is Industry 4.0?

Industry 4.0 represents the latest "revolution" in the world of manufacturing, one in which a combination of the digital and physical worlds allows for a data-driven, end-to-end optimization of the production process.^{1, 2}

1.0



MECHANIZATION

Water/Steam Power

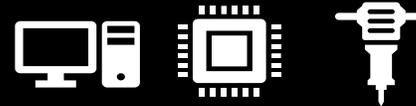
2.0



MASS PRODUCTION

Electrification
Assembly Lines

3.0



AUTOMATION

Software
Robotics
Programmable Logic
Controllers (PLCs)

4.0



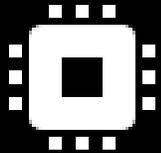
CYBER-PHYSICAL SYSTEMS

IoT
Cloud Computing
Big Data
Intelligent Production

Key Technologies of Industry 4.0

While there are many technologies that drive Industry 4.0, we feel that there are several groups which are integral to making this revolution a reality:

BUILDING BLOCKS



SEMICONDUCTORS



SENSORS

ON THE FACTORY FLOOR



MACHINE VISION



ADVANCED ROBOTICS



AUTOMATION CONTROLS



IoT PLATFORMS



5G NETWORKS



CLOUD/EDGE COMPUTING



BIG DATA and ANALYTICS

LINKING UP

TURNING DATA INTO ACTION

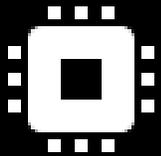
Building Blocks

Semiconductors and sensors represent the basic “building blocks” that make Industry 4.0 a reality.

TECHNOLOGIES



SENSORS



SEMICONDUCTORS

APPLICATIONS

- Sensors of all types (motion, speed, pressure, etc.) can collect vast amounts of meaningful data in challenging industrial environments.
- This data can help predict equipment failures and suggest maintenance, monitor raw material levels, and optimize and expand the use of automation on the factory floor.³

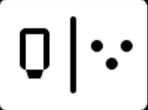
- Semiconductors not only power sensors but also play a role in processing the vast amounts of data they generate.
- What’s more, industrial semiconductors aid in “micro” tasks like power management, as well as “macro” tasks like fast, secure communications from NFC to 5G.⁴

KEY PLAYERS



On The Factory Floor

Increasingly sophisticated automation controls allow for the use of machine vision and advanced robotics.

TECHNOLOGIES	APPLICATIONS	KEY PLAYERS
 <p>MACHINE VISION</p>	<ul style="list-style-type: none"> Machine vision is being used across the production process- guiding robots and equipment, identifying parts for sorting or counting, or performing quality control.⁵ 	         
 <p>ADVANCED ROBOTICS</p>	<ul style="list-style-type: none"> Manufacturing robots are becoming smaller, cheaper and more efficient, and are becoming increasingly capable of collaborating with (as opposed to replacing) human workers.⁶ 	     
 <p>AUTOMATION CONTROLS</p>	<ul style="list-style-type: none"> Modern automation systems have existed for over 50 years. Today, these systems are being enhanced with new digital connections and capabilities.⁷ 	      

Linking Up

Industrial IoT platforms and 5G communication allow data to move across the factory floor and across the world.

TECHNOLOGIES	APPLICATIONS	KEY PLAYERS
 <p>IoT PLATFORMS</p>	<ul style="list-style-type: none"> • The increased connectivity of devices and hardware is only useful in so far as the ability to get them to “speak” to various digital applications and one another. • IoT platforms do just this- connecting hardware and applications in a scalable, secure and customizable system.⁸ 	
 <p>5G NETWORKS</p>	<ul style="list-style-type: none"> • 5G’s faster transfer speeds, lower latency and denser coverage allow for easy transfer of the massive amounts of data generated in an Industry 4.0 world. • To reap these benefits, manufacturers may soon create private 5G networks within factory sites.⁹ 	

Turning Data Into Action

With new computing technologies, manufacturers can receive actionable insights in real-time.

TECHNOLOGIES



**CLOUD/EDGE
COMPUTING**



**BIG DATA and
ANALYTICS**

APPLICATIONS

- All the new data being created by next-gen industrial devices can be stored, processed and disseminated thanks to cloud computing.
- In a similar vein, edge computing allows for this analysis to occur in proximity, allowing for real-time insights.¹⁰

- The translation of data into insights and recommendations is key to realizing the potential efficiencies promised by Industry 4.0.
- Whether it is better supply planning, pinpointing quality issues or reducing downtime, these efficiencies are possible thanks to big data and analytics.¹¹

KEY PLAYERS



How Does a Public Markets Investor Benefit?

With many of the companies we see as “Key Players” in the technologies that drive Industry 4.0, we feel there are several ways public markets investors can leverage their portfolios to this ongoing Industrial Revolution:

SEMIS AND SENSORS



INDUSTRIAL GIANTS



ELECTRONIC “EYES AND ARMS”



DATA PLATFORMS



Company Profile: Skyworks Solutions



About: Skyworks Solutions produces wireless communication semiconductors, from radio frequency (RF) modules to tuners. Though it has traditionally been viewed as a major supplier to the global handset producers (Apple, Samsung), it has recently been expanding into new markets.

Role in Industry 4.0:

- Growth of 5G creates a long-term opportunity for the business, as more devices (beyond mobile phones) become connected to networks.
- As these connectivity solutions become more complex, Skyworks' technology portfolio will likely play a prominent role in what the company refers to as the "wireless networking revolution".¹²
- Skyworks clearly identifies IoT, and in particular, factory robotics, as an emerging growth engine going forward.

Company Profile: Rockwell Automation



About: Rockwell Automation is the world's largest company dedicated to industrial automation and information. From software to controls to sensors, the company has provided automation solutions to a broad range of industries globally for decades.¹³

Role in Industry 4.0:

- Rockwell's long-standing leadership role in the "Industry 3.0" iteration of industrial automation provides it with a deep institutional knowledge base for creating the solutions necessary to make Industry 4.0 a reality.
- This push into the world of Industry 4.0 is best represented by the company's "Connected Enterprise" initiative, which seeks to provide new digital solutions for customers. These include industrial cloud services, AI diagnostics and predictive maintenance.¹⁴

Company Profile: Isra Vision AG



About: Based in Darmstadt, Germany, Isra Vision is a manufacturer of machine vision and industrial image processing systems. Most notably, it is a global market leader in surface vision technologies.

Role in Industry 4.0:

- Leveraging its experience and leadership in surface vision technologies, Isra Vision seeks to expand its offerings to a wider range of industrial automation applications.
- Most notably, Isra is working on several robot vision and guidance systems that can be used in the factories of tomorrow.¹⁵
- These solutions can also be integrated with wider IoT networks, allowing for data collection and analysis, and increasing the ease of implementing machine vision learning solutions.

Company Profile: Software AG



About: Software AG has long provided major global businesses with database processing solutions, linking a wide variety of IT systems, servers and devices. More recently, Software AG has sought to bring that integration expertise to IoT and Cloud systems.

Role in Industry 4.0:

- Recent acquisitions, most notably of Cumulocity in 2017 and Built.io in 2018 have solidified Software AG's status as a leader in the IoT space.
- Partnerships with manufacturing giants like Bosch in areas like data analytics, cloud storage and system architecture accelerate innovation.
- The company's technological leadership in this space, especially in industrial IoT, creates a large opportunity for growth.¹⁶

Overview

- Manufacturing has undergone several (r)evolutions, driven by the advent of new technologies and methods. We believe we are in the fourth such transformative period, one where new ways of collecting and analyzing data will optimize the production process from start to finish.
- The rise of “Industry 4.0” will impact many aspects of manufacturing, whether it comes to supply procurement, predicting necessary plant maintenance, further automating production processes or predicting customer demand.
- All of this is made possible by a number of key technologies, starting with better data collection through sensors and semiconductors, improving automation technologies, and the ability to bring all of this together on increasingly sophisticated data and analytics platforms that can develop solutions and suggestions in real-time, whether it is on the line, plant or firm level.
- We believe that public market investors have several options when it comes to obtaining exposure to this trend:
 - **Semiconductors and Sensors:** Companies which produce the building blocks for data collection.
 - **Industrial Giants:** Legacy players in industrial automation leading the digital charge.
 - **Electronic “Eyes and Arms”:** Leaders in robotics and machine vision.
 - **Data Platforms:** Viewed as “tech” firms, many of these are building strong Industry 4.0 franchises.

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