How Important Is Industry 4.0 for the Electronics Industry?

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The current transformation of the industry toward digitization is in full swing. Almost everyone is using buzzwords like (Industrial) Internet of Things, smart factory, or cyber physical (production) systems. In Germany, one of the strongest international industries, it's called Industrie 4.0—in other parts, Industry 4.0.

However, it seems nobody knows exactly what it means—there are various different interpretations though no clear definition. For many people, the change toward Industry 4.0 has already become part of everyday life, and with the repetition comes the erosion of the concept toward novelty. This is not helped by digitization and networking becoming frequently used buzzwords.

Focusing on Industry 4.0, especially in Germany, much of the industry is shaped by politics. Yet other nations have recognized the positive influence on their own country's economy and competitiveness, encouraging them to innovate further. In this context, political officials are promoting a dual strategy that combines the perspective of suppliers as well as the perspective of user companies, primarily in the industrial automation branch and in the mechanical or plant engineering segment. On one hand, it is important for manufacturers to use new, efficient, and intelligent technologies for their own production process. On the other, they have to put these technologies and products on the market.

By contrast, everyone agrees that Industry 4.0 not only drives new technologies and intelligent products, but also serves to expand the production sector. This also creates conditions for mastering the ever-increasing dynamics and complexity of existing and new markets. Companies that can play a role in multiple areas seem to have a particularly good starting position.

This applies especially to companies within the semiconductor industry. Semiconductor manufacturers like Analog Devices are already dealing with this complex concept to transform their own production lines into fully automated smart factories. The company also provides innovative technologies to companies within the manufacturing sector that assist them in transforming their manufacturing facilities into smart factories. But to start with this transformation, it is important to recognize the added value as it also implies high effort that has to be amortized by increased productivity with a corresponding reduction in costs.

Industry 4.0 not only means a change in production and expansion of technologies, it also means there is an increasing need to create new business models. Industry 4.0 is a much-discussed and very differently interpreted term, with outcomes that can be classified roughly into three fields: new technologies, new product offers, and new business models. All three fields together are covering the whole value chain of the production and its products—starting at the sensor node, via the cloud, up to downstream services (Figure 1).

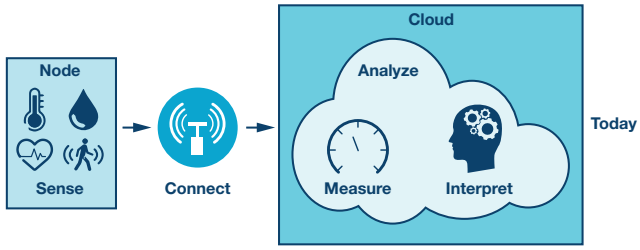

Figure 1. Today's signal chain.

Usually there is a node with a sensor or actuator in some form, which simultaneously establishes the link to the real, physical world. The signals to and from these devises are often very low and come from noisy, harsh environments. They have to be processed, converted, and forwarded to the next link in the signal chain.

Because of the issues with this signal chain, a change in the chain had to be made. Initially, where the pure data was transferred to the cloud, more and more data processing was taking place already at the node, as shown in Figure 2.

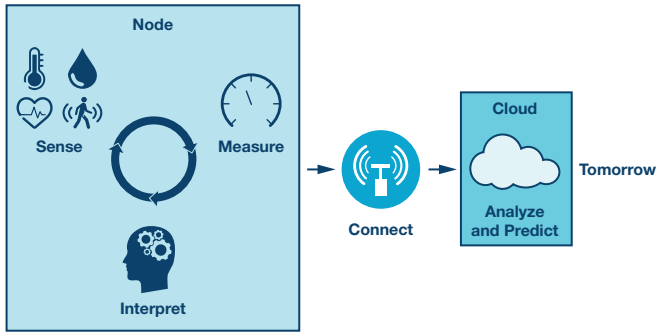

Figure 2. Tomorrow's signal chain.

This data processing generates more insight and knowledge at the node—turning data into information. This intelligent smart sensing technology lowers the overall power consumption, reduces bandwidth waste, and enables the move from reactive IIoT to predictive and real-time IIoT.

This is where technologies come into play. Many semiconductor manufacturers already rank them among their core competencies and that they need to be continuously improved.

In addition, energy efficiency plays a major role. Semiconductor manufacturers are encouraged to use their expertise to further develop not only their products but also their own design and process technologies, as the connection to the network is an important part of the IIoT overall solution. Whether wired or wireless, both technologies will be more and more in demand in the future and they have to be included in the portfolio.

If you go deeper into the system level and focus on the vertical segments, you can offer customers an even more complete system. The node, in terms of a complete hardware platform, can be offered together with corresponding software packages. This may also include associated algorithms to analyze data already in the node and finally only pass the results as less data intensive information to the network (cloud).

Although Industry 4.0 is an interesting and important topic, semiconductor manufacturers have to be very careful in their selection process. The market as a whole is still in a phase in which it is necessary to realize where and how you can apply your own strengths and technologies in the right way to meet the customers or applications really needs.

What Are the New Requirements of the IIoT Market?

In consideration of the industrial value chain, market requirements will change in the future. Among other reasons, this is why semiconductor manufacturers have to adapt their own enterprise, as well as their products, to the reality of the smart factory. The technological trend is moving toward intelligent and extremely efficient products and, if possible, with integrated safety and security functions as well as energy harvesting abilities. How such a device or rather a complete system may look is shown in Figure 3, which uses the example of an Analog Device' MEMS-based accelerometer, the ADXL356.

The ADXL356 is a low power, low noise, 3-axis accelerometer with a very low offset drift. Due to its hermetically sealed package, the ADXL356 is particularly suitable for precise tilt measurements within harsh environmental conditions, as well as for high performance (long-term) measurements in low power or battery-operated wireless sensor networks. This is where predictive maintenance and condition monitoring come into play. Both are closely related to Industry 4.0. Within these procedures, it is important to determine the level of damage of drive elements; for example, by carrying out vibration diagnoses, either permanently or periodically.

For such a smart sensor solution, as shown in Figure 2, the accelerometer forms the basis of the whole system. It is extended by further functions: integrated signal processing through analog-to-digital converters, microcontrollers, and various analog and digital interfaces, partly isolated or wireless. The wireless interface supports communications standards like Ethernet, 6LoWPAN, or WirelessHART, with the highest possible reliability. Especially for the latter two standards, wireless communication networks like SmartMesh IP™ and SmartMesh® WirelessHart bring very good solutions. The former complies with the 6LoWPAN standard, providing native IPv6 addressability to every node and making sensor data easily cloud-accessible. The latter complies with the WirelessHART standard (IEC 62591) designed for industrial applications to interoperate with WirelessHART devices from other vendors. Both offer extremely reliable and secure data transmission, by AES 128-bit end-to-end encryption and are scalable up to 50,000 nodes.

Finally, functional safety must not be ignored in the development process of these systems. In order to be able to offer customer security as part of the complete system solutions, semiconductor manufacturers should therefore also invest in technologies such as cyber security solutions (CSS) and encryption.

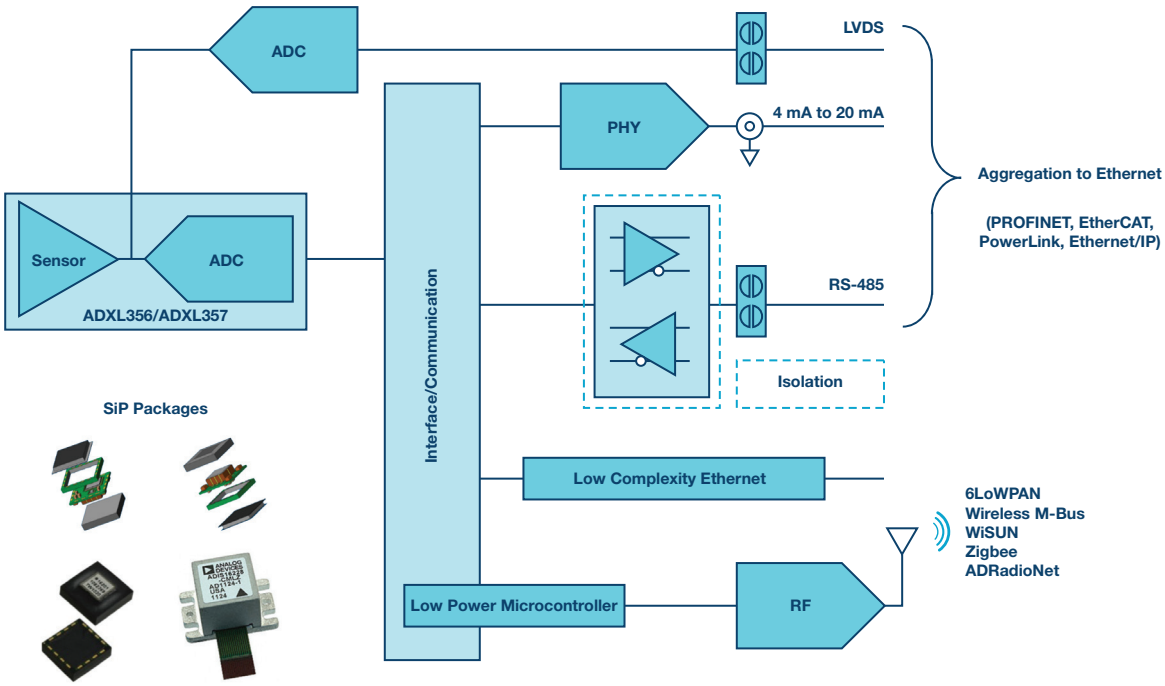

Figure 3. MEMS-based smart-sensor-solution.

Systems like those shown in Figure 3 have the consequence that fewer standard products are available at chip level, because in the future they can be integrated at the board level. The integration of standard products already takes place directly on the silicon or in the housing as a system-in-package (SiP). This means manufacturers will have to have in-depth knowledge at the chip level, or at least at the board level, together with a corresponding ecosystem. Therefore, customers are allowed to focus more on their own application and thus on the way to differentiating themselves from their competitors.

Suppliers like Analog Devices must consider the use or integration of proven technologies from other markets. This may help reduce high costs and increase life cycles. One example of a successful technological implementation in other products involves MEMS. MEMS technology never was supposed to create parts other than accelerometers, but it is now used for extremely fast switches like the ADGM1304. This single-pole, four-throw (SP4T) switch with integrated driver is operational from 0 Hz/dc up to 14 GHz, making it an ideal switching solution for a wide range of RF applications or relay replacements.

Such a combination of technologies helps serve not only individuals, but also different and sometimes new markets for manufacturers. In many cases, their wide range of technologies can be easily combined in this way to create new, efficient applications.

However, it will not be enough for semiconductor manufacturers to only extend their range of sensors and other semiconductor devices. In order to continue to be perceived as a global player in the market, and to fully exploit the potential of Industry 4.0, their portfolio should also be expanded in the field of communications technologies. For example, in the industrial automation sector, a clear shift toward Ethernet or, rather, Deterministic Ethernet, can be seen. For that reason, ADI recently acquired Innovasic, a supplier of semiconductor and software solutions for Deterministic Ethernet. With this acquisition, ADI added expertise for robust, real-time connectivity in highly synchronized networks and therefore expanded its portfolio with unique software solutions. So even with the prevailing trend toward digitization, the purpose of many semiconductor manufacturers is to move from analog technology into the vertical system area to offer complete system solutions that form the interface between the physical and the digital world.

However, in order to arouse customers' interest in such systems at all, a number of factors are likely to be important. It is not only the appropriate software, but also the tools and an adequate ecosystem surrounding the software, that will add value to the customer. Because of this, new services and algorithms for analyzing the generated data will also be required in future.

What Means Added Value for Customers in the Future?

Today, customers' resources are increasingly channeled into software. This is a certain challenge for the whole semiconductor industry and means that customers have to be offered more and more efficient development tools, but also training possibilities, documentation, and support; either directly, via ecosystems, or possibly via distributors. Of course, it doesn't make any sense to develop all these products and systems with Industry 4.0 functionality just because it is technically feasible. Instead, a significant added value must result for the customer. It is an elementary necessity to make this added value visible and accessible to the respective customer in order to justify the additional costs incurred for the acquisition and operation of the Industry 4.0 application. As a rule, the added values relevant to customers can be assigned to the three factors listed in the following overview:

- Improving operational efficiency by saving time, resources, and money.
- Improving customer satisfaction and loyalty by analyzing usage data.
- Creating additional revenue streams through expanded or new business models.

The success of intelligent products is directly related to the recognition of added value. Ultimately, they dictate all the technical and commercial parameters that are relevant for the implementation. Therefore they should be analyzed in detail. The result of the analysis may also be that a product idea is not economically feasible, or at least not yet. To make developments more feasible and for a faster and more effective integration into systems, support from manufacturers will play a major role. Manufacturers will bring their expertise into the development processes of their customers. This reduces additional effort and costs for the customers. Furthermore, manufacturers can continue to focus on their core business and they will not need to waste valuable time learning new technologies. Instead, partnerships and other cooperative efforts can help support continued growth.

Nevertheless, because of the many advantages of Industry 4.0 and its technologies, the question arises as to why many enterprises have not yet invested in their own smart factory?

Reasons for Hesitancy

One of the major obstacles is the perceived minimal benefit of a smart factory and its associated costs. For example, calculating the return on investment (ROI) currently remains quite difficult due to a lack of monetary evaluation criteria. Semiconductor manufacturers therefore have to increase their customers' awareness and provide educational material showing the advantages of smart factories and also in pointing out the value to be gained in investing. Investments are necessary for new technologies and business models, as well as for the development and expansion of marketing activities, qualification measures, and sales management.

With the transformation of the production sector, matters such as data and IT security have an increasingly important role. These topics are not just important requirements for the successful introduction of Industry 4.0—they have to be implemented into digital systems as critical acceptance and success factors.

Furthermore, it will be important for companies to set their fundamental strategic course at an early stage within the implementation of Industry 4.0 to gather experience with the corresponding technologies. However, this process requires patience because many of the relevant technologies are not likely to exploit their full potential for five to 10 years or even longer. Moreover, because of the lack of a clear definition, there is no exact date by which Industry 4.0 will be completely implemented. Instead of talking about an industrial revolution, it may be more meaningful to use the term industrial evolution.

With the change of the production environment, new players and competitors will also appear in or rather influence the market. Alliances will arise and shape the image of the production in a significant way. The future of companies will be less and less determined in the factory hall. Also, the software and services sector will play a major role, because only by linking and merging the virtual with the real world will ensure that manufacturers reach their maximum production potential.

Nevertheless, semiconductor manufacturers should not neglect their existing business or products that have been successful in the past or that still are successful. These major products should be further developed and should continue to be supported in the future by maintaining appropriate manufacturing capabilities. Although today's architectures of data converters are very stable and will continue to be the basis for the future, improvements will be necessary, based on their basic architectures. For instance, smaller processes are used for such products, which does not make it easy to achieve the same or even better performance.

Moderate Growth with New Market Trends

Megadeals in recent years have led to consolidation in the semiconductor market. Sales and distribution are changing from component to system sales. To be successful in the future means to reposition oneself or the company by recognizing the potential of disruptive technologies and new markets in Industry 4.0. Enterprises have to make consistent use of the few organic sources of growth in the semiconductor industry. Unfortunately, growth booms in the semiconductor industry with an annual sales increase between 30% and 40% are a thing of the past—these rates of increases now seem to be over. Between 2015 and 2020, only an average annual growth rate of 3.4% is expected. Companies must ask themselves the fundamental strategic question: Where will growth come from in the future?

The following sources of growth may be crucial: power semiconductors made of silicon carbide (SiC) are currently traded as a product source for new future growth. They are considered to be disruptive market breakers compared to semiconductor products made of regular silicon, since they are faster, more robust, and more efficient. The technologies SiC and its sister technology, gallium nitride (GaN), will dominate in the next few years, due to the increasing demand for hybrid and electromobility, as well as for regenerative power generation and certain industrial applications.

Conclusion

As part of the much larger Internet of Things—also known as the Internet of Everything—Industry 4.0 holds enormous potential. In the next few decades, the market value is expected to be in the range of trillions. Anything that increases productivity with the help of Industry 4.0 will be of great interest for companies of all sizes.

To fully exploit the full potential of the IoT market requires more than just hardware. It requires an ecosystem of hardware, software, and services. In this new environment, small, agile companies are encouraged to work with larger companies and develop collaborations.

However, semiconductor manufacturers should not neglect developments beyond the current trends and the buzz surrounding Industry 4.0. There are also technologies that traditionally belong to one market, but that eventually influence other markets as well; for example, 5G. Traditionally, 5G is a communication technology for mobile devices and infrastructure. But in the future, one of the markets that will drive the demand for 5G is the automotive market. Communication with other systems is particularly important for autonomous driving. Each vehicle becomes part of a complex ecosystem in which communication plays a key role. In addition to data exchange between cars, this ecosystem includes roadside infrastructure, the 5G network, and large data centers. Furthermore, the vehicles depend on sensors such as cameras or lidar and radar technology to acquire the necessary information about their environment. The entire communication system must work together. In light of the huge amount of data to be processed in autonomous driving with higher speed, lower latency, and ultrastrong reliability, 5G seems to be the most promising, currently existing communication standard.

In summary, Industry 4.0, the transformation toward smart factories and its required technologies offer enormous potential for semiconductor manufacturers and their company's success.

About the Author

Thomas Brand began his career at Analog Devices in Munich in October 2015 as part of his master's thesis. From May 2016 to January 2017, he was part of a trainee program for field application engineers at Analog Devices. Afterward, in February 2017, he moved into the role as field applications engineer. Within this role, he is mainly responsible for large industrial customers. Furthermore, he specializes in industrial Ethernet and supports related subjects in Central Europe. He studied electrical engineering at the University of Cooperative Education in Mosbach, Germany, before completing his postgraduate studies in international sales with a master's degree at the University of Applied Sciences in Konstanz, Germany. He can be reached at *thomas.brand@analog.com*.

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