Extended Abstracts of the 2017 International Conference on Solid State Devices and Materials, Sendai, 2017, pp1-2

PL-1-01 (Plenary)

The Semiconductor Industry: Changed and Unchanged

Tetsuro Higashi

Tokyo Electron Limited
Akasaka Biz Tower, 5-3-1 Akasaka, Minato-ku, Tokyo 107-6325, Japan
Phone: +81-3-5561-7000

Abstract

In this talk, the author's view of the semiconductor industry is shared with the audience. The semiconductor has been a center of enhancing human intelligence for several decades, and it will remain as such in the future. However, the future depends on our ability to develop innovative technologies and create profitable businesses that can pay for R&D. The significance of professionalism, diversity, and connectivity will be discussed based on the author's 40-year experience in the industry. Healthy competition and global collaboration are the keys to success, and as such the Tokyo Electron Group has been very active in collaborating with consortia, universities, and start-ups to develop innovative technologies for the brilliant future of mankind.

1. Applications driving the semiconductor industry

The IoT and Big Data have prevailed as promising business opportunities that are accelerating the evolution of our society. The semiconductor industry, along with other industries backed by AI, FinTech, and robotics, is a key driver of the IoT society and era. Applications driving the semiconductor industry can be categorized into three "I"s: interface, intelligence, and infrastructure.

The interface between the physical and cyber worlds, or the real world and IT networks, is a critical bottleneck in the IoT. This interface, also referred to as edge computing, is possible now through devices such as smartphones and medical sensors, which give us the ability to be connected at all times. In the layer of the interface, a key process indicator of devices and services is user experience and feeling. It is important for us, as scientists, engineers, and business people, to provide technologies that make consumers excited, happy, and comfortable.

Intelligence can be seen in fog computing with security and latency. The IoT, or cyber-physical system, is a concept of connecting the real world with information networks, where intelligence allows us to be safe and also very fast in terms of protection and efficiency. It is important to prevent security threats and hacking into these networks, especially as we move toward an era where more and more tools in our everyday lives are becoming autonomous. Furthermore, low latency, or real time operation, is crucial in cyber-physical systems. For example, we assume that autonomous driving cars and robotic arms in factories will have no delays in physical operation.

In the IoT era, 5G networks and data centers is an important infrastructure that supports the interface and intelligence. Data taken by sensors at the interface is transferred via the appropriate network. Meanwhile, the intelligence in the cyber-physical systems is stored in data centers as cloud computing. This means the data itself becomes a kind of infrastructure in our society. One key success factor of the infrastructure is cost performance. The industry has made huge efforts in terms of materials and processes to reduce overall manufacturing costs. As the semiconductor industry, we are expected to provide devices with sufficient volume and at an affordable cost to support the infrastructure of the IoT society.

2. Changes in the semiconductor industry

The semiconductor industry has had multiple axes in the United States, Europe, Japan, and other Asian countries in this decade, though Japanese device manufacturers had a very large market share before the 1990s, especially in memory devices. One of the main reasons for this shift is the density of personal networks among R&D professionals. Managerial analysis of the competitiveness of the semiconductor industry indicated that engineers from U.S companies have more connections with collaborators in other companies and institutes than engineers in Japanese companies [1], which may influence the quality of R&D, such as agility, flexibility, system-oriented thinking, and so on.

The changes to the business structure of electronics have also influenced the semiconductor industry. We all know that the fabless and foundry business model strength lies in creating innovative applications and new businesses. This has accelerated the shift of value from manufacturers of semiconductors to providers of systems and applications. Google, Amazon, Facebook, and Apple, also known as "GAFA," for example, are companies with strong business platforms connecting superior concepts and content with de-facto products and services. These companies have come to design and manufacture semiconductor chips by themselves as part of virtual vertical integration, following an era of horizontal specialization.

With regards to technology, we are now pursuing super integration combining heterogeneous devices to make a fully integrated system. We need innovation as a system, although semiconductors have been contributing to the enhancement of the logical parts of our brain, parts by parts, function by function, such as memory, logic, and image sensor, in order to accelerate the evolution of human capability. There's plenty of room for the semiconductor industry at the inspiration and creativity. What is needed is experience-based, adaptable hardware that can find a problem to solve. Neuromorphic devices are promising devices that will enhance human capability in terms of inspiration and creativity. The combination of Neumann and neuromorphic computing will help us to get closer to true intelligence.

3. Significance of professionalism, diversity, and connectivity

Collaboration between professionals across diverse fields of expertise is significant for the development of new devices such as the neuromorphic device. The success of the research community and business organizations depends on professionalism underpinned by expertise and experience, the diversity of members in the community and organization, and personal connections to find out "who knows what" based on mutual understanding and trust.

Respecting the significance of these collaborations, the Tokyo Electron Group has been active in participating in joint R&D programs with consortia, universities, and start-ups [2-4]. There are several ongoing collaborations with regards to emerging devices, materials, photonics, AI, and so on with venture spirits. It is these new combinations that create innovation. Healthy competition and global collaboration will remain a key to success in the semiconductor industry.

References

[1] For example, https://hermes-ir.lib.hit-u.ac.jp/rs/bitstream/10086/19135/6/070iirWP11_08.pdf
[2] http://www.tel.com/about/tech/index.htm
[3] http://www.tel.com/news/2016/0822_001.htm
[4] http://www.tel.com/about/tel_vc/portfolio.html