

Smart Manufacturing allows for a competitive advantage in the semiconductor industry

The Industry 4.0-based Smart Fab concept will allow semiconductor manufacturers to remain competitive in the dynamic and challenging market by virtue of ensuring an efficient supply chain integration and improving transparency, safety and reliability. We have spoken to Hartmut Schneider, Vice President of Technology at Exyte and expert on the Smart Fab concept, about the impact, benefits and challenges the semiconductor industry faces with its design, construction and operation.

Major semiconductor manufacturers recently published their plans regarding the development of Smart Manufacturing, Smart Factories and IoT platforms. Can you introduce us to the idea?

These are all based on the generic principles formulated within the framework of the Industry 4.0 approach that proposes the digital integration of the supply chain, direct communication between production equipment, as well as the analysis of and real-time response to big data collected during the operation of a Fab. Adopting these principles and tailor them to the need within a semiconductor wafer fab environment resulted in the concept of a Smart Fab.

The Smart Fab concept comprises an integrated approach of all fab operating systems such as the Manufacturing Execution System (MES), Enterprise Resource Planning (ERP) and the Facility Monitoring and Control System (FMCS). The combination of these systems or data silos provides the ability to analyze the interaction between process equipment manufacturing automation, supply chain and commercial management, as well as facilities monitoring and control. Finally, this platform can enable controlled access by a company's key suppliers for ease of communication and faster service response times, resulting in improved responsiveness, reliability and quality. The reduced cost of sensor technologies for Internet of Things (IoT) and the rapid development of Artificial Intelligence (AI) methods significantly expand the possibility to collect more operational real-time data. An automated analysis of such data supports real-time ex-

pert decisions and communication of actions along the supply chain. From a facilities stand point, this implies the integration of all facility systems via the central FMCS in the form of a Digital Facilities Twin as part of a manufacturer's IoT or Smart Manufacturing Platform. This has been recently proposed by major players in the industry.



Hartmut Schneider
Vice President of Technology,
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Hartmut Schneider provides almost 30 years of extensive global experience from projects in China, Singapore, Germany, and the United States. He specializes in Industrial Engineering and advanced fab concept development.

To what extent do you expect Smart Manufacturing to impact the semiconductor industry?

The Smart Fab concept progresses beyond today's typical approach of the optimization of capital expenditure (CAPEX), time to market and quality during design and construction and also focuses on continuous improvements of operational expenditure (OPEX) during the lifetime of the fab.

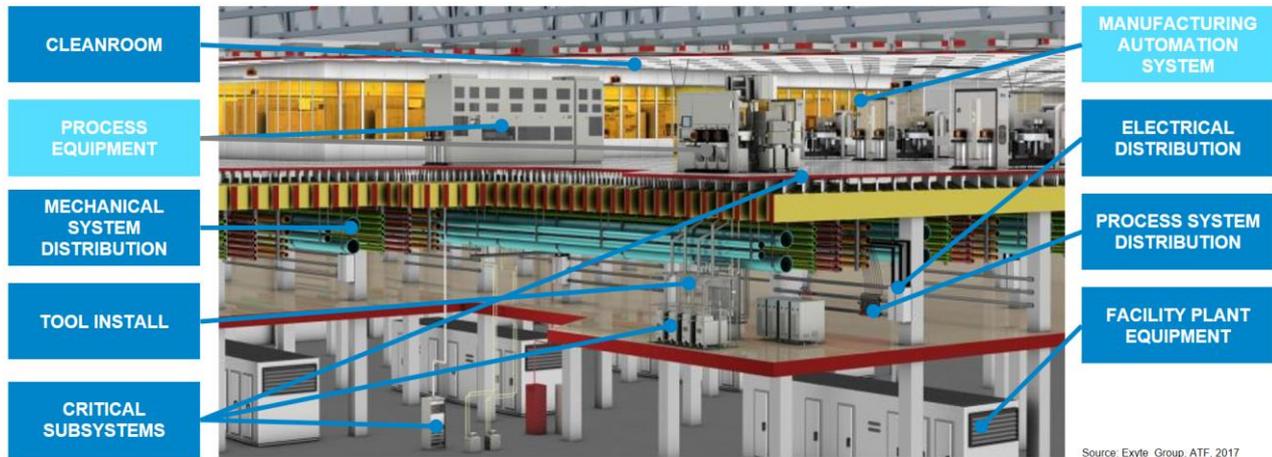
Improvements in both CAPEX and OPEX are mandatory for all semiconductor manufacturers to prosper and grow within the highly competitive and dynamic semiconductor market environment despite the challenges of diverging products, technologies and the client base. It is therefore mandatory to integrate the supply chain in the most efficient manner, given that it faces restrictions in terms of experienced expert resources (for both operation and maintenance) as well as the availability of spare parts and consumables. The Smart Fab concept provides opportunities for supply chain integration, but also improves transparency, reliability and sustainability of the facility systems – thereby reducing OPEX. And ultimately, the operational data from existing production lines can be used in comparative analysis to optimize CAPEX for new fab projects.

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Can you elaborate on the benefits of Smart Fabs compared to other solutions and designs?

The mentioned opportunities to continuously optimize OPEX and CAPEX result from improvements in a number of areas: transparency, standardization, operational efficiency and sustainability.

The ability of each component to communicate with other internal systems and the visibility of system and equipment performance promises an increase in transparency which in turn allows performance analysis and comparative benchmarking at tool, system and fab level. The ability to monitor and control fab operations benefits the operational efficiency as well, enables preventive and remote maintenance and even allows for virtual tours and trainings on real-time data. And last but not least the opportunity for a fab-wide environmental modelling and the management and optimization of energy usage will give way to continued improvements in sustainability.



The Digital Facilities Twin in the IoT Platform combines real time facility data with manufacturing data.

What are the challenges for semiconductor manufacturers to adopt it?

The full development of a Smart Fab in the semiconductor industry currently faces a number of challenges. It will be important to structure the needs of the fab owner and consider their priorities (OPEX versus CAPEX), define key players on both client and supplier side and find alpha users within the semi manufacturer organization. The industry will be required to explore potential degrees of standardization, agree on an R&D funding model and define the IP ownership between the stake holders. And of course the challenges of cyber security, IP protection and concerns regarding fast data transfers have to be mitigated.

Ultimately we have to consider the ever-changing landscape of digital tools and technologies. Take 5G communication technology for example. Its availability will enhance the development and implementation of Smart Fab concepts by providing an extremely fast mobile network platform that is required to reliably transmit an unanticipated volume of data. Replacing hard-wired with wireless connections will lead to a further reduction of CAPEX.

Does Exyte have any experience with or even completed a Smart Fab project?

Since the Smart Fab concept in the semiconductor industry is still under development, the concept has, to our knowledge, not yet been fully implemented in recently completed wafer fab projects anywhere around the globe. However, certain Smart Fab aspects and components are available on the market and have been already implemented and proven by Exyte and the supply chain. Among those are additional IoT sensors supporting preventive maintenance, idle modes of auxiliary equipment, real-time AMC monitoring/control in cleanrooms, cloud-based facility system monitoring, as well as enhanced 5D Building Integration Models (BIM) and the digitalization of design and construction processes.

Furthermore, Exyte is at the forefront of the development of a Digital Facilities Twin to support the need for Smart Factories, Smart Manufacturing or IoT Platforms and we are already engaging with our clients in their development.

You have already mentioned the Digital Facilities Twin as a key technology. Can you summarize the idea for us?

From Exyte's point of view the Digital Facilities Twin is a key element of the Smart Fab. It can be described as a virtual digital model of the buildings and facility systems that is developed and maintained during design and construction of a fab project and continuously collects, processes and responds to real time data. This model represents the as-built construction status at the end of the investment phase and is connected to other systems such as the Manufacturing Execution System (MES), Enterprise Resource Planning (ERP) and the core Facility Monitoring and Control System (FMCS). This core FMCS system is similar to already implemented FMCS platforms tasked with monitoring and maintaining stable and reliable operation of all facility systems and functions. But the Digital Facilities Twin incorporates data not only from the core FMCS system, but also from additional IoT sensors and includes advanced analytical methods for real-time expert decisions and actions in a secondary Smart FMCS module. In summary, the Digital Facilities Twin consists of an advanced Building Integration Model (BIM), a real-time data base, data analytics and a Smart FMCS module and is interfaced to the MES and ERP.