DAWN OF A NEW AUTOMATION ERA

When the pressure was on to increase productivity at the Hitachi ABB Power Grids semiconductor factory in Lenzburg, Switzerland, it turned to an innovative automation project that combined AGVs and robots for a fully automated manufacturing process

The facility manufactures a range of BiMOS power semiconductors for customers ranging from electric railways to energy transmission and distribution operators. Power semiconductors are traded globally. To ensure that operations remained competitive in Switzerland, a notoriously high cost location, it was crucial to ensure a productivity increase. This would also add ecological benefit to the operation through better utilisation of energy and other resources.

Like all industry 4.0 implementations, the project is a journey, and one that after six years is still evolving. The initial forays into automation began with two focused projects: one targeting the front-end process – where the silicon is made – and the back-end process where the final product is assembled.

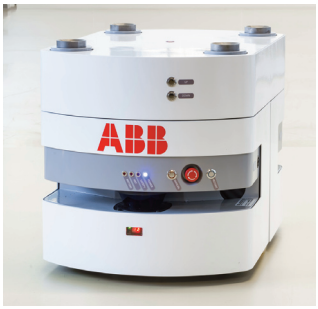
KEY POINTS

- ***The Genesis program to fully automate production at the Hitachi ABB Power Grids semiconductor factory began in 2014***
- ***It covers 100+ projects, 20 new production units, more than 50 robots and initially six AGVs all to be integrated into the MES***
- ***The AGVs were explicitly developed for the project and are controlled by BlueBotics' Autonomous Navigation Technology***

FROM PILOT TO PRODUCTION

The discrete back-end process was identified as particularly suitable for automation, so Hitachi ABB Power Grids set about fully automating the production. The transformation program was given the name 'Genesis' and the journey began in 2014. This was no simple program, with over 100 projects, 20 new production units, more than 50 robots and initially six Automated Guided Vehicles (AGVs) all to be integrated into the Manufacturing Execution System (MES), so it required a staged approach to adoption.

It was decided that the technology would be trialed on a pilot line that was specially built using actual production cells and equipment, along with four AGVs



and several ABB robots. "It was everything that we wanted to do later but built on a small scale just to test that the hardware, software and interfaces were working," David Hajas, Genesis program manager, says. "It tested the communication between the MES system and the robots; the communication between the MES and the AGVs as well as the mechanical handover between

AGVs and production equipment. We were working for two years from the start of the feasibility study until this pilot line was working."

During this pilot phase the team in Lenzburg developed their own standard together with the different suppliers and wrote the specifications for the interfaces. "We took a step, we discovered what the problems were, we solved them, and moved on to the next challenge; it was an iterative approach. In the two years of the feasibility study we created our standard and applied that to the rest of the equipment. We put it into every specification of each supplier that we were working with."

AN AUTOMATED PRODUCTION PROCESS

The final program involved several production cells where the set up was changed by ABB robots. The logistics between the production cells is handled with AGVs, which were explicitly developed for the Genesis project and controlled by BlueBotics' Autonomous Navigation Technology (ANT). This system makes use of permanent natural structures in the environment as its reference for vehicle localisation and combines information from industrial encoders and the AGVs' safety laser scanners that can achieve an accuracy of ±1 cm and ±1°.

The entire process is orchestrated and synchronised via MES and a control system, in this instance ABB Ability Manufacturing Operations Management (MOM). MOM enables an agile and autonomous production. In contrast to traditional automation solutions, where the material flow is permanently programmed in the cell, the business logic for this application is transferred to the MES. This permits flexible adaptation of the business logic without modifying the programming of the robot cells.

FROM HUMBLE BEGINNINGS

The initial concept to automate the production was developed by Hajas while working as an engineer on the production line where he witnessed the daily challenges of the operation. "I saw what the problems were," Hajas says. "Based on that, I presented the ideas of a fully autonomous production to the management and then the whole case started rolling. I have been managing this program since then. It is still ongoing, this is a transformation and lasts many years."

One of the prime enablers of the project is the manufacturing execution system. Hajas describes this as the brain that keeps track of everything and co-ordinates all the operations. The choice of ABB robots and control system was expected but when it came to the logistics of moving the materials from cell to cell several options were considered. Traditional conveyors were considered first and then an overhead conveyor system, but neither fit the bill.

"I evaluated different conveyor technologies but soon concluded that it would just be too messy because we do not have a linear production system. The logistics needed consisted of very complex routings that would have required conveyors everywhere, which would have made it difficult to access the line for maintenance. The second problem was that although there are clean room compatible conveyors, we have always strived to avoid them as they have additional surfaces that need special attention to keep them clean. AGVs were mentioned by a supplier with whom we were working and that opened my eyes to new possibilities. The initial plan was just to automate one area but because of the AGVs it enabled us to think of automating everything."

> ***THE BIGGEST HURDLE FOR THE AGVS WAS THE INTERACTION WITH THE PRODUCTION CELL***

MAKING A COMPLEX PROCESS WORK SEAMLESSLY

The production of semiconductors is extremely complex, in terms of process, and made more complex still by the stringent requirements for traceability. If something goes awry, it is crucial to know which machines and materials are involved. "It was challenging to integrate all the AGVs because the production in Lenzburg is a complex process with many steps. The MES needed to know everything," Nicola Tomatis, CEO of BlueBotics, explains. "Not only must the AGVs perform their role precisely but we had to ensure that all the communication between the equipment and vehicles was guaranteed."

The biggest hurdle for the AGVs was the interaction with the production cell. "The automatic transfer of the trays containing the components was the toughest part because it required high accuracy as well as a certain procedure to do this task," Tomatis says. "We needed the communication and coordination and synchronisation with the equipment, as well as with the MES. They had to communicate locally between themselves to make sure that the handshake was correct. The challenge from our side was that we had to implement specific handshaking protocols that are used in this market to fulfil the job; it was the integration that was a challenge."

Communications for the installation were handled by Wi-Fi over an industrial network and that has not given the team any problems. Neither has the thorny topic of latency that is often mooted as a concern in industrial robotic installations. "Latency is not a problem because we do not need real-time communication for this application," Hajas adds. "The beauty of our concept is that the MES system gets the status from the shop floor that a cell has finished its production and has material to unload. The MES sends a transport request to the ANT server [fleet management] software that equipment X is ready to unload, and an AGV is dispatched."

There was initially a total of 50 production steps in the scope of the Genesis program and to date approximately half of these have been implemented. The remaining part is now being installed and tested at the integrators site and will be the next ones installed. When completed, the chips will be inserted into the tool at the first process step and the finished and tested module will emerge at the end of the line without a single person touching the product. The transport and dispatching are then fully automatic as well as the recipe selection and several product routers are manufactured in parallel.

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