PUSHING THE BOUNDARIES FOR AUTOMOTIVE ELECTRONICS MANUFACTURING

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There is a dramatic shift occurring in the manufacture of automobiles. Electronics are taking over in every aspect, even to the point of connecting the car with the Internet and even other automobiles. The implications and challenges for the manufacturer are far reaching. A visit to Sanmina's Hungarian electronics manufacturing plant in Tatabanya shed some light on how one EMS company is navigating the highly regulated and competitive automotive manufacturing environment.

The electronic content in cars is expected to increase to around 35% by 2020 and by 2030 even more. Vehicles today are already filled with all types of electrical devices and functions as standard. There are for example, integrated GPS systems, infotainment systems and control devices. Park assist, safety features, lighting and many other controls are driven by the demand for greater comfort, connectivity, efficiency and safety.

Going forward, further digitalization and connectivity with hybrid and fully electric cars, as well as the driverless car, will further equip vehicles with an unprecedented number of advanced electronics. At the same time the regulatory requirements for functional safety, traceability, environmental aspects and end-of-life recycling are all contributing to the proliferation of high density complex electronics in and around the vehicle of the future.

So what are the implications for car manufacturers as mechanics intertwine with electronics? How does the supply chain need to adapt to the growing technological complexity and strict regulatory requirements?

To investigate further I travelled to Tatabanya in Hungary to visit a highly sophisticated electronics manufacturing plant run by Sanmina. Just a short 45 minute drive from Budapest, Sanmina Tatabanya is strategically located in the heart of Hungary's Technology Triangle of Győr, Budapest and Székesfehérvár.

Hungary itself lies within the Schengen Zone, in the Eastern part of the EU and enjoys direct access to a well-developed logistics and utility infrastructure that connects Hungary to Western Europe and the rest of the world. In 2004 Hungary became a member of the European Union with a fully harmonized legal system that is aligned to European safety and quality regulations for automotive manufacturing. With such a strategically important geographical location it is no wonder that many of the world's leading automotive OEMs settled in Hungary like Mercedes Benz in Kecskemét, Audi in Győr, Opel in Szentgotthárd and Suzuki in Esztergom and, in support, suppliers and outsourcing partners are in close proximity.

Sanmina has been in Tatabanya since 1997. Alongside its established complex automotive electronics manufacturing capabilities, the facility also provides a wide range of NPI (New Product Introduction), manufacturing and test services for both complex and high-volume products in the Communications and Networking, Medical and Industrial sectors with all the required certifications in place (ISO 9001, ISO 14001, TS 16949, TL 9000, ISO 13485, AEO-Authorized Economic Operator).

The Sanmina campus covers 40.000sqm with 1,000 staff supporting the facility and 14 SMT lines in operation 24/7.

But of course capacity, people and certifications alone won't suffice to compete in the highly complex automotive manufacturing sector. What is called for is a robust manufacturing environment, in terms of equipment, experience, best practise and access to a sophisticated supply chain.

Figure 1. Sanmina SMT Manufacturing Line

Today, the challenge is to build reliable electronic products with increasing density, complexity and sophistication whilst, at the same time, meeting the many automotive regulatory requirements and optimizing the investment in the choice of SMT equipment and their feature sets. As devices get smaller in size, density and miniaturization increases significantly in integrated circuits demanding a need for greater capability, accuracy and reliability from manufacturing equipment.

Sanmina has invested in additional high technology equipment such as SPI (Solder Paste Inspection), AOI (Automated Optical Inspection) and AXI (Automated X-Ray Inspection) as well as best-in-class printers, high-speed, high-accuracy pick and place machines and reflow ovens, in order to harmonize the complexity and durability demanded from sophisticated automotive manufacturing.

SPI for example, measures the true solder paste volume on each and every pad to ensure perfect joints even for ultra-fine pitch components in high density PCBA's. Although AOI machines aren't new to the production line, the latest 3D technology has revolutionized this tool, making testing more robust by increasing the test coverage and reducing false calls.

Machines form the backbone of any manufacturing operation but knowledge and experience of technology, processes, applications and supply chains can be a key competitive advantage in today's manufacturing environment where OEM's are looking for a commitment of Zero Defects from their manufacturing partners.

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Figure 2. Sanmina Employee Testing PCB Assembly

For example, large through-hole connectors mounted on PCB's are traditionally hand-loaded prior to a wave soldering process. This adds additional labor cost and an additional process step. By leveraging their expertise from other industries, Sanmina Tatabanya pioneered the use of pin-in-paste technology as part of the SMT process for large automotive connectors and was able to improve reliability and cost. Over two years of development and testing were invested to ensure the solution met the required standards and cost efficiencies. It paid off with the receipt of a Quality Award and a Pin-in-Paste Solution that provides greater reliability at a lower cost than more traditional processes. In order to inspect the hole-fill rate of the through-hole components using pin-in-paste technology and to inspect the solder joints under BGA components in-line, AXI machines have been strategically added to the SMT lines in the facility. The additional features offered by the latest generation 3D equipment are balanced with the requirements of test coverage, level of false calls and takt rates. The carefully implemented approach achieves an optimum solution that reduces cost and maximizes quality.

This is just one example of the many ways Sanmina leverages their experience inside and outside the automotive sector to improve processes and outcomes, saving money, increasing yield and improving quality.

New Product Introduction

A further challenge for today's manufacturers is the speed at which products are required to be ready for market release. As complexity, density and miniaturisation of components increase and the lines between consumer and automotive electronics blur, high-tech manufacturers are increasingly under pressure to shorten product lifecycles and drive innovation in an ever more competitive environment with a growing mix of more complex products.

The risks are high. Manufacturers without proper product lifecycle management, strict operational processes and tight supply chain control, will not succeed in balancing the need for consistent product quality and compliance to regulatory requirements such as TS 16949 with the equally critical need for fast product introduction.

The days of a year or two being available for electronic manufacturing industrialization are long gone. Six months and even three months are becoming the norm and that is where an in-depth technical understanding gained through years of manufacturing experience in multiple markets once again takes center stage.

Sanmina Tatabanya fulfils those credentials. With direct access to Sanmina's established global footprint of 75 operating locations, with more than 20 years' experience in the automotive market and an in-depth knowledge of automotive regulatory requirements, Sanmina Tatabanya is able to work closely with its customers to introduce new products in a very short timeframe and can even achieve a three-month turnaround when required by the customer, including process validations and, with such tight time-lines for New Product Introductions (NPI), Sanmina's robust process is a critical key to success.

The initial validation phase sets out to examine the entire manufacturing process with different methods to develop optimum processes and manufacturing requirements for a specific product. Detailed testing and measurements determine and confirm the optimum manufacturing process in accordance with customer and regulatory requirements. Beyond the process validations, the product itself can also be validated by means of thermal shock testing, aging and cross section analysis and various other tests, to ensure full lifecycle product reliability and quality compliance.

For the manufacturing process, equally rigorous and robust parameters and controls are set to meet and fulfil automotive standards and requirements. Tooling, mounting programs, inspection programs, reflow profiles and every key process parameter is verified continuously in order to ensure optimum balance between product quality, cost and delivery. Both automated and manual assembly solutions using standard or specific custom designed handling equipment are validated by applying intelligent testing and inspection methods at the end of the lines.

Where non-conformances call for a repair process, highly skilled and qualified operators are used for repair, along with specialized equipment such as automated vacuum controlled equipment for high value/high complexity components like BGAs and processors. After replacement of through-hole or BGA components the hole-fill-rate and the solder joint of the BGA balls are checked by trained operators with 3D X-ray machines.

Smart Factory

Traceability has generally been a requirement for many industry sectors including automotive and medical. Principally in these market segments, production is impossible without strict adherence to regulatory requirements such as TS 16949 and ISO 13485, and with it the necessity for disciplined measures and processes that track and record each manufacturing step to achieve compliance. Even part traceability is a requirement for all automotive, and medical products.

Sanmina Tatabanya's processes are strictly controlled. Upon material receipt all boxes up to the lowest packaging unit level are opened and verified. Each item then gets assigned a designated Sanmina ID, which acts as its unique identification during the entire manufacturing process. From that point onwards all further handling is paperless and fully automated by using intelligent bar code readers driven by Sanmina's sophisticated ERP (Enterprise Resource Planning) system. These processes ensure complete component and process traceability from receiving to final product shipment.

Based on 30 years' experience in traceability business segments such as medical and automotive, Sanmina in fact developed its own system which it calls SFDC (Shop Floor Data Collection) and PTS (Part Traceability System) which, in combination with Fuji's TRAX software on their SMT equipment, provides fully integrated and complete traceability throughout the entire manufacturing process.

Each raw PCB is also marked with a unique bar code and, after every process step, automated or manual bar code readers send a confirmation to the SFDC system to confirm that the process step has been performed and completed. Any results from testing functions are logged in the system and the next process step is determined by the result. None of the process steps can be performed until the previous was successfully completed. During the final packaging stage, the history within the SFDC is re-verified to ensure non-conforming products are not shipped.

The PTS system works together with SFDC and determines the connection between the component part number, the SMT feeder ID, the particular machine position and the PCB bar code for full component traceability. This combination provides full component batch traceability.

The direction for electronic content within vehicles is clear. Complexity, diversity and miniaturization are set to increase at an unprecedented pace. For the manufacturer, only strict conformity and process control will ensure that products can be launched within ever tighter schedules, comply with strict regulations and adhere to the cost and quality requirements demanded by customers. ■