Discussion on Application of Intelligent Manufacturing Technology in SMT product assembly manufacturing system

De Jian ZHOU [1], Xiao Yong CHEN [2, 1,a]

[1]*School of Mechanical & Electrical Engineering, Guilin University of Electronic Technology, Guangxi Guilin 541004*
[2]*School of Mechanical Engineering, Xidian University, Shanxi Xi'an 710071*

Abstract. Intelligent manufacturing techniques has attracted much attention in SMT manufacturing system in recent years. A brief introduction to the basic idea of introducing intelligent manufacturing techniques to form SMT products intelligent manufacturing systems is described. Based on the analysis of SMT manufacturing system technical characteristics and problems, the basic composition and key technologies of SMT products intelligent manufacturing systems and technical system architecture are discussed.

1 INTRODUCTION

SMT (Surface Mount Technology) is the main technology of core component of modern electronics-PCB (Printed Circuit Board) circuit module assembly manufacturing. In SMT production line as the core component of SMT assembly manufacturing system (hereinafter referred to as SMT manufacturing system) is a typical modern electronic product manufacturing system, it's development influence and even determine the electronic product manufacturing ability. The research of SMT manufacturing system in our country started late. Such as SMT product assembly manufacturing process control technology, or assembly manufacturing system integration technology, has a large gap with foreign advanced technology. With modern electronics manufacturing automation and quality requirements for SMT manufacturing systems, some problems restricting SMT manufacturing technology are more and more highlighted. Based on the concept of intelligent manufacturing technology, combining with the characteristics of SMT products manufacturing, go on the research of SMT products intelligent manufacturing technology and intelligent manufacturing system, it is a breakthrough in SMT product manufacturing technology and it's manufacturing system development bottleneck.

2 SMT MANUFACTURING SYSTEM AND CHARACTERISTICS

2.1 SMT manufacturing system

SMT manufacturing system is mainly in the form of surface mount, including instrumentation mixed assembly forms such as PCB level electronic circuit assembly production system, the essence of surface mount circuit module (SMA) is workshop assembly manufacturing production systems for particular product. It has the characteristics of general assembly manufacturing system and production system, at the same time, the particularity of modern electronic products manufacturing system.

Figure 1. The basic composition of SMT

Its basic composition content is shown in figure 1 [1]. (1) People and the environment, system and equipment managers, operators, and the man-machine environment etc; (2) Computer hardware, software, main control computer and its peripheral equipment, operating systems, software, production management system software, etc; (3) Surface assembly production lines and equipment: solder paste printing machine, plastic welding (adhesive), SMC/SMD stick glue machine, reflow welding/curing furnace, etc. (4) Cleaning, testing equipment, cleaning machines, optical detector, needle bed type tester, flying probe tester, etc. (5) Auxiliary equipment: unload

[a] Xiao Yong CHEN:cxy160@gmail.com

machine, load machine, plate turnover machine, turning machine, transmission lines, SMC/SMD material library, and power-driven equipment, etc. (6) Others: SMT manufacturing system for surface mount and instrumentation mixed assembly product, its basic components in addition to the above content, the main content of the need to increase the wave crest welding equipment and automatic instrumentation equipment (or manual assembly line), etc.

There are many means of SMT manufacturing system, even correspond to the same type of SMT manufacturing system, according to the different requirements such as SMC/SMD type and quantity of assembly product, and the variety, quantity, quality and production efficiency of assembly product, also can have different equipment and system forms. With the change of forms, the biggest change of equipment adjustment is the core of system components, SMT production line, There are single - side assembly, double-sided assembly and other assembly methods, as well as single - line composition, two - line composition, etc.

2.2 The technical properties of SMT manufacturing system

The domestic using SMT manufacturing system have a certain level of computer integrated manufacturing and digital manufacturing technology foundation, especially as a core component of SMT production line, which has its relative independence in the system, is a self-contained computer integrated flexible manufacturing subsystem, already has had a high degree of digital manufacturing technology level. At the same time, compared with the general industrial product assembly manufacturing system, SMT manufacturing systems have some inherent characteristics, mainly in the following.

(1) System of complicated: Systems have a high degree of automation of SMT production line, and need to artificial auxiliary instrumentation or inspection, repair welding assembly line; In the production process is often embedded in the assembly line automatic up-down material and fully automated links such as automatic detection, and there was a need to artificial auxiliary antenatal preparation and semi-automatic link such as product testing at the end; The equipment of system both have high speed and high precision SMT machine automatic high-end CNC equipment, also have need of artificial auxiliary half automation equipment cleaning and inspection. System units of basic automation level, technology, and digital manufacturing with big difference, difficult to achieve overall computer integrated manufacturing system.

(2) Variety of products and their raw materials: SMT products consist of different specifications of PCB and electronic components, connectors, its breed type is quite rich. And the solder paste, flux used in assembly process have varieties of raw material types. Also, the raw materials dynamically change on different products and their technical requirements, most of them are with tiny body, complicated structure, various shapes, and electronic products material are easy to deform, oxidized and deteriorate, its storage, furnish and logistics management requirements are difficult.

(3) Factors influencing the product assembly quality complex: SMT has already developed to mount speed 150000 CPH (actual mount beat 0.024 seconds per point) of the high-speed assembly [2], device pin spacing of 0.3 mm limit spacing micro-package, solder joint density per square centimetre dozens or even hundreds of points of high density assembly, and lead-free welding technology stage. Many factors influence on the quality of product assembly and welding, assembly equipment running speed, accuracy and stability performance indicators, raw material quality status of electronic components, solder paste, flux and so on, as well as the production environment, temperature and humidity conditions, the stability of production power supply, resistance to electromagnetic interference will be a comprehensive impact on product assembly quality. The control process of product assembly quality is complex, and difficult to control in real time.

2.3 The main technical problems of the SMT manufacturing system

Due to the above characteristics, although the computer integrated automation level of SMT production lines has reached a considerable height up to now, there are some problems in the process of production, such as induction to the environment, lack of adaptive capacity, weak ability of product quality in real time measurement and control and low logistics control and management automation. For the whole of SMT manufacturing system, due to the influence of traits including the diversity of the system form and production mode, the diversity of the variety of product type and material, the complexity of process control parameters and information processing, its degree of automation and computer integrated level has obvious gap comparing to other advanced manufacturing system in the field of machinery manufacturing. The problems mainly displays in the following respects:

(1) Material management problems in SMT manufacturing system. The SMT products raw material types are rich. It is necessary to make automatic in material warehousing, sorting and distribution in order to make sure that it is in time, rapid, accurate and low cost. However, the model of the finding of product materials, storage and sorting are still behind. Most of them are performed by hand. Some problems such as high human cost, low efficiency, easy error, easily producing dull materials, large occupied space of stock, the waste of headroom, trouble of inventory, many customer stored materials and low customer satisfaction are universal in the process of material management.

(2) Quality control problems in the process of SMT production. The assembly of SMT products have high quality requirements, it mainly reflects in two aspects of the assembly precision and solder joint quality. In order to guarantee product quality, it needs to effectively adjust and control parameters of the assembly equipment in real time in the process of SMT production. In the current

control mode, in addition to the automatic adjustment function of optical detection counterpoint of SMT assembly device, setup and adjustment of critical process parameters including solder paste printing pressure and speed, welding temperature and PCB transmission speed mainly depends on the experience of technicians and technical level. Its control of the quality of the product process automatic control ability is weak. For assembly product quality problems occurring in the process of manufacturing, it basically relies on manual analysis to find the reasons but it can't real-time automatically detect the fault source and modify process parameters and it lacks scientific statistics analysis, optimization and the capacity of adaptive control of product quality.

(3) Perception and adaptive problems of SMT manufacturing environment and equipment working status. In the process of SMT production, some quality problems are caused due to some elements such as property changes of solder paste and glue etc. the oxidation of bonding pad, pins and other welding parts and dynamic changes of motion accuracy in key equipment's such as printing machine and SMT. These elements which belong to perception and the adaptive control problem of the manufacturing environment and working condition of equipment involved include air, humidity, temperature, power quality, and many other content. For the content, the current SMT manufacturing system also has certain standardization, standardization requirements but the monitoring of manual control which is based on the help of instrument, instrument testing. It cannot automatically perceive the dynamic changes of the manufacturing environment and working condition of equipment so that it cannot do the adaptive control and adjust accordingly.

(4) Comprehensive coordination problems in SMT manufacturing system. With the personalized development trend of electronic products, it requires rapid response ability, ability of cost adaption when producing many varieties and small batch production in SMT manufacturing system. To have these abilities, it involves the rapid response of the market, equipment and resources utilization, production process of high efficiency and high quality control, system management and comprehensive coordination, and many other factors, so it is a complicated system engineering. Current SMT manufacturing system in this ability is weak, the manufacturing process of the supply chain mode, load saturation, each manufacturing unit load balance scheduling and the coordinated ability with the market and so on still restrict the improvement of manufacturing efficiency ,so that it cannot furthest meet market and customers' needs of fast response, low cost manufacturing. Improving the comprehensive coordination of SMT manufacturing system and reducing the production cycle and the manufacturing cost are important tasks to SMT products manufacturing enterprises.

Based on the existing technology in SMT manufacturing, using the concept of intelligent manufacturing technology and its related technology to establish an efficient, reasonable, agile and resource sharing new mode of SMT intelligent manufacturing is an effective way of breaking through the problem and promoting SMT manufacturing ability and level.

3 SMT intelligent manufacturing system and its key technologies

3.1 SMT intelligent manufacturing system

Intelligent manufacturing is merged by manufacturing technology, digital technology, intelligent technology and a new generation of information technology. It is a manufacturing model for the whole lifecycle of products, which has the function of information awareness, optimizing decision and execution control and is aimed to manufacture products and service users efficiently, high-quality, cleanly and safely. Intelligent manufacturing includes intelligent manufacturing technology, intelligent manufacture equipment, intelligent manufacturing system and intelligent manufacturing service, etc. It derives from a variety of intelligent manufacturing products. Figure 2 provides a system of intelligent manufacturing technology and application [3].

SMT intelligent manufacturing system is an intelligent manufacturing system of electronic products, which is formed in the process of application in SMT intelligent manufacturing system, and designs SMT products as a particular object. It is a new kind of SMT product manufacturing system which is based on the basis of SMT intelligent manufacturing system, digital manufacturing technology and computer integrated manufacturing technology, etc. It is the result that the traditional electronic products manufacturing technology, the artificial intelligence science and the computer technology integrates with science, the network technology and the information management technology. Meanwhile it integrates into the production environment perception and self-adaption, intelligent production quality test and control, intelligent storage and allocating the material system and internal and external intelligent coordination and collaboration in the system.

SMT intelligent manufacturing system is the general term that finishes all production activities in the period of the whole lifecycle in SMT product digital manufacturing. It is a process of digital manufacturing, which is for the purpose of customer demand, by means of objective material means and uses intelligent manufacturing technology, and using an effective method which has the intelligent manufacturing technology characteristic to make products transform from conceptual design into final material products and put them on the market. It includes a series of interconnected activities within the whole lifecycle of products such as market research and forecasting, product design, process design, production and processing, quality assurance, production process management, marketing and after-sale. It has the common technology in a general intelligent manufacturing system. Its basic technical system and application can be seen in figure 2, and the main supporting technical system can be seen in figure 3.

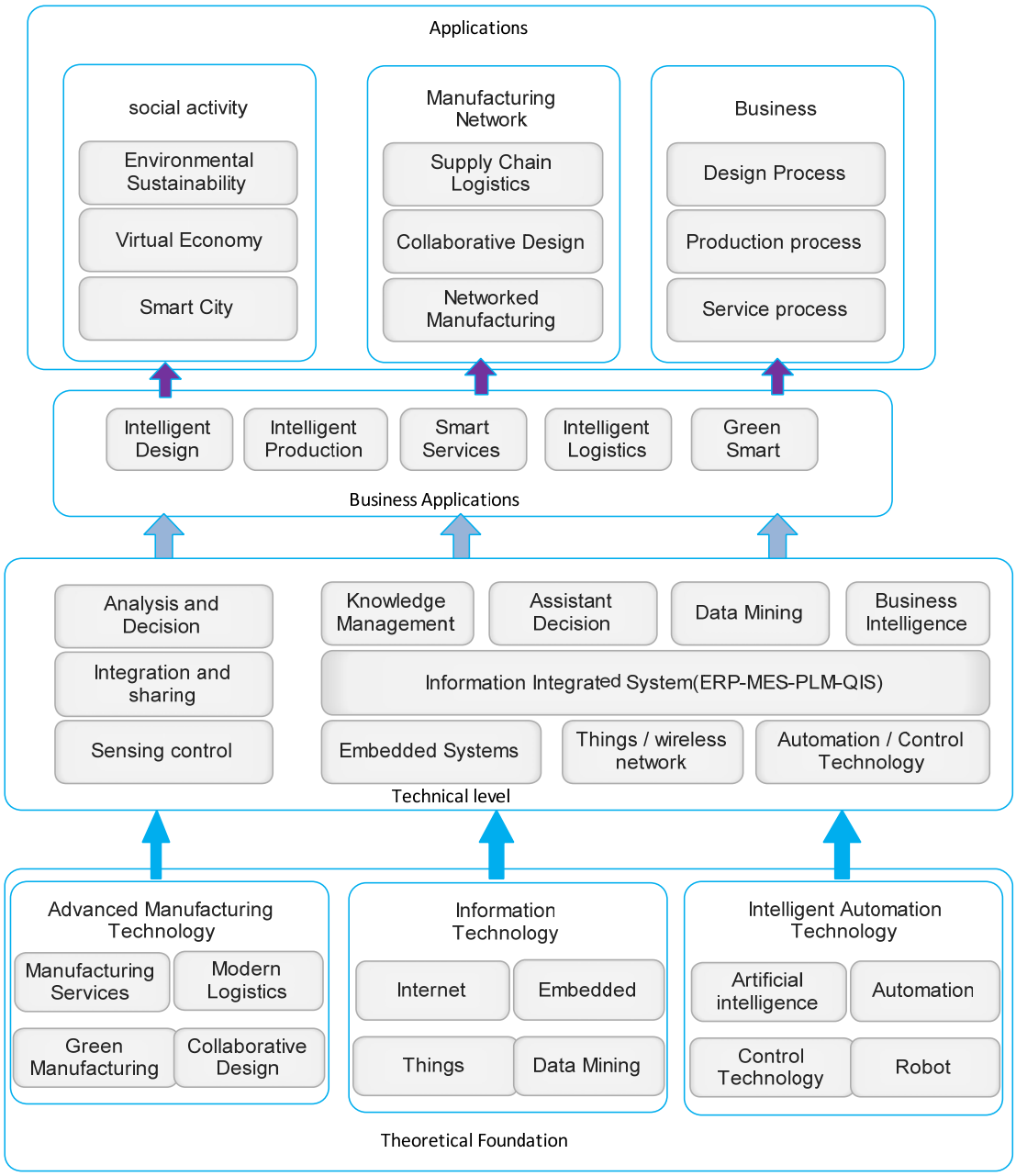

Figure 2. Intelligent Manufacturing System and Application of Technology

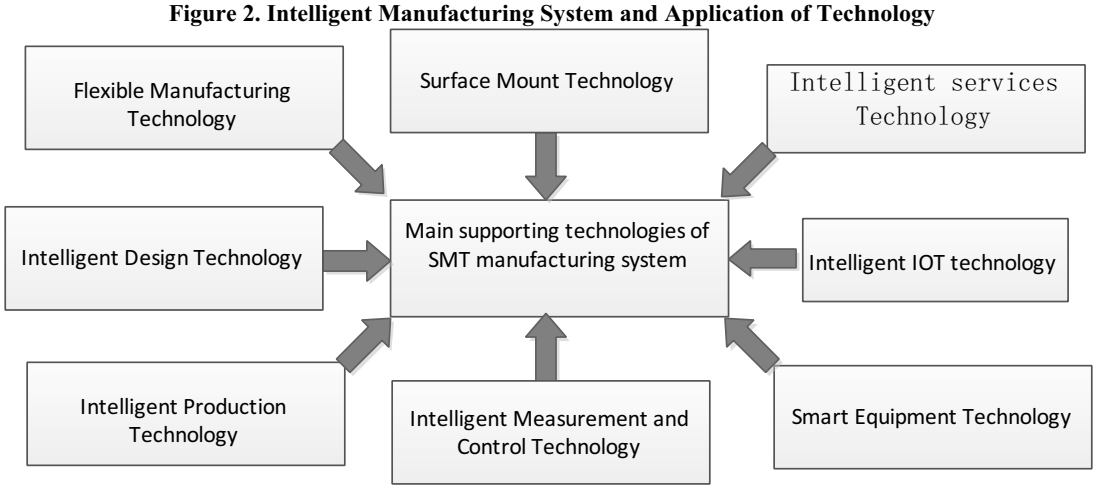

Figure 3. The Supporting technologies of **SMT Intelligent Manufacturing Systems**

3.2 The Key Techniques of SMT Intelligent Manufacturing System

The key technologies of SMT intelligent manufacturing systems required research priorities include the following aspects.

(1) Smart warehousing and distribution technology of SMT product material system. SMT Smart Material storage system is a kind Smart system with high integration of information technology and automation and control technology, and deeply optimizing on existing materials warehouse management mode of SMT industry. The intelligent material storage technology, SMT material access and sorting technology based on intelligent warehouse, stereoscopic warehouse and space storage technology required studied. It is based on network technology, radio frequency identification (RFID) and smart storage system, First of all, realize the intelligent storage of SMT product materials, then realize AutoFilter qualified materials according to SMT product BOM table with intelligent manipulator, after that study how to achieve SMT automatic load and unload materials by intelligent material handling device, and finally achieve market docking logistics management.

(2) SMT product assembly quality automatic detection and intelligent identification technology. In the SMT product manufacturing process, it generally relies on online test and complementally on manual inspection after critical process for assembling quality testing and statistical analysis. This traditional back-end process detection, measurement and control method of statistical analysis is difficult to form real-time quality feedback information, to achieve real-time quality control and adapt to modern electronic product variety, variable-batch, high reliability production requirements. The application of intelligent technology and SMT production process intelligence detection and real-time quality control technology based on optical or magnetic detection technology, so as to realized automatic real-time detection of product quality, intelligence analysis and production process data real-time control.

(3) IntelliSense and adaptive technology of SMT manufacturing environment. In the process of Micro-assembly and fine pitch assembly of the SMT product, which are sensitive to production environment, required to have the adaptive adjustment ability. IntelliSense and adaptive technology of SMT manufacturing environment means that the production environmental quality of SMT manufacturing system can be with real-time detection, analysis and automatic adjustment by use of sensor technology and intelligent control technology, for eliminating the dynamic changes of factors affecting the quality of products and ensuring the production environment stability in good condition, so as to ensure the stability of product quality. Research on this aspects, the first thing is to solve IntelliSense and self-adaption issue of climate change in manufacturing systems caused by external factors, and then gradual in-depth study the IntelliSense real-time and self-adaption problems on dynamic changes of the key equipment's system performance. Thereby, realize self-diagnosis and adaptive control in the manufacturing system's environment and production equipment.

(4) Research on Comprehensive information management system of SMT products intelligent manufacturing based on the Internet of things (IOT). Due to the lack of effective means information exchange means between management and automation of the production in traditional manufacturing workshop, poor control of the production process, some defects of efficiency and real-time in artificial data acquisition, so it has been difficult to meet the needs of intelligent information management systems. Therefore, means of data collection such as sensor, auto identification are necessary in enhancing the defects of advanced data capture tools and management systems should be applied in workshop to improve the disadvantage above, in order to achieve intelligent manufacturing informatization and modern management.

4 Conclusion

SMT manufacturing system is a complex manufacturing system with electronic product manufacturing characteristics, and there are many contents need special study in the process of technology advances towards system integration, digital manufacturing, intelligent manufacturing, which the investigative content discussed and the proposed in this article is just one part. There are many technical issues urgently to be solved for SMT Product Manufacturing. It needs the colleagues in the industry to work together. Meanwhile, the operation of intelligent manufacturing technology in the SMT manufacturing systems should also be scientific planning, step by step, gradually deepened based on the basic conditions of specific circumstances, integrated manufacturing and digital manufacture in corporation's existing manufacturing system.

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