

# Press Release

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## **Gain new insights through reviewing the past: Enhance Temperature-Sensitive Manufacturing Productivity and Quality through Industrial Big Data and Artificial intelligence**

High-precision temperature control process is commonly applied to industrial manufacturing. To guarantee the quality of temperature-sensitive manufacturing, it often leverages veteran engineers' experiences by frequently adjusting configuration which also implies suspending running machines. Thanks to the support of Digital Economy Project from Ministry of Science and Technology (MOST) of Taiwan, the research team at Department of Computer Science, National Chiao Tung University (NCTU) developed "Industrial IoT Temperature Control Mechanism for Production Prediction" to collect Industrial Big Data and establish a real-time production monitoring & prediction system based on artificial intelligence (AI). With the system, the complicated manual process of thermal profiling and calibration could be significantly reduced. Moreover, the parameters of manufacturing process for new products could be estimated based on historical manufacturing records, and therefore the process from new production introduction (NPI) to stable and mass manufacturing would be accelerated.

The challenge of high-precision temperature control production is that production quality is greatly related to the precise regulated temperature and time on target product. However, only the temperature of heating device can be well controlled. The heating temperatures are often different from what the target products suffer. The rough temperature control of facilities and environment could result in the production degradation. To achieve stable production, veteran engineers must frequently observe the production behaviors and adjust the process parameters. It increases the load of both facilities and labors. Moreover, the mass NPI keep engineers occupied to optimize the process parameters for each new production because the procedure of NPI depends on trial and error before an available recipe obtained. To solve the issues, the research team of NCTU CS have been investing several years in temperature-sensitive production. With some critical IoT

sensors, the dynamic properties of process and environment in temperature-sensitive production can be captured. Thus, the real-time production monitoring & prediction system is created based on Industrial Big Data and AI. With the system, many complicated processes of manual profiling and calibration can be omitted while the quality of each product is monitored precisely. Furthermore, the process parameters of new product, which is never manufactured, can be easily estimated based on the past manufacturing records, and the mass manufacturing stage can be quickly achieved.

Take Printed Circuit Board Assembly (PCBA) for example, the diversity of electronic product brings strict production restrictions while the quality requirements are continuously increasing. It is difficult to design suitable recipe of manufacturing process quickly to achieve good production quality with complicated and various product properties. Surface Mount Technology (SMT) is a critical procedure for PCBA production and has been widely used. In SMT procedure, electronic components are placed on a Printed Circuit Board (PCB) that solder paste has been spread on. Then the board will pass through the reflow oven under high temperature for soldering to attach the electronic components to the board solidly, and the temperature control is the most critical point. Overheating could damage the electronic components and insufficient heating behaviors could result in solder defects. To guarantee the product quality, SMT engineers must design specific process parameters for each product and verify it on production line; therefore, the efficiency of SMT production is decreased.

In this project, "Industrial IoT Temperature Control Mechanism for Production Prediction" is applied on SMT production line to assist industry in enhancing process of electronic products, and three highlights should be pointed out.

First, Intelligent Sensing with Hybrid Models. Thermal sensors are installed in reflow oven to capture real-time temperature curves. Combining thermodynamic and machine learning models, temperature prediction model of particular PCBA could be created, and real-time temperature curves for each product would be estimated. Different from the conventional approach, where only one sample board are recorded with frequently manual profiling, the proposed system could achieve 100% production history tracking based on real-time sensing and monitoring.

Second, Industrial Big Data Analysis. Repeated production trials and adjustments are required for introducing entire new PCBA and cost considerable time and money. With the proposed system, the massive data from IoT devices and industrial process of manufacturing can be efficiently collect for further analysis

via machine learning. The PCBA designs and reflow soldering process are studied; therefore, the process parameters of new PCBA product could be easily recommended and enter to mass manufacturing stage quickly.

Third, Real Field Application Driven. In this project, the research team closely collaborates with Advantech Co., Ltd. to study real manufacturing processes in depth and obtain firsthand data. The SMT production lines for PCBA mass manufacturing are selected for applying the proposed technology. The system and the sensors are deployed without affecting the regular production, and the system is continuously enhanced and verified with real-time production data. The real issues are immediately solved in this process; therefore, the system can be quickly duplicated to all production lines while the accuracy and efficiency has been verified. It brings instant and significant benefit.

Under the collaboration with four companies in this project, the real-time reflow production monitoring & prediction system has been created successfully based on the massive field data. The system has been introduced into more than 100 production lines, 7 factories around the world, and the overall benefit could exceed NTD 50M. For spreading novel industrial AI applications, several topics should be well studied, i.e., integration of heterogeneous facilities and fields, rapid creation and deployment of AI models, continuous enhancement and maintenance of AI models. The research team aggressively collaborate with Advantech Co., Ltd. to leverage its WISE-PaaS, which is a cloud platform for accelerating industrial AI applications. The proposed "Industrial IoT Temperature Control Mechanism for Production Prediction" would go on the market as WISE-Marketplace APP for promotion. We are looking forward to promoting the upgrade of temperature-sensitive manufacturing and raising industry benefit.

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