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Intelligent Yield Management System

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Product yield directly affects production cost. Thus manufacturers seek to quickly enhance product yield during the development and mass-production processes. In other words, when a yield loss occurs, the root causes should be found rapidly in both the development and mass-production phases.

To solve the difficulties the industries encounter in yield management, a scheme of high-dimensional Key-variable Search Algorithms (KSA) is proposed here as shown in Figure 1.

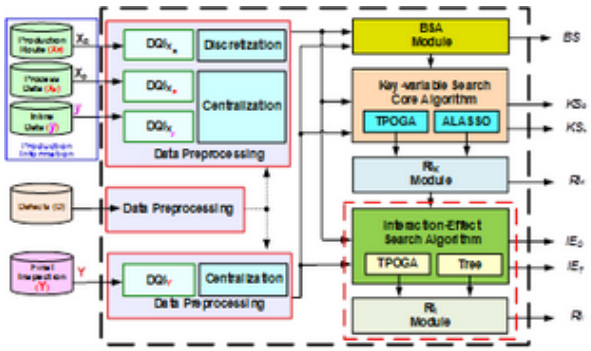

Fig. 1 Key-variable search algorithms.

The KSA scheme contains 5 modules:

- **Data-Preprocessing Module**: includes data quality checks, data discretization, and data centralization.
- **KSA Core Algorithms Module**: includes algorithms such as Triple Phase Orthogonal Greedy Algorithm (TPOGA) and Automated Least Absolute Shrinkage and Selection Operator (ALASSO) to analyze the key stages.
- **Interaction-Effect Search Algorithm (IESA Module)**: TPOGA and Tree are used to find out the interaction tools and parameters so as to set the parameter specifications for continuous yield improvement.
- **Blind Stage Algorithm (BSA Module)**: assists the three KSA algorithms to find out the possible key-stage devices affecting the final yield that might be missed out due to certain production limits.
- **RIK Module**: generates a Reliance Index (RI) through comparing TPOGA and ALASSO results to show users the reliance level of the key-variable search results.

Compare the results with expert experience and complete blind search and verify them with the actual bumping process data; the results are shown in Figure 2. It can be referred that the first two suspicious machines (tools) are consistent; and the Top 1 suspicious tool is quite remarkable as seen from its box-plot. After confirming with the engineers, the machine (tool) is indeed the root cause.

Fig.2 Experiment results (bumping process) comparison between expert experience and blind search

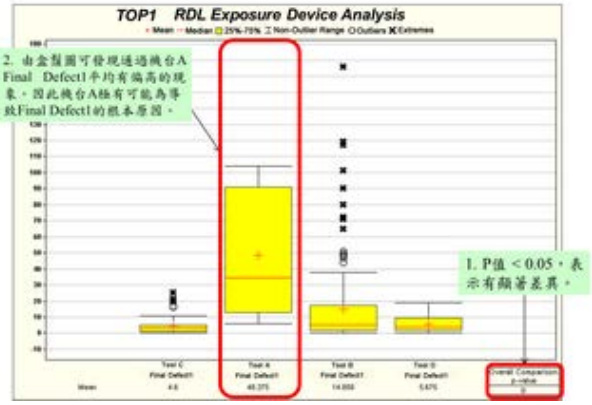

Fig.3 Top1 RDL exposure process device analysis

The verification not only indicates the accuracy of the KSA scheme but also implies the fact that the KSA scheme can still provide good results for blind search to serve as the reference of yield abnormality analysis, regardless whether the users have expert knowledge for a certain process or not.

On the other hand, many factors could affect the product yield, such as: transit information of WIP, processing conditions, and measurement between stages, etc. The data amount would be quite large if all these information for yield analysis are collected. Therefore, an intact information platform is required. Our team has proposed an Advanced Manufacturing Cloud of Things (AMCoT) based on IoT (Internet of Things), CC (cloud computing), BDA (big data analytics), and CPS (cyber-physical systems) to realize a high vertically-integrated smart manufacturing system, as shown in Figure 4.

The intelligent yield management system based on AMCoT captures the required data through the application of the Internet of Things via CPA; manages the data on a large number of production lines through BDA; and deploys the KSA scheme smoothly with cyber-physical technologies. In this way, the intelligent yield management system can be applied to the industries to achieve the goals of yield improvement and search-time reduction.

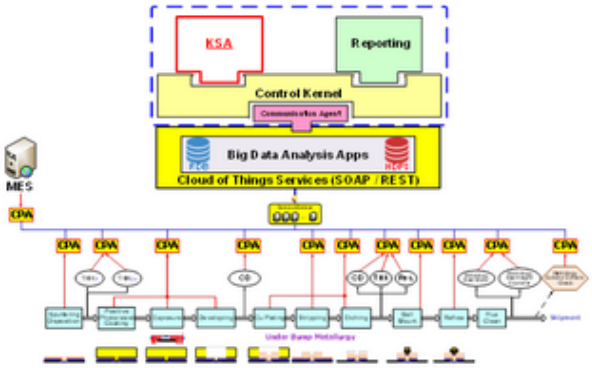

Fig. 4 The intelligent yield management system based on the AMCoT

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