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Using Web Service Middleware to Smart Smart Multi-Test System in CMOS Image Sensing Devices

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Abstract. The current CMOS image sensor industry has lots of challenges including product life cycle shortening, manufacturing cycle shortening, strategically vertical integrated operation and precisely quality. There are lots of difficulties in customized test system including duplicated function develop, less flexible, and hard to integrate heterogeneous systems. Currently, collect the test data in the test system is easy to make mistakes and causes the poor quality control. In this research, I have designed a web service middleware of software component structure and XML data structure to collect, integrate, and manage device test data. It provides an extendable, flexible, standardized and reusable web service middleware component test software platform. To use this software platform build a CMOS image sensor Smart Multi-Test System, then to integrate MES system, provide functions of automatic collect test process data, automatic hold and release process lot which has abnormal quality. It provide database and file system handling service, XML data format translate handling service, basic data maintain service, test result translate service, quality of production control service and abnormal event handling service. The result of this research, it automatically collects process data to save data entering time and prevent the making mistake in operation, and improve efficiency of operator operation. It also provides a quality control mechanism to improve efficiency including the quality of product and the inspection quality up to 95percent. And it makes the more flexible producing and save 75 percent of the new equipment data format develop time.

Keywords: Smart Multi-Test System, Web service middleware, Metal-Oxide Semiconductor (CMOS), Extensible Markup Language (XML)

1 Introduction

In recent years, the application scope of image sensor component has become more broaden than ever, and among the development technologies of image sensor component, the CCD (Charged Coupled Device) and CMOS were drew much attention than others. Compared with CCD, the CMOS image sensor component had the defects of lower resolution and higher noise, but it also possessed the

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advantages of low power consumption, small volume, lower price and high integrity; therefore, the trend of using low-price CMOS technology to replace the CCD technology that has gradually developed in the current market.[1-4]

U.S., Korea and Taiwan have become the major R&D and manufacturing bases of CMOS image sensor in recent years. They have the advantage of mass production competence for the process technology in wafer foundry; therefore, striving to integrate with R&D, business model, logistics system and total manufacturing is the main orientation of developing the CMOS image sensor industry.

In the component test process, most component test equipment providers have only conducted the software development for certain equipment and machine, and lacked for conducting the integrated planning of integrating computer and manufacturing system; Flexible manufacturing systems are not easy to control and it is difficult to generate controlling systems for this problem domain. Flexible job-shop scheduling problem (FJSP) is one of the instances in this domain. It is a problem which acquires the job-shop scheduling problems (JSP). FJSP has additional routing sub-problem in addition to JSP. In routing sub-problem each task is assigned to a machine out of a set of capable machines. In scheduling sub-problem, the sequence of assigned operations is obtained while optimizing the objective function(s). In this work an object-oriented (OO) approach with simulated annealing algorithm is used to simulate multi-objective FJSP. Solution approaches provided in the literature generally use two-string encoding scheme to represent this problem. However, OO analysis, design and programming methodology helps to present this problem on a single encoding scheme effectively which result in a practical integration of the problem solution to manufacturing control systems where OO paradigm is frequently used. Three parameters are considered in this paper: maximum completion time, workload of the most loaded machine and total workload of all machines which are the benchmark used to show the propose system achieve effective result [1]. In addition, the standardization has been only limited to the machine agreement but the application software; as a result, it existed these following problems: repeatedly developed functions, small flexibility, difficulty in integrating the heterogeneous system and conducting the system maintenance. In the process of accomplishing the total manufacturing, how to adopt technology to replace labor and effectively improve the production efficiency and achieve the demand for the precise manufacturing quality, will be the critical issues that vertical integration manufacturers of the image sensor component industry shall be confronted seriously. Therefore, regarding the testing process, standardization, flexibilization and process automation to accomplish the computer integrated manufacturing solution for the total manufacturing, which has become more and more critical to improve the back-end OEM competitiveness for the color filter film /micro lens and module packaging and testing in the manufacturing process of CMOS image sensor component [2]. Paolo Bellagente [12], in this work, a solution to easily develop Android APPs handling remote sensors, even of different type and manufacturers, is employed in the context of a smart living application. The proposed approach is based on a framework that allows achieving an easy development system architecture, exploiting the Bluetooth technologies. First implementations focused on safety in a Smart City projects are discussed.

Currently, the semiconductor manufacturing industry has encountered these following challenges: the shortening of product life cycle and manufacturing cycle, strategic vertical integration operation, precise manufacturing service quality, the intensifying business cycle and the participation of inter-industry competitors [5-8].

In order to respond to such rigorous challenge, in recent years, the semiconductor manufacturing industry has planned two major improving strategies and trends for the total manufacturing:

1. Production automation for semiconductor manufacturing

Production automation can effectively increase the productivity for personnel, efficiency of machine equipment, the equipment utilization rate and prevent personal error and mistake to satisfy customers' demand for quality and the delivery time; therefore, the production automation is an inevitable trend for CMOS image sensor component manufacturing industry.

2. Integrated manufacturing-related computer systems to achieve production process automation

In order to enhance the production competitiveness, it is a consequential trend from the fixed production mode of the large amount in few styles to the flexible production mode of the small amount in diversified styles; thus, the cost of production management and the burden of manpower has relatively increased. Therefore, through integrating computer systems, the production process can be informationalized and the process can be automatized to slow down or mitigate the cost of production management [9-12].

Thus, for the semiconductor manufacturing industry, the CMOS image sensor component manufacturing industry is adopted the standardized semiconductor IC process as its manufacturing process to increase processing procedures for color filter film and micro lens; among which, it included many component testing procedures about optical and electrical characteristics. Complicated and varied testing procedures and big differences between equipment will easily cause the occurrence of error and mistake and the omission of quality control while manually collecting and entering the production data. Component test system with customized testing procedure and specific equipment will be existed the problems, such as the repeatedly developed function, small flexibility, difficult integration between heterogeneous systems and difficult maintenance.

As shown in previous researches, the application of web service middleware technology to the software component architecture has possessed these following advantages: repeated use, flexibilization, easy maintenance, lower cost and cross-platform; at the same time, it can also effectively dissolve the limitation of heterogeneous system integration [13-15].

Based on CMOS image sensor component manufacturing industry as an example, design and establish a web service middleware component test software platform and an XML standardization data structure, and practically lead them into use web service middleware to CMOS image sensor component and Smart Multi-Test System to collect, integrate and control different processes for the testing data and information of equipment's component. Manufacturing Execution System (MES) has made the production process to be automatized, and enhanced the information and flexible for component test process to resolve these aforesaid problems. Using web service middleware to CMOS image sensor component Smart Multi-Test System can be provided as a reference model for other semiconductor manufacturers or enterprises while they're promoting the establishment of related systems in order to shorten the time of system establishment and enhance the competitive advantage in the market.

This study is expected that in the designing and analyzing process of practically introducing the use of web service middleware to CMOS image sensor component in Smart Multi-Test system, that can achieve the following goals:

(1) To establish and introduce the use of web service middleware to CMOS image sensor component in Smart Multi-Test System to achieve the following goals, such as achieve shortened manufacturing cycle, vertical integration operation, and precise manufacturing quality.

(2) To integrate the manufacturing execution system; make production process to be automated; provide automatic collection of testing production data and automatic hold for the quality abnormality; release production lot mechanism; and solve the problem of manually collecting and entering the production data which may easily cause the occurrence of error and mistake and the omission of quality control.

(3) Practically use the web service middleware to establish the component test software platform to make enterprise logics to be component-based and standardized in order to solve following problems, such as the repeatedly developed function, small flexibility, difficult integration between heterogeneous systems and difficult maintenance.

(4) Through this practical research to design the web service middleware software component framework and XML data structure which can practically be compatible with the production application of CMOS image sensor component.

(5) Provide related industries, such as semiconductor, as a practical reference for the further introduction of the integrated common software platform and integration with production [16-20].

2 Literature Review

2.1 Web service Middleware

According to the architecture definition [21-22] of W3C, web service middleware provides a standardized operating method for the software that implemented among various platforms. Thus, it shall be regarded as a software system which is used to support the interactive operation among different machines in network. The basic principle of the software web service middleware component-based technology is just like the concept of component framework, its components have contained a pile of abstract data types and the systematized approaches which can be called by external program or component.

Thus, we can use a framework which is composed of various components, and through the mutual cooperation among those components to solve the problem of certain domain. In addition, a good framework can save item and cost for developing the application program due to it can concurrently save the time of design and the code programming. According to the induction of the framework that conducted by [12, 13], framework has the following advantages:

(1) Modularity: Framework can enhance the capability of modularity, which can make the practical details to be packaged in the interface. Any modularized design can improve the software quality and reduce the cost in the process of software development.

(2) Reusability: A sound and steady interface can increase the reusability for framework and allows programmers to make use of their previous good models to solve the same problem in order to avoid the interference with repeated design process while they are encountering the new design.

(3) Extensibility: A fine framework is able to allow us to design a system which possessed extensibility, and through the Hook method that can allow interface and behavior to be diversely combined in accordance with different demands.

(4) Inversion of control: High-level modules will not be depended on the low-level modules; however, all modules will depend the abstract.

2.2 Extensible Markup Language (XML)

Extensible Markup Language (XML) is a streamlined version of Standard Generalized Marup Language (SGML) which is officially issued by International Standards Organization (ISO) in 1986. Until 1998, U.S. World Wide Web Consortium (W3C) has officially announced the syntax standard of XML. The main purpose of the great efforts that W3C threw in to promote the XML was to provide different enterprises with a standard of information interchange under the electronic commercial environment. XML is very identical to the Hyper Text Markup Language (HTML), the only difference between them is that HTML is describing how to display contents, and XML is explaining the type of contents.

There are several middleware technologies available for the XML-based integration of heterogeneous data sources. On the perspective of XML-based middleware integrating heterogeneous data source or heterogeneous information, for example, the OPAL launched an Information Integration System, named YAT system, which aimed to realize the transformation from relation model and SGML to ODMG using Mediator/Wrapper middleware framework. This research was further funded by OPAL and AQUARELLE program, and continued to focus on the XML middleware-based information integration system, in which the researchers studied on wrapping and querying heterogeneous data through XML integration view, and brought out the corresponding algebraic system. XPERANTO [11], a middleware system, supports publishing object-relational data in the form of XML and query-based XML relational data view. Moreover, it was targeted at DTD schema. But it did not support the primary key constraint or the foreign key constraint description or the conversion of multi-table relation constraints. In [11], a middle-layer structure was proposed to integrate and query XML data sources.

2.3 Manufacturing Execution System (MES)

MES system as collect various real-time data from the production lines, after converted into the useful information, and then promptly transmitted it to the demanding units. All related production units can know well of the real-time information for product in every production phase, and to make product to be produced in the optimal mode from the assignment of work order to the completion of finished-product." In addition, MES system, in the process of the production for a product from the assignment of work order to the completion of finished-product, has played information messenger of the optimal production activity. In case of variation, through the real-time and accurate information, the criterion of production execution system, original working status, data reaction and feedback, it shall promptly make a response to reduce the production activities without added value in order to enhance the efficiency of production process. MES can improve the production conditions and make on-time shipping and delivery, inventory turnover rate, gross profit of production and the benefit of cash flow, MES has also provided a two-way production information flow between enterprise and supply chain. In terms of the entire information system, the direction of direction designing for this study is to provide other enterprises' information system with a real-time and accurate information to make them to develop the system.

2.4 CMOS Image Sensor Component Manufacturing Process

Like the eye of digital camera module, CMOS image sensor component is responsible to convert the image signal that original is light into the electrical image signal; thus, we can imagine that the image sensor component as the retina for a camera, when light projected to the image sensor, the polarized light can be yielded though certain lens and color filters, and focused and displayed in image sensor's pixel array, and then through the electroluminescent effect to produce digital signals on silicon component. Currently, Computer Information System (CIS) technology is the mainstream for the image sensor, and it has adopted the standard semiconductor integrated circuit process. The standard value chain of IC production is included the major activities, such as IC design, mask manufacturing, wafer manufacturing, packaging, testing and marketing. In addition, the value chain of CIS IC production has added the processing procedures that specifically provided for wafer back-end R/G/B color filter (CF) and On-Chip Microlenses (OCM) between wafer manufacturing and IC packaging as Fig. 1.

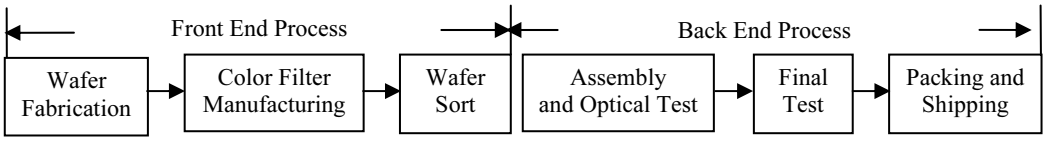

Fig. 1. Image Sensor Component Manufacturing Process

In the CIS production, the correlation between the final yield rate of the component system, which is from design, wafer manufacturing, the processing of CF/OCM manufacturing and packaging manufacturing, and each procedure's process is significant; thus, wafer manufacturers are able to understand and know well the integration with back-end process in order to solve the problem in yield rate and to take the lead in launching their product into the market to obtain the certification and adoption from system providers. Manufacturing process of CMOS image sensor component has five major processes, including the wafer manufacturing, color filter manufacturing, chip probing, packaging and the final testing, respectively. In general, the first three processes can be regarded as the front-end, and the last two processes can be called as the back-end process, as shown in the following diagram:

No matter what kind of CMOS image sensor component process, after every manufacturing or module assembling procedure, there are many component testing procedures that are used to classify the manufacturing results, convert files, cut and select, and control production quality; in addition, the testing items are included the component tests, such as image, appearance, electrical characteristics and optics [21-24].

3 Multi-Test System of CMOS Image Sensor Component

3.1 Operating Architecture for CMOS Image Sensor Component Test

The CMOS image sensor component test is a multi-test, which spread in all manufacturing processes for the image sensor component. In accordance with the explanation of process sequence, it will respectively test the wafer production process certification that executed by the wafer manufacturing process, and test the on-line parameters, which is used to monitor the problem in process and wafer-level reliability. Chip probing process is executed to test electrical characteristics of grains on the wafer in order to verify whether grains conform to the product specification, and adopted the classified result of electrical characteristics as the basis of selecting yield in the packaging process. There are testing procedures existed after every manufacturing procedure in the packaging process, which are used to classify the yield and defect grains, convert the testing results into files and cut those files to provide as the basis of selecting yield and controlling the production quality, in addition, the testing items are included the component tests, such as image, appearance, electrical characteristics and optics. The phase of the final testing is the final testing process before product entering the market, which including the component tests about the aging testing, appearance inspection, and function and optical testing.

In the operating architecture of CMOS image sensor component test, as shown in Fig. 2, PC controller is responsible to download the testing program and setting file, execute the testing program, control equipment, save the testing results, and shift and save the testing results. Interface (electronic interface) is

responsible to make conversion between digital and analog signals and play a role as the communication bridge between PC controller and testing equipment. Tester & Prober is the common term for the testing machine and probing equipment, and it is the equipment that mainly responsible for the actual component test; in general, the component test equipment will have different names of testing equipment in accordance with different testing items, such as electrical characteristics, optics, appearance, etc. File Server (raw data) is a file server to store the original data file and log files of the testing results. Commonly, it will integrate with computer integrated manufacturing system or MES as the source of collecting the production result data in the process procedures. File Server (Program) is used to store the product testing program and setting file; in general, it will be prepared by the product default setting in order to provide for downloading while testing the PC controller component, and the items that needed to be controlled and managed including the testing program of product equipment classification, the map of testing scope and setting file [25-32].

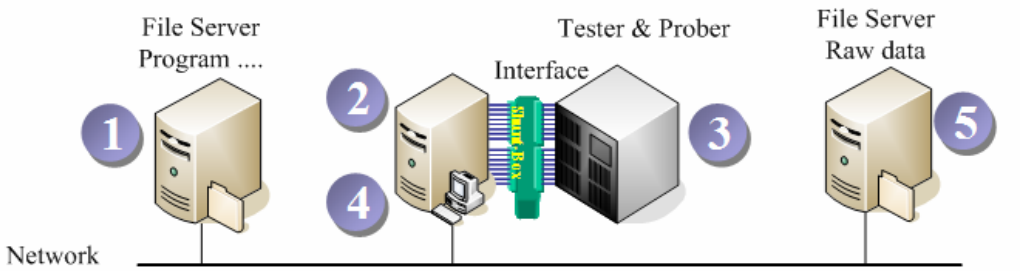

Fig. 2. Operating Architecture of Component Test

Tests of CMOS image sensor component are the multi-test which included image, appearance, electrical characteristics, and optics, their operating architectures are approximately identical to each other and the common operating procedures will be described as follows:

(1) Set the product basic data and setting file, such as Golden Map, which is also the map of testing scope when testing wafer. From the File server (Program) to obtain the testing program and its setting file for the executing component test, and store it into the area storage device of PC controller.

(2) Place the testing component into the testing equipment, check and prepare for testing. Through PC controller OI (Operation interface) to execute the testing program and setting that obtained from the previous procedure.

(3) Use PC controller through the electronic interface controlling and driving equipment to carry out the component test, and from each component test result to yield the Bin (classification) data and Log.

(4) Through the signal conversion to collect and compile the Bin (classification) data to form the testing result file and Log file, and then store into the HD storage device in the PC controller.

(5) For the original testing result files, set the auto FTP to transmit to File server (Raw Data) for backup process. Then use the machine checklist or the excel tool to analyze the Bin data of File server (Raw Data), operators shall compile and complete the Run Card, and then enter it to the Manufacturing Execution System. When compiling the classification data, if it discovered the product that not conformed to clients' specifications or the occurrence of abnormal data, then carry out the Hold production operation when executing the Manufacturing Execution System for such lot production. In addition, notify product engineers and wait for their analysis and handling, and coordinate with clients to determine whether accept, reject, discard such lot or continued execute the next production process or not. File server's (raw data) Bin data shall be provided for the next process as the basis of continuous production.3.2 Study on CMOS Image Sensor Component Multi-test Problem

CMOS image sensor component manufacturing process is adopted the standard semiconductor integrated circuit process with additional processing procedures for color filter film and micro lens. There are 5 major processes, including the wafer manufacturing, color filter manufacturing, chip probing, packaging and the final testing. Each process has various component testing processes that related to the optics and electrical characteristics. The difference between equipment is big, and the testing object can be wafer or grain. The testing items include: image, appearance, electrical characteristics, optics, etc. Same testing item may possibly have various testing procedures, and different products and machines shall use different testing programs. The file format of the component testing result may also be different, in the data between different processes and procedures, it shall be able to convert and interchange,

especially for vertical integration operating model. Since encountering such complicated multi-test, the exploration of related issues is an important subject for the production and manufacturing of CMOS image sensor component.

The issues of CMOS image sensor component multi-test are induced and explained as follows:

(1) Clients' demand in shortening the manufacturing cycle and the time of launching product into the market.

(2) Vertical Integration Operating Model: data shall be able to convert and interchange for different processing procedures or up/downstream.

(3) Precise Manufacturing Quality: clients demand that quality standards shall be effectively controlled.

(4) Manually collected and entered production data may easily cause error: the testing data that compiled and completed by the operating personnel, and then handled by excel VBA and manually entered to MES system that will be easily caused error.

(5) Easy Omission of Quality Control: it may easily cause the omission when manually inspect the specifications or manually enter in MES system in case of nonconforming to specifications to execute the Hold/Release production lot.

(6) Function has been repeatedly developed: same functions have been repeatedly developed for different machines and formats' thus its development cost is high.

(7) Small flexibility: developed for certain machine and cannot be repeatedly used. Thus, it needs to redevelop the additional machine, and its demand has become more difficult.

(8) Difficult to integrate heterogeneous system: the testing system and the production manufacturing system are the heterogenous system to each other, thus it will be difficult to integrate with not non-standardized data and procedure.

(9) Difficult to maintenance: developed for certain machine, the enclosed system is not easily to maintain

4 Design of Sensing Devices in Smart Multi-Test System

4.1 System Architecture

As shown in Fig. 3, the architecture diagram of using web service middleware to CMOS image sensor component Smart Multi-Test System is included the following hardware: the testing machine and equipment (Tester, Prober), File Server (Program Server), Database Server, application system server (AP Server), and area network (Network). Among which, the coding sequence will be the operating procedures of using web service middleware to CMOS image sensor component Smart Multi-Test System.

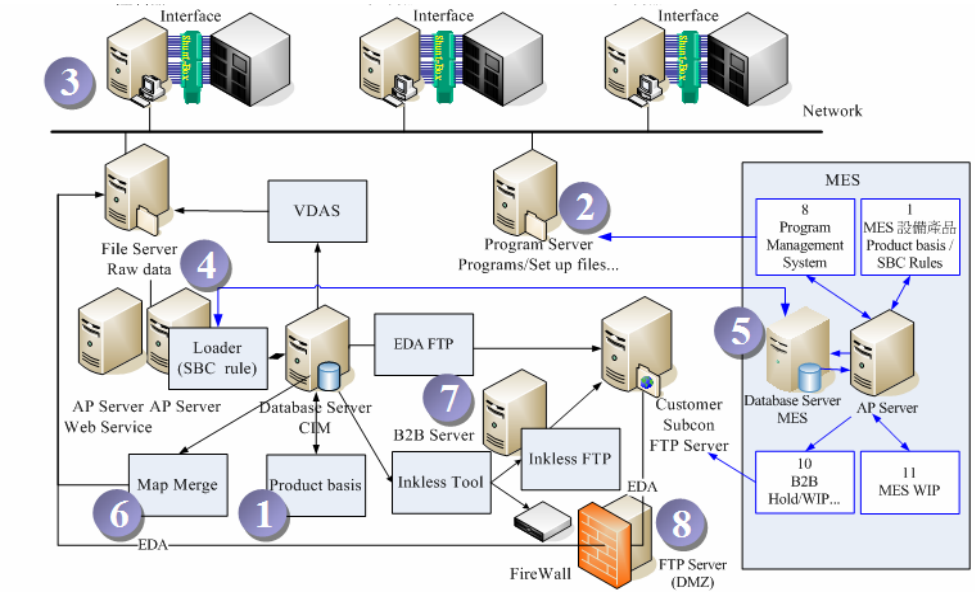

Fig. 3. System Architecture Diagram

The operating procedures of using web service middleware to CMOS image sensor component Smart Multi-Test System are described as follows:

(1) Set the product basic data and setting file, such as dolden map, as the testing scope for wafer.

(2) Download the testing program and setting file to area storage device in PC controller.

(3) PC controller executes the controlling for the testing program and drives the equipment to conduct the component test, and store the testing result into the File Server.

(4) Loader handles the conversion of the testing result file into the XML format to store in its database; at the same time, carry out the inspection of product specifications and handling of the abnormal event.

(5) Integrate the operating procedures, which included the auto collection of the testing result data and handling the abnormality that not conformed to quality specifications.

(6) In case of incomplete testing, use the map merge tool to combined the wafer overlapping with testing result.

(7) Operation of vertical integration will adopt the B2B method to give the production and logistics information to clients and downstream vendors.

(8) Handling the testing and logistic data by the way of electronic data that came from clients or the upstream vendors of the supply chain.

The major purpose of loader program is to dispose various testing results (optics, electrical characteristics, image appearance testing) for each phase of CMOS image sensor component; the combined result of wafer overlapping; and covert the files of grain visual check result into the standard XML format, and then store into the database; when shifting the storage and concurrently inspect the legality and validity for its data, and whether it conformed to product specifications; the abnormal dispose that responded to the occurrence of abnormality or any event that nonconfirm to product specifications; all abnormal messages and handling record that can be real-time shown in the management tools of the production line bulletin's Check list; and then integrate with MES procedure, such as the auto collection of the testing result data, and the handling procedure for the abnormality in quality specifications. Loader architecture, as shown in Fig. 4. Input means to input/ enter the product basic data; Loader means the files of setting file and component testing result; Process means to convert and store the Loader files and abnormal event handling; Output means to output the testing result, spam data files, back-up files and event messages.

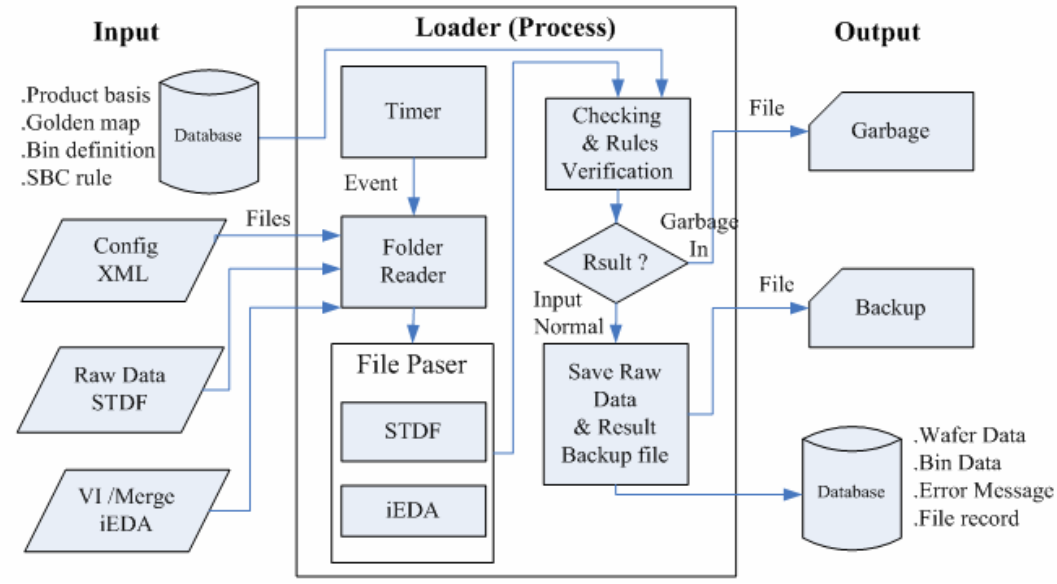

Fig. 4. Loader Architecture Diagram

Input data is contained the product basic data, testing scope, testing classification and classification definition, product testing program version, machinery equipment, product specifications, defect code, etc., its purpose is to provide the criteria for the data verification and the product specifications inspection. Loader is designed as possessing the balance workload competence, there can execute various Loader programs under a same host, and each Loader program can execute a same process or different works. Loader setting file is set as the balance multiple-access Loader which shall be responsible for executing

work, source and target file categories. When Loader starts to execute, Loader setting file shall be read, and its purpose is to give such Loader with responsible task and behavior. The component testing result file is included the Standard Test Data Format (STDF), EDA or other formats, EDA shall be used to merge the overlapping file for wafer, as for the testing result file and vertical integration operating interchange that yielded from visual check, and all test formats will be identical to the handling procedures within the Loader.

Process is the shifting storage of loader data file and abnormal event handling. In accordance with the contents of setting file, loader will automatically execute its responsible work, and it contained the regularly analyzing and handling test categories that triggered by a timer; the testing data is standardizationally shifted and stored into the database; verification of product quality specifications; handling of exceptional events; storing of the handling record; file backup; handling of spam data and integration with MES procedures. When the testing data is standardizationally shifted and stored into the database, it shall be concurrently verified the data legality and validity, and the product specifications SBC rules to hold the production lot when occurring abnormality.

Output is to output the testing result, which included the wafer data, classification data, error message and handing record and store into the database to be the basis of automatically collecting data, engineering analysis, and integration with abnormality handling procedure. In addition, move the file that successfully handled by loader to the backup category area, and move the abnormal data file to the spam area to regularly delete. The path of backup record and spam record shall be set on the setting file. For the error message and handling record, the handling status can be inquired from the management tools' check list of the check list bulletin board of production line.

4.2 Web Service Middleware Component Design

Design of web service middleware component framework is adopted the microsoft NET web service middleware architecture as the basis, as shown in Fig. 5, it divides into four major modules: Base frame, Data & XML, User interface and Web service:

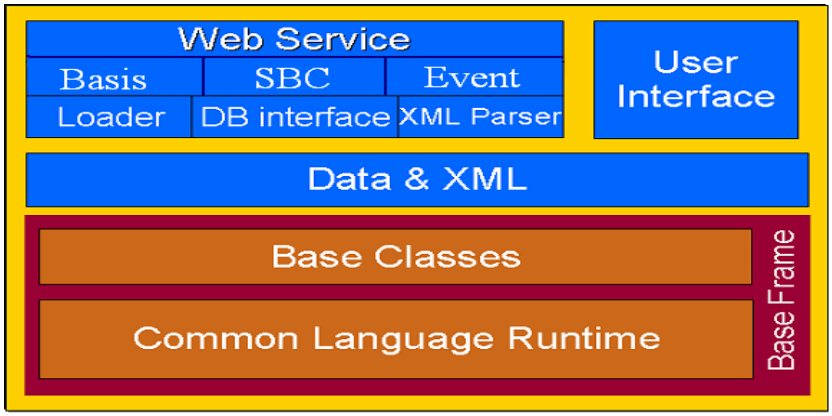

Fig. 5. Component Design Architecture for Web Service

(1) Base frame is the .Net framework which is a software platform with adopting the virtual system to operate, and will be based on the Common Language Runtime to support the development for various languages (C#, VB.NET, C++, Python, etc.). Its application program interface (API) has provided new function and developing tools that made Windows application software and network application software, as well as the component and service (web service) can be constructed and developed on it.

(2) Data & XML are the software and service, and also the interface data and message format that communicated with the operation of .Net framework.

(3) User interface is the user-operate interface for the application program, which it can be operated to use the application software function or directly request for the Web service.

(4) Web service middleware the basis of testing software platform's component service, which can component-based and service the enterprise logics.

web service middleware component test software platform will provide various hetergenous application programs with acquiring common component service from the Web service, and the

component service of such platform is contained 6 major parts, which are:

(1) Database and file processing service (DB Interface), including the file-opening and on-line handling for file, database, FTP and Email.

(2) XML format conversion handling service (XML Parder), including XML combination, disassembly, coercion, shift store database or shift storing the file service.

(3) Basic data maintenance (Basis), including the basic data new addition, revision, delete and inquiry for the multi-test system.

(4) Testing result conversion handling service (Loader), the Loader can handle related enterprise logics, including various data conversion handling, transmission handling, abnormality cause analyzing handling and report format handling.

(5) Production quality control service (SBC), including the basic data check and the service of quality specifications verification.

(6) Abnormal event handling service (Event), including the Hold production lot handling, Release production lot handling, Log record and warning message handling.from the management tools' Check list of the Check list bulletin board of production line

4.3 Abnormality Notification Mechanism Design

Using web service middleware to CMOS image sensor component multi-test system, when the loader program is analyzing the testing result file, it will request the component test software platform to provide the test data conversion handling service with converting the file into the standardized XML information, if the production lot needs to check its quality, then the system will request the software platform to carry out the service of quality verification, and the verification items will be mainly the internal product limitations and clients' product specifications. In case of discovering that the production lot is not conformed to the verification specifications and needs to hold such production lot, and then enter the product rules, where it has regulated the abnormal production lot Hold handling procedure, and its mechanism design is shown as Table 1.

Table 1. Hold Handling Procedure of Abnormal Production Lot

Loader	web service middleware	MES	staff	test software platform (background)	description
	↺				Loader discovered a certain lot is not conformed to the specifications and requested to hold such Lot
	→				Loader sent the Hold Message to the software platform record
		→			Background Program is regularly received data from the software platform, and according to such data to change the Lot's status to Hold
		←			Background Program return ACK to the software platform record
	←				Loader is regularly received data from the database, and completed the status change
			→		Background Program will notify the message of Hold Lot to related personnel for further handling

If loader discovered a certain lot has abnormality and needed to hold such lot, the loader will send the hold message to the software platform for record. Now, MES background program will be regularly received data from the software platform and based on such data to change MES system's status of lot into hold; that is such production lot is unable to continuously execute the next procedure. MES background program will recover Ack to the software platform record. When loader is receiving data, it means that it will receive such data and complete the changing status for the testing system. MES background program will then be notified the message of hold lot to related personnel.

After verified by engineering personnel and confirmed by clients, such Hold production lot can be regarded as releasing the limitation and can be carried out the next procedure, and then it will be handled by abnormal production lot Release procedure, and its mechanism design is shown as Table 2. Execute

the action of lot release on MES, please press on confirm to make confirmation. MES will send the release message to software platform for recoding. Then, MES will close the Release function. Loader will be regularly received release message from the software platform to change the lot status in the testing system to release, and release from the inspection notification for the using of Web service middleware to CMOS image sensor component multi-test system and write it into the log. Check list will be promptly showed the completion of abnormality handling. Loader returned ACK to the software platform record, which means it has confirmed for the receiving and handling. MES background Program will received ACK, if not, it will be determined that whether it needs to continuously send release message to software platform, till receiving Loader's ACK.

Table 2. Abnormal Production Lot Release Handling Procedure

Loader	Web service middleware	MES	test software platform (Background)	Description
				Execute Lot Release action on MES
				Confirmation
				Record of MES sending Release Message to software platform
				Close Release function
				Loader is regularly received Release Message from the software platform Release Message, and change the Lot status in the testing system to Release and write into Log, then Check list will be promptly displayed such Lot abnormal handling is completed
				Loader returned ACK to the software platform record that meant it has been received and under the process of handling
				MES Background Program has received this ACK; if not, it will determine whether it will continuously send the Release Message to software platform till receiving the Loader's ACK

4.4 System Integrated Interchange Message Design

The main purpose of the system integrated interchange is to achieve the production procedure integration between CMOS image sensor component multi-test system and Manufacturing Execution System, which will be the collection and integration of testing data, the handling procedure for abnormal production lot Hold, the handling procedure for abnormal production lot Release, etc. The interchange method will be applied system through requesting web service middleware to achieve the component test software platform service, and the design of interchange message will be based on the aforesaid procedure integration, as shown in the following Table. Message items will be the procedure for handling the abnormal production lot Hold, and Release Message handling abnormal production lot Hold. In addition, the BIN Data Message is the collected and integrated message for the testing data, and its transmission format will be XML.

5 System Implementation and Performance Analysis

The using of web service middleware to CMOS image sensor component multi-test system that established by system practice and analysis, which applied the database and file processing service, XML format conversion handling service, basic data maintenance, Loader testing result conversion handling service, production quality control service and abnormal event handling service that provided by the web service middleware component test software platform, to collect the production information and integrate MES system to achieve the automation of collecting the testing production data and quality abnormal automatic controlling production lot mechanism in order to solve the related problems that yielded from

the customized testing system and manual collection and entering the testing data. As for the following text, it will start to introduce the system environment, practical exhibition and efficiency analysis.

5.1 System Environment

The component test software platform for web service middleware is based on web service middleware architecture to develop, the web service middleware is executed in Windows, Base frame is the .Net framework which is a software platform with adopting the virtual system to operate, and will be based on the Common Language Runtime; and the component test software platform for web service middleware is developed by the program language.

The using of web service middleware to CMOS image sensor component multi-test system is developed by VB .Net. If users want to execute the system operation, it shall install .Net framework first, and in Microsoft Windows operation system to execute; in addition, adopted Windows Network and virtual disc to link the execution files, and the function limits and authorities shall be applied to setup in advance.

Loader program's execution environment is identical to the operating interfaces or tools that adopted by other users in the using of web service middleware to CMOS image sensor component multi-test system, and they will be developed by VB .Net. Since a same host can be concurrently opened various loaders, made the loading balance, handling different testing procedures of component test data and handling abnormal quality event; therefore, it shall set Loader setting file before executing; among which, it is included the testing of data source pathway, backup pathway and spam collection pathway and executable behavior, etc.

System database is adopted Oracle Database to operate in the Linux operation system platform. Manufacturing Execution System and its background program are a 3-Tire architecture, which developed by Java program language; Web AP platform is used the Approach server to make users to execute the system function just through IE. Background program will be set to be auto execution by the default command.

5.2 System Environment

The main purpose of Loader is to convert various testing result, combined result and the result file of grain visual check from each process of the CMOS image sensor component into the standard XML format, store into database, and check its data legality, validity and SBC rules; in addition, if there's any abnormality or non-conformed specification, it shall make promptly respondent abnormality handling. After successfully handled files that shall be moved to the backup area, the abnormal data file will be moved to the spam area and shall be regularly deleted. The setting screen is shown as Fig. 8.

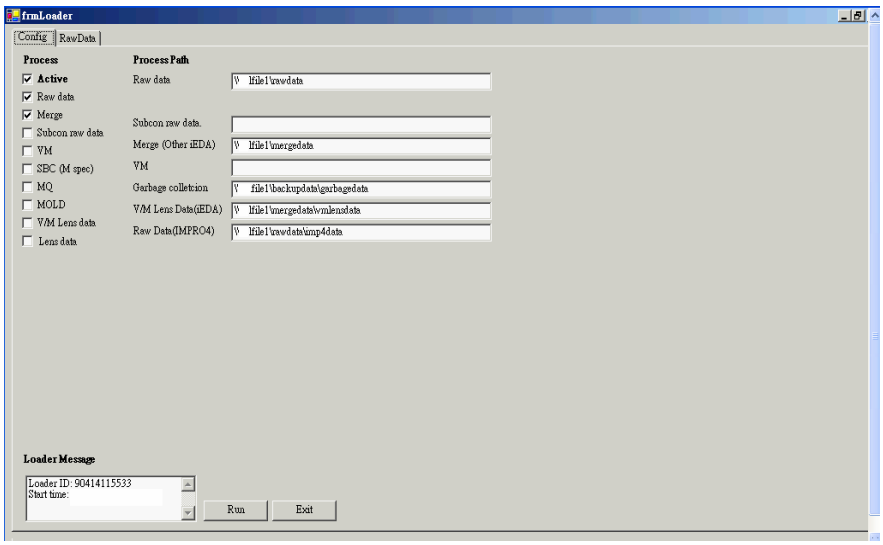

Fig. 8. Loader Setting screen

Since Loader is designed as possessing the balance workload competence, there can execute various Loader programs under a same host, and each Loader program can execute a same process or different works. Use mouse to select the process column on the Loader screen, and it shall be multiple choices and can be set as auto storing. Loader will be executed its responsible works according to its setting.

The abnormal error message for loader data, the on-line operating personnel can monitor the handling status form the management bulletin board for the check list production line. Map merge wafer overlapping and combining tools operating screen, as shown in Fig. 9. The same production lot, the carved number and procedure production have occurred in not completed or partial testing, then it can make use of the Map Merge function to overlap and combine the all parts with the same carved number, after combined, submit the combined testing result to the Loader for handling, and inspect the specifications result, and then the abnormal results will be logon to Check List to wait for dispose.

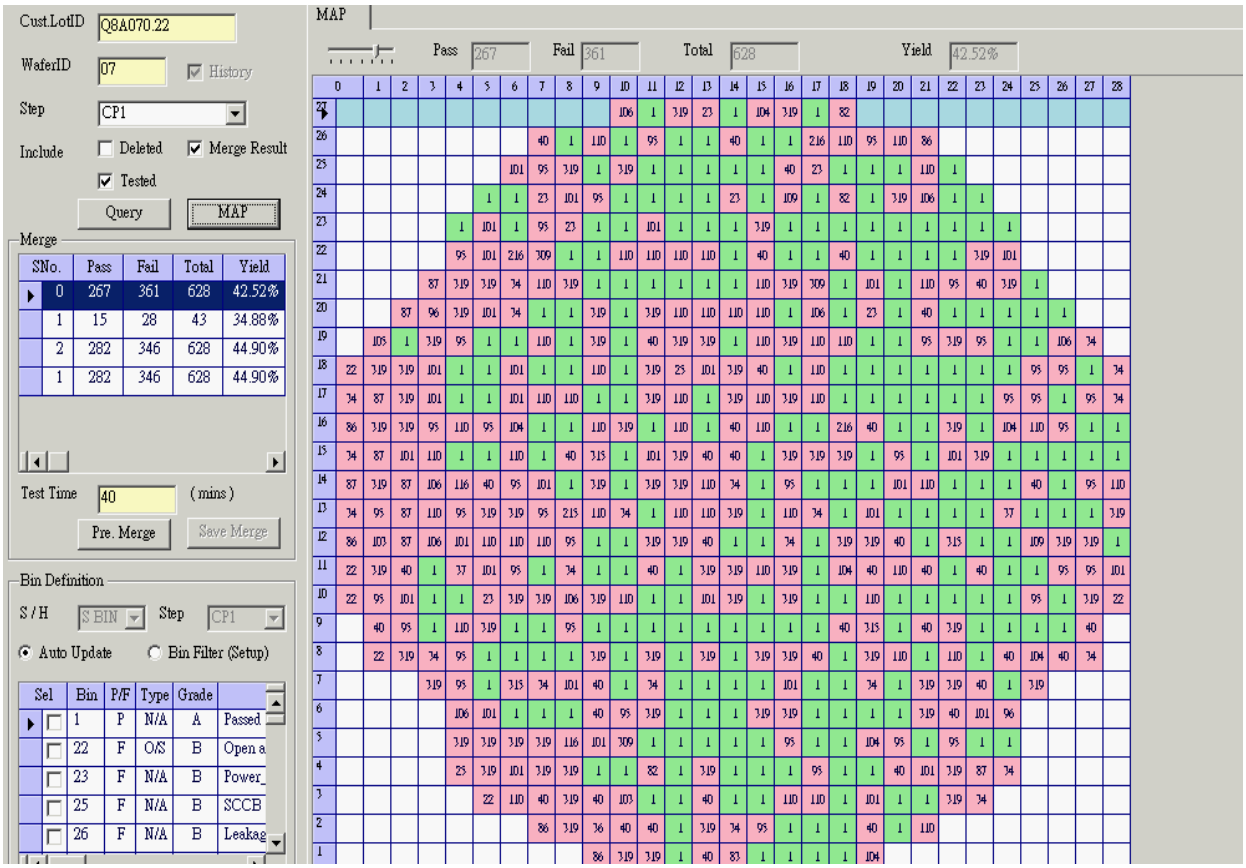

Fig. 9. Operating Screen of Map Merge

Description of Operating Screen: The data inside the Merge frame will be categorized as the same production lot, carved number and partial test. Use mouse to press the key/ button to select any number/ digit of data and then press Pre Merge to simulate the combination process, and display the Map and yield rate of the wafer overlapping after combined, and then store such data after confirmed. It also can selected the total testing data as the bottom Fig. and then combined with the partial testing result and display in the form of wafer overlapping and to show the Map and yielded rate after combined, and then store such data after confirmed. However, no matter what kind of combination it adopted, the combined result shall be submitted to Loader for further handling, inspecting quality specifications, and then the abnormal results will be logon to Check List of the production line bulletin board to wait for handling.

MES track-out posting screen as shown in Fig. 10, its main purpose is a posting screen which used to enter the production information (testing result) into the record of Manufacturing Execution System for production line operating personnel with completing the testing procedures.

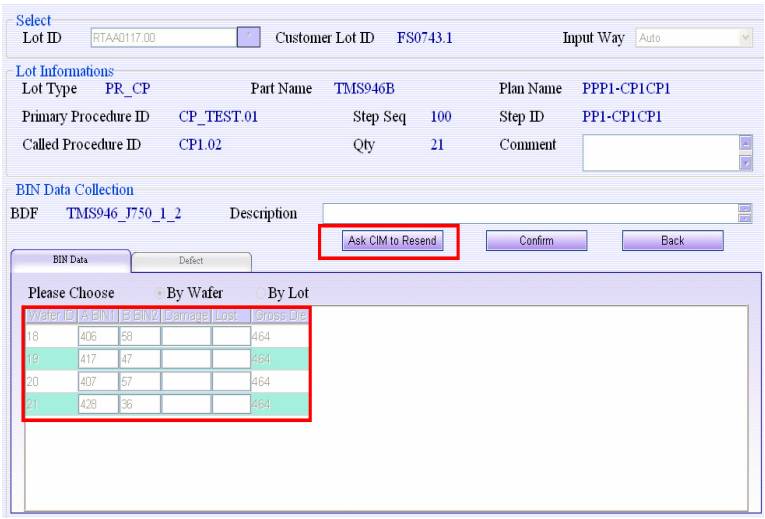

Fig. 10. Track-out Posing Screen of MES

When the content of Input Way filed is Auto, it meant that the data collection of such production procedure shall be manually entered by operating personnel, and it shall use the web service middleware to CMOS image sensor multi-test system from the original data of the equipment testing result to convert and automatically convert to Manufacturing Execution System. Data that signed on BIN Data is the Loader of multi-test system that converted into the testing result data. When setting the product process for Input Way, the procedures are setting and determined in advance. If the setting is conducted by manual, then it can be automatically collected or manually entered.

Commonly, the using of web service middleware to CMOS image sensor multi-test system will handle the original data f the equipment testing result first, then convert and automatically convert to Manufacturing Execution System; however, when the Loader of the multi-test system cannot be promptly transmitted the data or it needs to be resent to the testing data, then it can make use of Ask CIM to press the Resend to request system to transmit the latest update of testing result data. The transmitted testing result data is included the production lot data, wafer carved data, Bin data, Defect data and abnormal events.

5.3 Benefit and Performance Analysis

The using of web service middleware to CMOS image sensor component multi-test system has already launched.

Its quantitative benefits are described as follows:

(1) As for the collection of testing data, it can be logged on from the excel handling to the system, the file of component testing result through the Loader handling to the MES system, such as Fig. 11, the statistic data has been conducted from last August to December 2018, converted 2475 Lots in total, and the converting time of one Lot has reduced from 750 seconds averagely to 50 second with improving about 93% efficiency.

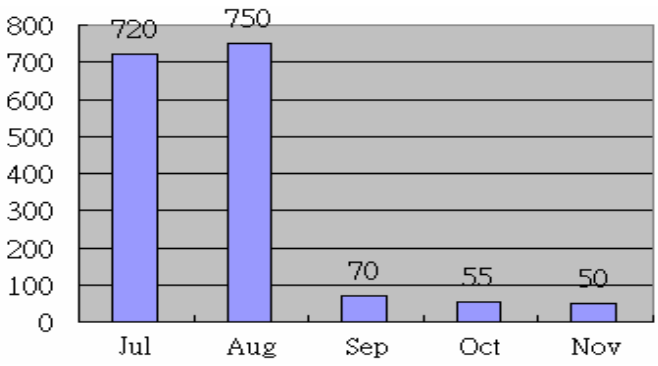

Fig. 11. Diagram of Testing Data Collection and Converting Trend

(2) As for the quality control, before intruding the system, it needs to manually calculate and verify the client's demand for specifications. Before introducing, the time formula of checking a Lot is:

Lot Quality Inspection Time = Number of Quality Inspection Formula *Manual Calculation Time According to the calculation of formula, 50 times 24 seconds, thus it will take about 1200 seconds to check a lot of products. After introducing to system, when the data is converting, it will concurrently provide quality inspection and control mechanism; that is, it will calculate the Loader handling for a lot, and added about 50 seconds into the averagely check time of one lot products in order to improve the efficiency of quality inspection for 95%.

(3) As for the developing time, before introducing the system, when the testing program is revised its version or newly added machine format, it needs to take about 2 days to modify the related and customized Excel tools, which including the accessing file, analyzing file, testing classification and calculation, output format handling, etc. After introduced the system, it only needs to take about 0.5 day to modify the file conversion module for the Loader program. The developing time is reduced about 75%, which can be effectively increased the flexibility and improved the new speed of mass-production.

The Table 3 means that before and after using of web service middleware to CMOS image sensor component multi-test system, the benefit comparison among these following items: data collection, quality control, using technology, developing time, using object and integration scope.

Table 3. Benefit Comparison Before and After of Web Service middleware

Items	Before the system	After use web service middleware
Collection of Testing data	take 750 seconds to dispose a lot of products	Testing data will automatically, take about 50 seconds to dispose a lot of products
Quality Control	Data is compiled by users, it take 1200 seconds to dispose a lot of products	Testing data will automatically, for 50 specifications, it will take about 50 seconds to dispose a lot of products, will automatically Hold the production lot without any error
Using technology	Use the VBA program language to capture the data	through machine's Loader function to capture the data, and use the Web service middleware technology to the data shift
Developing time	added machine format: it will take about 2 days to revise related Excel tools	added machine format: it will take about 0.5 day to revise the machine's loader program
Object of using	support the daily operation procedures, it needs to conduct the manual verification	automatic collection as the purpose without manual verification
Integration Scope	without integration	Use Web service middlewareto integrate with the collection of MES track-out data and the disposing procedure of abnormal production lot

6 Conclusions

This paper use web service middleware to practically establish the web service middleware component test software platform and construct the model of XML testing data; thus, the CMOS image sensor component multi-test system is actually feasible.

Application program, through this platform, has to make enterprise component-based and standardized in order to solve the problems: repeatedly developed function, small flexibility, difficult to make heterogeneous system integration and maintain and integrated with MES system to make production process automation, and provide the auto collection of production data and quality abnormality auto control for production mechanism, in order to solve the problem and enter the production data may easily be occurred and the omission of quality control. The contributions are described as follows:

- Automatically collect the production data and avoid occurring mistake, improve the efficiency and shortened the production cycle.
- Provide with the quality control mechanism to improve product quality and quality inspection efficiency up to 95%.
- Production flexible made the developing time of new equipment and format be reduced.
- Improving sources may be obtained from each type of machines, thus it can be used to conduct the engineering analysis and improve the yield rate.

- Integrated with systems to improve efficiency and productivity for enterprise.
- Production information can be fully used to obtain the significant competitive. Data is reliable which made the engineering analysis and assumption to be closed to the truth and can be easily traced
- Effectively manage the abnormal production lot to improve the product quality.
- Integrated with production procedures to form the strategic vertical integration business model.

Based on these results, the limitation such as use deep learning to CMOS component based structure of the software. As the data analysis of the conducted evaluation experiment is still ongoing, further results on the proposed structure in cloud based will be presented in future work. As the cloud computing model is used on the UML environment.

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