Establishing Component Traceability as an EMS Provider: A Mission Critical Service

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Abstract
As an EMS provider of high complexity backpanel assemblies, traceability of components with performance issues found at system test, functional test and in the field was limited to the ability to trace the raw board or fab defects and not much more. As more and more technology was being integrated into these complex backpanel assemblies, customers began in earnest to require EMS providers to provide traceability of components as well as fabs. Endicott Interconnect Technologies attempted to track a few critical components, such as ASIC modules and power supplies manually. This quickly became unmanageable logistically and the manual process of logging data in notebooks was unreliable. It was apparent that an automated system needed to be developed, that could integrate with automated manufacturing equipment, in particular the pick and place equipment. Utilizing the central processor and employing the on board software and some available industry software, data generated during component placement would be used to develop the component traceability database. Modifications to all portions of hard and soft tools would have to be made to integrate them into our server database so we could offer a reliable, dependable and economic solution to this problem. This paper will describe the solution that was developed to solve this challenging problem.

Introduction
The continual drive to automate assembly processes while maintaining cost competitiveness is a challenge in any manufacturing domain. This is especially true in electronics manufacturing where data collection is concerned. Component trace data is usually used only when a problem or disaster has occurred at system test, functional test or in the field. In that instance, a fast reliable response is needed to be able to quickly determine the exposure of a particular quality anomaly. These anomalies usually involve components placed on the assembly. Being able to determine quickly what exact assembly a defective lot of components is on or being able to determine the defective lot from a group of failed assemblies is critical in determining root cause and corrective action both for the EMS supplier and the EMS shops customers. The system we are going to describe is a totally automated system that enables the EMS supplier to determine important FA information quickly, usually in a matter of hours. The best part of this system is that the data is tracked automatically, therefore the reliability of the trace data for FA is very high .

Problem Definition
The concept of component traceability has been with the EMS industry for quite awhile, however on Complex Assemblies, with multiple part number ASICS and other fine pitch components placed on the PWB, automation could prove to be quite a hurdle. Most automated systems for component traceability were primarily directed at simpler assemblies that almost exclusively had components placed on them that were packaged in a tape and reel format. This made the trace data tracking relatively simple since most pick and place machines could track when reels where changed and one could easily use the floor control and purchasing system to determine what lot parts were on what lot of PWAs. Many EMS suppliers for the automotive industry used this approach or one similar in order to provide trace information on their PWAs. Problems arose however when you need to build more complex PWAs which have many different types of components that can not be packaged in tape and reel. This is particularly true with components that are fine pitched, like QFPs or larger SOICs and bigger BGA and CGA type modules. These components are normally packaged in specific JEDEC trays. Getting the trace information for each module from the JEDEC tray proves to be very difficult. Most pick and place machine manufacturers stumbled when you needed to track the data on components that were picked from tray feeders since the individual JEDEC trays do not have bar code labels on them. Tray feeders were usually big and bulky simply due to the fact that JEDEC trays were bigger and bulkier than reels. To compensate for this size constraint, the tray feeders usually had more than one tray available for use in a particular slot or palate. There was no restriction on being able to put a different part number in the same slot or palate. Therefore the machine software had difficulty distinguishing two part numbers in one palate. Most machine software was not designed to handle this type of variation and could not relate what assembly serial number a particular lot of modules was placed on. Also, long lead times and mixed lot shipments of ASIC modules usually restricted tying the floor control system and purchase order information together in giving a general bounding of component lot to PWA serial number. Thus, most EMS shops that had to track the module information recorded it from the part itself at a later operation after placement and reflow. The data was either recorded by hand or read into a data base using a bar code reader. Bar coding was a problem however since most module assembly shops do not put bar codes on individual modules.

Even the ones that did have barcodes, reading them was very difficult. Black ink on the silver metal background of the module "can" created a glare that was hard for the bar code reader to pick up. That left the EMS shops with only one option, recording the trace data manually in log books or inputted to the floor control system. Reliability of the data entered into the system was always in question since it was dependent on the efficiency of a particular operator on a particular day. Thus the challenge, create an automated system that can collect all component data, especially modules packaged in JEDEC trays.

Solution Overview

The approach that we embarked on to solution the problem of total automation of component traceability started with the SMT pick and place equipment. If we could get the pick and place tools to automatically record the trace information of all parts placed, verify it against the PWA serial number and send it to a data base in a standard format, we would then be able to manipulate and sort that data for component trace recall. First, we must look at how to enter trace data into the placement equipment machine database. Most pick and place tools have a process to enter component part number information into the machine processor, usually employing the use of bar code scanners. Specific software links are then employed to put the part number information into the machine processor data base. This is where the trouble starts. In order to get the specific trace information of a particular part into the machine database, barcode scanning must be employed. This is the only reliable data entry method. Standard barcode formats are not always used by the component manufacturers and the trace information is not always available on the reels and boxes that trayed components are packaged in. Furthermore, on the occasion that component availability causes the EMS supplier to procure parts from a distributor, bar code information may be on the incoming parts at all. It is easy to see that a uniform system needs to be developed so the pick and place machines can get consistent and uniform bar coded information. The way we solutioned this problem was to create a database utilizing the customer AVLs. Knowing what approved components and suppliers were required, a company standard part number was issued to each AVL part. This part number is used in all areas of operation from warehousing to pick and place programming. When the parts are received into the stocking crib, the crib attendant will first try and scan the barcode of the vendor part number. This will query the AVL and bring up a screen of the company part number. The crib attendant then must enter the trace data from the component package into the bar coding program. If the barcode for the trace data is not scanable, the crib attendant will type in the vender trace information. The trace information along with the company and vendor part numbers produce the required component barcode label. We now have standardized barcodes that contain all the information required to present to the pick and place machine memory, which will be stored and transmitted to a central data base. At this point, technical solutions are needed to allow the tray fed parts to read into the database, what file format to put the data into the pick and place processor, how to get the data from the machine processor to the central data base, how to make the association between the trace data and a particular PWA, and how to quickly sort he data. When finished, the automated component traceability system will go from concept to a workable system.

JEDEC Trayed Parts

JEDEC trays present a difficult problem for trace data automation. Complex backpanel assemblies have migrated from passive interconnect boards to active sophisticated assemblies with a high count of logic and memory designed into them. Most have many IC's (packaged as Fine Pitch SOICS or QFPs) and complex modules (BGA,CGA and MicroBGA), all of which need to have the trace information recorded. With JEDEC trays being the only feasible packaging method, a new method of tracking the trace data needed to be developed. Working in close cooperation with the pick and place machine manufacturer, ideas on how to redo the machine software were brainstormed. The first solution that seemed to be the best was a total redesign of the software and hardware associated with the machine that placed the ICs and modules. This included a complex method of labeling each JEDEC tray in a bag, a software interface to that tray and extensive use of barcodes on the trays. When the idea was summarized and costed, it became obvious that the cost of redesign of software and hardware was so high that it was prohibitive. A paradigm shift was required to solve this cost problem. After several more brainstorming sessions, the equipment provider agreed to unlock some of the restrictions on discussing the actual proprietary software code and its intended function. To everyone's surprise, there were multiple software locks that were not required by the average EMS supplier but were assumed by the software. One of the major assumptions made by the original designers involved software part verification in the tray feeder palates. Modifying the current software code and hardware setup proved impossible with this assumption in place. After the team decided to remove that assumption, the software coders were able to come up with a minor code change which would not require any machine hardware changes. With these restrictions out of the way, the solution became affordable. An EC to the equipment software at a minimal expense was implemented. The method to get the data from the tray into the data base was also overcome. When the modules were received in the crib, each bag was tagged with a bar code containing the company part number and trace information. (individual JEDEC trays could not be labeled since that would involve opening a sealed moisture sensitive ESD bag which is not desirable). When the ESD, moisture sensitive bag was opened and the appropriate machine tray feeder was loaded, the ESD bag with the bar code label was scanned into the machine processor and stored for retrieval later. Each time a JEDEC tray needed to be reloaded, the bag was rescanned. If a rescan of that particular JEDEC tray was not made, the placement machine would not cycle. Thus all JEDEC trays were scanned and the

Process Setup
Process setup of components on the placement equipment is done with a set of tools provided by our placement machine vendor. The hardware and software tools verify that the correct component is loaded in the appropriate location for the product that is being assembled. Every time a component feeder is installed on the tool, the technician will be prompted to scan the trace id label. The part number will be derived from the traceid for the setup verification. The data collected by the machine includes: tool name, part number, traceid, and timestamp. The software EC that was done to accommodate the JEDEC trays was designed to operate the same way. Not only does this set of tools provide the software links to automatically collect the trace data, it also provides the added benefit of preventing the wrong component from being loaded into a feeder slot on the placement machine.

Data Format
As our team worked with the equipment software team, it was discovered that all of the data could be easily saved in a relational database. The placement machine generated data, the trace data, and the board tracking data, which includes: tool name, part number, board serial number, and timestamp, where added to the database server. Together, these database tables form a data infrastructure that facilitates trace data inquiries. By using an off-the-shelf database reporting tool, the equipment software team was able to develop a set of reports to allow an EMS provider to enter some simple search criteria and generate an answer to the FA inquiry. The database server was set-up to automatically back-up the data to a host system for additional data security.

Data Association to Specific PWAs
The last issue that needed to be overcome was the ability to associate all the trace info to a particular assembly. A prerequisite of this method was that each PWB had to be serialized, in bar code format, prior to being presented to the pick and place tools. The equipment supplier again came up with a hardware solution that was moderately priced and used stock software and hardware. A system of adjustable bar code readers was devised that would automatically scan the PWB, with the label in any location on the front or back. These adjustable scanners were mounted on the conveyors just before the PWB cycled into the placement tool. The software was modified so that the machine would not begin its cycle until the bar code was read and recorded. We now have trace info being recorded while the PWB was being assembled and the machine data base automatically provided the PWA associated serial number. Even if parts were changed during the assembly and a different lot was put on the machine, the data base recorded that. All this trace and PWB data was automatically recorded and transferred to the central floor server. This entire process was now 100% automated at a very minimal cost to the EMS supplier.

PIH Connectors and Power Supplies
Hybrid Complex assemblies usually have some PIH connectors and power supplies. Most RAM and RAF connectors and power supply vendors provide the parts with the trace information already barcoded on each individual part. The method of collecting this trace data involves the use of an online routing system that provides an automated data collection sheet. This data collection sheet must be filled out by scanning the part trace info into the sheet. This is stored in the EMS suppliers host data base for potential retrieval at a later date. If the data is not recorded in the automated data sheet, the PWA will not be able to be moved to the next operation in the build cycle. This prevents operators from skipping the data collection steps. In the case of connector headers, the same methodology is followed, however the box that the parts come in have their trace information scanned verses the individual connector.

Conclusion
The expectation of this project was that a totally automated solution for component traceability would be devised. This system would not only be able to serve simple reeled components but trayed components as well. We needed to reach this goal because nearly all our customers require automated traceability, particularly on complex assemblies. Reaching our goal was not a matter of desire but a matter of survival if we wanted to continue to compete as a viable supplier of complex assemblies. After we installed this system, our major customers conducted several audits to test the reliability of our new system. Each time we passed an audit, our customers confidence grew. Today, our customer feedback refers to us as “World Class” in regard to component traceability and we have no reason to disagree.