ESSEGI AUTOMATION

INTEGRATING THE AUTOMATED COMPONENT STORAGE TOWERS INTO THE FACTORY ENVIRONMENT IN INDUSTRY 4.0

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INTRODUCTION

With the growing interest in industry 4.0, many OEM and EMS electronics equipment manufacturers are making steady progress towards the goals of “smart factories” and “lights out manufacturing”. One of the key requirements for achieving these goals is streamlining the material flow between the warehouse and the production floor, assuring that all components reach the production lines accurately and at the proper time. In recent years, the Automated Component Storage System has come to play a major role in improving productivity and efficiency for many electronics OEM and EMS companies.

Combined with a comprehensive database of all materials, processes, and procedures necessary to manufacture these products and the software systems which must work together to successfully achieve their manufacturing goals, these Automated Towers are providing a powerful tool for both volume manufacturing and high mix environments both. While most companies use an ERP (enterprise resource planning) system to help manage the business, they may in addition be using an MES system (manufacturing execution software) on the factory floor. In addition, the many pieces of equipment used in the manufacturing lines may have their own operating software, maintenance software, individual machine controllers, and line controllers.

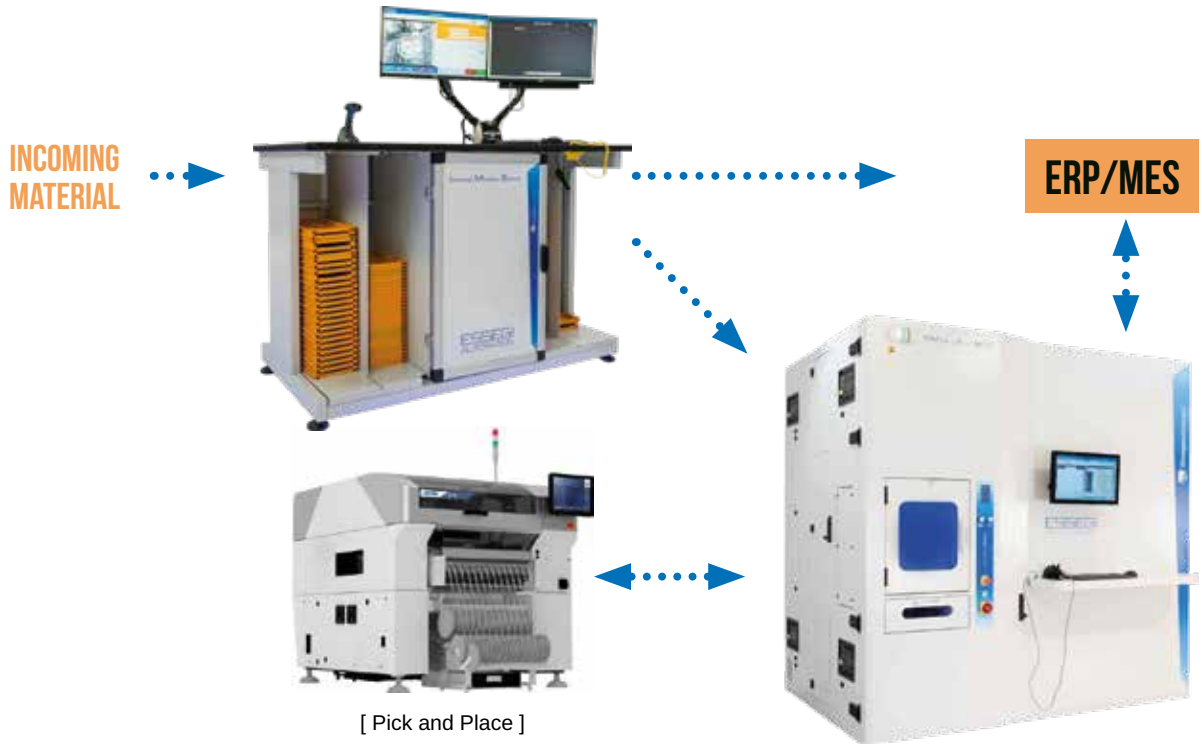
The integration and management of these systems is a challenging task. Perhaps the first important requirement to achieving this integration is to have accurate and complete data in the database of materials, processes and procedures. In this series of papers, we address the growing field of automated component storage and retrieval, and its exciting impact on the link between the warehouse and the production floor. In Part I, we examined the different types of component storage towers, and their various features and benefits. In this paper, we explore the integration of Component Storage Towers with the other hardware and software systems in the factory environment. Later, in Part III we will discuss the use of automated transport, such as AGV’s (Autonomous Guided Vehicles), to collect the materials from the Component Storage Towers and distribute them to the proper locations on the factory floor, and the challenges of the ultimate goal of the “Lights Out Factory”.

CONNECTING TO THE **ERP SYSTEM**

Enterprise resource planning (ERP) is the integrated management of main business processes, often in real time and mediated by software and technology.

ERP is usually referred to as a category of business management software—typically a suite of integrated applications—that an organization can use to collect, store, manage, and interpret data from many business activities.

[**Incoming Material Station**]
(Registers Material, Prints Unique ID Label)



[Pick and Place]

[Intelligent Storage]

ERP provides an integrated and continuously updated view of core business processes using common databases maintained by a database management system. ERP systems track business resources-cash, raw materials, production capacity—and the status of business commitments: orders, purchase orders, and payroll.
The applications that make up the system share data across various departments (manufacturing, purchasing, sales, accounting, etc.) that provide the data. ERP facilitates information flow between all business functions and manages connections to outside stakeholders.

The Automated Component Storage System can be connected with the ERP system easily, MES, pick and place lines, etc. Thanks to the API interface, any software can easily communicate and receive information from the Storage System and automatic filesharing with other software is also possible. The result of these connections, is that all company systems are updated as to inventory availability immediately, allowing for a more efficient and timely production cycle. Also, all information necessary for the automatic generation of traceability reports is automatically transmitted to both ERP and MES systems.

Let us review the types of information which can be transmitted by the automated storage system to the ERP. First, and most important is the part numbers and quantities of all components held in the automated storage systems. Within this data is the unique ID of each reel, the manufacturer's part number, the lot number, the date code, and any other specialized information which the customer has linked to the unique ID. Through this link, it is possible for the ERP system to update itself on the current inventory held in the automated storage systems as frequently as it desires. Secondly the automated storage system can confirm to the ERP system the components by reel, tray, and unique ID that are currently in the production process, their present locations, and the jobs and bills of materials they are currently assigned to. If the ERP system were to request an update of inventory quantities every 10 minutes throughout the day the automated storage system would comply. While this might be considered excessive, in a large manufacturer with 100 production lines and producing tens of thousands of assemblies per day it might not be excessive, but necessary.

For moisture sensitive devices, the MSD data and tracking is also fully available to the ERP system at any time. Each reel or tray, identified by its unique ID, has its entire life history recorded by the automated storage system. Each time the component was withdrawn for use, the time it was outside the controlled humidity environment, the time it was returned to the automated storage system, and the remaining validity time for the component before it expires, is available to the ERP system or any other outside software system, such as an MES, at any time.

If the manufacturer uses the ERP system to manage production and generate the orders to pull the kits of components required for each job, the ERP can send the bill of materials to the automated storage systems to automatically generate the pulling of the kit prior to production. Some users use an MES software system to manage this function. In this case the MES software can also send the bill of materials and kit pulling request to the automated storage system.

The ERP system is the main control center for business operations in most companies. The automated storage systems are able to share any data that they store with ERP, upon request. From large well-known providers of ERP such as SAP and Oracle, to homegrown ERP systems developed by customers themselves, to simpler small business oriented ERP systems, the automated storage system can be fully integrated as a key partner in the manufacturing process.

THE MES SYSTEM

Manufacturing execution systems (MES) are computerized systems used in manufacturing, to track and document the transformation of raw materials to finished goods. MES provides information that helps manufacturing decision makers understand how current conditions on the plant floor can be optimized to improve production output. MES works in real time to enable the control of multiple elements of the production process (e.g. inputs, personnel, machines and support services). (2)

Some manufacturers use an MES software to directly control the production floor and monitor critical production processes. Usually, the MES is used in conjunction with an ERP system with integration and communication between the two systems on a continuous basis. In electronics manufacturing, some of the larger providers of MES are Siemens (formerly Valor/Mentor Graphics), Aegis, Cogiscan, and there are many less well-known providers.

When an MES software is used, the automated component storage system generally communicates primarily with the MES in the MES passes through information to the ERP. The MES sends the bill of materials and requests the pulling of kits from the automated storage systems and also receives the input from the automatic MSD component monitoring system run by the storage system. Though in some cases while the production is directly controlled by the MES, the ERP system will communicate directly with the automated storage systems regarding inventory, component quantities, and FIFO compliance.

THE PICK AND PLACE LINES

The automated component storage system can communicate directly with the pick and place systems line control software to accomplish a number of things. First, it will deliver the kit of components specified by the ERP system or the MES to the proper line. The kit can then be loaded onto feeders and then onto the line. At the end of the production run of that assembly, the components can be removed from the feeders, loaded into cases barcode side up, and returned to the automatic storage system to be returned to inventory.

For most modern pick and place systems, it is possible to use the placement machine data to update the quality of components in each reel or tray as they are returned to the automatic storage system. For example, when a reel is returned to the storage tower the unique ID is read, and the storage tower requests the quantity information from the pick and place line control. Each pick and place system knows how many parts from each reel have been placed, and how many mispicks occurred during the picking from that reel. These numbers can be added together and combined with an attrition number which takes account for the number of parts on average lost when a reel is loaded onto a tape feeder. By combining these numbers and subtracting the total from the previous inventory count for that reel, the inventory quantity can be updated and kept current. This process can be done without any external counting device or labor time necessary to perform the count.

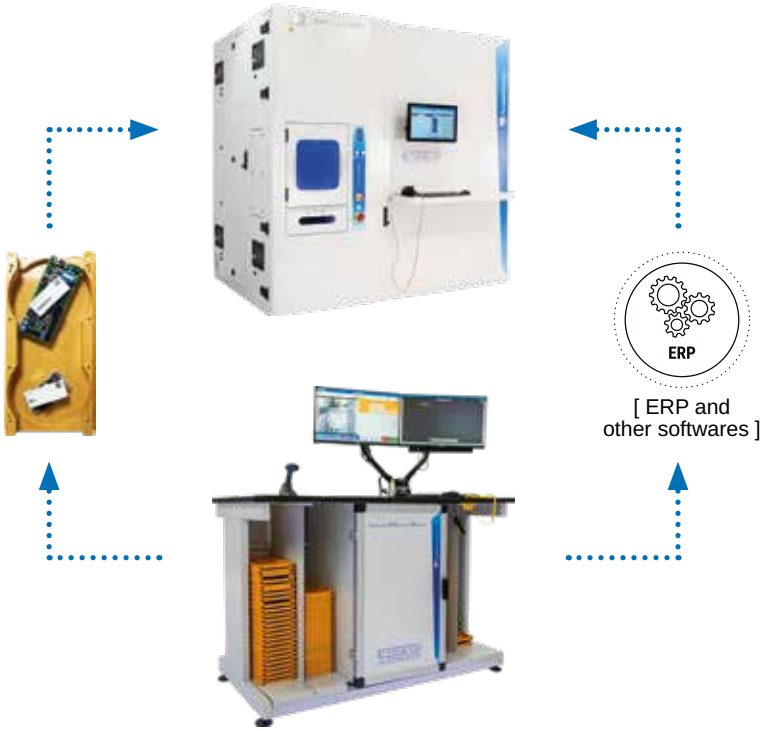
Another exciting feature of the automated storage system is its ability to supply components to the production line in anticipation of its need, thereby eliminating wait time usually needed to replenish a reel or tray which is run out of components during the production run. Many modern pick and place systems have the ability to monitor the quality of components remaining in each reel or tray by counting down the quantity as the components are used. The user of these placement systems can set a warning level so that the pick and place line sends a warning to the automated storage system when a component reel or tray is approaching empty. Even though the storage system may be in the process of pulling another kit, or returning components from a completed production run to inventory, it can interrupt its task, retrieve another reel or tray of the component about to run out, and place it in the urgently needed drawer located below the main door of each storage tower. The storage tower will then sound the alarm for the operator to come to the tower. When the operator arrives, they will see displayed "this real urgently needed on Line 2, Machine 3, Feeder 26" and can open the drawer, obtain the reel, and take it to the line arriving before the current real is completely exhausted. The reel can then be spliced or loaded on a different feeder and swapped thus preventing line down time which would've occurred at the reel been allowed to run out, and a replacement reel had then been sent for. At one customer recently, this feature alone resulted in an increase in production time of 8% on a 272,000 CPH placement line. Often this feature results in enough production line efficiency improvement savings to pay for the automated storage systems in less than a year.

Other possible features of communication between the pick and place line and the automated storage systems can include MSD validity time warnings, split real requirement situations, and multiple reel requirements for very high-volume components such as decoupling capacitors.

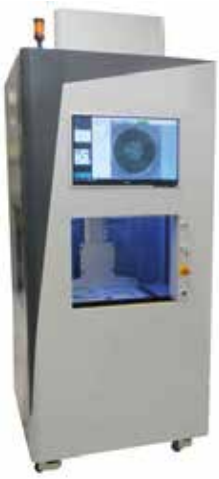
INCOMING MATERIALS PROCESS

In my earlier white paper, "Automating the Incoming Materials Process Contributes to Implementing Industry 4.0", the possibilities to further automate the incoming materials process and speed the receiving an accounting steps involved in this procedure were fully described.
The new incoming material station or IMS, recently introduced by the largest manufacturer of automated storage systems, was described in detail.

The ability to speed the receiving process makes it possible for the ERP system and the automated storage systems to have all the data necessary for production immediately after the parts have been received. And also, to be assured that the proper unique ID has been printed and attached to each reel, tray or tube. By referencing this earlier paper, the user can update themselves on the latest developments.



X-RAY COMPONENT COUNTERS

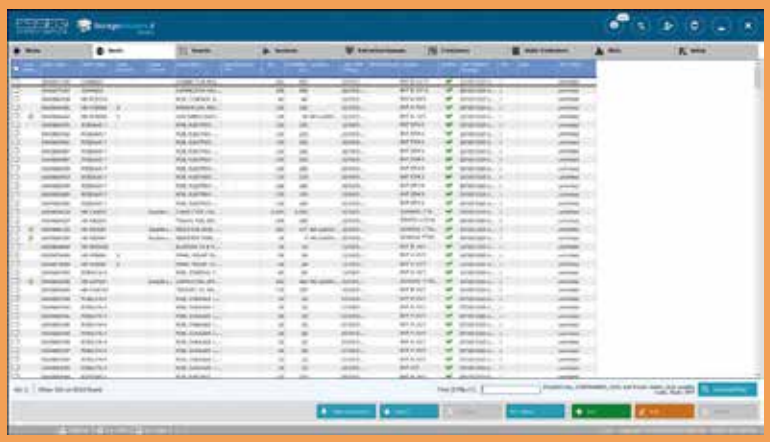


A relatively new piece of equipment which has been introduced during the last few years is the x-ray component counter. These systems count the number of components in a reel, tray, or tube in a matter of a few seconds, without having to remove the components from the reel, tray, or tube. More and more companies are acquiring these systems due to the speed with which they can count the components, and the considerable labor savings instead of doing it manually. These new x-ray counters can also be integrated with the automated component storage towers.

If the x-ray counter is used as a stand-alone unit, and all reels or trays are brought to the unit and counted after they are removed from the production line at the completion of an assembly run, this information is available to the automated component storage tower. For example, a reel has been removed from the feeder at the end of production and has been counted by the x-ray component counter. When the reel is returned to the automated storage tower, the tower will read its unique ID and will inquire of the x-ray counter if it is been counted and what was the quantity. The automated storage tower will then update the inventory count for that reel and unique ID in its database. As we have described earlier, this means the updated count is available to the ERP system or MES software immediately after this reel has been returned to stock.

Two manufacturers of x-ray Component counters have recently introduced in-line versions of their ounting systems. At the recent Productronica show in Munich Germany, the largest manufacturer of automated component storage towers debuted in future development integrating the in-line x-ray counter with the group of automated storage towers. With this configuration, it would be possible for the automated component storage towers to send reels or trays directly to the x-ray counter for processing and then return the reel or tray to inventory automatically. This gives the possibility for the user to give a list of the components to be cycle counted, and the automated storage tower would process these during downtime from normal production, perhaps during the night. The next morning the user would receive a report detailing the cycle count activities of the night before. The possibility of physically integrating the x-ray component counter with the automated storage systems should be available commercially by the end of 2020.

In this paper we have described many of the ways the automated component storage systems can be integrated with the ERP system, and MES software, the SMT production lines, MSD control software, and other equipment such as x-ray component counters. But it should be made clear, that the automated component storage towers can share any and all data they contain with any other system capable of integrating with the Windows operating system. By filesharing, or by using the API possibilities included with the component storage tower, it is easy to exchange and monitor any



data which the user desires. Whether the software integration is done by the manufacturer of the component storage tower as a service, or is done by the user of the component storage tower themselves, the deep integration of the automated component storage tower into the production environment creates benefits and savings for the user over many years.

[Open Data Availability]

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