TECHNICAL GUIDE

Advanced MES Critical Capabilities for Electronics Manufacturing

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Critical manufacturing
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Introduction

New business opportunities are widely available for electronics companies: new applications, industries, and business models (product as a service, data analytics, etc.). Yet electronics manufacturers face significant challenges, including increasing product complexity, diversity, and customization; shorter product lifecycles; component shortages; uncertain conditions in many regions; and a talent shortage.

Electronics companies need both speed and confidence in new product introduction (NPI) time to market, to accommodate new components and suppliers, and to manage new manufacturing processes. Yet each of these can be challenging. A single electronic product may consist of thousands of components requiring several manufacturing processes across a variety of sophisticated tools and machines. At the same time, the manufacturer must maintain complete and thorough traceability, from suppliers' raw materials through the production process to each unit of finished goods.

Manufacturing plants need software that manages production and connects to sophisticated equipment and enterprise software systems. To meet these challenges, electronics manufacturers are realizing they need a modern manufacturing execution system (MES) designed for their particular needs. The following sections will explore the manufacturing scenarios, challenges, and advanced critical capabilities that a modern MES for electronics must support.

Master Data Management

The Challenge

According to Gartner, "Master data is the consistent and uniform set of identifiers and extended attributes that describes the core entities of the enterprise…."

In the case of electronics manufacturing, entities to manage include:

- Bills-of-materials (BOMs)
- Product as-designed models (computer-aided design (CAD), electrical computer aided design (ECAD), or electronics design automation (EDA) files)
- Recipes for particular products, machines, and processes
- Tools – from stencils or feeders used in a surface-mount technology (SMT) line to a bed of nails used in a stand-alone in-circuit testing (ICT)
- Direct materials – active and passive components, whether individual, in trays or on reels; boards; solder paste; and mechanical components
- Flows – routing of the processes through which a product must flow for perfect quality

Change control must enforce that revisions and new versions follow a well-defined approval process with easy revision of each master data element assigned to a particular object. A common issue is that some execution-relevant master data is maintained in separate enterprise systems, such as the product lifecycle management (PLM) or enterprise resource planning (ERP) systems.

The Solution

The MES must deliver change management and versioning capabilities to support the required level of change control. Master data maintainability allows the company to reuse data elements.

In electronics manufacturing, common sub-flows can be repeated for different PCB products, with changes (e.g., to the recipe, tools, and BOM), as shown in Figure 1. Reusing entire sub-flow blocks is essential for efficient master data as it reduces the number of master data elements. In addition, to support modularity and maintainability, the MES must provide a mechanism to re-use complete flow blocks multiple times when defining a new flow while being able to set the appropriate context (e.g., PCB side or product variant) so that it can resolve the different process elements correctly.

Furthermore, to provide flexibility while improving the reusability of common elements (e.g., data collections and recipes), a product or lot and the elements to be used at a particular process step must be linked using a flexible context resolution mechanism and not hard-linked. With the variety of data contributing to master data, MES needs to integrate with systems such as PLM, ERP, and equipment to reduce effort, time, and opportunities for errors.

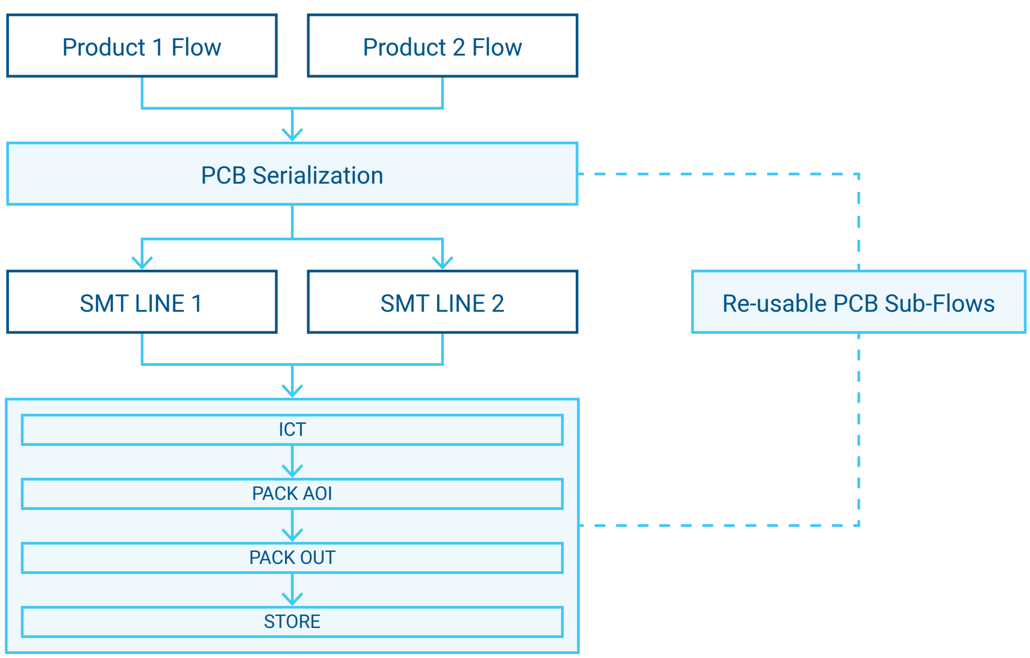


Fig. 1 Repeated re-usable sub-flows

Planning

The Challenge

The planning process involves translating orders with information about products, quantities, and deadlines from the ERP system into concrete job sequences and delivery times for production operations. The goal is to have reliable, efficient, and on-schedule production. This planning process becomes increasingly complex as the number of products, customizations, and customers increases, lead times become shorter, and lot sizes smaller. In addition, manufacturers must be able to consider and respond to rush orders and unforeseen events in planning and processes without delay. Without the proper support for planners, manufacturers will incur more mistakes, miss customer delivery dates, and suffer higher costs.

The Solution

Implementing a modern MES that includes detailed planning and scheduling lets manufacturers build a fast, highly automated, and, therefore, highly flexible planning system. It must allocate and cluster family products across SMT, through-hole technology (THT), or assembly operations based on existing resources, materials, and capacities. The system must seamlessly reflect restrictions and short-term interruptions to increase planning quality and reliability.

Simulations provide certainty about cycle times and delivery schedules, analyze target vs. actual variances, and consider these findings for future planning processes. At the same time, as shown in Figure 2, the planning process must be adaptable at any time, even for multiple lines, to reflect new requirements (rush orders, equipment failures, delayed material deliveries, etc.) and instantly communicate these changes electronically to all employees and process steps.

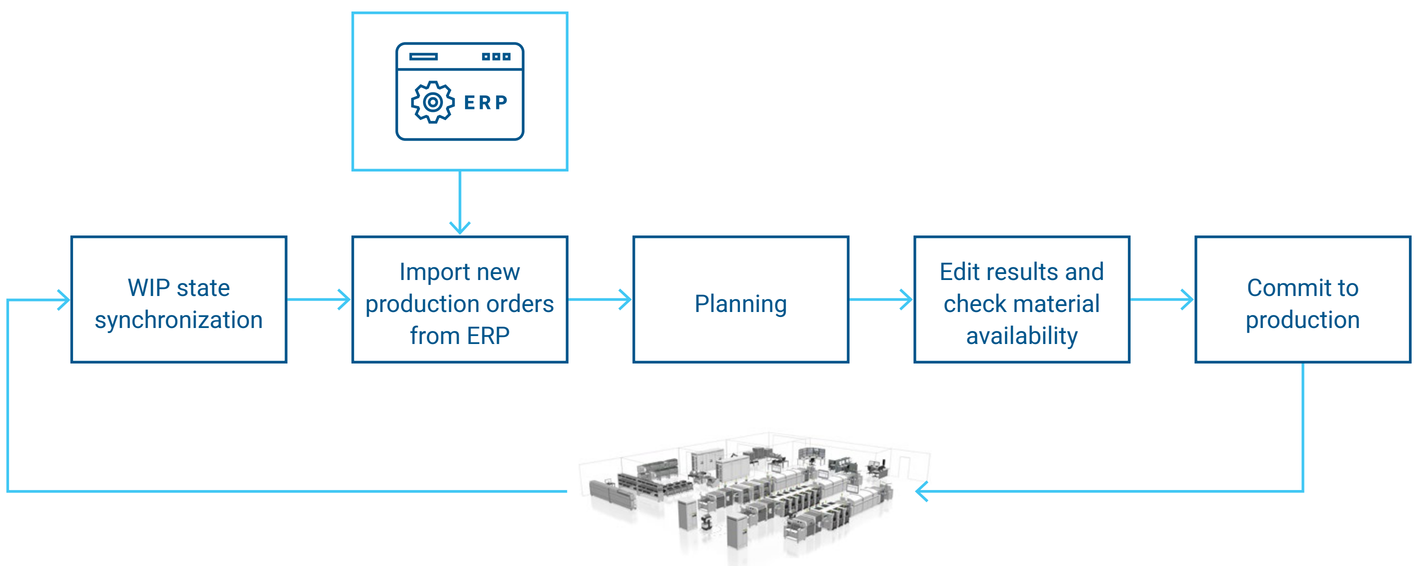


Fig. 2 Planning synchronization flow

Material Management

The Challenge

Missing, mishandled, or damaged material is one of the main reasons for SMT line stoppages. In these days of constrained capacity to meet rising demand, no company can afford to lose that time available to generate revenue. Effective electronics production plants need inventory management that goes beyond what's in a supply chain plan.

One obvious issue for most SMT lines is replacing material reels on pick-and-place machines in time to keep production moving. Even beyond that, many common electronic materials require special handling. Semiconductors often have a specified floor life. Moisture-sensitive devices (MSD), or electronic devices encapsulated with plastic compounds and other organic materials, typically come in special packaging. These need to be handled carefully in specified humidity and temperature ranges. Often they must also be used in the assembly quickly once the bag is open to prevent moisture from atmospheric humidity from collecting and damaging the component. Even solder paste has specific time queueing needs as it typically must rewarm before being used.

The Solution

The plant's software needs the ability to manage and request materials, fulfill those requests, and move material between locations as shown in Figure 3. It must have all the relevant information around a single component, such as supplier part number, internal part number (e.g., reel ID), and detailed logic about the parts and materials and their environmental and handling requirements. The model driving this material management capability must include floor life, moisture sensitivity level, rewarming times, and all supporting details.

MES must provide the capability to define minimum component inventories at a given piece of equipment. By automatically requesting the correct material once the threshold is reached, MES helps ensure the SMT lines keep running while the component replenishment takes place on time.

Handling materials and ensuring they move efficiently and effectively not only through automated lines such as SMT but through the entire production facility is crucial. MES materials management on mobile devices supports operators as they pick or store materials anywhere in the facility. If the warehouse is automated, like smart storage towers, it can also integrate with them directly and have them prepare the materials for pick-up.

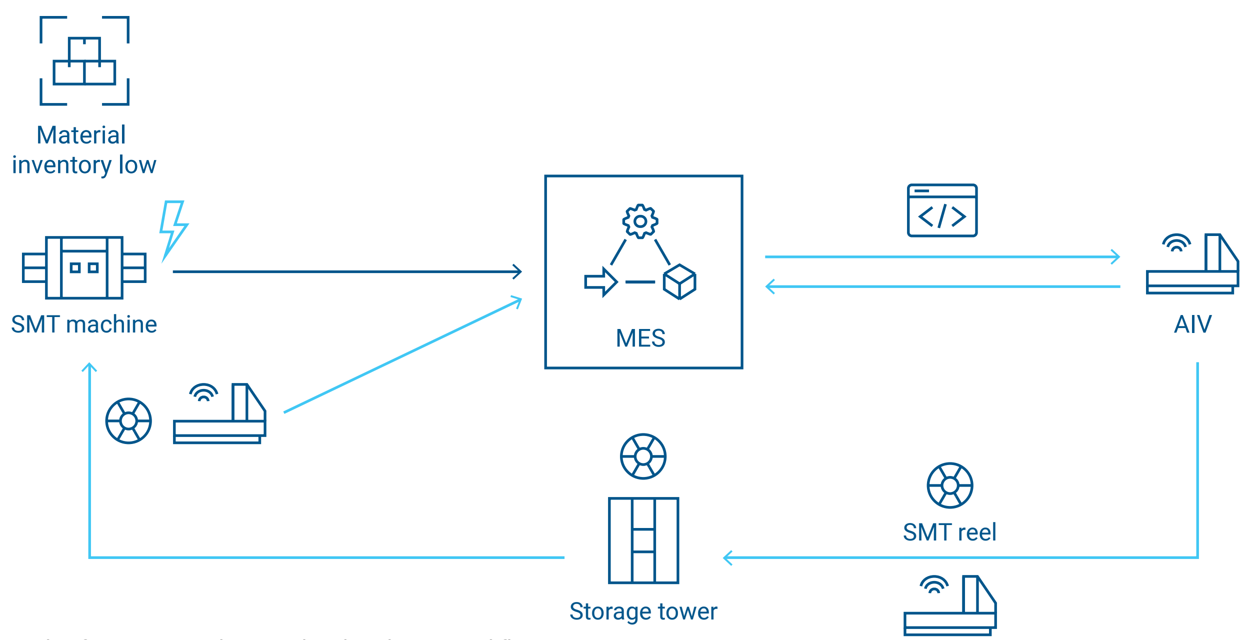


Fig. 3 Example of an automated material replenishment workflow

Recipe Management

The Challenge

A recipe is a critical process element consisting of the recipe program and parameters. In the case of a placement machine, it also includes the placement list and components setup. Some recipe programs are complex and require special recipe editors or software development kits (SDK). It's essential to ensure that approved recipes uploaded to the appropriate equipment are not changed in any way.

Recipe parameters can be static or dynamic and are a vital enabler for re-using recipes. A critical aspect of recipe management is verifying that the right recipe is used for a specific material, product, process flow, or process step at the correct piece of equipment. The specific recipe version and individual recipe parameter values used for each material process must be captured for traceability and process improvement purposes. The recipe definition is the foundation, but actual processing and recording requires all details from the recipe instance used.

The Solution

The MES must provide a centralized recipe management system (RMS) that allows recipes to be uploaded to and downloaded from equipment using equipment integration. The MES must also provide a flexible context resolution mechanism to resolve and verify the recipe to be used for a particular lot or PCB at one specific piece of equipment in a particular process step. This resolution flow from recipe definition to instance is shown in Figure 4.

To ensure complete traceability and support process improvement, the MES must capture the exact recipe version, valid setup in the case of pick-and-place machines, as well as the set of parameter values used for each job. For high-automation purposes, it must be possible to upload or select the approved recipe at the equipment via integration. For process integrity purposes, the system must ensure that the recipe has not been modified.

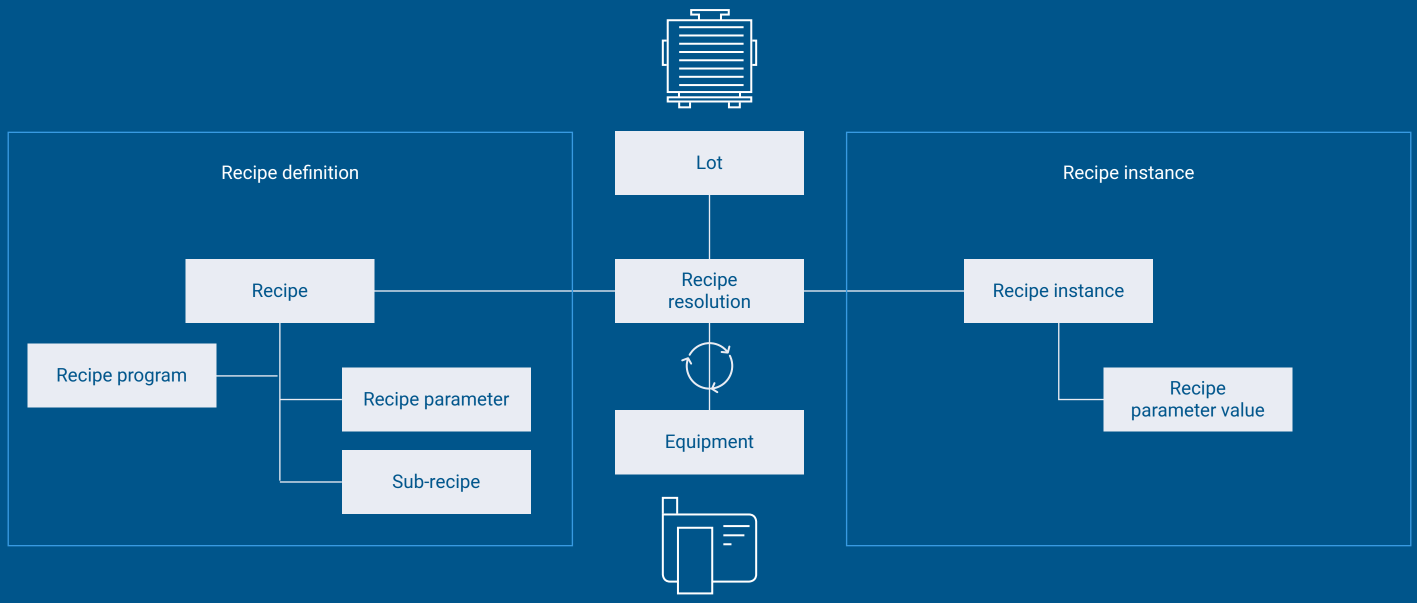


Fig. 4 Recipe definitions and recipe instances

BOM Validation

The Challenge

The overall product BOM from ERP is divided into several BOMs in production, each designed to allow a specific piece of equipment, such a pick and place machine, to handle each product. BOMs can be complex, as can the recipes, materials, and equipment. When programming a pick and place machine, it is very easy for an engineer to make an error, such as programming a wrong part number for a given reference designator or even bypassing a component that should be part of the placement list.

Without an automatic BOM validation mechanism in place, the opportunity for errors on both sides of every PCB arises. Ensuring the match between product BOM and each pick and place recipe, setup, and placement list is crucial to prevent errors that result in wasted time, effort, and materials on products that end up in either rework or scrap.

Additionally, the increased use of LEDs introduces significant new challenges in BOM handling for electronics manufacturers. The potential for aesthetic defects is introduced if the brightness index number (BIN) from one reel to the next is incompatible and traditional methods for component traceability and line setup validation are not sufficient to assure the valid LED pairing.

The Solution

As shown in Figure 5, MES performs a BOM validation check every time a product is about to enter a line or piece of equipment. For all the equipment at a line or standalone operation that should consume BOM items before production takes place, MES ensures consumables are present in the right quantities and in the right place. It also significantly reduces the administrative effort and risk of errors in the LED pairing process. The software administers LED brightness classes and combines them with matching resistors.

At an SMT Line, PCBs are not allowed to enter a printer machine if the valid solder paste for that product is not in place. In the case of the pick and place machines, checking the placement program against the BOM of the PCB to be manufactured ensures that:

- the active recipe and setup on that piece of equipment matches the valid recipe and setup for the product to be manufactured
- the placement list of the machine that will consume the BOM contains all the BOM items matching the ERP BOM for that step

Additionally, after each PCB gets processed, the MES will cross-check that every component in the ERP BOM is actually on the PCB. With all this validation and error-proofing built into the MES, the process can be done quickly and confidently.

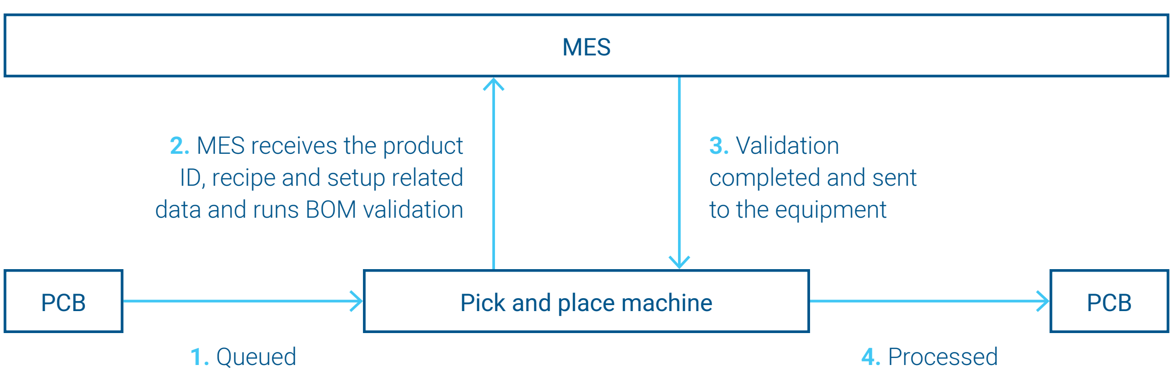


Fig. 5 PCB BOM validation sequence

WIP Tracking

The Challenge
Materials cost of goods sold (MCOGS) is typically one of the highest costs for electronics manufacturers. So, keeping inventories low, minimizing defects, and improving yield dramatically improves profitability. Yet as we mentioned above, missing or improperly handled parts constitute a significant issue in this industry. Keeping WIP low without starving the equipment of materials is a balancing act. So, work-in-progress inventory (WIP) is particularly challenging.

Tracking WIP sounds simple, but it is not. The production process moves fast, and products and materials change rapidly in electronics, too. Thus, a lack of WIP control leads to inflated inventory spend, material obsolescence, poor production efficiency, and waste of shop-floor space. This means that value-stream mapping is not a one-time event. Electronics manufacturing facilities must frequently re-vamp and evaluate the effectiveness of their processes and flows to ensure that WIP moves at same pace (throughput/velocity) to avoid WIP buildups and WIP shortages.

The Solution
MES can help enforce that WIP is pulled on time and only on demand at every step through the process. More modern systems also include analytics to gauge the effectiveness of process flows. Some analytics can pinpoint WIP problems not only as they happen but also in advance as trends or issues arise. They can also start to identify if particular suppliers' lots, lines, machines, or personnel are correlated with critical WIP points as shown in Table 1.

MES can reduce WIP by controlling production execution – not just on the SMT line but across the entire operation. This process-to-process WIP can link SMT materials flows with additional steps. Ensuring that materials flow where they are needed precisely when and how they need to flow for both basic assembly and value-added processes is not trivial.

Perhaps most importantly, the MES can ensure the process route and thus prevent errors. Process interlocking, where various manufacturing steps depend on one another, is crucial to traceability and ensuring that each unit is made following appropriate material time and handling constraints.

			Bottleneck		
Operation	**A**	**B**	**C**	**D**	**Total**
Equipment count	1	1	1	1	4
Cycle time (days)	1	1	2	1	5
Throughput (units/day)	1	1	0.5	1	0.5
Critical WIP (BNR * CT)			2.5		
	WIP	**WIP**	**WIP**	**WIP**	**Total WIP**
Day 1	1				1
Day 2		1			1
Day 3	1		1		2
Day 4		1	1		2
Day 5	1		1	1	3
Day 6		1	1		2
Day 7	1		1	1	3
Day 8		1	1		2
Day 9	1		1	1	3
Day 10		1	1		2
Capacity utilization	50%	50%	100%	50%	63%

Table 1 Example of a critical WIP operation

Equipment Management & Optimization

The Challenge

Equipment and tooling are becoming increasingly complex and expensive. Manufacturers must not only track these capital resources' health, performance, and utilization to operate efficiently but take action to maintain them. In addition, there are both durable and consumable tools for many types of electronics manufacturing equipment that need similar attention.

Those who can keep equipment running at optimal performance can also improve utilization, output, and profit. While production cannot proceed if equipment goes down, the staff, materials, and maintenance scheduling is typically wholly separate from that of production. Coordinating activities between these groups is crucial to keeping an electronics plant running efficiently at a profitable capacity.

When demand exceeds capacity, keeping everything running at peak availability, performance, and quality is crucial. So, companies monitor overall equipment effectiveness (OEE) closely. Yet it is not simple – with so much more automation and equipment in most plants than just the SMT line, keeping OEE high is a puzzle of interdependencies.

The Solution

The MES offers a hierarchical resource model with user-defined or industry standard state models to track resource status, as shown in Figure 6. A rich set of transactions includes changes in resource or system states, plus materials, instruments, durables, and container management. It also includes calibration and verification of instruments so each plant or line can configure procedures to avoid using gauges or instruments with expired calibration status. Equipment and instrument qualification and calibration become part of the overall production process traceability records. Monitoring degradation throughout the process and the test equipment's lifecycle is inherent in tracking the process.

Comprehensive MES includes maintenance management so that the actual usage of each line or piece of equipment is automatically reported to the maintenance group by cycles or hours. The native asset management in MES also helps production trigger maintenance as needed and understand maintenance plans and the expected time when equipment will be unavailable.

Maintenance includes plans (in some cases, multiple plans per resource), history based on actual production, and guidance for technicians. The system prevents production if the equipment is due for maintenance or technicians need to update their certifications. It also updates spare parts inventory based on actual consumption. Planned maintenance downtimes appear as unavailable in the production schedule.

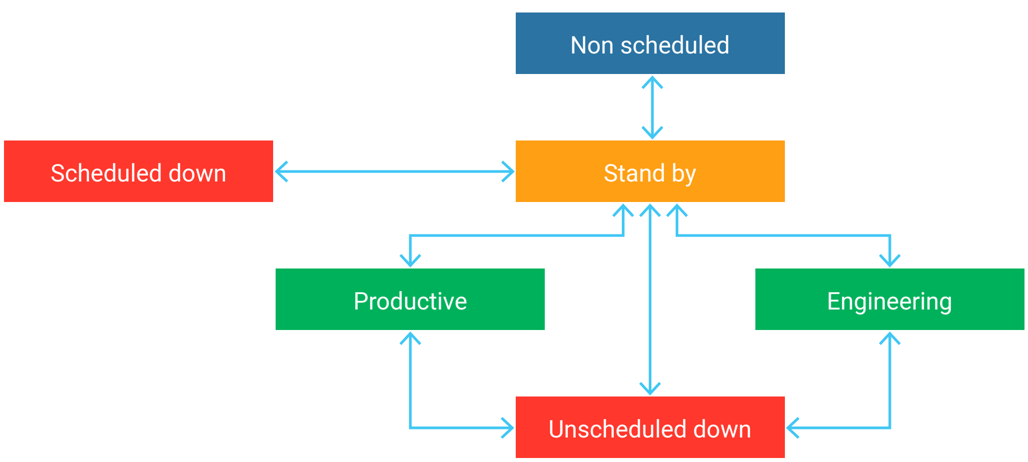


Fig. 6 SEMI E10 equipment state models

Monitoring

The Challenge

Because electronics production processes move fast, it's easy for something to go wrong and not be detected for some time. Thus, monitoring the process is highly valuable for the operation's quality, efficiency, and profitability. Data from the process is also essential to what customers need from their electronics suppliers, along with product shipments.

Issues that are signs of weaknesses in monitoring:

- Difficult to visualize the current status and access process data
- Data is maintained in separate systems/no central view and aggregation
- High manual reporting effort
- Reports and documentation are rigid and paper-based
- Alarms and escalations are not automated
- No integration of smart devices (push mail/messenger, smart glasses, smart watches)
- Alarms without user guidance
- No traceable material and process information about assembled products

The Solution

With a monitoring tool, as shown in Figure 7, MES information about fill levels, components and consumables running low, MSD exposure times, order status, remaining run times etc. is visible for the entire line. Monitoring a factory in real time enables manufacturers to respond instantly to all sorts of events while flexible analyses of historical data highlight trends and process changes.

A modern factory monitoring system also identifies process irregularities and automatically notifies specific technicians or managers when needed. Intelligent monitoring systems speed up the troubleshooting process by providing teams with the necessary information and documentation – anywhere, anytime, and on a wide range of devices.

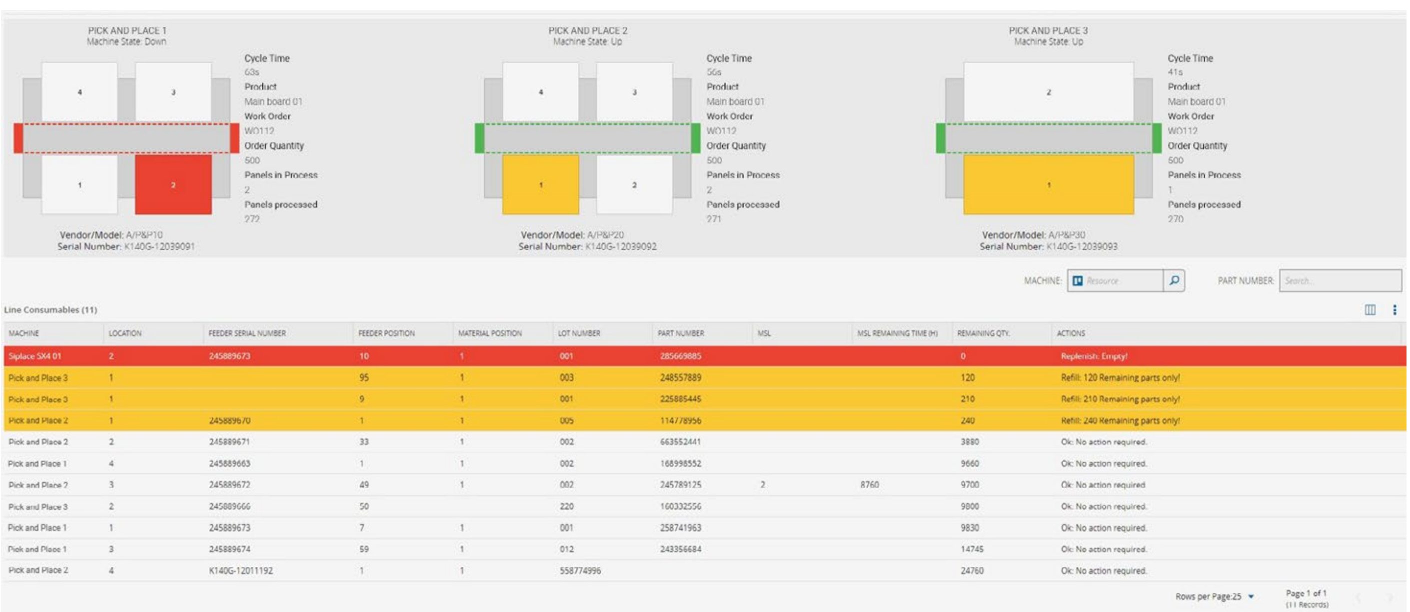


Fig. 7 Monitoring tool example for pick and place equipment

Traceability

The Challenge

Every electronics component, sub-assembly, and assembly needs a complete and thorough genealogy from suppliers' raw materials through the production process to finished goods. Tracing the origin of every material in every product is fundamental for regulatory and customer compliance – often down to serial numbers or reference designators. Traceability is essential to keeping liability and business risk low. It can feed product and process improvement. Traceability can also help to measure process adherence.

Yet traceability is more challenging than it might appear with the many products and variants – and frequent material and supplier changes. Many sources of information must come together to trace from final assembly to component and process within it. Relying on manual means or data from many systems and databases for data collection and transfer is fraught with opportunities for error.

The Solution

As every value-adding step occurs, MES can track and record the details for traceability, as shown in Figure 8. This moves from incoming raw materials receiving and inspection through finished goods. In short, not just the elements of the SMT line, but all operations before and after it.

As the MES guides each step, it automatically collects the data of what occurred. Thus, traceability data can also feed process optimization and capacity utilization improvements. Process interlocking is ensured with detailed tracking and reporting of materials and processes to the individual board level, enabling electronics manufacturers to contain any quality escapes. For example, they can reduce the number of products to recall by accessing accurate data detailing precisely which units were impacted by a counterfeit component. This minimizes the risk of liability and protects the company's reputation and relationships.

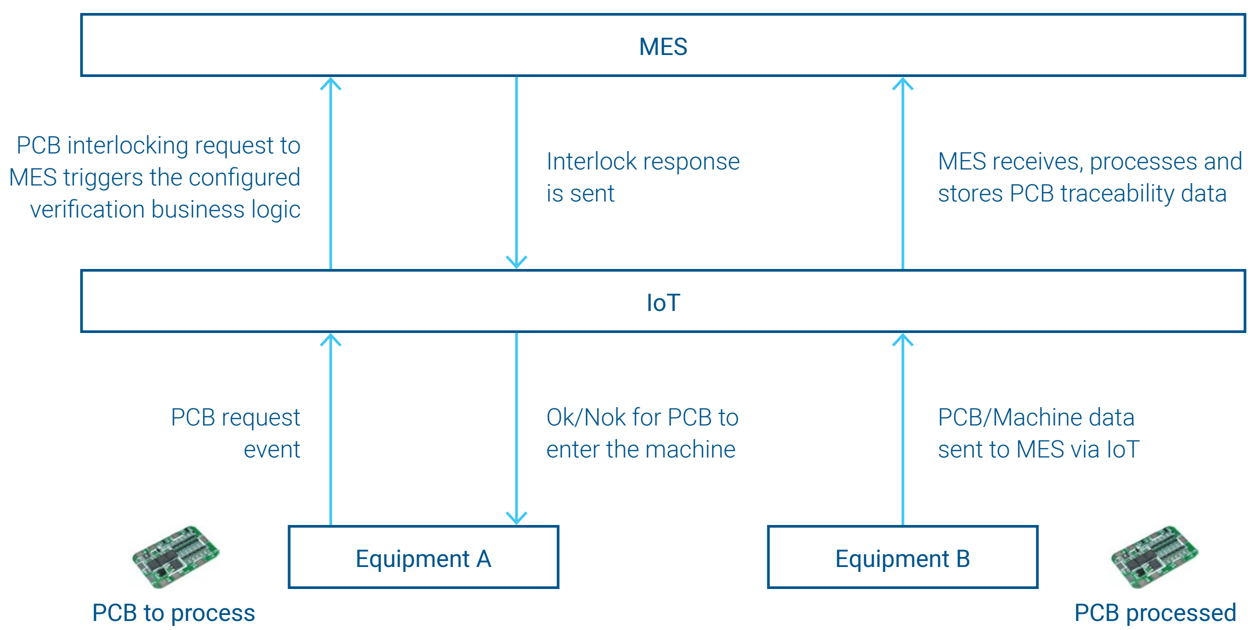


Fig. 8 Process interlocking and traceability record

Defects and Repair Handling

The Challenge

Defect handling is crucial to meeting high and changing customer expectations in a competitive market. Often, electronics providers face quality expectations that appear to be unrealistic. IPC, the global association for electronics manufacturing, is working to define better 'zero defects' and how to prevent and measure defects.[1] Even when the customer is not pushing, effective defect management and product repair and rework support profitability and efficiency.

In PCB production, boards that fail an electrical test or final inspection are typically marked with an X to indicate not to use them. These defective boards will hurt the SMT process' efficiency. Companies that forbid X-Outs or insist on zero defects in incoming PCB arrays will pay higher prices because the supplier must make more panels to eliminate all X-Outs and repackage before shipping.

Given how intricate electronics boards and assemblies are, it's no wonder that many units do have quality issues. This is a day-to-day challenge with the speed of change in product design and component availability and use. In some cases, companies can prevent defects from escaping to customers. To do this, they rework products while still in the production plant to correct any problems. This typically involves replacing components and resoldering them or re-assembling as needed. Increasingly, companies are also seeking to make their products repairable after they ship.

The Solution

Quality must be inherent in the electronics manufacturing process to prevent defects where feasible and address them as early in the process as possible. MES for electronics provides a plantwide view of all defects from incoming materials such as X-Outs through prep, printing, SMT, and beyond. The system allows users to configure alternate routings and dispatch rules to handle X-Outs and other identified defects as they come through the process. This can increase efficiency when working with less than 100% acceptance quality limit (AQL).

Rework and repair guidance can be an integral part of the work instructions. Work instructions guide associates step-by-step with drawings, schematics, or specifications. Supporting the most manual-intensive aspects of the process with guidance, checklists, and process error-proofing increases rework efficiency and effectiveness. When repairing a defect on a multi-panel PCB, as shown in Figure 9, the system delivers the defect code, the board ID, the component part number, and the reference designator. The system can also highlight these visually in the PCB ECAD to support the operator in quickly identifying the location of the defective component.

The system also delivers visibility into the defect and rework rate performance. Dashboards can display charts for metrics, including first pass yield (FPY), defect rate per product, line, or supplier's materials. These are available in real-time on any device.

Fig. 9 Defect location with ECAD support

Sampling and Reaction Limits

The Challenge
Test and inspection operations can be expensive and time-consuming, and not every lot or PCB gets measured every time. Thus, manufacturers rely on sampling for cost-effective test and inspection to ensure the product meets performance expectations such as AQL.

Electronics companies use a variety of different sampling strategies. In SMT, as shown in Figure 10, the most commonly used sampling strategies are time- or counter-based. The first step is defining a sampling strategy at the lot or product level.

- Time-based example: for Product P1, two PCBs must go to an X-Ray step every two hours during the production shift.
- Counter-based example: for Product P2, two PCBs per lot must go to an X-Ray step.

Yet, sampling is not always static – sometimes, the results of the samples should dynamically change the sampling plan. For example, if two samples in a row are bad, the strategy might shift to sample more often or even to test each unit for a set period of time. Once the strategy is defined, the operation must be able to reliably execute to that sampling plan and prove they did so.

The Solution
Modern MES provides the capability to define sampling plans that include which attributes of which sub-materials of each product to measure and how often. The system also supports defining time- and counter-based, plus dynamic and static sampling plans.

For full capabilities, the MES enables sub-material definition for sampling either in the pre-definition or at the inspection step. The sample testing process can also be defined, such as the sequence of which elements to test in a particular order. As with other areas of operation, once these sampling plans are defined, the MES will automatically execute those plans. It can also automatically adapt and enforce correct sampling according to the defined strategy.

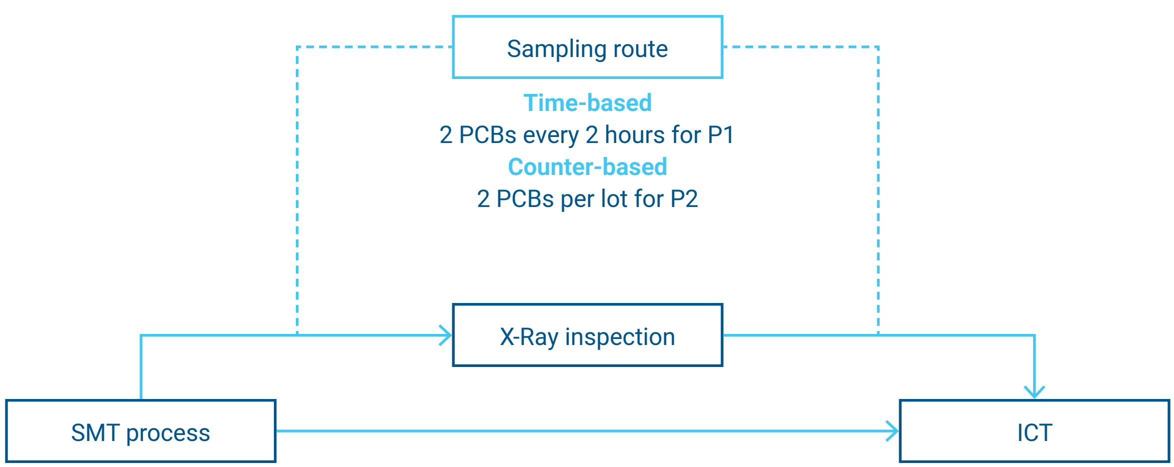


Fig. 10 Time-based and counter-based PCB sampling

Golden Board Run

The Challenge

Because some processes are critical and present some risk to the lot, it's very common to use "golden" or test boards to check the quality of one or more processes, at one or more pieces of equipment, before processing the remainder of the lot. If any problem is detected during the golden board run, the process and equipment can be adjusted until the result is a successful run that confirms the process is within the specified tolerances. Once the golden board results meet the desired specifications, the remainder of the lot can be processed with the same equipment and processes, as shown in Figure 11.

The Solution

The MES must support the creation of a trial run that includes the definition of golden boards and the definition of the lot (or group of lots) that cannot be processed until the golden board successfully passes the defined measurement steps.

In cases when a golden board fails a measurement step, the MES must adjust the run so that the same or a new golden board can be processed to meet the required specifications. It must also prevent work on the rest of the lot until the golden run succeeds.

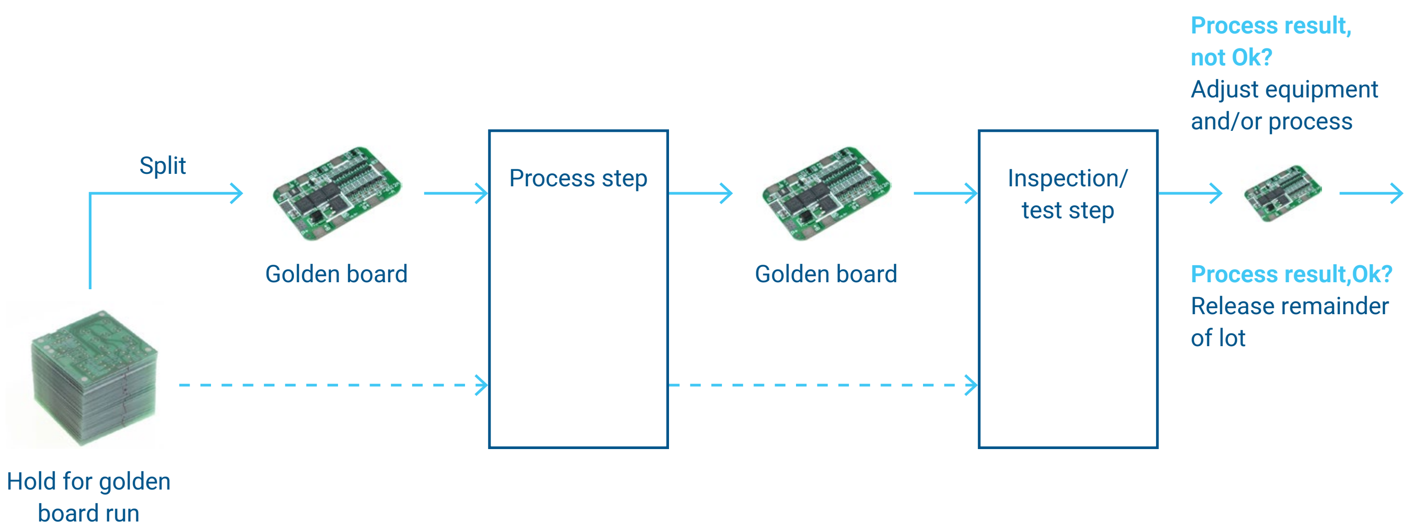


Fig. 11 Golden board run

Analytics/Data Silos

The Challenge

The promise of Industry 4.0 is higher agility and efficiency through more automation and better decisions. All of this rests on effective data analytics.

The variety of data can be challenging to harmonize. Electronics assembly plants use data from a wide array of software systems. These include enterprise-level systems such as ERP for order and materials management, PLM for product information from ECAD to specifications to simulations, and design for manufacturability (DFM) analyses. Unfortunately, data flows from these systems may not be easy to coordinate in the plant.

At the same time, electronics assembly equipment typically has its own software. While the intent is to optimize that process or set of functions, having separate data sources can prevent effective data analysis to optimize the overall operation. Today's value-adding processes need effective analytics to optimize them. Plant managers and their teams need clear signals to prevent equipment stoppages, quality escapes, and downtime. Yet if data is challenging to assemble, harmonize and act on, their capability to see issues and make improvements is limited. With demand so high, this impacts not only costs but often revenues also.

The Solution

Companies typically need MES to harmonize this varied data and put it into context as information ready for analysis. One of the primary roles of MES is to manage data across the entire plant in an operational data store. To work well, it must connect to enterprise systems, SMT lines, and other equipment efficiently and effectively, as shown in Figure 12.

With the IIoT, data is far more distributed than it was in the past. Managing equipment and IIoT data within the MES is a crucial step toward Industry 4.0 capabilities. That combination enables an array of new rich data to feed into the plantwide context.

MES goes beyond the traditional roles of handling data and generating reports. A complete manufacturing data management platform inside the MES includes live dashboards, a digital twin of the factory, and advanced alarm management. In addition to handling any equipment or IIoT data, it can work with new technologies such as mobile devices. This allows operators to adjust to current situations as they arise, with correct guidance based on the product, equipment, tooling, and materials in front of them at that moment.

Plant managers, executives, and non-factory employees also benefit from analyzed and optimized manufacturing data. This ability to access comprehensive manufacturing data can feed success with supply chain and procurement activities, product portfolio planning, customer collaboration, and more.

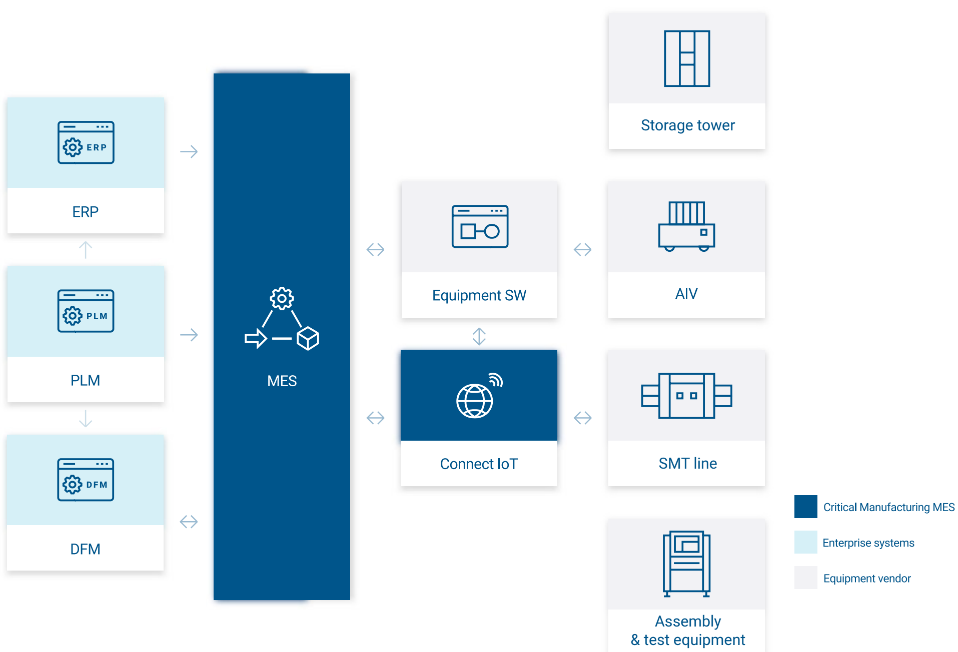


Fig. 12 Integrated MES SMT solution

New Product Introduction (NPI)

The Challenge

Design engineers from across disciplines – electronics, hardware, software, and mechanical- contribute to new product designs. However, there is often a gap between design engineering and production where the design intent can be lost. So, designers may not always succeed at ensuring designs are manufacturable when they arrive on a particular line in a specific plant. Even if they are, the production team often cannot immediately see the design with all the manufacturing data and specifications they need to measure and ensure quality.

In addition, available and sourced parts may not always meet the original design specifications. Particularly with the electronics components shortages, procurement teams consistently struggle to find appropriate materials with high quality and reliability. With constantly changing bills of materials (BOMs), defects are bound to arise. NPI success and profit rest on how well early failures are contained and how quickly they can be prevented from recurring. Yet, that's typically not easy.

Finally, new products may run on the same lines as other established products, and managing both new and high-volume products together is very challenging. New product trial runs ideally interfere only minimally with the production of other products. However, they typically must interrupt regular output on the line.

The Solution

The MES includes every new product BOM with components specified. It also lets operations personnel see the ECAD files. The system loads and associates these ECAD design files with each product to be produced, allowing users to zoom, pan, rotate, measure, and select which components they want to visualize or hide. As shown in Figure 13, engineers can access all layers of a PCB on one side of the screen, while the other side displays the product tree with all the product components and corresponding reference designators. Manufacturing engineers can also use the same ECAD file visible in the plant to create work instructions and checklists for operators. Delivering all this information to the operation reduces the opportunity for errors, even for a product no one has seen before.

NPI speed is crucial in most electronics segments, whether based on direct competitors' activity or customers' requirements for their end product improvements. Having the BOM and ECAD files available in the MES reduces the possibility for errors to occur in later deployment stages by ensuring the integrity of data from multiple sources from the very beginning of NPI. The deep quality, WIP tracking, and operator guidance allow trial runs to be planned and occur without affecting established products' running while significantly speeding NPI.

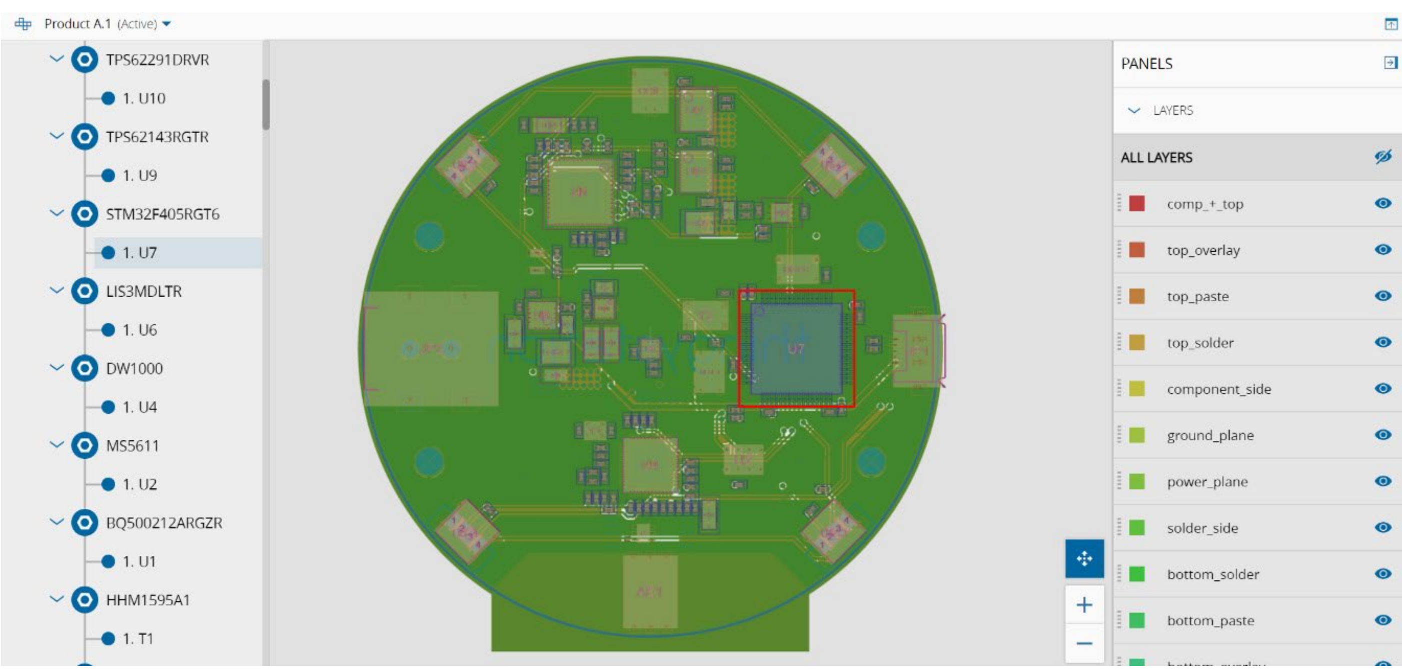


Fig. 13 PCB BOM and ECAD view

People Engagement

The Challenge

No matter how automated a plant is, the operation's success still relies on people. Unfortunately, the electronics industry continues to face challenges in finding and recruiting skilled talent[2]. Thus, companies must create the best possible working environments for both long-time and newer employees. Keeping everyone happy might seem impossible since experienced experts often want to guard their knowledge while new employees need to gain it rapidly.

Historically, employees might have seen MES as just another thing that slowed down their work rather than supporting it. Employees typically measured on efficiency and throughput don't like that. Some software projects failed to achieve the benefits possible due to workforce resistance.

Even if the initial fit was good, the production software has often become outdated. To get updates to match new capabilities from people's continuous improvement efforts, they typically had to wait weeks or months for the software provider or an IT expert to update the system. By that time, new changes will have occured, leading to ongoing frustration.

The Solution

MES should be easy to use and add clear value to the users' ability to perform their tasks confidently and efficiently. People will want to use MES if it makes their daily work easier, even when new products, new requirements, or other changes in their tasks are required. The solution should also enable them to work on mobile devices and quickly request configuration updates if needed.

For this to occur, the MES must have a thoroughly modern architecture. This includes containerization for a composable architecture[3] that can be deployed on the cloud, on the edge, on-premises, or a mix. The MES will also have a DevOps environment that the manufacturer and its service partners can use on an equal footing with the software provider. A deployment approach that enables best practices and changes to roll out quickly to only the plants and lines that need them also supports people's success.

The manufacturer implementing MES must also make it clear that they understand that people are critical to the success of the MES project and the plant. In deploying MES, the workforce who will use it must participate from the outset. Agile implementation methodologies will enable operator feedback on the configuration and quick updates to get it to something that genuinely does improve users' work life.

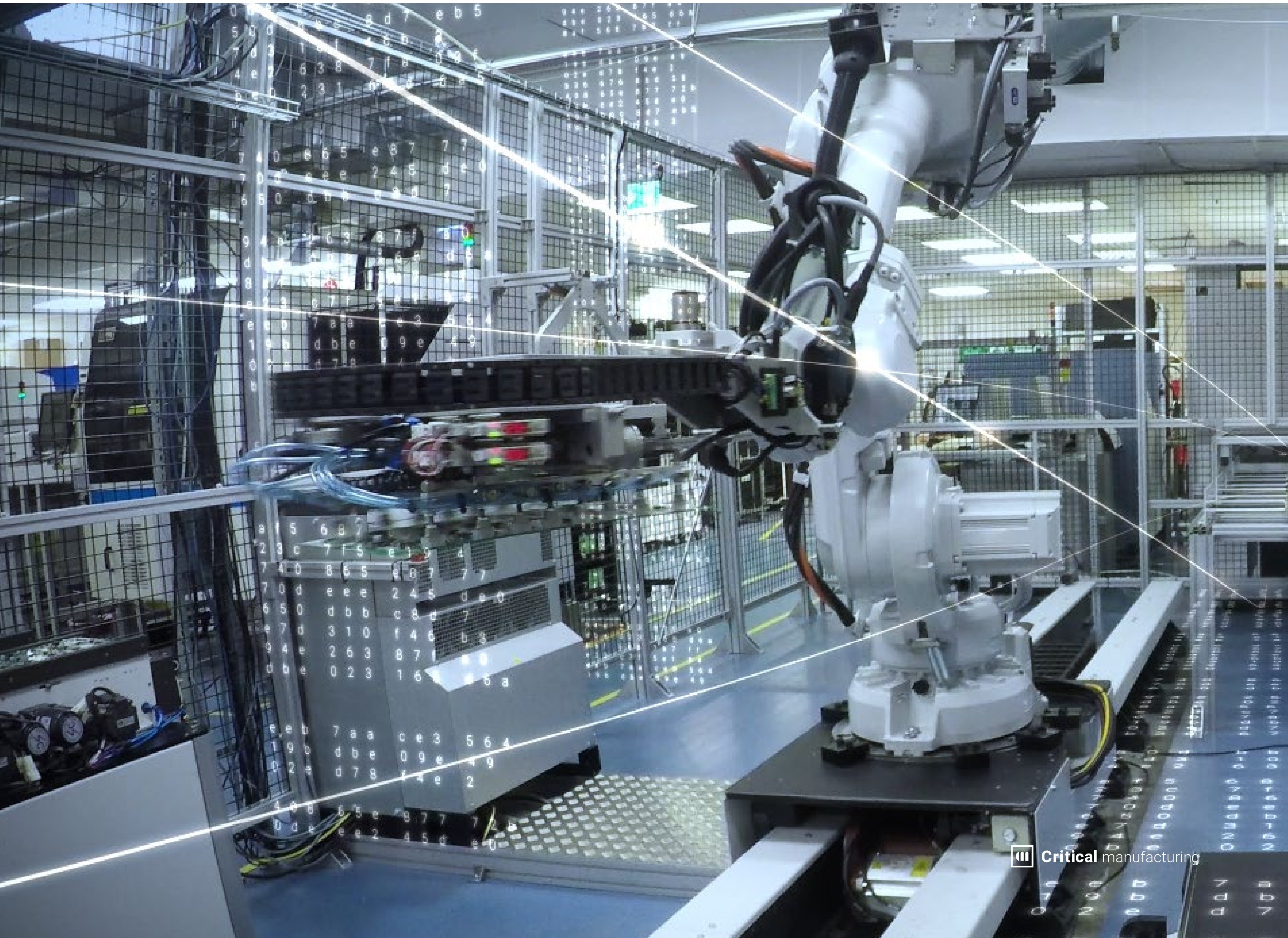
Conclusion

Electronics manufacturers have been innovating as businesses and must ensure their manufacturing software can accommodate their success. Companies need software that covers not only the SMT lines, but manages the entire factory. Upstream and downstream processes such as incoming inspection, testing, assembly, packing, and shipping must operate smoothly as an entire production process.

This need to manage the total operation means electronics manufacturers must have consistent views of their manufacturing data through master data management. With supply shortages, materials and WIP management are crucial. Traceability is essential for compliance with regulatory and customer demands and shareholder value. Keeping customers happy requires defect handling, including rework and optimizing flows around known X-Outs and defects.

Resource tracking and maintenance support low-cost, high-quality and speedy production. This is possible not only for known, standard products but also for new products. Speeding NPI through production is crucial. And being able to leverage all the rich streams of data in production for advanced analytics can enable new levels of business success.

Innovation is not limited to products in electronics. The production floor can be a direct source of success if its people and processes are adequately equipped to innovate effectively. With this solution, electronics manufacturers can find the advanced capabilities they need to win in their market segments.



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About the Author
Hugo Leite holds an Electrical Engineering degree from Instituto Superior de Engenharia do Porto (ISEP), Portugal. His professional career started at Bosch Car Multimedia Portugal as planning and process engineer. Within his role, among other activities, Leite was responsible for the plant technical capacity calculations for SMT lines, milling, coating and IC programming processes. And also, for purchasing and release new SMT production lines, process optimization and new product introduction. After Bosch, he worked as assembly project engineer for Kirchhoff Automotive Portugal. With extensive knowledge and experience in SMT processes, in 2020 Hugo Leite became product manager for Electronics/SMT at Critical Manufacturing.

About Critical Manufacturing
Critical Manufacturing provides the most modern, flexible and configurable manufacturing execution system (MES) available. Critical Manufacturing MES helps manufacturers stay ahead of stringent product traceability and compliance requirements; reduce risk with inherent closed-loop quality; integrate seamlessly with enterprise systems and factory automation and provide deep intelligence and visibility of global production operations. As a result, customers are Industry 4.0-ready. They can compete effectively and profitably by easily adapting their operations to changes in demand, opportunity or requirements, anywhere, at any time.

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