TECHtips
Electronics Manufacturing Insights from ACI Technologies, Inc.

Virtual Manufacturing

"What is Virtual Manufacturing?"

The simplest answer is a manufacturing simulation using a computer. The more complete answer is that virtual manufacturing is the process of designing a model of a real system and conducting experiments with this model for the purpose of understanding the behavior of the system. In today's complex manufacturing environment, processes must be completely understood before implementation in order to "get it right the first time." To achieve this goal, the use of a virtual environment is essential for simulating individual manufacturing processes and the total manufacturing system. By driving compatibility between the product design and the assembly plant process, these virtual tools enable the early optimization of cost, quality, and time to help achieve integrated products, process and resource design, and affordability.

Moreover, manufacturing systems may be widely distributed geographically and linked in terms of material, information, and knowledge flows. Virtual manufacturing is the only method that can encompass product, process, resources, and plant to provide flexible and agile production. With the increase in global competition for high-quality products and compressed development schedules due to shortened product lifecycles, virtual manufacturing allows early entry into the marketplace.

Benefits of Using Virtual Manufacturing

- Visualize the material flow through the manufacturing system.
- Identify the bottlenecks of the system.
- Understand the equipment and manpower utilization.
- Optimize the system by virtually adding resources (equipment/manpower) to observe performance responses.
- Perform cost analysis per manufacturing process.
- Predict and eliminate on-the-job injuries as well as ensure manufacturing feasibility, part by part.
- Assembly planning and validation.
- Process simulation.

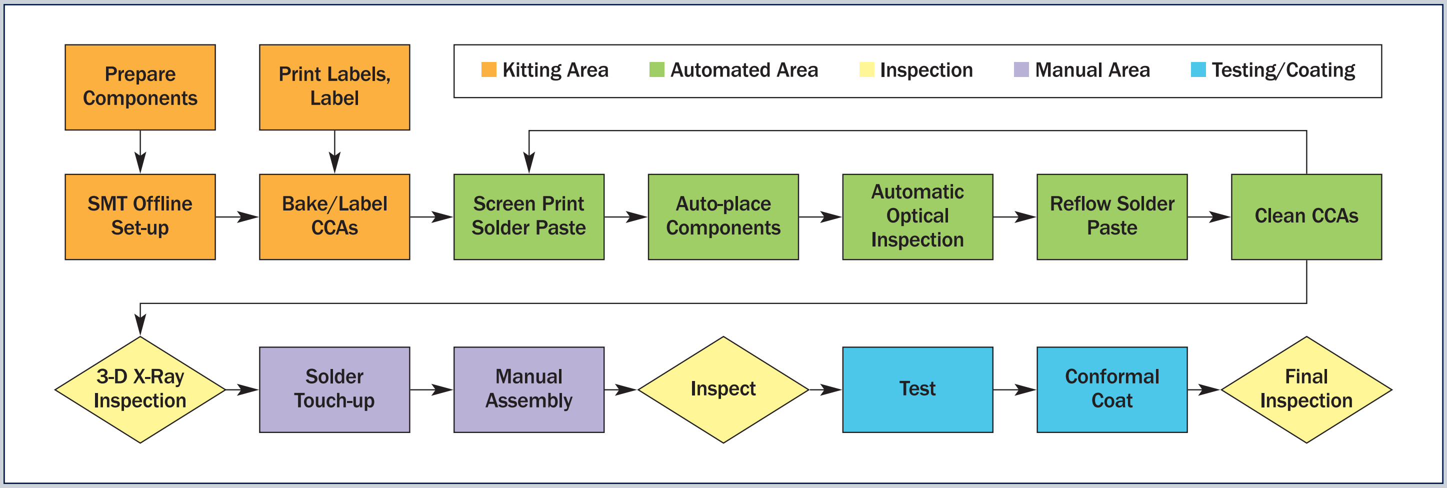

Figure 1: CCA Assembly Flow Chart

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Virtual manufacturing has also been successfully implemented in the following areas:

- Airport operations.
- Urban traffic study and development.
- Maintenance operations.
- National economy study.
- Waging military battles.
- Material and warehouse distribution systems.

Manufacturing a double sided circuit card assembly (CCA) is shown in Figure 1 and modeled using simulation software.

Double Sided Circuit CCA Flow Diagram

1. Kitting Area: Work orders are created, printed wiring boards (PWBs) and components are pulled from the stock room and kitted. Components are replenished.

2. Automated Area: PWBs are labeled and routed through an automated solder screen printing machine. Solder paste is inspected and the surface mount technology (SMT) components placed on the PWB using a chip-shooter or a pick and place machine. An automated optical inspection system (AOI) checks the presence of the component, component value, and the orientation. Missing components are replaced manually. The PWBs are then passed through a solder reflow conveyor where the solder paste is melted and component attachment takes place. Residual solder flux is removed using circuit board cleaning equipment. If components must be attached on the back side, the process is repeated. Assembled SMT components on the PWBs are then inspected under an x-ray system for solder reflow quality. If any defects (like missing solder, voids, or shots) are observed, the PWBs are reworked.

3. Manual Area: Non SMT components and some of the heavy SMT components which need special attention are hand soldered in this area. The PWB panel is depanelized into individual PWBs using a depanelizing tool. After mounting on a special casing to protect the bottom side components, connectors and filters are hand soldered, and the PWB is cleaned. Flying probe and continuity tests are performed on individual PWBs. Failed components are reworked or replaced at this station.

4. Conformal Coating: PWBs are then conformal coated, cured in the oven, and inspected. Any coating defects found in this area are returned to the manual area for recoating. Good parts are packed and the job order closed out.

Assumptions Before Simulation

During the simulation of the CCA manufacturing process, educated assumptions were made regarding the resource, equipment layout, equipment availability, and the manufacturing process flow. Some important assumptions are listed here.

- Double sided, hybrid PWBs will flow through the kitting area, automated area, the first manual area, coating area, and the second manual area. Individual PWBs are in a 2x2 panel.

- PWBs are transferred between different areas in batches of sixteen PWBs.

- Six operators will be needed in these positions: kitting operator, placement operator, inspector, assembly operator, testing operator, and coater operator.

- Assembly time used in the simulation is based on previous experience.

- Equipment resource was assumed to be dedicated to PWB assembly with no conflicts in resources. It is assumed that machine utilization is 100% with no down time. Resource utilization (manpower) is 70%.

- Defects like solder paste printability, component placement, solder reflow defects, and conformal coating are assumed to be 98% defect free.

Simulation Report

The Arena software ran ninety-five iterations to get a 95% confidence level in the simulation model. The time spent in each area and manpower utilization was calculated. The average time spent to assemble a batch of sixteen PWBs was determined to be 26 hours. The most time is spent in the first manual area where hand soldering of connectors and cleaning of the PWBs occurred.

Analysis Results

Based on statistical analysis, with 95% confidence we can state that:

- The time spent in the manual area accounts for approximately 50% of the total manufacturing time.

- The assembly operator is the most utilized resource at 34% utilization, which is more than twice as much as any other resource.

- The system is under-utilized, with most of the resources utilized less than 20% of capacity.

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Virtual Manufacturing Simulation Conclusion

It can be concluded that with the current input parameters, the system is underutilized.

- The biggest bottleneck was the manual hand soldering station. With operator cross training and additional hand soldering stations, this bottleneck was eliminated and manpower utilization improved to 50%.
- Equipment layout was modeled using simulation software to optimize the product flow with minimal handling thus saving unnecessary installation and moving costs.
- Operator movement around the machines and work benches was modeled to provide ergonomically designed work cells.
- Kan-Ban storage for replenishing components and floor stock was strategically placed to optimize the production flow.
- The kitting operator was trained and certified to also perform conformal coating. After optimizing the production line resource to five operators instead of six, the simulation was recalculated and showed an additional 10% improvement in manpower utilization.

Adjustments like these can be made before large investments in capital, resources, and time using virtual manufacturing software available in manpower utilization.

Please contact the Helpline at 610.362.1320 or email helpline@aciusa.org for more information about Virtual Manufacturing and "get it right the first time."

ACI Technologies