How to Increase Production and Reduce Costs Through Optimized Dynamic Scheduling

The electronics assembly industry is changing rapidly. Today’s OEM and Contract Manufacturers face mounting challenges in meeting growing customer demand for greater product diversity, incorporating lean manufacturing standards and new environmental requirements, and managing supply chain issues – all while maintaining rock solid product reliability.

Introduction

A growing number of manufacturers are experiencing a shift in order types, volumes and requirements from customers. The new emerging model is one that requires companies to produce a higher mix and lower volume in short, just-in-time scenarios. Consequently, manufacturers are facing massive changes in the way they must operate their plants, maintain margin, and generate a profit.

Much greater management control and insight is essential for plant managers to keep the production environment aligned with the needs of the business, and ultimately, the needs of the customer. In this new reality the production operation – from the shop floor to the materials cage – must be more agile to accommodate rapidly changing production demands, including real-time production rescheduling and efficient hot jobs handling.

The shift to a high mix model introduces an array of new complexities, including larger numbers of daily changeovers, a greater variety of materials and varying setup strategies for production runs. These factors result in costly production issues such as lower production rates, higher headcount, more machine downtime, lower utilization, higher production costs, and ultimately, lower margins.

Many Manufacturing Execution Systems (MES) software vendors are addressing this challenge by incorporating production scheduling capabilities for work order grouping into their product offering. In most cases, these software solutions only enable the grouping of two or three work orders in a static one-time event. While these solutions provide some production efficiency gains, they fall short in addressing the full scope of the problem.

What’s needed is a new approach – one that enables manufacturers to redefine the production scheduling management and execution process.

Manual Production Scheduling Approaches Impede True Lean Manufacturing

For many electronics assembly companies production scheduling entails a tedious planning and execution process that relies on rudimentary tools such as a whiteboard.
or spreadsheets. In a typical manufacturing plant, production scheduling entails the following process steps which, in most cases, are performed manually:

The scheduler receives the work orders from the ERP system and initiates the process by evaluating plant production constraints – such as order due dates, materials, line capabilities, and labor resources. Planning in earnest then begins, as the scheduler selects the line for producing the assembly, determines the quantity, checks the MRP to verify the availability of materials and ensures that the proper tooling is on hand.

These initial checks and planning steps must be completed before any optimization or workload balancing can be conducted, which is also typically performed manually. Given the myriad variables and data involved, managing these manual tasks is extremely challenging and further complicated by frequent schedule changes that occur due to customer demands, such as hot jobs and prototype runs. These changes often void the initial production schedule and affect other process steps critical to efficient manufacturing such as kitted materials, machine setups, etc.

After comparing current production to future production requirements, the scheduler generates a schedule that defines the specific production lines to be used and run time for each work order. Programming and setup instructions are then generated and transmitted to each machine in the production line. Many manufacturers have multiple brands of SMT machines – each requiring specific programming, setup and verification – which dramatically increases the scheduling complexity.

Rather than attempting to manage different programming software for each machine type, many companies dedicate certain lines to certain products, which results in missed production schedules, additional labor costs, multiple scattered libraries and assembly programs, and inefficient equipment usage across the factory.

The limitations of this manual approach prevent manufacturers from maximizing production capacity and leveraging the full value of capital equipment, materials inventory and labor resources.

Thus, true lean manufacturing is unattainable in this environment.

While some manufacturing operations use software tools to automate pieces and parts of this process, significant inefficiencies remain due to the lack of overall integration across the total production process. Even when new process improvements are implemented, manufacturing output is not fully maximized – because achieving full optimization is beyond human capacity.

However, new Dynamic Optimization technology now enables companies to overcome these limitations to realize a new level of production efficiency and dramatic gains in production capacity.

Optimized Dynamic Scheduling Delivers New Levels of Production Efficiency and Operational Agility

Optimized Dynamic Production Scheduling is a state-of-the-art approach, developed by Optimal Electronics, for automating printed circuit board assembly and achieving fully optimized production capacity, in real time, without adding capital equipment or headcount.
This innovative approach, shown in figure 1, utilizes advanced mathematical algorithms – at three levels – to achieve fully optimized production scheduling:

- **First tier:** At the first tier, all available work orders are analyzed using a custom engineered heuristic greedy algorithm that optimizes the grouping of work orders, based on commonality, thereby maximizing your production output, minimizing the total number of groups, and drastically reducing changeovers.

- **Second tier:** Optimization at the second tier employs an advanced genetic algorithm that optimizes the sequencing of work order groups based on specified criteria, such as optimizing fixed feeder placement, so that the number and placement of common feeders between groups is maximized and changeover time is minimized.

- **Third tier:** Two final custom genetic algorithms are used in the third tier to achieve the best machine setup to minimize component placement time for SMT machines. Optimization of component placement on the board is performed within the constraints of the optimized schedule generated in the first two tiers.

As shown in figure 2, the production schedule is then dynamically adjusted and re-optimized as new work orders enter the production stream.
Optel also optimizes the fixed feeder setup, rather than just the groups; thus, the range of assemblies that can be included in a group is much broader, further increasing production and flexibility.

This new Dynamic Optimization approach enables manufacturers to maximize production capacity far beyond the gains that can be achieved with basic work order grouping approaches. Often referred to as job clustering, family setups or group setups, these static approaches entail the evaluation of currently scheduled jobs to assess the component commonality between boards and the ability to group work orders based on available machine slots. This basic approach does not optimize the work order groupings, the order of the work orders within the group, nor does it optimize the sequencing of work order groups to minimize changeover time. Thus, most of the potential for changeover reduction is not garnered.

Most importantly, these static approaches do not account for three critical factors:

- The volatile nature of the production environment and the need to dynamically re-optimize when changes occur in production objectives and product delivery requirements.
- The need for a dynamic materials management (kitting) system that can fully support a real-time, dynamically optimized production line.
- An integrated system that incorporates all other aspects of lean manufacturing, including component traceability, process traceability, and quality management.

When a company employs advanced Optimized Dynamic Scheduling technology, a new level of efficiency and productivity can be gained from eliminating the complex, time-consuming, often error-prone, aspects of creating and managing production schedules.

For example, with Optimized Dynamic Scheduling technology, production information is integrated into one system – connected by a single database – which allows production parameters to be automatically checked and verified, while user control is still maintained. Once the work orders have been automatically imported, the system selects which work orders and quantities to optimize and schedule, based on specified parameters such as target production windows (a day, a week, etc). The production scheduler selects the assembly and imports CAD and BOM files into the Optimized Dynamic Scheduling system, if those files are not already present. The system automatically performs line fit and verification, based on the assemblies to be built. Optimization is then performed at three levels using the three tiers of advanced algorithms described previously.

Dynamic re-optimization can now occur, automatically, as new work orders arrive and are introduced into the production stream. As shown in figure 2, the system automatically re-optimizes the previously generated groupings that have not been kit – resulting in continuously re-optimized production runs.

In addition to scheduling optimization, true lean manufacturing requires control and communication capabilities throughout the entire production process. With Dynamic Optimization technology, once optimized groupings are created, pick lists can be automatically generated for the kitting in the warehouse with the required time horizon.
Offline and online setup instructions can also be automatically generated and displayed to the operators, in real time, to facilitate shorter and more accurate setup and changeover processes.

Most importantly, this new Dynamically Optimized manufacturing environment enables the production operation to efficiently accommodate changing requirements – such as hot jobs or unanticipated component packages – by re-optimizing production on the fly to fully maximize manufacturing output.

**Major Benefits and Capabilities of Optimized Dynamic Scheduling**

The impact of this innovative production scheduling approach has significant implications for the electronics assembly industry. It has a direct and immediate impact on manufacturers’ ability to adapt the production operation, in real-time, based on business drivers – with as little cost as possible. By leveraging Optimal Electronics’ state-of-the-art optimization technology, OEMs and Contract Manufacturers are significantly more equipped, both strategically and tactically, to deal with the new demands of high mix, low volume, just-in-time production scenarios.

Some of the major benefits include:

- Allows manufacturers to build more with less, faster – speeding time-to-market and making low volume, niche market opportunities more profitable to pursue.
- Provides innovative new capabilities for leveraging product commonality.
- Enables new economies of scale that dramatically reduce materials and labor costs – increasing overall profit margins.
- Reduces the impact of new standards, changing market requirements and shifting customer demand.
- Provides an integrated approach for greater visibility and control over the production scheduling process.
- Allows production managers to avoid or quickly resolve potential production scheduling issues.

Specific production-related benefits include:

- Dramatically reduces changeovers – less people, less downtime, less materials.
- Enables real-time, dynamic rescheduling and efficient hot job handling.
- Reduces headcount from warehouse to shop floor.
- Improves Overall Equipment Effectiveness (OEE).
- Provides centralized production information and a global components library.
- Improves inter and Intra-line workload balancing.
- Reduces machine downtime due to advanced low parts warnings.
- Improves materials inventory accuracy; reduces materials handling, loss and damage.
- Automates the generation of routing, line setup, and machine setup instructions.
- Automates job assembly data validation for evaluating completeness before scheduling.

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**Case Study Snapshot: Rockwell Automation**

“Our high mix PCB manufacturing environment benefits from Optel’s powerful dynamic scheduling algorithms, coupled with its machine optimization and program generation capabilities. Integrating Optel into our broader MES architecture helps us better balance multiple assembly lines, automatically program a variety of machines, and schedule setups instead of work orders.”

Mike Reynolds
Director, Operations
Rockwell Automation

**Case Study Metrics**

- Reduced setup time by 65%
- Slashed total setups by 400%
- Nominated for Chairman’s Award

**Before Optel**

- 23% machine utilization
- 20 - 30 changeovers per day
- 1 hour avg. setup time

**With Optel**

- 40% machine utilization
- 3 - 6 changeovers per day
- 20 minute avg. setup time

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About Optimal Electronics Corporation

Optimal Electronics is a global provider of innovative manufacturing execution system (MES) solutions for the electronics assembly industry. The company's state-of-the-art dynamic optimization technology enables you to align your production operation to changing business goals, to meet growing customer demand for product diversity, and respond to competitive pressures and volatile market conditions.

Optimal Electronics’ flagship product, Optel, provides a fully integrated, modular shopfloor control system for production improvement, materials management, traceability and quality management. With Optel's real-time visibility, you gain greater control and management insight for better planning, decision-making and execution across every aspect of the production process.

Optel’s Dynamically Optimized Scheduling Module enables you to optimize your production environment well beyond human limitations, increasing your production capacity by up to 50% -- without adding equipment or headcount, and while reducing WIP materials cost. Optel delivers the productivity, production efficiency and quality you need to achieve economies of scale, time-to-market, cost reduction and ultimately, greater profitability.

Optimized Dynamic Scheduling Analysis

The Optimized Scheduling Analysis is a no-cost program that enables you to make a side-by-side comparison of Optel’s Optimized Dynamic Scheduling capabilities against your current state process.

The goal of this program is to identify, quantify and compare the specific benefits that Dynamically Optimized Scheduling can deliver, as part of a proof-of-concept process before making a purchase decision.

Based on your historical data, Optel produces an optimized schedule that can be directly compared to your actual production schedule. The resulting analysis enables you to evaluate and contrast Optel's optimized results with the actual (historical) time required to produce the same product(s), as well as the number of setups, teardowns, changeovers, and changeover duration.

To learn more about Optimal Electronics’ Optel solution or to schedule your free Optimized Scheduling Analysis, please contact Bill Crowley at bill.crowley@optelco.com or 512-372-3415.