APPLICATION OF FINITE CAPACITY TECHNIQUES IN AN ERP ENVIRONMENT

Carl Tomlinson MIOM, ABB

ABSTRACT

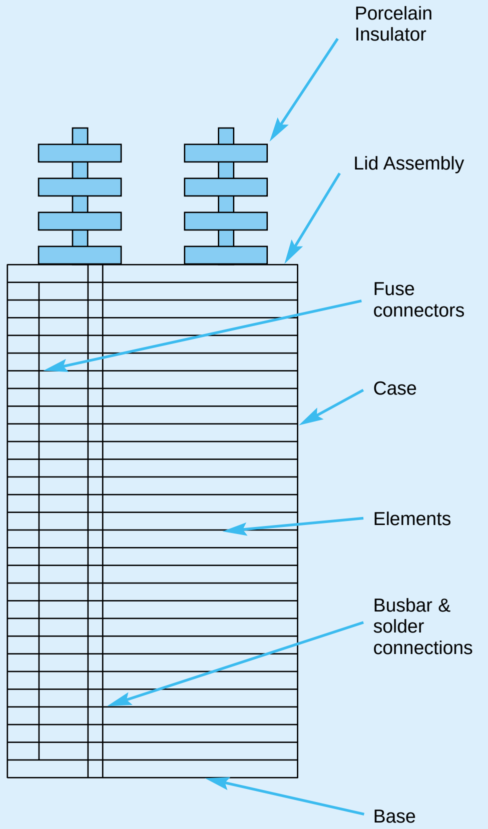
This article describes how finite capacity scheduling techniques were applied in an ERP environment. Finite capacity techniques were first introduced in the 1980's and were brought to prominence by Eli Goldratt who developed 'OPT', arguably the first APS (Advanced Planning System), and wrote *"The Goal"*. Many companies have used the techniques of bottleneck theory to improve their business performance with or without APS software. However, the adoption of JIT and subsequent adoption of lean techniques especially in industries such as automotive where efficiencies are gained from levelled scheduling of common components, with little variation in standard times, has meant that finite capacity scheduling has lost some of its previous favour.

THE 'DRUM BUFFER ROPE SYSTEM'

The 'drum buffer rope system' is an analogous title, which attempts to explain the concept of synchronised manufacturing ie. moving material quickly and smoothly through the various resources in a manufacturing system in concert with demand. The analogy used is a troop of soldiers on a forced march. In any troop of soldiers there are some that march faster than others. Were there no controls in place, the soldiers would spread apart, analogous to increasing inventory. If the slowest soldier is in the middle of the troop, then the soldiers following him will always be on his heels. The gaps therefore will spread in front of the slowest soldier. By linking the slowest soldier (in the middle of the troop) with a 'rope' to the soldier at the front of the troop, the length of rope chosen will determine the size of this gap. The troop is then forced to march at the pace of a 'drum' beating a pace no faster than the maximum pace of the slowest soldier: the 'drum' beat is analogous to the rate of customer demand and the whole troop can walk no faster than the slowest soldier.

Figure 1

Capacitor Cross Section



In summary the 'drum buffer rope' system attempts to optimise the whole manufacturing system by balancing the flow through a manufacturing system rather than the traditional approach of optimising each individual workstation to balance their various capacities. The outcome is resources only produce what is needed, when it is needed, rather than creating unnecessary work in progress. Moreover unlike the Just-in-Time system, bottleneck operations are protected from disruption with a planned level of work in progress (length of rope).

INTRODUCTION

Capacitors have been manufactured for around 100 years and very little has changed to the design. Basically the capacitor is a series of 'elements' encased in a steel box and impregnated with special oil as in Figure 1. The elements are wound from reels of polythene film and aluminium foil between 5 and 16 micron thick. The manufacturing process is shown in Figure 2.

Each capacitor can have between 10 to 60 elements. Each capacitor element is wound from one foil roll and up to 4 film rolls. The wound length of element and the film and foil thickness will be different for each capacitor and customised for each customer order. The batch sizes will vary from 1 to 600. A truly, customised environment. The winding speed is constant at 40 elements per hour. However, as the number of elements for each customer order is different and the soldering time changes with the size and complexity of the capacitor, capacity planning and SFC (Shop Floor Control) are complex.

Traditionally, the normal production order process had been applied. Orders were launched with production based on a sales forecast without regard to production capacity. The shop was organised functionally. Consequently, production was stifled by excessive work in progress and lead times extended as production planning tried to 'push' more production through a constrained and unbalanced shop with skills demarcation.

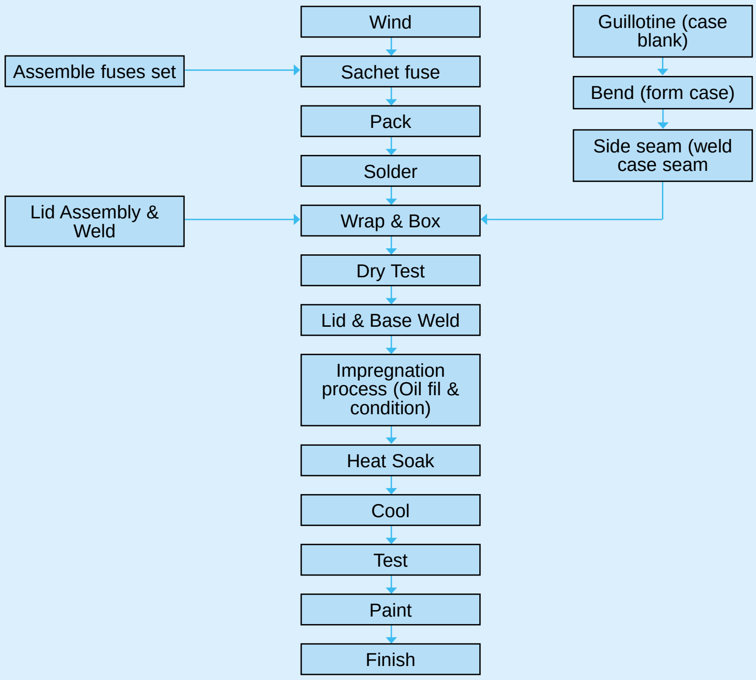
FIXING THE PROBLEM

The first step was to establish the bottlenecks. This was easy! The mountain of WIP in front of the soldering operation soon gave it away. However, validation against standard times and knowledge of the process revealed, winding, which is machine dependant, becomes a bottleneck when demand reaches a threshold of about 350 units per week dependant on mix. Soldering, which is labour dependant is a constraint, which can be addressed by training and adding skilled operators. This was tested against the standard times. However, occasionally if the product mix changed or absence was high, the winding shop would become the bottleneck, in which case solder would become constrained and efficiencies would plummet.

The next step was to design a 'drum buffer rope system', introduce a disciplined planning regime and define the scheduling points. To do this the planner matches the solder shop resource available hours against hours required. Then

Figure 2

Capacitor Manufacturing Process



checks this against the winding hours available and if this checks against available capacity in winding he creates a schedule for lid weld, which is the natural synchronisation point in the process. Effectively lid weld becomes a fictitious 'drum' and the rope is the schedule at winding. In practice this tends to be an iterative process. Once everything is balanced, the plans are issued to lid weld and winding. The solder shop is issued with a guidance only schedule because the ERP system uses fixed lead time model and cannot provide a realistically sequenced schedule; this is the other reason for lid weld being made a 'fictitious drum'. An APS system would not only solve this problem, but would also cut the planning time from 1-day to a couple of hours maximum.

The result was effective immediately; work in progress between wind and lid weld reduced from 250 to 120 capacitors in 6 weeks.

FURTHER REFINEMENTS

Once the basic system was up and running and people had got used to working with less work in progress, it became clear that the plan was not being met for a number of reasons. The team leaders were asked to identify the root causes of non-conformance to plan. Root causes were found to be:

- Unplanned absence
- Shortages
- Not working to plan.

A two-bin system was implemented which has eliminated material shortages to solder shop. Unplanned absence was minimised by asking the operators to give more notice of their holiday requests and conducting back to work interviews. An ongoing education programme has been effective in helping operators understand SFC and the need for maintaining the planned sequence.

Performance to plan has improved from 10% to 80-90% daily over a 12-month period. The total manufacturing process lead time has correspondingly reduced from 20 to 16 days. WIP is now averaging 30 units between wind and lid weld.

NEXT STEPS

This really has been the first step in our journey of continuous improvement. We have recognised the solder shop as a capacity constraint rather than a bottleneck because more labour can be employed to add more capacity. It is the 2 winding machines that become the bottleneck dependant upon demand and product mix. The current forecast has consistently indicated a level of output of 300 capacitors per week in quarter 3/4 this year, which will create a bottleneck at winding. Therefore the next steps are to 'break the bottleneck'. Although the winding machines can be run 6 days/week 24 hours per day with the 7th day for maintenance, the preferred method of operation is 5 day 3 shifts, which is more cost effective and easier to manage. An OEE (Overall Equipment Effectiveness) exercise has been conducted, which has established that breaks and set ups account for 25% of idle time. An improvement workshop has been planned which will apply the Kaizen techniques of OEE and SMED (Single Minute Exchange of Die) to increase the available time on these machines. In the meantime a cross training programme has been introduced so that solderers can wind and vice versa. This will give the supervisors much more flexibility when trying to balance the flow in an environment where the product mix is constantly changing.

CONCLUSION

Loading the shop to its own potential and the application of the 'drum, buffer rope' system has significantly reduced process lead time and work in progress. Identifying and implementing counter measures to the root causes of non-conformance to plan has further enhanced process reliability and fostered stronger relationships between Sales, Shop floor and Planning.

REFERENCES

1. Goldratt and Cox, *"The Race"*, 2nd edt, North River Press, 1986.
2. Goldratt and Cox, *"The Goal"*, North River Press, 1984.
3. Shigeo Shingo, *"A Revolution in Manufacturing: The SMED System"*, Productivity Press 1983.
4. Tincher and Sheldon, *"The Road to Class A Manufacturing Resource Planning (MPR2)"*, Buker, Inc 1995.

About the author

Carl Tomlinson, MIOM, CIPS, AIMechE is Supply Manager at ABB Limited in Ellesmere Port. He has held supply management planning and inventory roles and has been an active practitioner of lean techniques within leading companies and is a member of the Institute of Operations Management. Carl started his career in 1985, at the then Lucas Diesel System, implementing JIT and went on to train as an OPT Analyst before taking management roles at JCB Transmissions and Garrrett Turbochargers.