# CAPACITY MANAGEMENT AND THE CONTROL OF BOTTLENECKS WITHIN A SHOP FLOOR CONTROL SYSTEM - A CASE STUDY

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This article describes a project in wire and cable manufacture using shop floor control.

The brief was to improve delivery performance and this was certainly accomplished. However, there were many other surprises along the way.

This was my first project in the wire and cable industry. Initial discussions met with the usual, "It's all black magic and cannot be controlled formally". There was disbelief that formal and effective control could be exercised over manufacturing operations.

## OBJECTIVE

The system was not MRP. Neither was it machine monitoring or process control. Rather the bit in the middle. It was the provision of shop floor control. Effective capacity management, using finite capacity techniques, was a key element of the total system. This was used in conjunction with materials procurement, to ensure that expensive materials (for example copper) were obtained to match the processing capacity of the factory.

Shop floor control is the system that executes a manufacturing plan at shop floor level. Shop floor control takes into account all the constraints and uncertainties that happen on the shop floor and maintains an achievable plan. That is, it controls the unplanned, as well as the planned.

This approach does not mean throw away your MRP system, rather supplement it, recognising its limitations.

The shop floor is undoubtedly the most difficult part of a business to control. But done effectively it is the most rewarding. People react to this level of control, because some of the decision-making is removed. It is undesirable to have people making decisions which adversely affect the plan, although they are probably working with the best intentions. Initially they will react negatively to this concept and fight against it. Only when they see that it actually helps them will they become supportive.

## PROFILE OF COMPANY

The user company manufactured a wide variety of products. The environment was make-to-order with some repeat business. Products included copper and aluminium wire, plastic and rubber insulated cables. Applications were power, wiring, signal and electronics cables.

Appoximately 100 different wire types could be required, although usage obeyed the 80/20 rule. Wire and strand (wires twisted together) were made to stock.

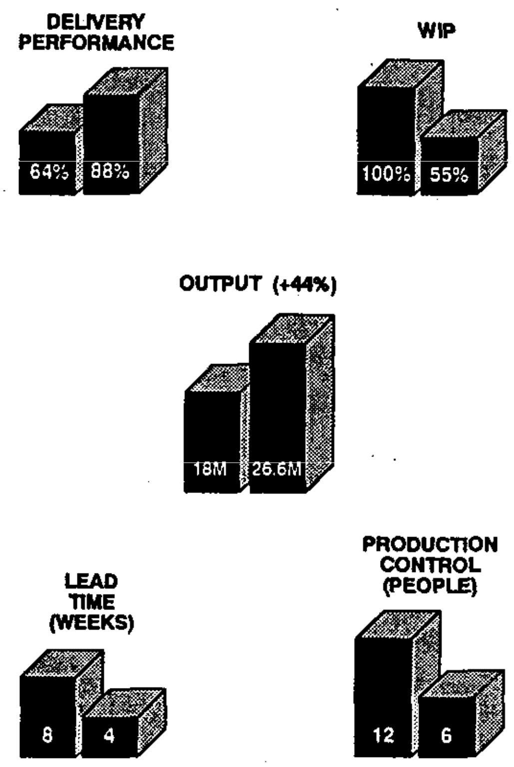
Performance to the customer was poor. Fire-fighting was the order of the day and progress chasing was intense. The company was unprofitable. Output was £18 million per annum.

The brief was to improve delivery performance. The operators batched together similar requirements at core extrusion level, and there was no control over this batching. To meet delivery requirements batching of similar jobs would have to be reduced. The company agreed to expect loss of output due to reduced batching, in order to produce better delivery performance.

## BENEFITS OBTAINED

- Delivery performance — From 64% to 88% on time.
- WIP .............. Reduced by 45%
- Output ............ Up 44% £18 to £26.6 million
- Lead Time ......... 8 weeks down to 4
- Production Control .. 12 people down to 6
- Raw Material Stock Turns ............. 7.5 to 10.6 per year.

**FIGURE 1**
**BENEFITS OBTAINED**



These benefits did not appear overnight, it was a fight all the way.

At the start the business was month end driven. By the finish, the output targets were being met 3/4 through the month. The business went from a loss to a profit. This was surprising, it was all down to bottlenecks.

## WHAT IT'S NOT - FAILURES OF MRP

This system was not MRP. MRP assumes there is infinite capacity on the shop floor to meet all due dates. However, it does not offer the means to ensure due dates are met. Most factories do not have elastic walls.

The output from MRP to the shop floor is an idealised work-to-list. If a work-to-list is less than 50% achievable, then it will not be followed and will become discredited. I have never seen MRP operating where the work-to-list could be considered to be anything like realistic. The tolerance of the shop floor to unrealistic demands is low.

MRP does not easily offer the means to achieve due dates. It assumes that the user will make management decisions about due dates and feed in something which is achievable. For a company in the situation that it finds it difficult to meet due dates, then material ordering from MRP will mean the materials available are not the ones that the factory has capacity to consume. This has cashflow and stockholding implications.

The suppliers of MRP systems tend to blame the users for the failures of MRP, and maintain a pure philosophy to the problems facing companies.

If requirements can be translated into something achievable, then this provides the means to maintain control in unstable environments. It needs other things also however. This is where shop floor control comes in.

## SYSTEM STRUCTURE OVERVIEW

The user company had installed various modules from an MRP system on a mainframe computer. Requirements planning had not been installed.

Two further levels of control were required and the implementation was taken slowly.

Firstly, a finite capacity planning and scheduling was installed. This was a standard system and was used to provide realistic work-to-lists. Realistic in terms of capacity, capabilities and resource availability. This only provided part of the solution. It did not provide the means to execute the work-to-lists.

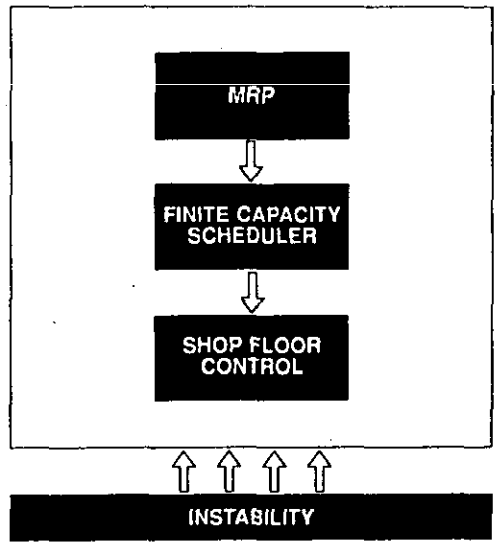
These work-to-lists were then linked to shop floor control. This was developed from scratch.

The diagram shows the structure. The provision of shop floor control meant that the planning systems were protected from the unstable world outside - customers changing requirements, materials not turning up, machine breakdowns and so on.

It was ensured that any changes to plan were communicated properly, that is planned properly, and were not allowed to disturb the shop floor.

I have found that if a firm work-to-list is provided and is not altered, then the shop floor will easily achieve its requirements. If priorities keep changing and no protection is offered to the shop floor, output and morale will suffer. Shop floor control allows a compromise to be met and maintains control when unplanned events occur.

**FIGURE 2**
**SYSTEM STRUCTURE OVERVIEW**

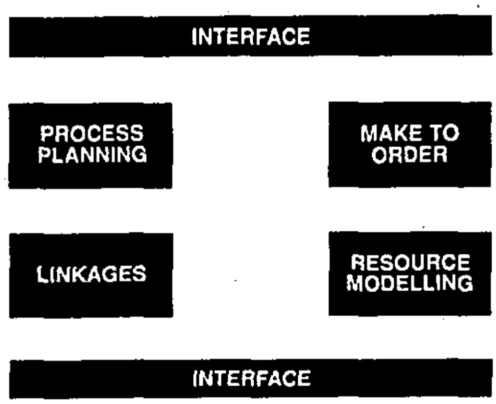



## SYSTEM STRUCTURE SCHEDULING

The scheduling system worked to finite capacity. The system calculated forwards from the current situation.

Initially paper work-to-lists were used. The full implementation required the development of interface software to receive orders from MRP, and to send work-to-lists to the shop floor control system.

**FIGURE 3**
**SYSTEM STRUCTURE SCHEDULING**




Because strand (twisted wires) and wire were made to stock, orders for these were not linked to core and cable requirements. Each element was treated separately, wire, strand/bunch, cores, cable. It was decided to only make wire and strand to order, and therefore interfacing software was developed to generate individual wire and strand requirements as required. This was to ensure that materials were produced in the quantities actually required, to prevent overruns and identify and eliminate reasons for scrap.

Coupled to the interface software was a process planning element. This generated operation codes which could take into account unique features of particular production machines and match these to product manufacturing requirements. This was used to ensure machine speeds and constraints were considered, for example.

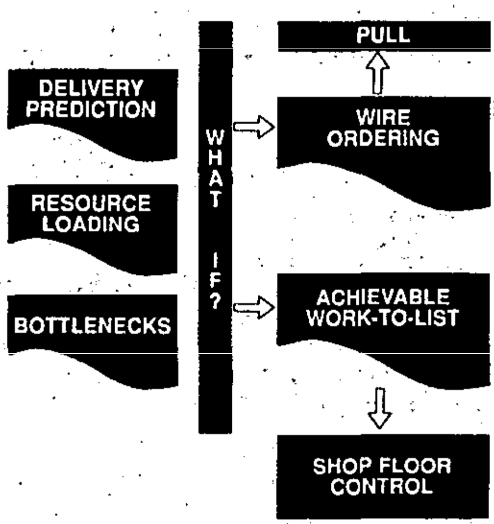
Furthermore, in order to schedule lay-up (assembly) correctly, it was necessary to take into account core availability. This is shown as linkages in the diagram.

The result was an achievable work-to-list which was realistic. Work-to-lists are only part of the picture and have to be drawn from the overall manufacturing plan, also calculated to finite capacity.

## FEATURES RESOURCE MODELLING

The area of most significance was wire ordering. There were chronic wire shortages. It did not matter how much wire and strand were bought in, they were consumed without bottlenecks appearing further down the system. This indicated that there was a front-end bottleneck.

**FIGURE 4**
**FEATURES RESOURCE MODELLING**




It had previously thought lay-up (assembly of cable cores) was the bottleneck. What was being described was many incomplete core sets in the lay-up area. These were caused by core extrusion operators running all requirements for a particular specification at once, most notably all colours. In effect they were making core to stock.

It was decided that if the wire that was actually required was ordered (wire came from another group company), then given shortages the factory would have the best mix of what was actually required. By setting firm wire schedules it was found that wire drawing could produce 40% more. What had happened previously was that customer demands (ie. orders already late) were allowed to disturb wire drawing schedules. Lost output was the result. The capacity model showed, given no wire shortages, the factory could consume approximately 100 tonnes per week. It had been actually receiving 70 tonnes per week on average.

By calculating what the factory could accommodate, and ordering wire to suit, this ensured that the wire delivered would be consumed on the orders it was actually required for.

What If ? for longer term planning then indicated :

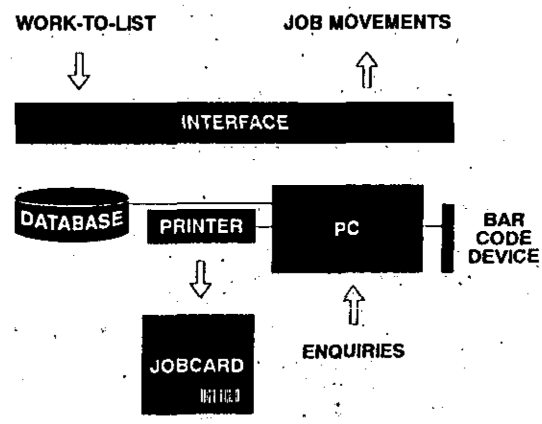
- **Delivery Prediction -** so sales could be notified in the event of problems.
- **Resource Loading -** to show overloads/underloads.
- **Bottlenecks -** to identify bottlenecks ahead of time.

Thereby a programme of action could be assessed, and then implemented if acceptable, automatically being translated into realistic and achievable work-to-lists.

## SYSTEM STRUCTURE SHOP FLOOR CONTROL

There were problems also in getting the shop floor to produce what was actually required. The concept of the shop floor control system was to control the execution of the work-to-list. Each shop had a PC to which a printer and bar code reader were attached. The work-to-list showed the sequence of jobs required for agreed period. The work-to-lists were issued twice a week.

**FIGURE 5**
**SYSTEM STRUCTURE - SHOP FLOOR CONTROL**




The system operated by presenting the shop floor with a list of jobs required in priority sequence, who would then chose the next job. This produced a job card with bar code. The operators could not obtain a job card unless the job was required within the current work-to-list. This was resisted most strongly. The local system then kept the data current. Job completion recording was by reading the bar code and entering quantity complete. All movements were then communicated back to the master system.

The system provided for job status, including job available, held up, in work, complete, or under repair. Each area could look at another's work-to-list to determine when a job could be expected. In line with shortened leadtimes some jobs were scheduled in more than one area within the horizon of the work-to-list. Departments actually started communicating. This was implemented with trepidation.

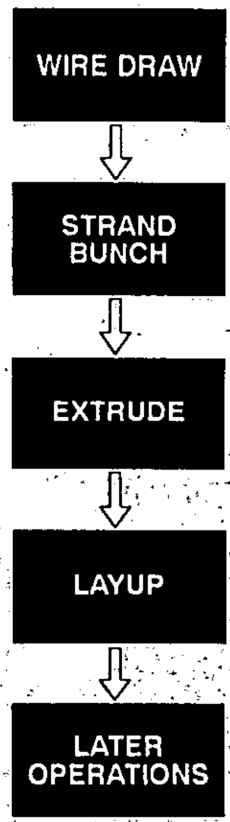
Inter process buffers disappeared and JIT resulted.

## SEQUENCE OF EVENTS

Initially, implementation was started simply by creating a manual interface between MRP and a finite capacity scheduler piloted in core extrusion. This created a paper work-to-list. Output doubled, but then buffer stocks of strand disappeared.

From this, strand and bunch requirements were manually derived and input into a separate copy of the scheduler. Output rose but then wire buffers ran out. Wire requirements were calculated from this using a simple report programme. Overall output had risen 25%.

**FIGURE 6**
**SEQUENCE OF EVENTS**




| | | |
|---|---|---|
| 1. PAPER WORK-TO-LIST | EXTRUDE | |
| 2. PAPER WORK-TO-LIST | STRAND | |
| 3. PAPER WORK-TO-LIST | WIRE DRAW | + 25% |
| 4. INTERFACE & REQUIREMENTS LOGIC | | |
| 5. SHOP FLOOR CONTROL | ALL | + 44% |

The shop floor control programme with interfacing and requirements logic then developed and installed. This was a sizeable task. Output rose 44% and became stable.

## PROBLEMS FACED ORGANISATION

The cause of most problems was lack of control on the shop floor and uncontrolled changes to plan.

Batching was behind this. Arguments forwarded against the system were that output would suffer. People were making the assumption that optimising their area would produce maximum output. The system demonstrated that the opposite was true.

There was aggravation between areas, particularly core extrusion and lay-up. Control and reporting disciplines were poor. Wire and strand shortages were a problem throughout. Control of those areas was incomplete until shop floor control was installed - core extrusion could still run the wrong job.

To succeed the company had to be taken from 0% planning. 100% firefighting to 100% planning 0% firefighting. The difficult bit was the transition. That transition was bridged with shop floor control - the system was tamperproof. As the pressure from customers lifted so did the temptation to alter production. As the monthly outputs were met, then the cherry picking disappeared. The phones stopped ringing in the production control department.

## PROBLEMS FACED SYSTEM

There were a number of system problems to be overcome. The software development required was significant. To generate make-to-order requirements was a large task.

The shop floor operates in realtime. Therefore the work-to-lists must be up-to-date. The structure of the complete system meant that new work-to-lists were always behind the current situation, as these were calculated centrally.

Ways to superimpose the new work-to-lists on top of the existing ones had to be developed.

If strand was used on the wrong job, that practise did not disappear completely, then the original requirement was cancelled because it had been produced, and the new requirement disappeared as the job had been produced. It meant however that such indiscretions were highlighted.

## REASONS FOR SUCCESS

It was fortunate because the bottleneck was the first process, wire drawing, or if wire was considered as bought in, then it was stranding and bunching. This meant scarce materials were used in the best way.

Because the system allowed jobs to be linked together, this meant that lay-up would not be considered available until all the cores had been scheduled to completion. In general, realistic schedules were produced which asked the shop floor to produce something that was achievable. Shop floor control helped because it both ensured that operator choice was diminished and kept within the schedule horizon, and secondly it provided accurate feedback. Accuracy of the data bred confidence in the system.

Job status and issuing meant the work-to-list was real time and believed by all. Most important of all, early successes were obtained and built the momentum.

The largest single item of work was education. This probably constituted 50% of the effort.

An off-the-shelf system was not available. It was not expensive, the capital cost being £25,000. It was an appropriate solution to a set of circumstances.

### About the Author

**Nick Norton** is an independent consultant who specialises in helping companies to improve manufacturing performance. He has 15 years' experience at the sharp end of manufacturing industry, including successfully introducing change at shop floor level.