SURVEY OF CURRENT UK SHOP FLOOR SCHEDULING PRACTICE

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1. INTRODUCTION

The planning of work that has to be done in a particular time period within a factory is usually undertaken on more than one occasion and with an increasing degree of precision with each repetition. The number of occasions will be determined by the complexity of the products to be produced and the uncertainty of both the market and the production methods used.

For a number of factories manufacturing complex products in fluctuating.markets, the process takes place at three distinct levels. The higher level process starts with the development of the Master Production Schedule and the rough-cut capacity check that the load generated by the MPS is feasible.

The second level process concerns the planning of material and component availability to ensure that the MPS can be met, after taking into account supply or manufacturing lead times. This Material Requirements Planning (MRP) activity may involve a much more detailed check on machine and labour capacity which takes into account set-up, run, move and queue times for each operation – Capacity Requirements Planning (CRP). Typically, MRP will look almost as far ahead as the MPS but the horizon for CRP may only be a few weeks and culminates in the issue of 'a work-to-list' for each work centre group.

However, it is the third level process, shop floor scheduling, where the adjustments have to be made to cope with the real world problems which have not been predicted by the plans.

There has been much development work concerning the two high level processes and these are now well understood and supported by effective computer packages. However, this does not appear to be the case with shop floor scheduling. It is the authors' view that there are currently few automated shop floor scheduling approaches in use, that the use of finite scheduling aids is not widespread and also that few systems in use are well integrated with the higher level planning systems. Most commonly the shop floor supervisor still has the last say and is supported in his decision-making by nothing more than a manual planning board.

This article outlines the main results of a survey, in collaboration with BPICS, into current UK shop floor scheduling practice which supports the view that most current approaches to short term scheduling are poorly developed and leave much scope for improvement.

2. OUTLINE OF SURVEY APPROACH

The approach adopted three specific routes: a survey of literature; distribution of a questionnaire to a selected group of companies with BPICS members; and finally, a series of brief industrial case studies to provide some degree of validation of the results.

The questionnaire was divided into four sections. Section 1 requests back-ground company information. Section 2 contains detailed questions about products and processes employed within the company. In Section 3 information about the manufacturing planning system is requested because the higher level planning method has a direct impact upon the shop scheduling approach. Finally, the principal questions relating to the shop floor scheduling procedures and tools currently in use are contained in Section 4.

Because the survey was undertaken to meet the project requirements of Peter Jarvis's Advanced Manufacturing Systems and Technology Masters degree, a pragmatic approach to company selection was adopted and BPICS corporate membership database was used as the principal source. A second important source of companies was the UK list of Class A MRP II users from the Oliver Wight Organisation and UK OPT users were included because of the high relevance of the OPT approach.

Analysis of the completed questionnaire was performed in two stages. The initial examination was executed manually with basic data extraction and cross-correlation performed where relationships were obvious. This was followed by the installation of the data set in a PC version of the statistical package SPSS which enabled much more comprehensive analysis to be undertaken.

3. PROFILE OF RESPONDENTS

Of the 114 questionnaires distributed, 35 were completed and returned to give a satisfactory yield of 30%. The questionnaires were completed principally by middle managers who were generally production managers or manufacturing controllers. As expected, there was a bias towards larger companies with the breakdown by employee numbers shown below:

No employed	% of respondents
Less than 250	23
250 - 1000	66
More than 1000	11
	100

Sales Turnover (£)	% of respondents
Less than £3 m	3
£3 m to £10 m	8
£11 m to £20 m	26
More than £20 m	63
	100

The range of product types was very broad with a leaning towards engineering but no other discernable bias. The main industrial sectors responding were:

Industrial Sector	% of respondents
Clothing	3
Foodstuffs	14
Chemicals and Plastics	14
Pharmaceuticals	5
Packaging and Printing	5
Electronics / Instrumentation	20
Automotive and Accessories	14
Light Engineering	14
Metals	11
	100

Unit value of products produced ranged from 16 pence to £80,000.

The type of production system used is dominated by batch production. This is not surprising when NEDO claims that some 75% of manufacture is of this type. The response for type of production system was:

Type of production system	% of respondents
Batch	63
Flow	17
Mixed	17
Jobbing	3
	100

The low response of only one company using a jobbing system is to be expected for this sample of mostly large companies, but is a limitation to the study, for some interesting STS problems are associated with jobbing production.

4. PLANNING SYSTEMS OVERVIEW.

The planning systems employed are mainly MRP based, representing 80%, with a surprising 63% claiming to be operating full MRPII. Equally surprising is the 11% of responding companies still using manual systems for planning.

Principle planning method	% of respondents
Manual	11
Materials Requirements Planning (MRP)	17
Manufacturing Resource Planning (MRP II)	63
Optimised Production Technology (OPT)	9
	100

Finite scheduling, Kanban, and manual methods were also found to be employed in a supporting role to these other methods.

The output of these systems is primarily work-to-lists, (86% of respondents generated such lists). It is argued that for effective short term scheduling there must first be a realistic plan on which to base the scheduling procedure.

The profile of modules operated within the manufacturing control system was:

Module name	% of respondents
Materials Requirements Planning	91
Master Production Scheduling	80
Rough Cut Capacity Planning	60
Capacity Requirements Planning	51
Shop Floor Data Collection	40
Shop Floor Control Procedures	57
Detailed Short Term Scheduling	60

The frequency with which planning is undertaken is strongly dominated by the traditional weekly time period, but a surprisingly high proportion of respondents claim to replan on a daily basis.

Replanning frequency	% of respondents
Daily	25
Twice weekly	9
Weekly	60
Monthly	6
	100

Interestingly, although many companies were found to have imminent changes to their planning systems arranged, the most common enhancement proposed was the installation of a finite scheduling tool.

5. THE SHOP FLOOR SYSTEMS

Shop floor scheduling procedures show an interesting trend

Scheduling method	% of respondents
Purely manual by supervisor	25
Using a physical manual aid	29
Computerise package	46
	100

Interestingly 37% of responding companies claimed to have fully integrated computerised planning and scheduling systems. This figure is thought to be augmented by respondents who, rather than having integrated systems, operate direct from the plan without a detailed scheduling procedure. The manual scheduling processes where supervisors or foremen work from work-to-lists was expected to have a higher profile. Also where manual decision aids were employed, these were found to include Gantt charts, planning boards, T-cards and spread sheet systems.

Of the computerised systems in use, 17% developed their systems to some extent in house, while 29% purchased the system as a package with any necessary tailoring performed on request by the vendor.

The short term scheduling systems employed tend to be more modern than the planning systems showing that detailed scheduling is a current issue in industry. 23% of systems were less than 1 year old and another 37% were between 1 and 3 years.

An attempt to categorise the systems in terms of the level of detail provided by the output gave results with a trend towards more detail than expected.

Category description	% of respondents
Start & finish dates only	26
Above plus routing by process requirement	9
Above plus routing defined by work centre	14
Routings fully defined by work centre and completion times for every operation.	51
	100

In the situation where the scheduling procedure reveals that the plan is not achievable, this information is communicated to the master planning system for consideration in the next planning run with the following frequencies :

Feedback frequency	% of respondents
Never	6
Real time	30
Daily	40
Weekly	14
	100

When we look at the final stage of communication of the schedule to the work force we find a very strong leaning towards computer print outs.

Communication media	% of respondents
Hand written	9
Scheduling board	14
Computer print out	77
	100

The time horizons and periods within scheduling systems are surprisingly widely spread with a maximum period of 6 months reported as being scheduled at the shop floor level, a figure we considered to be extremely long. The companies later evaluated as better achievers, all create detailed short term schedules by rescheduling using a weekly time frame or less.

It is important that the rescheduling period is small in comparison with the production lead time, however it is assumed that the two cases where no feed-back loop exists will have problems with schedule adherence.

The length of time taken for a full reschedule to be performed is an important consideration, this determines the versatility of the system and may provide the scheduler with scope to test "what if" scenarios. 20% of the respondents are in the desirable situation of being able to reschedule in under an hour, but at the other end of the range 17% cannot reschedule within 24 hours which leaves them with little flexibility to react to general operational variability such as breakdowns.

Rescheduling lead time	% of respondents
Under 1 hour	20
1 to 12 hours	49
12 to 24 hours	14
Over 24 hours	17
	100

71% of the companies surveyed operate a shop floor data collection system, the distribution of the frequency of analysis of the data is as follows:

Frequency of data analysis	% of respondents
Real time (on line monitoring)	33
Daily	37
Weekly	30
	100

It is thought that those using only weekly analysis do not have timely enough information to use effectively in the short term scheduling procedure.

Creation of a good schedule is of no value unless it is adhered to by production supervision and for this to happen it is necessary for the work force to have confidence in the schedule. Other non-scheduling priorities such as expediting at the expense of other orders are undesirable and as such to be avoided. 74% of companies claim schedules are adhered to.

Frequency of deviations from schedule	% of respondents
Never	3
Very rare	31
Occasional	54
Frequent	12
	100

Participants were asked what performance measures are applied to production to asses how well the plant is being used. The responses were:

Measure	% of respondents
Machine Utilisation	54
Machine Efficiency	71
Delivery Performance	86
Schedule Adherence	68
Down-times	49
Defect Rates	55

It is considered good practice that delivery performance is the most frequently used measure. In business terms, this is the ultimate goal of most manufacturing organisations. The level of performance achieved on this measure ranged from 50% to a claimed 100% with an average of 86%.

% of original customer due dates met	% of respondents
50 to 70	9
71 to 80	12
81 to 90	26
91 to 100	53
	100

The cost of scheduling systems varied widely from a mere £2000 to £250,000. Obviously quite substantial performance advantages would need to be demonstrated to justify the cost of a system in the latter price bracket.

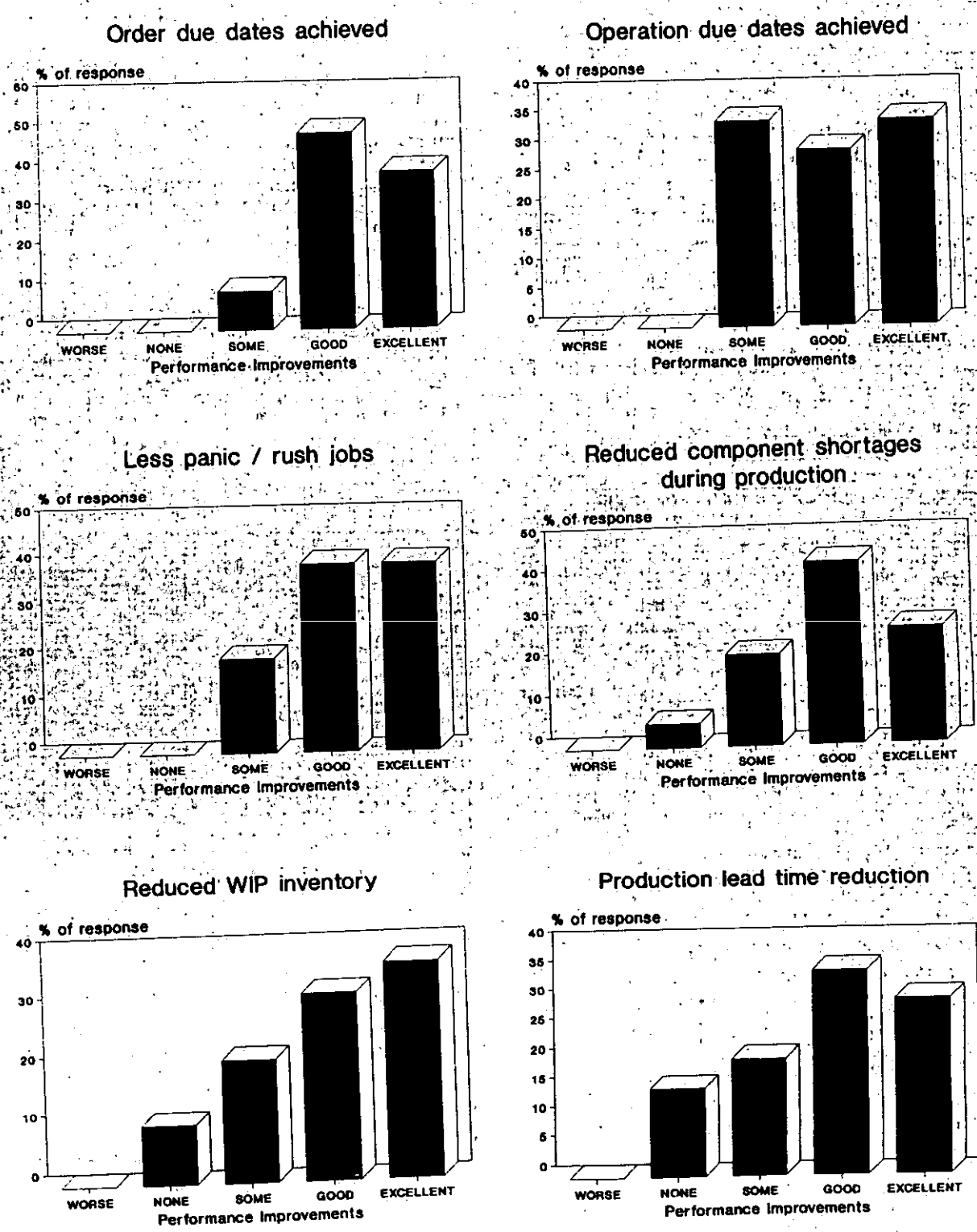
It is worth noting that when asked to suggest areas in which the respondents could see greatest scope for improvement in their scheduling systems, the most common response stated the installation of finite scheduling systems, better capacity consideration within scheduling, implementation and expansion of Kanban systems and more frequent scheduling.

The following graphs show how the respondents perceive their own performance against a range of measures, some of which are directly attributable to the scheduling system and others which arguably, are consequences of the effectiveness of short term scheduling.

The majority of companies appear to believe that their scheduling systems are in the higher performance categories scoring their performance most frequently as 4 out of 5. It is very interesting that when the respondents who have recently installed new scheduling systems are asked to grade their level of improvement in performance, against each of the same measures, over 80% have shown some improvement and the majority claim major levels of benefit in all the parameters.

FIGURE 1

Improvements attributed to new scheduling system installation



6. CONCLUSIONS

This brief and necessarily limited survey was initiated to investigate what we considered to be the "Cinderella" of the manufacturing control area. The analysis of the responses to the questionnaire plus detailed interviews held in five other companies have validated the view that shop floor scheduling is indeed the "Black hole" described by one of the interviewees.

Generally the results are encouraging, the histograms show that responding companies have a better than satisfactory achievement of both order due dates and operation due dates. Similarly pleasing results are also demonstrated for work-in-progress inventory levels and production lead times. Also of those companies who have installed new systems in the last 3 years, as can be seen on the histograms, the benefits attained are extremely encouraging with manufacturing and customer due date adherence showing great improvements across all this section of companies, progress has also been made in reduced lead time and work-in-progress stocks and inventory as a whole, while the frequency of material shortages has been reduced.

As for the use of systems, the higher level planning system is dominated by the use of Manufacturing Resource Planning (63% - MRPII). OPT is in use in some cases and often to good effect but represents only a tiny minority. Kanban is used mainly in conjunction with an MRP system.

Shop floor scheduling systems vary from purely manual systems with a single person at supervisor level, ordering the work by the use of informal despatch rules and experience, to integrated computerised scheduling systems. In many cases the scheduling function is performed by a scheduler using some sort of mechanical model or aid to make the necessary decisions, in this category planning boards, T- Cards and, increasingly, spread sheets are used. Also rapidly on the increase is the use of computer based finite schedulers. These schedulers generally run using a simulation model of the plant to "optimise" the loading.

A range of factors have been identified which have a direct bearing on the performance of a shop scheduling system. The over-riding factor however, in every case is the way in which the system is operated rather than the system type. If problems are approached in a common sense manner the difficulties experienced later are reduced and schedule performance can be greatly enhanced. The key to scheduling success appears to be the ability to keep in touch with the system in operation and make pertinent adjustments as necessary. This indicates the importance of a real time approach to shop scheduling.

Scheduling factors which have been related directly to improved plant performance include :-

- Realistic original work-to-lists
- Full capacity requirements planning
- Short time buckets for schedule creation
- Frequent data feedback from shop floor data collection
- Regular communication between planning and scheduling systems
- Fully defined schedules with routings defined by both machine and individual operation times.
- Monitoring of operation times so as to understand progress.

The survey was used to support an application to the ACME Directorate of SERC by John Kenworthy and David Little, for research funding to examine the area further and to identify best UK practice in short term scheduling. This application was successful and provides funds to support the employment of two full-time researchers into the topic, Keith Porter and Peter Jarvis. The research is again supported by BPICS and has the benefit of two other collaborators: Cincom Systems and ICI Group Engineering Services.

The authors wish to express their sincere thanks to those BPICS members who replied to the questionnaire. They would also welcome comments and debate on the issue either directly , or via the papers of Control (why should Ernest Heptonstall have all the letters pages to himself ?). They are also very keen to learn of companies with highly effective or innovative approaches to shop floor scheduling.

About the Authors

David Little joined the Engineering Faculty at the University of Liverpool in 1984 and lectures to final year students and post-graduates in manufacturing systems. He is also senior partner of D. Little & Associates, an AMT and Maplon listed consultancy specialising in manufacturing systems. Before this, he was a Senior Lecturer in the Department of Management Studies at Huddersfield Polytechnic.

David is past President of BPICS having formerly been a Vice-President and Chairman of the Society's Education Committee.

Peter Jarvis graduated in Engineering Science and Industrial Management in 1990 and has since completed a Masters degree. He is still attempting to learn about and understand the manufacturing industry, and currently works as part of a Short-term Scheduling Project Team in Liverpool, which is in line with his continuing post graduate research