WORLD CLASS MANUFACTURING : PART 3
THE BUSINESS REQUIREMENTS FOR WORLD CLASS SHOP FLOOR CONTROL

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INTRODUCTION

This third article in a series of four discusses the crucial role of the shop floor in meeting the requirements for world class manufacturing control. It specifically defines shop floor control and explores functions that must happen on the shop floor. Without shop floor control, other planning systems cannot operate effectively and a strategy in pursuit of world class manufacturing control must be incomplete.

The limitations of materials requirements planning systems (MRP) must be recognised. On its own, MRP has proved difficult to implement in unit based applications and almost impossible in length and volume based industries. It has failed to live up to its billing. Sometimes its use has forced the users to corrupt the way system tools have been used, thus creating integration difficulties between different systems. Other tools and philosophies are also discussed in this article, such as Just-in-Time.

Shop floor data collection is not shop floor control. There are many cases of shop floor data collection (SFDC) equipment being introduced onto the shop floor. As with process control, companies have not been able to use the data collected. Shop floor control provides the interface between process control, or shop floor data and higher level planning systems. Without shop floor control, the collection of shop floor data is futile. Most SFDC equipment has never been used properly, or even installed.

The input to shop floor control is a work-to-list, preferably calculated to finite capacity.

WHAT IS SHOP FLOOR CONTROL?

This can be defined as follows:

Shop Floor:
A colloquial term for those areas of a manufacturing company physically associated with the performance of manufacturing processes, including material and product handling.

Shop Floor Control:
An amalgam of functions, enabling the progress of orders to be controlled, from and including their scheduled release and continuing until their satisfactory completion, by a planned end date.

Shop floor control takes over where higher level planning systems stop. These higher level systems include core business applications, MRP, MRPII, capacity planning and shop floor scheduling. Where shop floor scheduling is being used, the interface to shop floor control is a work-to-list (comprising a schedule, or sequence of work).

Typically, the planning functions used by higher level systems are out-of-date at the point of production, because they are snapshots based on previously collected data, and are unaware of the dynamics of the shop floor. Shop floor control manages the schedules derived from higher level planning systems. Because any schedule is a snapshot, additional functions are required to maintain control in the interval between snapshots, especially when unplanned or urgent events occur.

Even in the most dynamic systems, where shop floor control is not implemented, schedules are typically 12-24 hours out-of-date by the time they are released into the factory. The loading of the work from any new schedule then has to take into account work status changes that have taken place since the last shop floor communication. These changes include priority alterations and work that has been completed in the intervening period, and the arrival of urgent and unplanned orders.

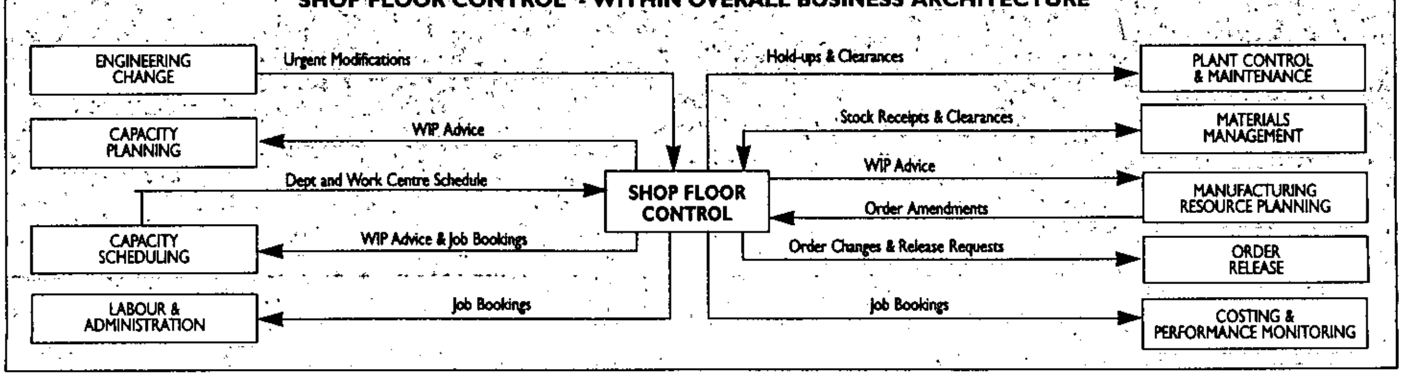
In addition, there is usually a lot of effort involved in shop loading, prior to the manufacture of each operation. Shop loading includes preparing work, arranging materials, tooling and resources. It is to the suffering of shop floor personnel, the detriment of shop floor schedules, and the loss of credibility of the whole process, if this information cannot be taken into account when the new schedule arrives. It is unrealistic to tell the shop floor "Drop that, here's your new schedule".

Shop floor control is pragmatic, allowing the realities of the shop floor to be monitored and fed back to higher level planning systems. Usually, these higher level systems cannot actually do anything with this information. Shop floor control manages the shop floor and allows something to be done with this data. The realities of the shop floor must be made known to management so that they can plan based on what is **actually happening**. This allows management to control the shop floor.

The relationship of the shop floor with other business functions is shown in Figure 3.1. It is deliberately drawn at the centre of the business. We would argue that other business functions solely exist to support the shop floor, not the converse.

FIGURE 3.1

SHOP FLOOR CONTROL - WITHIN OVERALL BUSINESS ARCHITECTURE



WHAT REALLY HAPPENS ON THE SHOP FLOOR?

Over the years we have developed functional definitions of the source and location of shop floor data for any manufacturing company. This is represented by 11 data flow, or communication, diagrams and is supported by the functional requirements' specification necessary to achieve shop floor control within any manufacturing enterprise. The top level data flow diagram is shown in Figure 3.2.

In this article, two of the high level diagrams have been included. These go down to three major functional areas:

- Order Control
- Manufacturing Management and
- Inspection Management.

The next level of detail is shown in Figure 3.3 and this starts to show the relationship between different functions within the shop floor as well as the relationships with external business functions.

There are a further 9 lower level diagrams that show the detailed data available on the shop floor. These diagrams define the data and processes required if shop floor control is to operate effectively.

The diagrams show the relationships between data in manufacturing and the correct functional location of the data. They describe all the shop floor communications that must take place, whether or not they have been recognised formally. For commercial reasons the 9 lower level diagrams have not been published.

The diagrams were originally developed in 1982. Compared with major system requirements' specifications that have been published, we have never found any serious control requirements that we have not identified and more importantly, we have been able to show their functionally correct location. These diagrams have worked in every case. These data are available in all manufacturing businesses and have not changed since manufacturing began.

The requirements for shop floor control are independent of type of industry and methods of production.

TRADITIONAL APPROACHES TO CONTROL

Materials Requirements Planning (MRP) and MRPII

MRP's main assumption is that manufacturing takes place where due dates are always met, irrespective of capacity. While the concept of MRPII (manufacturing resource planning) recognises this difficulty, through adjustment of the plan in line with available resources, most available business systems do not appear to provide the necessary functionality to support the concept.

At best, the interface with the shop floor from MRP can be an unrealistic and unachievable work-to- list. Even in situations where performance to due date is good (usually in companies that are paying for excess capacity), MRP systems do not offer the means to execute the work-to-lists, and are usually incapable of maintaining control when urgent and unplanned events occur.

MRP offers little to the shop floor, despite considerable efforts on the part of users.

Just-in-Time (JIT)

Just-in-Time recognises the constraints of push systems, such as MRP. The concept of JIT is that work is pulled into the factory at the rate of demand for the products. The factory throughput is such that it meets demand and thus consumption meets demand.

JIT requires that resources are always available to meet that demand. In the absence of finite capacity planning and scheduling and shop floor control, the company may be paying for spare capacity, in order to always meet demand. This probably means the workers are always available on stream for overtime and/or a high degree of labour flexibility is available.

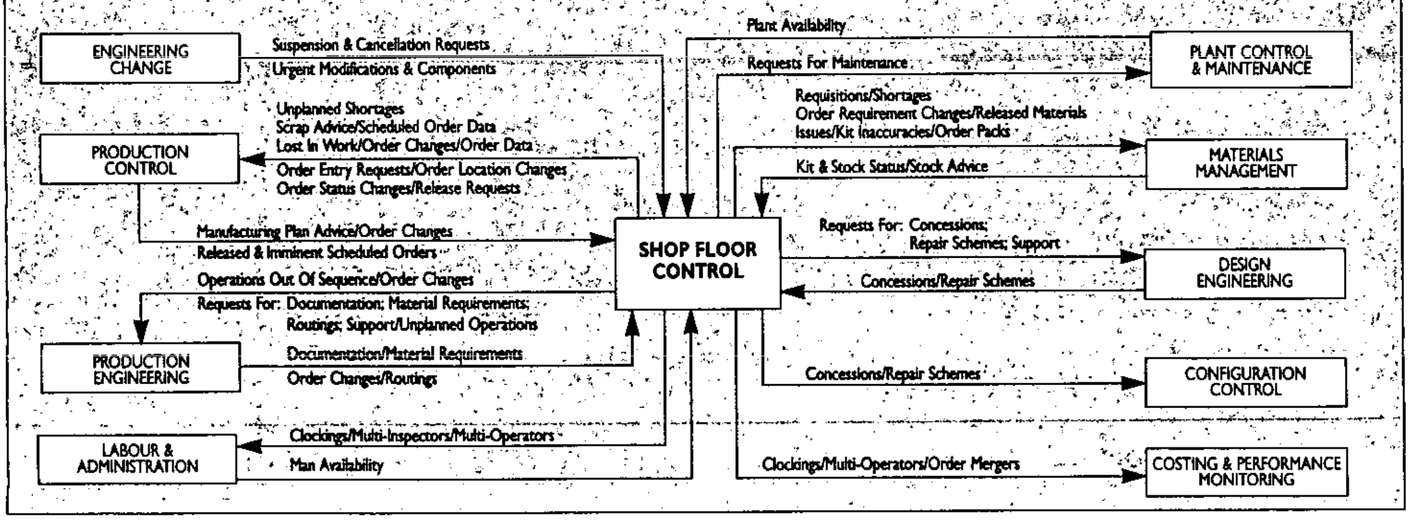
Just-in-Time (JIT) results when products are made to coincide with their due dates, or very close to their due dates. There are a number of ways to effect JIT, including both mechanical and software controls. JIT works well when product variety is small and demand is well known and stable.

Mechanical systems of JIT include Kanban, which will impose mechanical constraints of the output of linked processes. Kanban should theoretically be fairly easy to apply to industry. It is easy to operate, because the scheduling is automatic.

JIT requires that resources run under-utilised and have spare unused capacity, in order to satisfy demand as it occurs. This must be wasteful. JIT cannot run properly where bottlenecks are present. Once uncertainty is introduced and flexibility introduced, it becomes difficult to manage. There are tremendous advantages to JIT, which can make it worthwhile to have spare capacity available. JIT coupled with finite capacity scheduling is a powerful combination.

FIGURE 3.2

SHOP FLOOR CONTROL - DATA FLOW



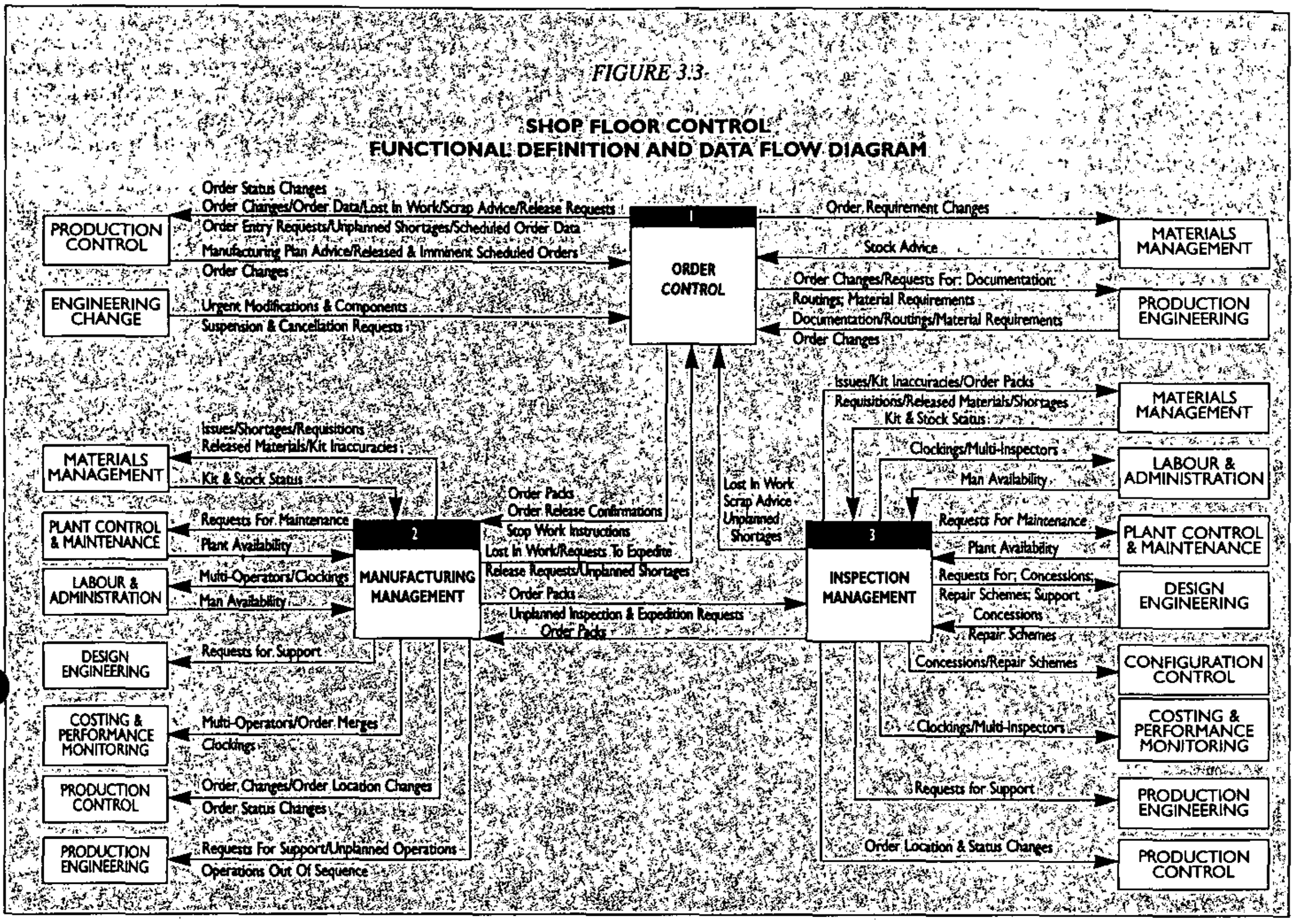


FIGURE 3.3

SHOP FLOOR CONTROL FUNCTIONAL DEFINITION AND DATA FLOW DIAGRAM

DRAWBACKS OF SOME TRADITIONAL APPROACHES

Many of the traditional business tools available have forced the users to corrupt the way their data are represented. This has created a number of integration problems between different systems. While the requirements defined for world class manufacturing control are generic to all types of manufacturing, some of the tools available are only suitable to unit-based and discrete manufacturing processes. The true package solution is independent of manufacturing type.

Volume and Length Based Industries

Many systems are engineering based, where for example you start with a piece of metal and take off material through machining processes, or start assembly from the first operation of an assembly routing. They have not recognised the requirements of length or volume based industries. Here products can become both shorter, due to set up lengths or volumes and longer (drawing). Their designers have not considered that the finished length or volume is a key item of data and is **not** the part quantity.

In many cases of implementing MRP, the users have made the part number significant to reflect the length. This is perhaps because the MRP system used had been designed for engineered parts. The fact that different lengths of the same product were treated as separate parts was a solution to the constraints of those particular systems.

Kitting

Many engineering business systems force kitting at the first operation. This might then cause the kitting requirements for two operations that require the same material to be accumulated into one. The solution adopted by users has been to create multi-level bills of materials, one product for each operation, to then allow different quantities to be related and to allow proper kitting. This creates a nightmare for maintenance of data and integrating or interfacing different systems, especially where early operations may be make-to-stock, process type manufacture.

Stage Lengths

Where material can be added at each operation available systems must reflect this. Input does not necessarily equal output. Stage lengths and volumes may be critical and an operation may need to be automatically held pending advice if the output at any stage drops below the minimum required to support the finished requirement.

To use particular systems users have been forced to create data that does not reflect what really happens. This presents difficulties when interfacing and integrating different systems and systems have fallen into disrepute.

The users may be forgiven for pondering over the value of their investments in those systems. However, there are ways forward, provided the requirements are not compromised with the available solutions. It does not mean that they have to discard those applications. They should map the tools to their requirements, rather than contort their business requirements to meet the needs of the application system.

REQUIREMENTS FOR INTEGRATION

The requirements for integrating and interfacing products are well defined. So long as the application of systems has not corrupted the users' data, then these problems can be avoided.

Over the years we have been involved in interfacing MRP to finite capacity planing and scheduling and shop floor control (manufacturing execution) systems. The difficulties arise when the master system, cannot hold the detailed data required in the lower level systems. This may require a radical approach to the way data is held and different views taken as to what is the master system.

A different approach is to look at the functions to be provided by each element of manufacturing control, and question the tool kit required.

The advantages of a manufacturing plan based on available capacity are overwhelming. As this is at odds with MRP, then why not synchronise the business system (which will include MRP), from a master system that always remains real time and valid? This is different to the traditional (available) approach.

THE MANUFACTURING EXECUTION SYSTEM

Finite Capacity Planning and Scheduling Systems:

These have tended to concentrate on algorithms, rather than the realities of manufacture. As such they are useful aids. Their application will serve to develop in the users minds the detailed requirements for control.

To gain maximum they must integrate both ways with the execution system.

CONCLUSIONS

The total requirements for world class manufacturing control have now been defined in these articles and apply regardless of type of manufacture. Delivering these requirements will result in manufacturers being able to consistently provide quality products and service; to meet and exceed customer expectations; achieve delivery requirements; and reduce lead times. All will be provided at minimum cost.

Solutions are required that can take advantage of the methodologies described. Some of these are available to other industries, but have been denied to length and volume based industries. The design of systems must allow for hooks to be made to other systems, to allow the users maximum flexibility while taking advantage of those approaches. The limitations of MRP must be recognised.

It has been argued for many years that the shop floor is impossible to control, because it is ever-changing, and many urgent and unplanned events occur, making any plan deteriorate. This is why it is so important to maintain control. Shop floor control allows management to stay in control, and to know what is happening, even when things happen outside their control.

The shop floor holds the key. Without shop floor control, other planning systems cannot operate effectively, and the business strategy must be incomplete. To address these requirements will deliver massive ongoing benefits to the companies that can successfully apply these methodologies.

In the final article, a solution to many of these requirements will be illustrated. While the solution has been designed for a length and volume based industry, the techniques are generically applicable to all types of manufacturing.

ACKNOWLEDGEMENT

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About the Author

Nick Norton FIOM is consultancy partner of Borderbow. He has 20 years experience applying the described methodologies across the spectrum of manufacturing industry.

Borderbow is a manufacturing consultancy specialising in the definition and implementation of the applications described in this series, including shop floor control and finite capacity planning and scheduling.