Why Is Making To Order So Different?

This paper looks at some of the key elements of operations management in Make to Order businesses and assesses the suitability, or otherwise, of the manufacturing planning and control techniques which have come to be accepted as standard. This area is not well served by the textbooks and the generic approaches to scheduling and material planning, nor, in general, do the popular computer packages lend themselves to helping this type of business.

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What Do We Mean By “Make To Order”

The term **make to order** can mean many things. We may think perhaps of bespoke computer systems or fitted kitchens. For such businesses we may hear the term “make to stock and assemble to order” signifying that the business carries out some primary processes ahead of receiving a customer’s order. At the other extreme, in, say, shipbuilding, we may do nothing at all until we take the order and at this point begins the work of converting the customer’s requirement into a product specification, then a design and then a list of parts to make and buy.

This latter type of company may be termed **Design and Make to Order**, and it is to this area of manufacturing that this paper is addressed.

How Important is This Sector?

**Design and Make to Order** is an important part of the UK economy and, in my view, will be increasingly so if we are to survive as a force in world manufacturing. We have a significant share of the world market in capital equipment for oil and gas production, chemical processing, power generation and many other specialist areas because of accumulated design know-how. This offers some protection from penetration from companies in emerging economies. We have all seen how the domestic market for standard products – be they lawn mowers, washing machines, pumps and valves for our central heating systems – has been successfully attacked by far eastern competitors able to offer equivalent quality at lower costs.

These competitors are now moving into other areas. We see the Chinese, for example, supplying cast components for European and American manufacturers of capital equipment. From the supply of raw castings they are expanding into providing finished, machined parts. How long will it be before they are selling finished products? More importantly, how do we respond when this happens?

My answer is that we will survive by recognising and playing to our strengths. Their cost base, in the short term at least, means that for “standard” products we may not be able to compete. They can afford to fund the inventory necessitated by the long supply chain and still offer lower prices to our customers than the domestic manufacturers. We need to capitalise on those areas where we hold the advantage. In products which are designed, or at least heavily configured, to meet specific performance characteristics, they do not - at present - have the specialist expertise.

Thus we see companies who for years have supplied “standard” products with the odd “special” thrown in now moving towards a far higher proportion of business in the “design and make to order” sector. In order to maintain our manufacturing base we need to remain strong in this particular sector, and this requires that we continue to improve in terms of cost, lead time to customer and timeliness of supply. This area is therefore essential for the future of the UK as a manufacturing economy.

I take as given that we will continue to develop the expertise to design leading edge product; our challenge is in efficiency of execution of customers’ orders. Those companies increasing their level of business in this area, however, find that the standard manufacturing planning and control textbooks do not have all the answers.

What Is Different?

Since the first appearance of MRP and the many computer packages which followed, we have all been told that the techniques of planning and control are universally applicable, that we should stop kidding ourselves, that we are not different to everybody else and that our requirements are not unique to us. For the most part we have all learned to accept this, and in general have gained the benefits from applying lessons learned in other businesses in different industries.

Thus we now see successful users of MRP and MRPII in all fields of manufacturing ranging through engineering, electronics, textiles, chemicals and pharmaceuticals, and others. In each industry the basic building blocks remain essentially the same, with variants to cater for specific constraints. For example, many companies in food and drink manufacturing have incorporated finite scheduling as part of their systems to ensure achievable plans and optimal use of high-cost, constrained resources. In more recent times these businesses have been at the forefront of moves to replace MRPII functionality, and its separated materials and capacity planning, with APS where the two are scheduled simultaneously. On a different strand, high volume repetitive manufacturers, such as those in the automotive sector, have replaced discrete works orders with rate-driven schedules.
In both of these evolutions of the approaches first set out by Messrs Wight, Orlicky et al, the essential task remains that of planning and controlling production resources and materials. In this paper I am considering companies where there are many other aspects to order fulfilment, all of which must be properly planned and controlled, and all of which are at least as important (in terms of timeliness of delivery and cost control) as manufacturing.

Another, often critical, differentiator is that taking account of capacity when master scheduling - recognising the load on constrained resources represented by each new order - is a very difficult (yet essential) task in such businesses and is very poorly addressed by the standard techniques of Sales and Operations Planning and Master Production Scheduling.

The following sections identify these differences in more detail and suggest some of the things we need to do differently to effectively plan and control these businesses.

**Quotations**

Any business offering products which are either designed specifically for a customer’s order, or require significant engineering development around a theme, will undoubtedly be involved in putting together quotations, or tenders, for the major proportion of its output.

A quotation encompasses both the proposed price for the product and service being quoted and the lead time to be offered. Information required to produce a quotation often includes some form of costed bill of material for a similar product (which has to reflect today’s costs – no easy task!) together with a cumulative lead time picture for this similar product. To all this must be added some assessment of what the differences this customer is seeking will add in terms of cost and time. It may be that we recognise that the physical form of the product will require a new pattern at a foundry (time and cost) or that a higher grade of material is required (certainly cost, and possibly extra time for certification and so on).

Having established the quotation there is usually a series of rounds of negotiation leading possibly to changes in the specification of what is to be supplied. At the end of all this, if we have succeeded in winning the order, we have to ensure that we clearly communicate to the rest of the business what we have sold, what we have stripped out to keep the cost to an acceptable level, and what the resultant cost must be held to. Ideally, the quotation should form the first pass of the product design, in order that we take advantage of any up-front design work and avoid re-inventing any wheels.

Another important factor to recognise is that quotations often impose a significant workload on the company’s engineering resources. Standard planning systems such as, for example, the Rough Cut Capacity Planning element of a standard MRPII package, are all geared around the company’s proposed output plan. In “make to stock” environments this may be a forecast-based master schedule; in “make to order” it is the order book. What we need in this type of industry is something which recognises quotations and, indeed, internal projects for new product development.

**Master Planning**

In one company where my colleagues and I have worked recently we use the term *Sales and Operations Planning* for a monthly meeting looking at the forward load. Anybody coming straight from the IOM’s master planning course, or from reading one of the books bearing this title, would find this name misleading. The textbook definition describes long term planning based around a forecast by product family, with generic resource profiles for each family used to compile an overall capacity plan. This is then refined to come up with a master production schedule at the end-item level.

In this particular business such an approach holds no relevance. We cannot hope to forecast by family and even within a family the resources required can vary immensely. One order might be for an end product very similar to something supplied previously; another may be for a variant on this theme requiring a lot of development work; another may be for a radically different variant requiring an entirely new manufacturing method. Planning the load on the constrained resources in Design Services therefore requires an approach suited to this business.
In this company we use the term **Sales and Operations Planning** for one very simple reason. It is the forum where the **Sales** side of the business sit down with **Operational** people to look ahead. What we actually do is start by examining the load on resources presented by the current order book and what we are doing to address any problems. We then consider the potential impact of specific sales opportunities with a realistic prospect of an order. Sales identify what product the customer will require, whether it is an existing configuration or new design, which particular features and options will be required, the delivery being sought, whether the order will comprise one delivery or a series of phased shipments, and so on.

These opportunities include, of course, quotations which have already been submitted. We need a mechanism by which these are monitored and removed when it becomes apparent that this particular opportunity no longer exists, or hopefully, converted into a definite customer order.

The impact of the order or potential order in terms of the supply chain is then evaluated. The key material lead times are considered and this can lead to decisions to amend the quoted delivery to the customer – for example “if they want that option it will add 6 weeks to the delivery.” An essential feature in such industries is demonstrating to the customer that we understand our product and give quotations that are real. The effect on resources is then considered and it may be that decisions are taken to start the process of hiring contract staff or finding sub-contract manufacturing capacity.

The upshot of the process is that Sales leave the meeting knowing what they can offer, and Operations have an insight into what is likely to hit them.

![Capacity Plans Required For All Constraints](fig1)

**Contractual Dates**

In most manufacturing businesses the term “due date” is fairly well defined. It is normally the date that the product must arrive with the customer - most of us have learned as buyers that we wish to place our purchase orders for goods delivered to our premises by a specified date. (To avoid shocks, we normally prefer to negotiate delivered prices, but this is not always possible.)
Most standard manufacturing control systems are provided with the facility to maintain something called “due date” and these systems, for planning purposes, normally treat this as our required despatch date. Such systems expect us to allow for the transit time to our customer in entering the sales order to the system, and in most cases this is a perfectly adequate solution.

In designing and making to order, life gets more complicated. The end date may actually be “ex works” which is defined as the date when the goods must be available for shipment or collection. It may, however, be related to installation or commissioning of our product on the customer’s site. Within these two extremes it may be any of a range of dates - delivered to site, quayside in the destination country, on board ship, quayside in the originating country or delivered to an intermediary being among the more common.

**Contractual Terms**

The contractual terms against a particular order can be many and various. The first issue to be resolved is which of the dates as defined above constitutes the actual contractual obligation. Although we may well - and, to be sensible, we should - define a projected despatch date for our goods even where the contractual commitment is delivery to site by a specified date, it is quite feasible for us to ship late but still meet this commitment by paying extra for a faster means of transport.

A similar issue arises in defining our point of sale - legally, we are not allowed to claim the sale for our accounting purposes until title of goods has passed to the customer. In many large multi-national corporations where each operating unit is monitored closely against its monthly sales plan this can be the cause of considerable management stress - it is not uncommon to have a peak month in terms of manufacturing workload but have a low sales output because a major contract has been despatched but cannot be invoiced until two or three weeks, or more, later. This has a further knock-on effect in that until title has passed we continue to have the product sitting as part of our inventory.

Another point relates to who pays for which elements of shipping - freight charges and duty. These costs can often be significant and have to be borne in mind when contracts are negotiated. A deal struck as “Delivered Duty Paid” can represent a significant discount to our customer.

Other contractual obligations under a contract can relate to the provision of drawings at an early stage of manufacture (often to help the customer plan the siting of the product) or to the supply of various types and volumes of documentation. On the other hand, certain aspects can actually favour the manufacturer - notably with regard to deposits and stage payments. Our processes need to be geared to help manage around these milestones, and critically to highlight any potential failings – something which the standard production and inventory control approaches do not cater for in any way.

**Stage Payments and Retentions**

In fulfilling any order where the eventual sale happens many months after the supplying company has begun to incur costs it is only prudent that the customer be asked to make some payments during the life of the contract. The amounts and timing of deposits and stage payments are a matter for negotiation and have to be thought of as part of the whole contract. For example, a customer may be seeking a price which gives an unacceptable margin, but which can be made palatable by a substantial payment up front.

In essence, the interest gained on this money (or avoided on overdraft) is thought of as being an additional margin on the job.

Because stage payments cannot be claimed as sales some subsidiaries of multi-national corporations, who are judged purely on sales and margins, often neglect the benefits they offer. This is one example among many of the axiom that the performance measures used to manage a business often drive managers into bad decisions. Stage payments in effect offset inventory and so do improve one vital business statistic - return on capital. They should not be neglected.

In systems terms stage payments impose their own requirements. They may be linked to specific contract events - such as approval of drawings, receipt of major materials, and so on - or may simply be time-based. In either case it is advantageous for the planning and control system to issue some prompt or reminder. More importantly, the invoices generated must not be taken as part of the company’s sales. Each should be logged against the specific contract and upon fulfilling the contract the final invoice is taken to sales together with any earlier pre-payments.
Similarly, for most capital products, most customers wisely insist on some form of retention to be released only after the product has been proven in service. Again, our business systems must recognise this. There is a complexity here in that if we produce invoices only up to the contract price minus retentions we may only claim a sale of £950,000 when shipping goods to the value of £1M. (We get a further £50,000 - net of any additional costs incurred - windfall some time later.) If we claim the full £1M upon contract completion we appear to have poor debt collection performance as this final £50,000 may sit in our receivables for many months.

Many readers will consider their own company’s approach to this matter and recognise that the choice depends upon the particular measurements held to be sacrosanct within the organisation. If debtor days is the prime measurement, we tend to invoice later. On the other hand some companies look to maximise billings at every opportunity, and take to other approach.

### Non-Manufacturing Activities

Companies in this type of market normally undertake significant activities in addition to simply making product. A key activity in most is the design function, where the customers’ specific requirements are translated into designs. How the design function is managed is a key determinant in the company’s success or failure.

In establishing overall lead times and contract plans we have to make assumptions as to how long the preliminary design activity will take - that is, when will we be in the position to order the long lead time castings and so on? How long will it take for these to be delivered, hence when do we need to place the orders? Is there a conflict here? Are people in the design function saying they need 8 weeks when our plan says they can only have 4? We need to set out an agreed, achievable plan.

Having set out our assumptions in the form of a plan we need to monitor actual achievements in order that we are aware of potential delays in contract fulfilment. It is a fact of life that designers, in all product areas, are perfectionists. They want to specify ideal product and sometimes this may be in conflict with the plan, which requires that we decide what we are going to use and get orders placed. Many companies suffer from the problem of contracts running late while specifiers find some way of squeezing some extra performance out of the product – in many cases actually exceeding the contracted specification but producing something they are happier with.

A further problem is that they are often looking to develop a variant which can serve as the basis for future broadening of the product offering. Whilst in principle this is to be applauded, it can be forgotten that right now the company has a contractual obligation and designing a generic range extension may be a good idea, but not if it leads to this obligation being missed.

| Activities Which May Have To Be Managed Within The Order Fulfilment Process |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Initial Design                  | Complete Design | Method Development | Testing         |
| Advance Ordering Of Long Lead Time Components | Ordering Balance Of Components and Materials | Manufacturing | Installation |

In reality, the activities must overlap in order to keep overall timescales to a minimum.

Other activities not shown may include agreement of testing plans with customer, collation of supplier material certification, generation of instruction manuals, etc., etc.
Other activities to be managed can include extensive testing – often witnessed by the customer’s representatives. Setting a plan for this activity is fraught with dangers. We usually wish to test the product ourselves, and rectify any causes of poor performance, before opening ourselves up to external scrutiny. Allowing time for testing is simple, but how long do we need to set aside for corrective action? This can itself be further complicated by the customer requiring several weeks’ notice to arrange visas, and so on.

Finally, the supply contract may include on-site installation. Our planning and costing systems need to cope with this as it brings with it many complications. It may be that our contract requires our retaining title to the goods until final acceptance and our inventory recording needs to take account of this. We need to record time spent on the exercise, and purchase invoices if relying on a third party.

Incomplete Planning Information

One major difficulty in using standard manufacturing systems for businesses designing and making product to order is that, quite simply, the full set of information relating to an order is not available on day 1. Material Requirements Planning cannot identify all the items required until the bill of materials is complete. Even where items do exist within the product’s bill many of them will be recent additions and, in the case of manufactured parts, may well be awaiting the development of a routing. Capacity Requirements Planning (CRP) relies upon this information to report the load on work centres and so it too is of little value outside the very short term.

How do we cope with this? Do we wait until bills are complete, and all routings developed, before releasing an order into our planning system. Emphatically not! Progressive release of bills is an essential step in meeting our obligations. We need to ensure that designers work to specify long lead time items as early as possible in the design process. These can include castings, motors, control equipment, and must be ordered “up front” so that buyers can get these in motion whilst other parts of the specification are finalised.

Progressive release means that we may specify a “bill of material completion date” but that this in itself is meaningless. Many companies specify this as the date by which major components must be ordered – and always appear to be late because nobody takes the action of recording the fact that these key items have actually been released. Other companies may define the date for the very last item, and then have no warning system for the critical, long lead time constituents. In reality we need a plan which has a final date and also key milestones for particular items. This plan will include non-manufacturing activities and it is this plan which must be the key to the requirement dates for these items. We may choose to work outside MRP for these items, or we must ensure that the lead times built into our MRP plans reflect reality.

Ah, you may say, but how do we know when we need to release a casting? We don’t yet know which casting we may require. It might be an existing pattern, it may be an existing pattern needing modifications or it may be that we need a new pattern made. We might allow ourselves the standard 10 weeks and suddenly find we need 14 – what then? The answer is that we have to have our best guess at the outset and make sure everybody is aware of the assumptions on which the plan is based. We then rely on our people highlighting potential problems as soon as possible. A design engineer, for example, may have to highlight the fact that although we set our plan on the assumption that we could use a standard catalogue gearbox, we actually need something a bit special so the planned 12-week delivery may well be 20.

As for capacity planning? The standard approach is of no use other than for the very short term. Longer term planning relies on our generic knowledge of our product offering. “This order is for the Z103 family, requiring 22 hours on a machining centre, normally 5 to 6 weeks before despatch.” This is not an exact science, but how could it be when we are dealing with the unknown?

Component Planning & Pegging

Component planning when designing and making to order usually encompasses the feature of contract pegging of key components. In some cases this may only be for comfort – “have we cast the bearing housings for contract number 109564 yet?” – but in others there is a more clearly-defined need. For example, in one of our clients we use the peg detail to carry product duty conditions down to the purchase order for key components. The supplier then warrants that his product will meet this specification and bears a proportion of any product liability costs.
In other cases the peg detail is used to ensure that the customer can see and touch “his” product throughout the manufacturing process, perhaps in witnessing component testing and taking away test certificates for castings. We could handle this by giving unique part numbers but this throws up the requirement for lots of information being duplicated. It is far easier to use the standard part number with a contract peg detail.

**Purchasing**

In most organisations we have learned that we do not wish to waste buyers’ time by asking them to place orders. Any fool can place an order; the key task of buying is to set up the deal. The buyer’s job is to set in place the supply arrangements which give us quality components at the right price, right quality and right time. Additionally, the arrangements must incorporate a relationship where the supplier’s expertise is added to our own in-house knowledge. This is a full time job and we don’t wish to waste the necessary skills by making buyers perform the essentially clerical task of entering orders.

In designing and making to order the buyer can still do much of the work involving the establishment and maintenance of the relationship, but we can’t set up prices and lead times for every item we may buy, because we don’t know what we are going to want – other than for fairly standard components and materials. We may sometimes use standard catalogue offerings, but will also often be relying on our supplier designing or at least configuring his product for us. A classic example of this is buying motors, gearboxes or actuators.

In such cases every purchase brings with it at least some element of negotiation. This is fraught with dangers as this is often handled very early in our order fulfilment process – before we have created bills of material and part numbers, for example. In many cases the discussions with suppliers form part of our design and bill creation process. This topic itself is fraught with dangers, the primary one being a people issue. Quite simply, there is a tendency for everybody to see himself or herself as a buyer. Engineers and specifiers are very reluctant to stand up and say “oh, I’m not a very good negotiator. I’d rather have a buyer doing the deals.” Managing the procurement activity in these circumstances requires a great deal of thought.

**Aftermarket Supply**

Providing spares for the product can be a highly lucrative operation and one which cannot be neglected. Even if it weren’t such an attractive area commercially, it is essential that we more than adequately support our product in the field, or, quite simply, the new business will dry up. To be successful requires lots of different topics addressed successfully – for example in establishing stock profiles which meet the needs of a changing product base in the market. We can’t simply forecast on historical use if we launched a new major product type two years ago; these items in service will be coming round for their first refurbishment and we will be supplying as spares items which we have never sold in this way before.

There are many marketing (and I do mean marketing, not simply advertising) issues to be covered in this area and an Operations Management journal may not be the place for detailed exploration.

**Other Differences**

There are many other differences in such companies, and in their approach to planning and control; far more than can be listed in an article of this type. A major element is in projecting and tracking costs, but again, that is perhaps for another forum.

**Summary**

I have tried in this article to give an insight into some of the key differences between companies designing and making to order, compared to those with standard products made against some sort of forecast. Where possible within the confines of space I hope I have given some insights into how the particular issues might be addressed.

As I said in my introduction I believe this sector of manufacturing is vital for the future of UK PLC. We need to maintain our edge. Good luck to all of you.