Focusing customer demand through manufacturing supply chains by the use of customer focused cells: An appraisal

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Abstract

A key driver for manufacturing change in the 1990s is that of customer choice, whereby customers are demanding new, more innovative products with greater variety. The attributes of quality, price and level of technology are seen as ‘qualifiers’, which allow the manufacturers entry into a market sector. To maintain or increase market share, manufacturers seek product differentiation through other attributes such as availability and variety. This paper examines the role that customer demand, especially changes in demand, plays in influencing supply chain structures, in terms of flexibility, responsiveness and resource utilisation, as they become more customer focused. It considers the ability of JIT Manufacturing to match customer demand more closely than conventional manufacturing strategies and highlights some weaknesses in the JIT approach. By the use of three case studies, the paper then explains how in certain circumstances, this can be improved by focusing on individual customers through customer focused cells. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

It seems quite simple: all the companies in the chain, their staff, the buildings and equipment would not exist without the end consumer(s) buying their products or services. Therefore, all activities within a supply chain should be directed or focused towards satisfying the consumer’s needs – to provide him with what he wants, how, where and when he wants it. Years ago this most certainly was not the case with products being pushed into the market place. Consumers were expected to be loyal to the brand, to be grateful for the privilege of buying. Today it is different, with globalisation, improved communications and more companies competing for the consumer’s business. Consumers as a result have more choice, they expect new products, better quality, shorter lead times and at a reasonable price. Hal Mather comments “Most competitors today are very similar with their product performance, quality and price. They are not close with availability and delivery when needed” [1]. What this says is that attributes such as quality, technology and price are very often taken for granted, but getting the right product to the consumer in the right place at the right time is difficult to achieve at an acceptable cost [2]. In order to
differentiate their products in the market place, companies are seeking new approaches, new methods. One fairly widespread approach has been that of JIT Manufacturing. This however has not always been sufficient to provide the flexibility needed to respond to sudden and often unpredictable changes in customer demand. Companies are developing different strategies. One, which deserves special attention, is a development of the concept of JIT Manufacturing. The strategy is JIT Manufacturing focused to a specific customer, to satisfy, to excite, all at a reasonable cost. The methodology supporting this concept can be best described as customer focused cells. This paper examines the various types of demand found in many typical supply chains and how customer focused cells can be used, in certain circumstances, to satisfy this demand.

2. Customer focus

To present a customer with a single product just when he wants it requires one to foresee the future. Even if one could, to provide the service would necessitate holding large amounts of dedicated stock, close to the customer with the supplier on 24 hours standby (Fig. 1).

The customer may not be too keen to be surrounded by warehouses devoted entirely to his needs. Even if he was delighted by the service, the cost of resourcing such a service would be astronomically high, and the measure return on assets (ROA = profits/net assets) would become too small for a company to even think of. Yet Zairi argues ‘successful competition is the result of a rigorous attack (by companies) to fulfil customer needs’, based on an understanding of one’s capability [3]. This does not mean that we should not pursue the idea of satisfying individual needs, rather we should pursue it where possible within our resources. In a recent article on Agile Manufacturing, providing individual products at mass production cost levels, Owen et al. talk about ‘run length(s) of one unit’ [4]. Understanding true customer demand and how to satisfy it is a key issue for companies in the 1990s. The next section looks at how manufacturing companies, particularly those employing the concept of JIT Manufacturing, have significant problems when dealing with large fluctuations in overall volume demand, especially at short notice. As they try to optimise their own situations they often create extra problems for their suppliers over and above those that would have been caused by the original volume demand fluctuations.

3. Customer demand

3.1. Variation in demand

Stable demand is what supply chains want – forecasting and subsequent planning is easy. However in real time, demand is likely to be anything but stable. It is convenient to consider demand in two ways:

- mix demand,
- volume demand.

Mix volatility is normally easier for companies to react to, particularly those who have developed a flexible approach to manufacturing [5]. Volume volatility is more problematic, requiring trade-offs between resource utilisation and efficiency. Hal Mather sees three ways in which companies tend to tackle it:

(a) Through high inventory: with huge assets and still no guarantee of getting it right, ROA will be very poor.

(b) Increased lead times: while this may be fine for specific segments, e.g. hand made cars, it is hardly likely to provide customer satisfaction in more competitive markets.

(c) Matching the flexibility of resources within a factory to that of the marketplace.
Mather sees this last area as one where opportunity appears to lie [1]. Companies are seeking manufacturing flexibility to match demand. However volume variation is difficult to manage and control. One finds that companies running JIT have as a rule dealt with the problem by pushing the effects back down the supply chain. They have learned to cope with mix variation but find volume variation too difficult or costly to handle. In a recent study, sudden volume variation affecting an OEM’s production schedule was ‘solved’ by rescheduling the product mix [6]. This, however, resulted in sudden volume changes to supplier orders, which had unforeseen effects. Some suppliers producing complex sub-components, sequenced to the OEMs build schedule, had difficulty in responding. This in turn led to problems with quality and availability, and was ultimately a cost to the consumer. The study showed that improved communications could have lessened the effects. The cascade system of communications, common to the automotive industry [7], is fine in theory, but here the data on variations was being corrupted at the inter-tier nodes with delayed and/or limited communications. Greater flexibility from the OEM could have reduced the effect, but as so often happens, their optimisation became suppliers’ problems by passing the need for flexibility back up the supply chain.

3.2. Nature of demand

Before looking at some examples of how companies respond, it is helpful to look at the nature of changing demand. Over a given period an individual consumer’s demand is summed with those of other consumers giving us a summed demand signal. We talk of an average ‘resultant demand’ with variations about it, Fig. 2.

We may look at the causes of this variation in two ways:

(a) Consumer-led change (true demand)

Long-term changes:

- seasonality,
- changes in the economy,
- markets.

Short-term changes:

- weather,
- environment,
- buying habits.

(b) Company-led change (induced variation)

- sales and marketing strategy (e.g. promotions),
- delivery methods (unit loads, vehicle sizes),
- supply chain structures (no. of warehouses, no. of suppliers).

To provide customer satisfaction it is the signal from the consumers that the supply chain needs to focus on. As Rachel Burgess points out, supply chains are rarely planned in their entirety, rather they develop piecemeal to serve immediate functional needs. Inefficiencies can thus affect the process, producing an increasing amount of distortion to the signal [2]. This is called noise. As the customer signal passes along the stages of the supply chain the signal may be weakened (attenuation) through distance and lack of focus. The amount of noise, on the other hand, may well increase. See Fig. 3. There is a danger that the true signal can disappear, swamped by the noise, as seen in Section 3.1. Parts of the supply chain may even respond to a different ‘signal’, increasing costs and still fail to satisfy the actual demand. For example, a car company forecasts and then manufactures a lot of purple cars. Nobody wants to buy the cars. In the salesrooms the purple cars are pushed with special deals to clear the stock. The car company suddenly sees record sales of purple cars and hence issues
instructions to manufacturing to...! This extreme example of course is rather unlikely in today's industry. It does however illustrate induced variation in demand and the need to control it. A lot of work has taken place to identify the cause of this variation (first highlighted by Forrester [8]) and remove or reduce it [9].

Reducing the effect of these causes requires a greater control of processes and flow of materials. A more sudden way to address the problem is to remove the causes. Many companies are achieving this through re-engineering their supply chains and businesses. For example in the retail trade, especially in food retailing with supermarkets such as Tesco and Asda, the major players are improving customer service by a range of methods. These are designed both to 'flow' the information through the supply chain more quickly and to take greater control over this information and the resulting product flow. Tesco, by adopting the principles of efficient consumer response (ECR), are improving links with their suppliers who in turn are becoming more focused on their customer, Tesco. Daily deliveries, minimum stock and category management are helping to minimise noise in the system. Car companies are also effectively reducing structure in supply chains in terms of order-processing, warehousing and transportation. Using dedicated companies or supplier cells they assemble and deliver small batches of complex parts, sequenced in the correct order of variety, to trackside within very short lead times in a process known as synchronous supply [10].

3.3. Reducing demand variation

Many manufacturing companies are beginning to appreciate the difference between manufacturing efficiency and manufacturing effectiveness. The first concentrates on performance measures such as machine utilisation and productivity whilst the second is process orientated, coping with greater variety and shorter lead times through manufacturing flexibility. Whilst cost and hence manufacturing efficiency are important the emphasis is on managing effectively those processes that focus on customer requirements. The introduction of a JIT Manufacturing philosophy is seen by many to be the way forward. 'JIT companies aim to close in on the ideal of meeting demand instantaneously with perfect quality and no waste' [11] – as has been seen above, the essence of customer focus.

JIT companies are characterised by low levels of stock and wip, short lead times, reducing costs and a continued attack on waste. The manufacturing control systems are based on pulling customer demand through the supply chain rather than a push system typified by MRP. The basic concept of JIT is the elimination of waste. It relies on a combination of techniques to achieve this. If you have little or no stock your machine reliability must be excellent, hence total preventative maintenance (TPM). A mix of products requires minimum set-up time, hence single minute exchange of dies (SMED). Quality, of machines, components and people, must be a priority, hence total quality management (TQM). These require Teamworking, Kaizen and
the 5Ss, all of which require a multi-skilled, trained workforce.

Where the components require a number of operations the introduction of Cellular Manufacturing becomes a requirement. Cellular Manufacturing was originally introduced into the UK in the late 1960s under the name of group technology (GT) [12]. Depending on a number of different classification systems, it grouped ‘families’ of components and groups of machines. Whilst it had many of the potential advantages that modern systems claim, it was basically a production engineering technique for reducing lead times and wip. Its focus was functional, not the customer, and it, GT, never gained mass popularity, slipping into oblivion in the mid-1970s.

Cellular Manufacturing however remains and is widely used, working best with level loading (Heijunka). ‘JIT is also helpless unless downstream production steps practice level scheduling (Heijunka in Toyota speak) to smooth out the perturbations in day-to-day order flow unrelated to actual customer demand’ [13].

With careful planning, cellular manufacturing can cope with significant variations in product mix. Volume variation, as stated above, is a different problem. However, the characteristics of JIT, low stock and small batch sizes, mean that a lot of the volume variation causes, i.e. the noise, has been eliminated or reduced. Thus cellular manufacturing in a JIT environment and with downstream practices in step with the concept of Heijunka can cope with a certain level of customer demand variation, which in a traditional push, manufacturing environment, would cause significant demand fluctuations both on manufacturing and more crucially on others further upstream.

4. The path to customer focused cells

We have seen above that on the one hand JIT Manufacturing and its manufacturing cells cope well with mix variation if not so well with volume variation. On the other, one can focus on satisfying any customer need in terms of variety and volume, but this is more than likely to lead to problems in terms of resource utilisation, high levels of stock and manufacturing inefficiencies. However the two approaches are not exclusive, in fact we argue that the two may be successfully combined as an extension of JIT which we refer to as customer focused cells (CFCells). We see these as manufacturing cells (space, machines, equipment and people) operating in a JIT environment but focused on the true demand of a particular customer. The accepted wisdom on manufacturing cells, which tend to be product orientated, has been that they are geared to customer demand (made to order). In practice, however, products are being made to forecasted demand (the quantity that is predicted to be required at a given time). Most of the focus and measured outputs from manufacturing cells are thus to do with manufacturing rather than customers.

In CFCells the resources are geared to specific customers and less concerned about specific products. The cells may well be structured in a similar style to manufacturing cells or, may have one or several dedicated lines. Whatever the structure, the concept is different. The cell is focused on one customer only. The challenge is to maximise the flexibility of the cell’s resources, both physical and human, to cope with variation in volume as well as in mix. This will be easier to achieve if a given cell makes a variety of products for the customer. Manufacturing in these cells will most likely be characterised by small batches, high variety and most crucially short lead times. They may well be seen as a low volume facility similar to the higher volume, dedicated product and system lines being used by ‘wrap-around industry’ suppliers. A logical extension of this idea is the ‘factory of the future’ concept. Predicted in the 1960 and 1970s as an ‘all-singing, all-dancing’ factory of the 21st century, which could make any type of manufactured product at the push of a button (echoes of the manufacturing capabilities aboard the USS Enterprise).

CFCells and their personnel can provide a number of benefits:

- Extraordinary customer satisfaction. The correct volumes in a very short lead-time.
- Focus for removing waste and misunderstanding. Easier to observe.
- Transparency of information. More direct, leads to less intra-company waste.
Improvement of partnerships. This will allow a more focused attack on inter-company waste.

The latter suggests that the cellular focus on a customer may have wider implications for supply chains. In fact Brace and Rzevski have suggested a supply chain of the future as being made up of self-regulating cells, each with its own technology niche or knowledge base, since management of the whole process is likely to be too complex [14]. This concept of cells appears to fit in nicely with that of CFCells (cf. Section 5.2).

There are of course constraints:

- Trust. Not a widely recognised characteristic within UK supply chains.
- Long-term partnerships. CFCells dedicated to a given customer will be susceptible to changes in the customer’s market. Risk will be reduced in proportion to the number of products manufactured in the cell.
- Capital intensive. The problem here is that it will be more difficult to justify any non-use of the CFCells in terms of efficiency. This constraint is likely to become less crucial as equipment becomes more portable and can be used elsewhere.
- Insufficient volume or business. There is likely to be a critical volume required, below which it is difficult to justify the commitment of resources, space, equipment, etc.
- Nature of volume variation. High variety will obviously pose difficulties. Some companies can cope, cf. Section 5.2.

So although the noise of variation has not been removed, the signal is far stronger in CFCells (less distance to travel and less distortion in the focused cells). This stronger signal will help reduce misunderstandings in information flow, a major source of errors and demand amplification. There are many examples of cells in industry which are in some way dedicated to particular customers, e.g. focused cells, customer cells, customer lines, dedicated lines and business units. Few however are designated with a sufficient degree of flexibility to efficiently satisfy the levels of both mix and volume demand variation that are becoming the norm for manufacturing companies. The following case studies illustrate some of these cells and how they fit into our definition of CFCells.

5. Case studies

These are based on information gathered indirectly from recent research and industrial projects carried out with OEMs and SMEs at the Supply Chain Development Centre in the University of Central England. The research involved a close examination of supply chain activities in 35 automotive companies in the West Midlands by means of company visits and semi-structured interviews. Industrial projects are regularly undertaken with a variety of manufacturing companies as part of the Industrial Logistics Masters Programme. The case studies are used to illustrate how different companies are currently dealing with demand variation in both mix and volume.

5.1. Case study 1 (PlastA)

PlastA is a first tier, plastics component company situated in the West Midlands. Supplying OEMs in leisure, automotive and electronics industries, it has developed in recent years into a multi-million pound company. Not only has the company invested heavily in new equipment, but it has also continually invested in people, quality, IT and manufacturing systems. The winner of numerous awards for quality and manufacturing excellence, it offers design, manufacture and assembly services to its customers, and is keen to work in partnerships through best practice teams and dedicated ‘on-site’ engineers. Its hallmark of success is flexibility of response, coping with high volume production, short lead times and short specialised runs. The company achieves this through a number of cells focused on individual customers.

PlastA’s customer focused cells operate as extensions of the customers’ own design and production teams. A range of machines and people are dedicated to a particular customer cell, with its own cell manager. The latest automated moulding equipment with specialised robotics systems allow for fast, high volume production. The cells have invested in fast ‘mould-change’ facilities and in
multi-skilling for the workforce. This allows considerable flexibility of volumes and product lead times. The cell will manufacture to order, with some orders ‘driven’ by OEMs’ Kanban systems. Purchasing in the company is centralised. As PlastA’s main suppliers are the large multi-national, plastic manufacturers such as Dupont, they hold relatively large stocks of raw materials.

The cells tend to balance their resource scheduling by product mix. Any free time is devoted to machine maintenance, training and continuous improvement. Small volume variation can be catered for in a cell by rescheduling. Large or sudden volume variation can be accommodated by reallocation of resources. For example the company runs most of its work on one 8.00–16.00 shift. A much smaller second shift 16.00–23.00 operates on certain products in whichever cell is needed. This and overtime are usually sufficient to satisfy the demand. In certain cases a third shift or weekend working may be introduced, although this is rare. The company expects their work force to be flexible in terms of hours and shift patterns and to remain in cells, rather than import other cell members or temporary staff. As the OEMs focus more closely on their customers’ demands, so PlastA as a “first tier supplier works more closely with them. Flexibility is achieved in response to demands of mix and volume through sufficient cell capacity and a flexible workforce.

The company’s commitment to quality, consistency and performance through CFCells provides customer satisfaction and increases competitive advantage for the supply chain. Its flexibility to customer demand has led to a greater range of products being sourced by its existing customers. Further, although this has increased resource demands it has also enabled an overall greater efficiency in the use of cell resources.

In this example we have seen parts of the company, the CFCells plus administration, focused on particular customers and working in close harmony with them. The majority of the JIT principles are in place, e.g. customer focus, products when required, emphasis on waste elimination, team work and Kaizen. They are linked by the willingness/ability of the company to manage volume changes, partly by reducing noise through better cooperation and communication, and partly by the flexibility of machine and human resources.

5.2. Case study 2 (AeroB)

AeroB, in the West Midlands, manufactures a wide variety of hydraulic and mechanical products for the aircraft industry. These are characterised by high levels of technology, quality and variety, but low volumes. Profit margins are very low on OEM, but high on after-market, sales. Its major customers are the aircraft manufacturers such as Boeing and Airbus with over 50% of sales. The make to order policies of the latter mean forecasting is difficult, leading to very lumpy demand on first tier companies such as AeroB. This in turn is passed on to their suppliers. AeroB has recently adopted a JIT Manufacturing philosophy, particularly to focus on their customers’ demands [15]. Being proactive to customer wishes for quality systems, visibility and traceability is extremely important in an industry, which has large up-front (sunk) costs from product design and prototyping. It is crucial to ‘excite’ the customer. Failure here means an inability to partake in the more lucrative after-market. As with other aerospace companies [16], the use of JIT has led to cellular manufacturing. AeroB has carried this further by proposing to develop the supply chain as a series of CFCells. Burgess has referred to such structures as channels [2]. There are three channel versions:

- customer-based channel,
- supplier-based channel,
- usage-based channel.

In a company she argues, ‘(customer-based) channels should be more successful if a difference could be found between the processes required for customers’. AeroB’s version is based solely on the customer at each stage, from suppliers through to the customer (see Fig. 4). Some functions such as design will still remain centralised. Suppliers will not be part of more than one channel to prevent cross competition between channels. This will also isolate other channels from supplier or cell failure. Purchasing and order functions are to be devolved to the individual channels. This will deliver customer focus through a single point of contact.
The channels will facilitate better traceability, visibility and communication, make costs easier to determine. The latter is very important in an industry dominated by long-term contracts between the OEMs and their suppliers. Volume variation can be managed, by moving staff between cells in different channels. As yet only the assembly and test cells for two channels are commissioned. It is too early to judge the system's effectiveness.

The use of separate suppliers for separate end customers, whilst going against the modern trend of supplier rationalisation, allows the channel to concentrate its attention on minimising 'noise' and hence reducing demand fluctuations, undiluted by the competing demands of the other channels. ‘Noise’ can further be reduced by direct feedback to the end customer allowing orders to be prioritised, based on detailed knowledge of the capacities of its dedicated supply chain. Real demand variation can then be absorbed by moving staff between cells in different channels.

5.3. Case study 3 (AutoX)

AutoX is a global first tier supplier to the automotive industry. It delivers subassemblies direct to the trackside of a major vehicle assembler in the West Midlands. The subassemblies are ordered in batches (approx. 100). They are then built and delivered within a 2 1/2 hour lead time. To achieve this the company operates a 'customer-dedicated' plant close to the assembler. This can be seen as an example of a CFCCell.

AutoX operates within a narrow band of those characteristics that our paper suggests are necessary for CFCCells to produce a competitive advantage within a supply chain. The supplier operates two lines, each supplying a different assembly line – basically two CFCCells. At the end of each week it receives a schedule of daily demand for the following two weeks. Production, however, is based on the actual daily build programme taken, via computer link, direct from the assembler giving them 2 1/2 hours to assemble and deliver in a sequence that exactly matches the assembler's line build. Theoretically delivery should exactly match demand, but in practice stock at the trackside can vary from 15 minutes (ideal) to 2 hours.

Demand can vary by up to 10% per week when comparing forecast against actual. Daily demand variations are likely to be higher. Yet the company, dealing with 14 product variations on one line and 8 on the other line, and with 34 suppliers, some based in Germany, one in France and one in Japan, manage to 'delight' their one customer with sequenced delivery at 2 1/2 hours notice. Even with volume variation at 10% they have no component stockroom, relying on their suppliers to deliver just in time (the one exception, ironically enough, being the Japanese supplier). Compared to other CFCCells it should be noted that these cells are purely assembly. The product variation, whilst numerically high, is minor in detail (basically product focused) and the volume variation is relatively small. The cells however are customer focused. They respond to customer demand, in terms of both volume and mix variation, with no stock and without the flexibility of using assets from adjacent cells that would be found in many other factories, all within 2 1/2 hours. They do this by a complete focus on the customer and the willingness to provide the necessary resources to cope with demand variation.

AutoX is typical of a number of automotive companies supplying subassemblies just in time to
OEMs, trackside. The emphasis is on making to order and waste elimination. Demand fluctuations of customers are to an extent flattened by the OEMs in an attempt to maintain steady production. However, with their large plants and heavy investment they do not have the flexibility to build to customer order within the increasingly short lead times confronting them. As increasing stock or extending lead times is not an option, the solution is to make use of their suppliers to reduce the ‘noise’ of mix and volume variation through effective resource management in their CFCells (see Fig. 5).

6. Conclusions

What the research team at the University of Central England have seen is that companies are becoming more involved in customer focus, particularly in terms of the new parameters of variety and availability. Focus in terms of flexibility and response in supply and manufacture have become key issues for supply chains. What is becoming clear is that there is no common way of tackling it. Different industries and individual companies are evolving their own methods. This paper has pointed to some of the issues in demand variation, in particular those of satisfying product mix and volume variation and how the real demand signal can lose its ‘focus’ back up the supply chain. Volume variation can be satisfied either by high stock or excess capital resources, but this hardly provides a cost-effective solution. The three case studies have illustrated that the use of CFCells gives another approach to satisfying variable volume demand. Here the companies are making to customer order, in terms of greater variety, smaller batches and shorter lead times. All are using flexibility of resources to cope with the changes in volumes. PlastA has been highly successful in terms of customer delight and increased orders. AeroB is still developing its structure of CFCells, using a fairly narrow customer focused channel. AutoX’s cells provide a highly efficient service working in tandem with its given customer. All are using JIT systems and all are working closely with their customers. What distinguishes them are features characteristic of their different sectors and the degree of resource flexibility they are prepared to commit to individual customers.

Over the last 30 years JIT has shown itself to be a very effective system/concept for enabling companies to satisfy customer demand, particularly the increased variety now required by consumers, within the limitation of relatively stable demand (Heijunka). Another characteristic of successful companies in the 1990s has been the emphasis placed on customer focus. The three case studies illustrated have shown that companies can incorporate customer focus into their JIT systems without being constrained so significantly by the concept of Heijunka. CFCells are an extension to normal JIT systems delivering outcomes which JIT alone cannot deliver. We would argue that under the right conditions such cells are the logical
conclusion of satisfying the key concepts of JIT and customer focus.

References


