The following article is the first in a series introducing the concept of Lean Thinking. The aim is to take readers through the application of lean methodology and tools for the improvement of supply chains. The content will be a mix of theory and practical examples. Future articles will cover: 'Customer Value: applying the first principle of lean' 'Learning to See: how does your supply chain function' 'Making It Flow: moving from batch and queue to single piece flow' 'What the Customer Wants: making at the pull of the customer' and 'Making it Stick: sustaining your improvements'

Lean Thinking: What it is and what it isn't

by Nigel Wood

What is Lean Thinking? This is a question that it is perhaps best to start answering by saying what it is not. It is not about zero inventories. It is not a collection of tools to be applied mechanistically to problems. It is not a Japanese philosophy to be applied indiscriminately. It is certainly not a collection of buzzwords designed to confuse the uninitiated whilst stating the obvious.

So if that is what it is not, what is Lean? At a high level it is a way of giving people at all levels of an organisation the skills and a shared means of thinking to systematically drive out waste by designing better ways of working, improving connections and easing flows within supply chains. By eliminating waste we can simultaneously reduce our costs, make better use of our resources and deliver better customer value.

Lean Thinking is being successfully applied by a wide range of industries including automotive manufacturing, chemical processing, food manufacturing, clothing, retailing, healthcare and local government. If you are manufacturing a product or providing a service – Lean is both applicable and appropriate.

Understanding Waste

The Japanese use the term muda. In English we translate this as waste. Within Lean Thinking this waste is defined as any human activity, which absorbs resources but creates no value. Taiichi Ohno, the Toyota executive identified seven types of waste [1]. These are identified in Figure 1 opposite. Womack and Jones [2] add an eighth waste, namely the design of goods and services, which do not meet the customer's needs. Untapped human potential can also be considered as a waste.

In a typical process, waste, or non-value adding activities, can amount to more than 95% of day to day work. Traditionally, we have concentrated on improving labour productivity etc, ie the 5% value-adding activities, whilst ignoring the potentially bigger prize of waste elimination (See figure 2).

As Peter Drucker says:

"There is nothing so useless as doing efficiently that which should not be done at all".

It is the remorseless pursuit of the elimination of these wastes that is at the heart of Lean Thinking.

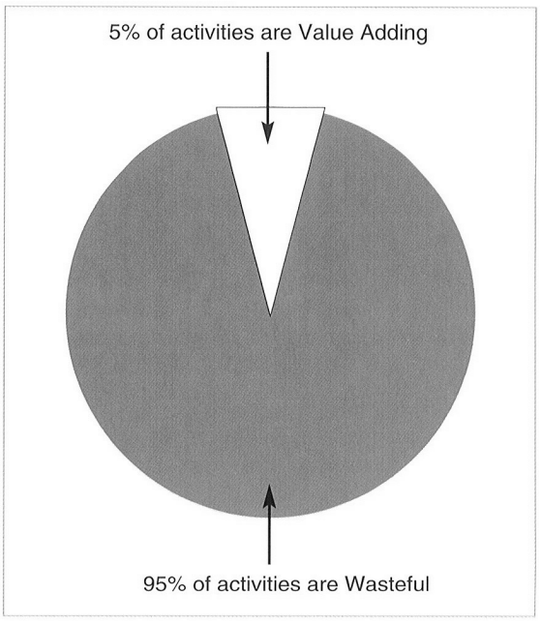


Fig. 2. The Split between Value Adding and Non-value Adding Activities

The 5 Principles of Lean Thinking

If waste elimination is the aim of Lean Thinking, what are the principles we need to follow?

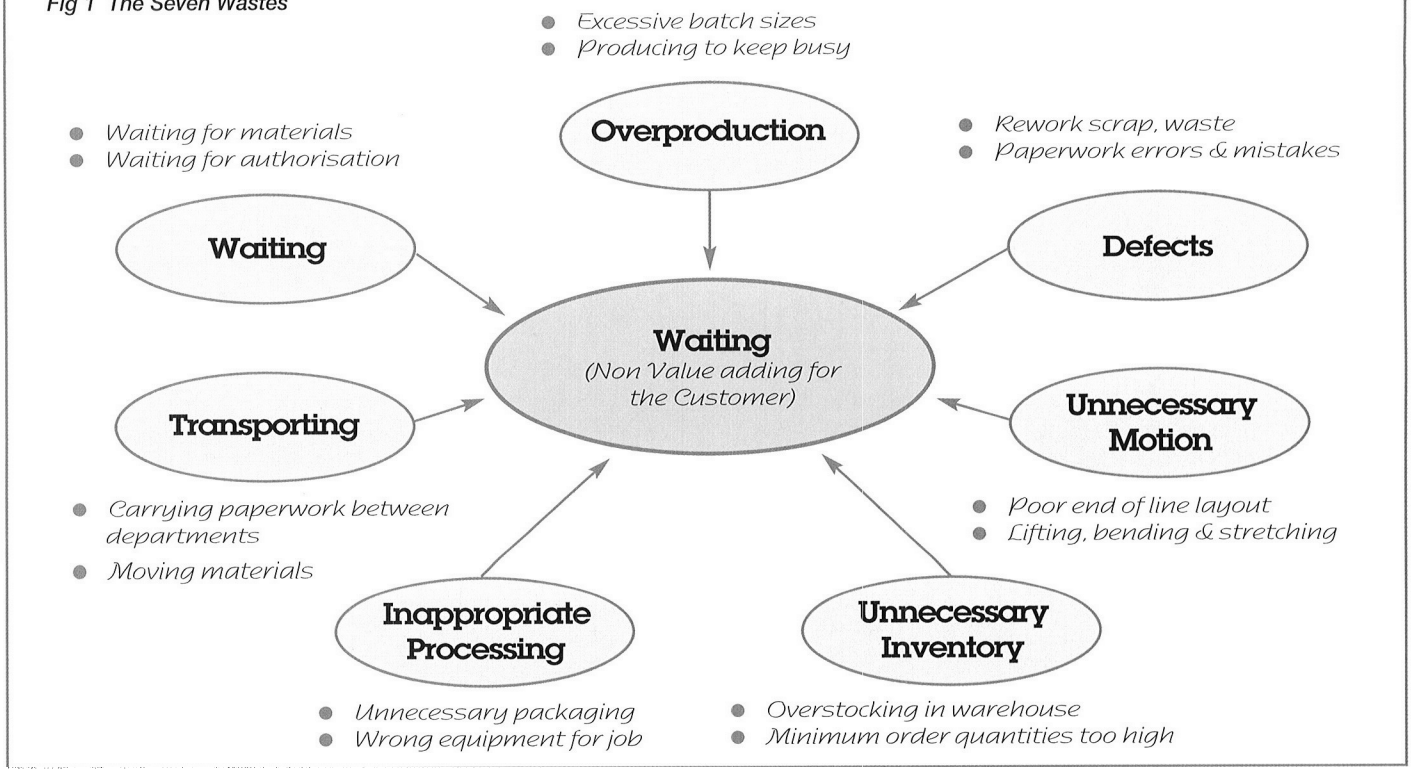
Principle 1: Specify Value by Product

Identify what the customer actually wants. Ask yourself this question. "Would I pay for something I did not want?" You would certainly not be happy paying for any of the wastes identified above, so why should your customers be different?

Principle 2: Identify the Value Stream

What is your process from product design, development, procurement, manufacturing, distribution and sales for satisfying your customers' needs? How does your supply chain function? What are its capabilities? Where are the wastes?

Fig 1 The Seven Wastes



Principle 3: Make the Product Flow

Does your process involve 'batch and queue'? Are there bottlenecks? Is there no clear line of sight through your process?

If the answer is yes, the aim is to reduce or eliminate these and to move as close to single piece flow as possible. If you can make at the rate of sale, so much the better.

Principle 4: Supply at the Pull of the Customer

Only make what the customer requires, when the customer wants it.

Principle 5: In Pursuit of Perfection

Perfection is the complete elimination of waste. It is at this point that every activity creates value for the customer. This is a journey of continuous improvement based on an intolerance for maintaining the status quo.

Lean Behaviours

Effective change does not happen by chance, it must be planned. There will be significant resistance to change, as all those involved will feel threatened unless they can see a compelling need for the change.

An environment needs to be created to ensure any change is both understood and becomes sustainable. To do this we need to adopt the behaviours shown in Fig 3 below:

And in this we must follow Charles Darwin's advice:

> *"It is not the strongest of the species that survives, nor the most intelligent, it is the one that is most adaptable to change"*

These changes in behaviour can be unsettling, especially for organisations used to 'command and control' styles of management. Most projects that fail do so as a consequence of underestimating the human element in the change process.

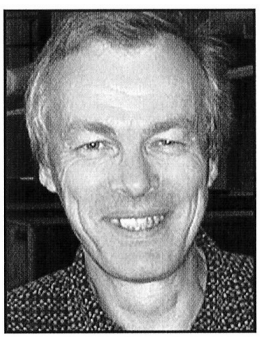


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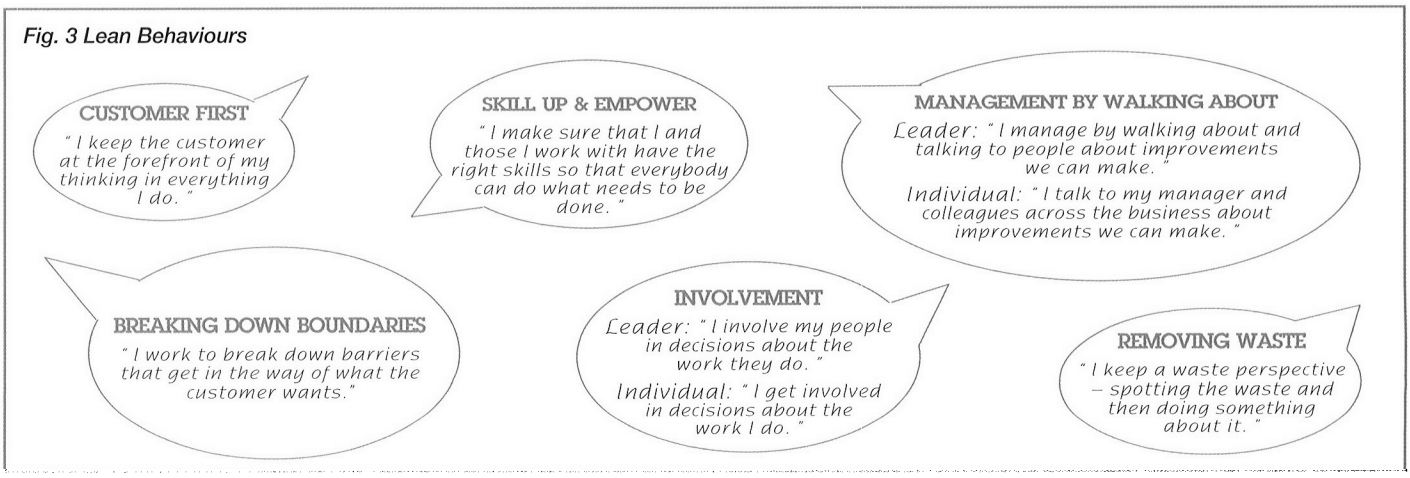
Fig. 3 Lean Behaviours



First Steps

In the next article in the series we will look at how to get started by identifying the first steps of our journey by looking at Customer Value.

We are also publishing with this series a 'Lean' Glossary of terms which readers will hopefully find useful. This will also be published in six parts together with the articles. The first part is published below.

References

1 Taiichi Ohno, The Toyota Production System: Beyond Large Scale Production, *Productivity Press, 1988.*

2 James P Womack & Daniel T Jones, Lean Thinking: Banish Waste and Create Wealth in Your Corporation, *Free Press, 2003.*

Lean Glossary (Part 1)

Activity-based costing –

A management accounting system that assigns costs to products based on the amount of resources used (including floor space, raw materials, machine hours, and human effort) in order to design, order, or make a product.

Contrast with standard costing.

Andon board –

A visual control device in a production area, typically a lighted overhead display, giving the current status of the production system and alerting team members to emerging problems.

Autonomation –

Transferring human intelligence to automated machinery so machines are able to detect the production of a single defective part and immediately stop themselves while asking for help. This concept, also known as jidoka, was pioneered by Sakichi Tbyoda at the turn of the twentieth century when he invented automatic looms that stopped instantly when any thread broke. This permitted one operator to oversee many machines with no risk of producing vast amounts of defective cloth.

Batch-and-queue –

The mass-production practice of making large lots of a part and then sending the batch to wait in the queue before the next operation in the production process.

Contrast with single-piece flow.

Brownfield –

An established design or production facility operating with mass-production methods and systems of social organization. Contrast with greenfield.

Cells –

The layout of machines of different types performing different operations in a tight sequence, typically in a U-shape, to permit single-piece flow and flexible deployment of human effort by means of multi-machine working. Contrast with process villages.

Chaku-chaku –

A method of conducting single-picce flow in which the operator proceeds from machine to machine, taking a part from the previous operation and loading it in the next machine, then taking the part just removed from that machine and loading it in the following machine, etc. Literally means 'load-load' in Japanese.

Changeover –

The installation of a new type of tool in a metal working machine, a different paint in a painting system, a new plastic resin and a new mould in an injection moulding machine, new software in a computer, and so on. The term applies whenever a production device is assigned to perform a different operation.

Cycle time –

The time required to complete one cycle of an operation. If cycle time for every operation in a complete process can be reduced to equal task time, products can be made in single-piece flow.

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Customer Value: Applying the First Principle of Lean

by Nigel Wood

In the last article we introduced the 5 Principles of Lean Thinking. This month we will concentrate on the first principle 'Specifying by Value' and examine the role of Value within the supply chain.

You may recall we defined the first principle as:

Specify Value by Product

Identify what the customer actually wants. Ask yourself this question:

"Would I pay for something I did not want?"

Why should your customers be any different?

As customer value refers to everything we do that the customer is prepared to pay for, we must seek to maximise value to the customer by planning what we do around the customer instead of what is easy or convenient for us.

What is it that customers actually value? At Boots Manufacturing we have looked at this in terms of both the end customer, or consumer, and our internal customers. Our findings indicate a subtle difference in their requirements as follows:

Consumer

- Product is always available for them to purchase
- Product 'does what it says on the tin'
- Product is defect free
- Product is value for money
- Buying the product makes them feel good

Internal Customer

- Stock is always available to meet marketing and merchandising plans
- We are responsive to market conditions
- Our products are perfect in quality
- There is speedy introduction of new products
- There is a hassle-free working relationship
- We produce at the lowest product cost

As can be seen, in the main, our consumers' values are based around the product, whilst our internal customers' values are based around the service we provide through the supply chain. This perspective allows us to focus our efforts on these specific requirements. So let us look at 'Product Related Values' and 'Supply Chain Values' in turn.

Product Related Values

Dr Noriaki Kano [1] has developed a model by which it is possible to identify the factors which customers look for when they make purchasing decisions. These he defines as Basic (or 'must be'), Performance (or 'more is better') and Delighter (or 'excitement'). In response to these factors the customer's response in terms of satisfaction will range from 'disgust', through neutrality, to 'delight'. For the relationship between the factors and the customer's response see Figure 1 opposite.

Basic Factor

This is something the customer expects to be present as a matter of course. If it is not, the customer will be dissatisfied or disgusted. If it is fully in place the customer will be neutral. Examples would include a heater in a car, clean sheets in a hotel bedroom, or a full pint of beer dispensed by a bar person!

Performance Factor

The absence of a Performance factor is likely to result in disgust; however, full implementation can result in delight. As often as not they are already present and result in a neutral response from the customer. It is not the existence of the factor that is critical but more how it can be improved. Examples would include temperature-controlled air-conditioning in a car, speedy check in at a hotel or a quick acting pain killer to treat a bout of toothache.

Performance factors are best identified using market surveys. It is critical that those causing dissatisfaction are quickly identified and remedied.

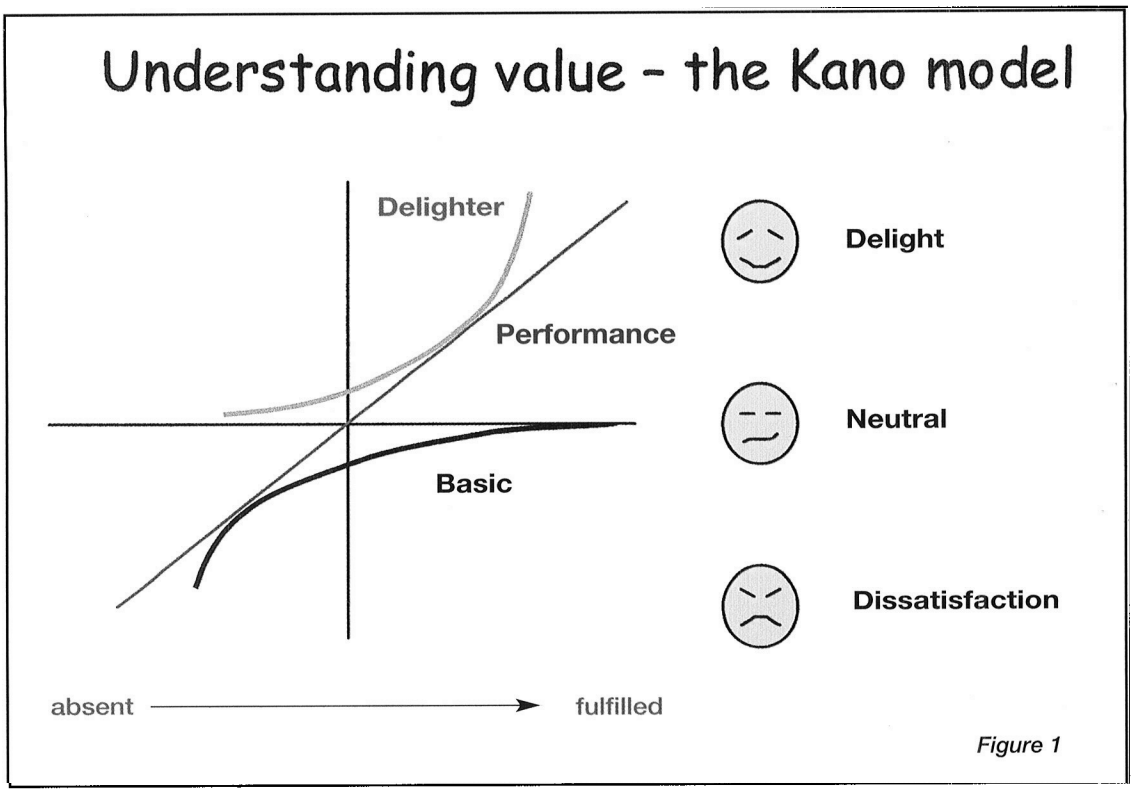
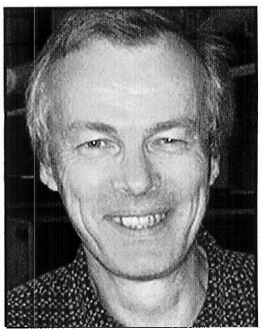


Figure 1



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Process redesign or creative product design are often required to ensure faster and easier delivery of the factor.

Delighter Factor

A Delighter is something the customer just does not expect and will cause increasing delight if present. Examples would include complimentary flowers and chocolates for hotel guests, free insurance and servicing for a new car or a radio that retunes itself automatically when it moves out of range of a transmitter.

Market surveys are of little use in identifying Performance factors. One needs to be creative building on an appreciation of latent customer needs.

Unfortunately for manufacturers and service providers Kano factors do not remain static. Performance and Delighter factors will inevitably migrate to being Basic as customer expectations grow with time as shown in Figure 2.

Although out of scope of this series of articles it is worth noting that Quality Function Deployment is a tool often used by product designers to identify attributes which will satisfy the Kano factors[2].

Supply Chain Values

We will now turn our attention to fulfilling values of customers other than consumers. As identified earlier these usually relate to the performance of the supply chain. Reliability, flexibility and cost effectiveness are the key issues. Ultimately these will be achieved by applying flow and pull techniques, which we will be covering in future articles but the starting point for these is understanding the demand pattern for the products.

A convenient approach is to identify if the products can be classified as Runners, Repeaters or Strangers. This is an indication as to the predictability of the frequency and quantity of demand. As shown in Figure 3 below.

Figure 3	Predictability	
	Frequency	Quantity
Runner	Yes	Yes
Repeater	Yes	No
	No	Yes
Stranger	No	No

Not surprisingly Runners are the easiest to supply as planning is uncomplicated and can be achieved by the use of cyclic schedules. Repeaters are a little

Identify what the customer actually wants.

Ask yourself this question:

"Would I pay for something I did not want?"

Why should your customers be any different?

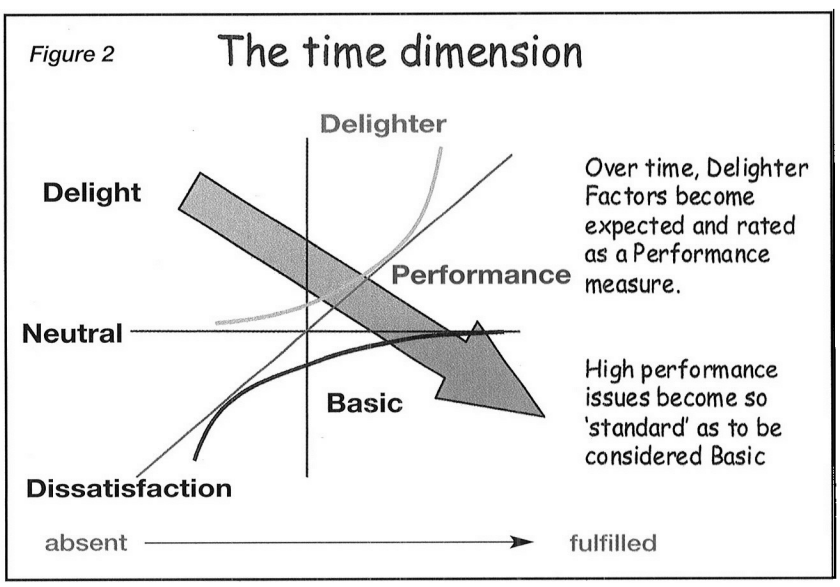
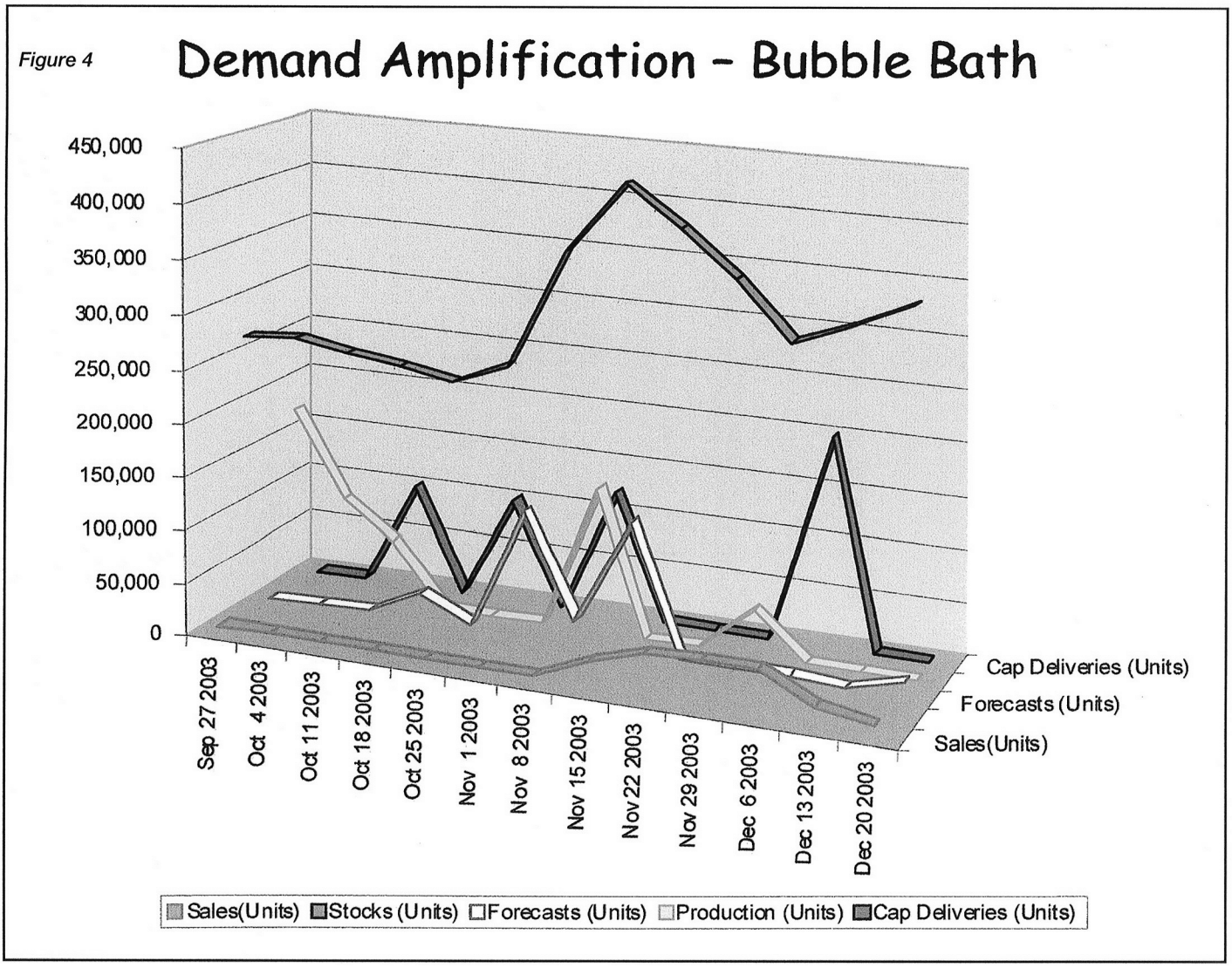


Figure 4



more complex but are still easily handled by the use of Kanbans etc. Strangers offer the biggest challenge. You may be able to treat these as make-to-order items, assuming your lead times are acceptable to your customer.

Demand Amplification

Understanding demand pattern is only part of the equation. We also need to understand how the supply chain is responding to demand. For this we use a tool known as Demand amplification. The demand for a product is plotted for a time period along with other data such as forecasts, production plans, inventory levels etc for the same period. Such data for a range of bubble baths is shown in Figure 4 above.

As can be seen the weekly sales are consistently around 8,000 units rising to 50,000 for the period leading up to Christmas. However, the forecast for the same period indicated sales at a higher level with a spiky profile. Production, as calculated by MRP II using this forecast, is similarly higher than the sales and is also spiky. The orders placed on our supplier for caps have resulted in an uneven delivery pattern. Finally, the stocks of finished goods have increased.

In terms of waste we can see Overproduction, Excess Inventory and, by implication, Transporting. How has this situation arisen? In short the forecast data has been used as the driver for MRPII. In comparison to this the inventory of finished stock represents some 4 to 6 weeks stock rather than the actual of 20 weeks and more. Within the stock cover parameters set for the planning system no-one would query the planned production. It is only after the stock has been produced and sales not met and the forecast adjusted downwards that any action would be notified to the Planner.

To identify which element is most out of control we can use the Noise to Signal Ratio. The average weekly sale is defined as the Signal and the maximum value of the other data as noise and we calculate the ratio of the latter to the former as in Figure 5.

Noise to Signal Ratio

Average Weekly Sale (Signal)	=	19,500	
Maximum Forecast (Noise)	=	127,138	6.52
Maximum Production (Noise)	=	177,088	9.08
Maximum Supplier Delivery (Noise)	=	199,500	10.23
Maximum Finished Stock (Noise)	=	442,350	22.68

Figure 5

A Noise to Signal Ratio of 1 indicates a supply chain in perfect balance running at the pull of the customer. The larger is the deviation from 1, the more out of control the supply chain. In the example above the ratios for forecast, production, deliveries and,

especially, finished stock are much greater than 1. For prioritising action take the highest figure first, root cause the problem and take the appropriate action. In this case the variation in forecasting was identified as the root cause and the way of calculating this is to be changed by making better use of sales data.

By using some or all of the above we can obtain a better understanding of our customers' needs. This knowledge allows us to begin to look at what we need to provide and how we need to provide it. In the next article we will look at ways of identifying the capabilities of supply chains and the presence of waste.

References

1 **Special Issue covering Kano's methods:** *Center for Quality of Management Journal, Vol 2, No 4, Fall 1993.*

2 LOU COHEN, *Quality Function Deployment, Addison Wesley, 1995*

Lean Glossary (Part 2)

Five Ss –
Five Japanese terms beginning with S utilised to create a workplace suited for visual control and lean production. ***Seiri*** means to separate needed tools, parts, and instructions from unneeded materials and to remove the latter. ***Seiton*** means to neatly arrange and identify parts and tools for ease of use. ***Seiso*** means to conduct a cleanup campaign. ***Seiketsu*** means to conduct ***seiri, seiton*** and ***seiso*** at frequent, ideally daily, intervals to maintain a workplace in perfect condition. ***Shitsuke*** means to form the habit of always following the first four Ss.

Five whys –
Taiichi Ohno's practice of asking "why" five times whenever a problem was encountered, in order to identify the root cause of the problem so that effective countermeasures could be developed and implemented.

Flow –
The progressive achievement of tasks along the value stream so that a product proceeds from design to launch, order to delivery, and raw materials into the hands of the customer with no stoppages, scrap, or backflows.

Greenfield –
A new design or production facility where best-practice, lean methods can be put in place from the outset. Contrast with ***brownfield***.

***Heijunka* –**
The creation of a "level schedule" by sequencing orders in a repetitive pattern and smoothing the day-to-day variations in total orders to correspond to longer-term demand.

***Hoshin kanri* –**
A strategic decision-making tool for a firm's executive team that focuses resources on the critical initiatives necessary to accomplish the business objectives of the firm. By using visual matrix diagrams similar to those employed for **quality function deployment**; three to five key objectives are selected while all others are clearly deselected. The selected objectives are translated into specific projects and deployed down to the implementation level in the firm. ***Hoshin kanri*** unifies and aligns resources and establishes clearly measurable targets against which progress toward the key objectives is measured on a regular basis. Also called **policy-deployment**. ■

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Learning to see: How does your supply chain function?

by Nigel Wood

How does your Supply Chain function? This is a question we must be able to answer, but often find ourselves unable to do so. We usually choose to pick one link in the chain, seek to optimise it and then become disillusioned by our results as they fail to meet our expectations. By choosing a selective approach we miss the impact of interdependencies and causal relationships. To avoid this we need to take an end-to-end view, to undertake Value Stream Management.

'Value Stream' may be a phrase with which you are not familiar. A Value Stream is all the actions currently required to bring a product through the main flows essential to every product: the production flow from raw material through to the ownership of the customer or the design flow from concept to launch. Effective management of this value stream will result in the reduction in wasteful activities and bring supply in line with customer demand, thereby delivering greater customer value at a lower total cost.

The first step in Value Stream Management is to understand the capabilities of our processes and to identify the source and size of any wastes. For this we can choose from a variety of Lean Tools. Which tool we choose is dependent upon its effectiveness in identifying the wastes. Figure 1 opposite is a matrix which is useful for tool selection. We covered Demand Amplification in the previous article in the series. In this article we will look at the others starting with the most effective general tool, Big Picture Mapping.

Big Picture Mapping

A Big Picture Map helps to identify where we are now, where we want to be and how we plan to get there. It tracks a product's path from its raw material state to delivery to the customer, providing a visual representation of every process, including quality checks, rework etc, and the material information flows.

The benefits of mapping are:

- It helps us to visualise more than just the single process level, helping everyone involved to understand how where and why things happen
- It helps us see both the waste and the source of waste
- It provides all those involved in the value stream with a common language
- It makes decisions about flow apparent
- By tying together Lean concepts and techniques it helps us avoid 'cherry picking'.
- It becomes the blueprint for our implementation plans by helping us design how the whole end to end process should flow.
- It shows the linkages between information flow and material flows.
- The tool is both quantitative and qualitative allowing us to identify what we are going to do and the impact of those changes.

Figure 2 is a schematic map identifying the icons used and the format of the map. Conventionally material flows are shown along the bottom of the map from Supplier to the Customer with information flows along the top of the map. Colour coding is useful to differentiate materials from information, black for material flows and red for information flows.

The map is drawn as a combined effort by the fact-holders within the value stream using their data. Once complete, the map is then audited by the team to identify waste.

Opportunities to reduce or remove these are identified and a Future State Map is drawn. This is in the same format as the Big Picture Map and describes the way the value stream will be configured following these improvements. Comparing the quantitative data between the two maps identifies the benefits to

The Value Stream Management Tool Kit

	PROCESS ACTIVITY MAPPING	QUALITY FILTER MAPPING	DEMAND AMPLIF-ICATION MAPPING	BIG PICTURE MAP	FOUR FIELDS MAP
Over Production	L		M	M	
Waiting	L		M	M	H
Transportation	H			M	
Inappropriate Processing	H	L		M	H
Unnecessary Inventory	M		H	M	
Unnecessary Motion	H			M	
Defects	L	H		M	H

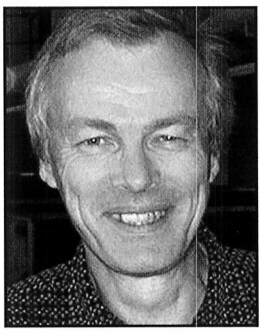

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Figure 1

be gained. Once an overall view of the value stream has been established it may be necessary to obtain a more detailed view of elements of the process. For this we can use Process Activity Mapping.

Process Activity Mapping

This form of mapping involves the breaking down of a process into components identified as:

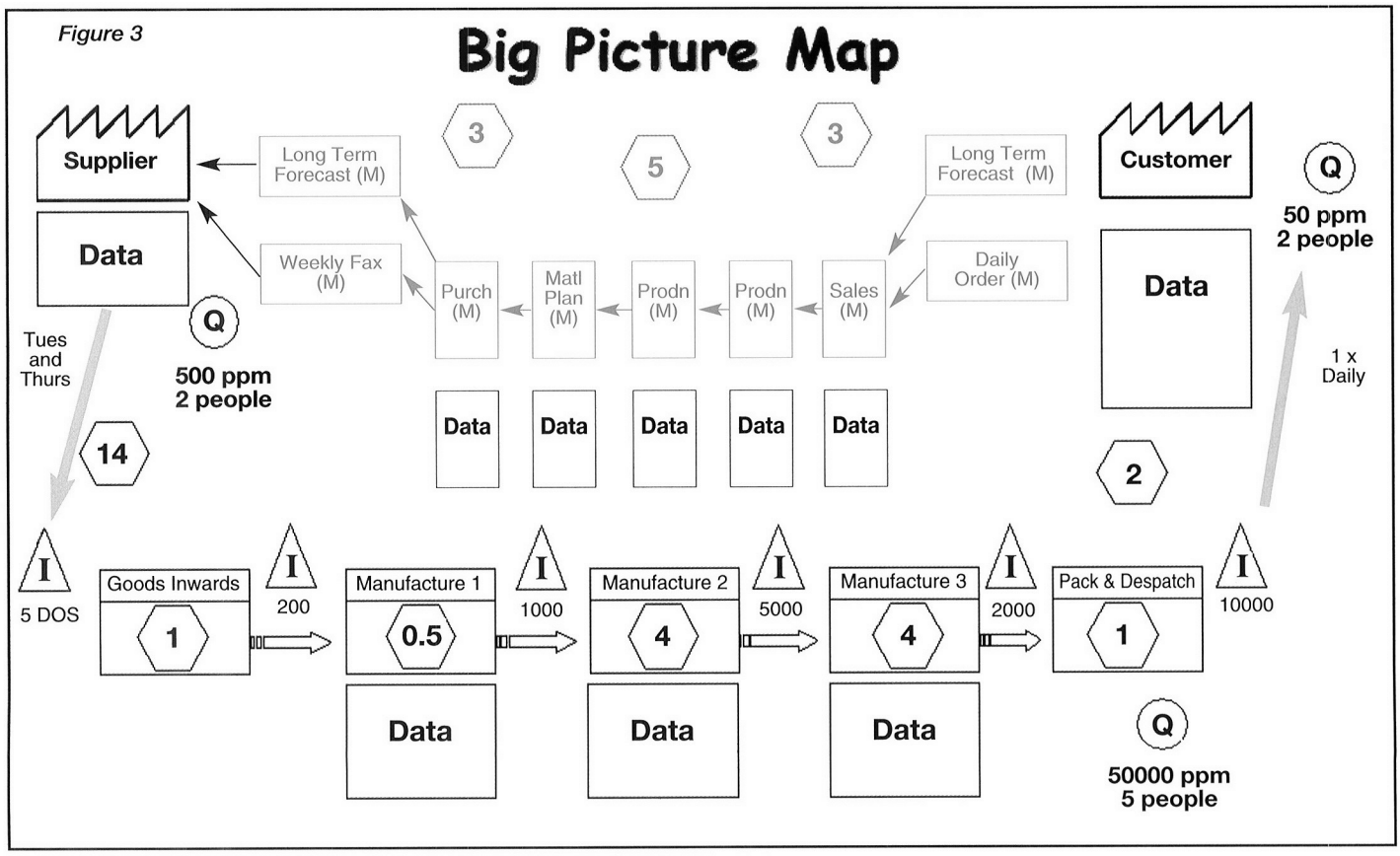
- **Operation** – value adding activities
- **Inspection** – any checking activity
- **Transport** – any activity involving movement
- **Delay** – waiting and storage

The time for each activity is measured as is the distance travelled and the number of people involved. The results are compiled in a spreadsheet based chart as shown in Figure 3 overleaf.

To achieve visual impact it is better to present the data in the form of a pie-chart as this will emphasise the large amount of non-value adding activity. The data from the chart shown in Figure 3 are therefore presented in Figure 4.

"Effective management of the value stream results in the reduction of wasteful activities and brings supply in line with customer demand, thereby delivering greater customer value at a lower total cost."

Figure 3



Process Activity Mapping
Order Fulfilment Example

Total Process

	OPERATION	TRANSPORT	INSPECTION	DELAY
Stock Replenishment Process	0.1	1.5	5	8
Customer Forecast Processing	0	2.1	0	7200
Material Planning/Purchasing	3.3	38	18	8192.1
Production Planning	3.7	51.9	12	1035.4
Goods Receiving/Inspection	0.1	19.2	10.5	158.2
Raw Material Store	0.1	30.5	0	15162
Bulk Manufacture	240	38.3	9.5	1549
Packing	15.1	602.6	3.1	15921.4
Stock Transfer	2	13.1	1	14502.1
Finished Goods Despatch	0.1	176.6	0	7317
Tool Room	5	20	15	150
Invoicing	1	5	20	480
Inspection Activities	15	31.7	46.1	74.1
	285.5	1030.5	140.2	71749.3
	0.39%	**1.41%**	**0.19%**	**98.01%**

Figure 3: Process Activity Mapping chart

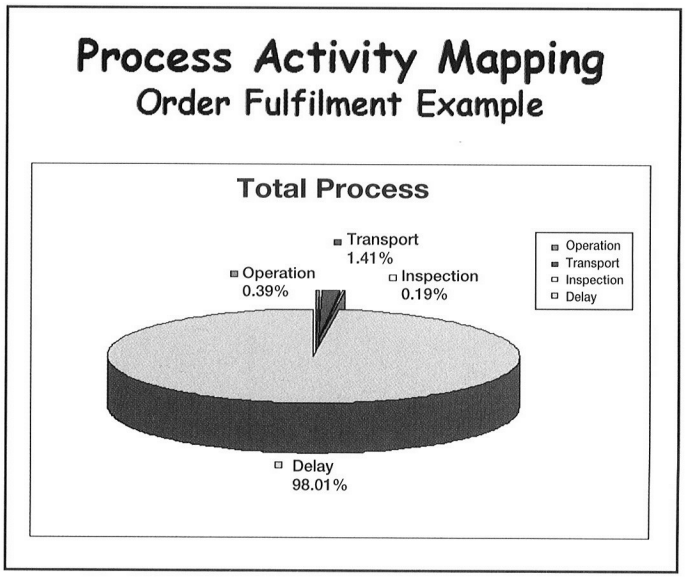


Figure 4: Process Activity Map Pie-chart

The example given is typical of most processes with non-value-adding activities amounting to more than 98% of time expended. Traditionally we have expended our efforts in squeezing more out of the 0.5% or less of time spent on value adding operations whilst ignoring the bigger (and easier?) target of waste elimination.

Improvement activity can be prioritised by looking at the biggest wastes and tackling these first.

The preceding maps are most appropriate for value streams which involve the movement of both materials and information. If the value stream or process is one involving largely information flows with decision points it is best to use a Four Fields Map.

Four Fields Mapping

This technique originated in Japan but the style used by Boots Manufacturing is that as further refined by SA Partners. A completed map is shown as Figure 5 opposite.

A Four Fields Map is a diagnostic tool which creates a fact based map of a process. It is particularly useful for identifying wastes such as waiting, rework and inappropriate processing. As with Big Picture Mapping it is used to describe the current state and also can be redrawn in the form of the future state of a process.

The map is drawn as follows:

- Select the process to map
- Identify the major phases of the process
- Specify the triggers and outputs of each process.

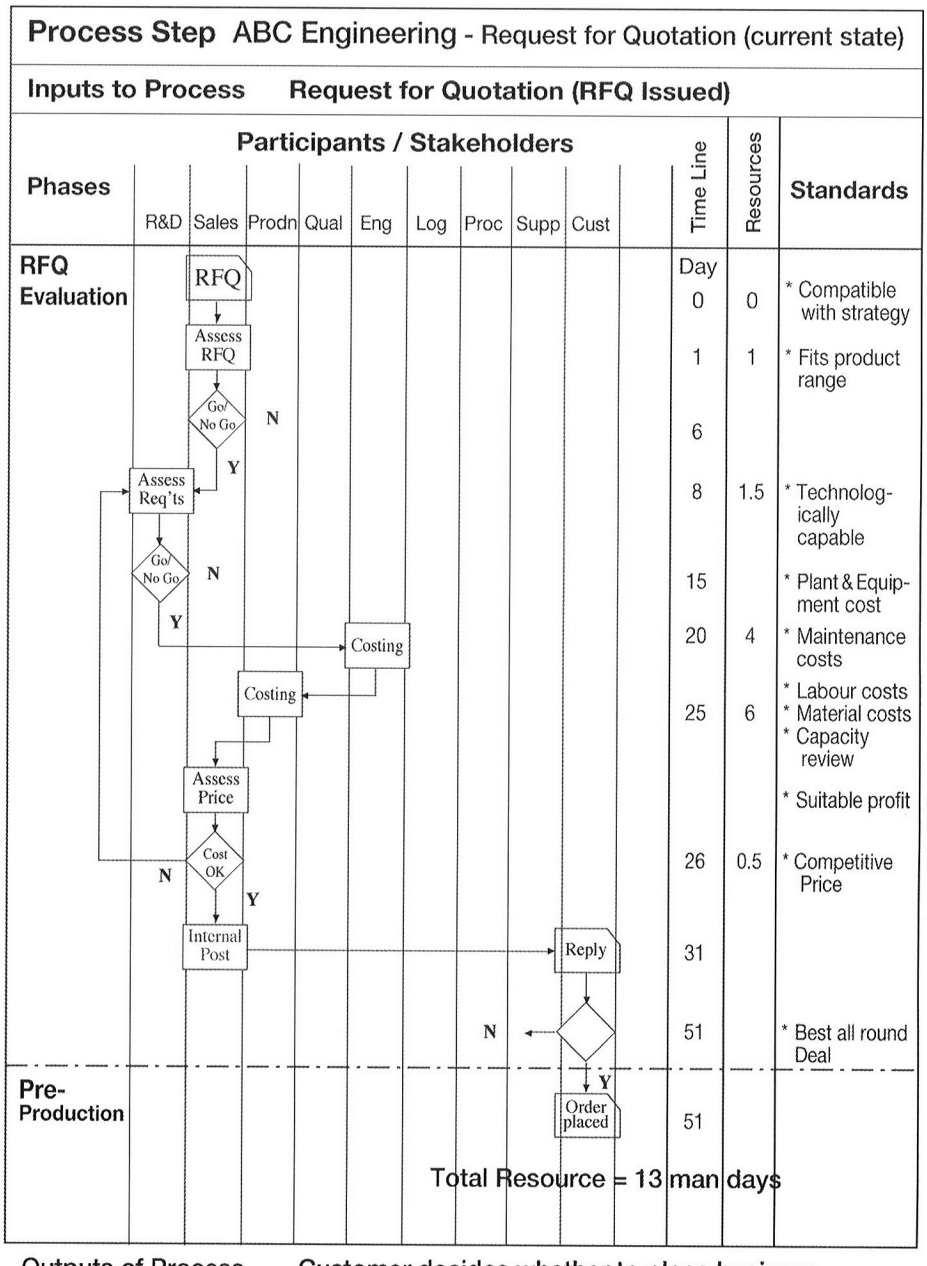


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Figure 5

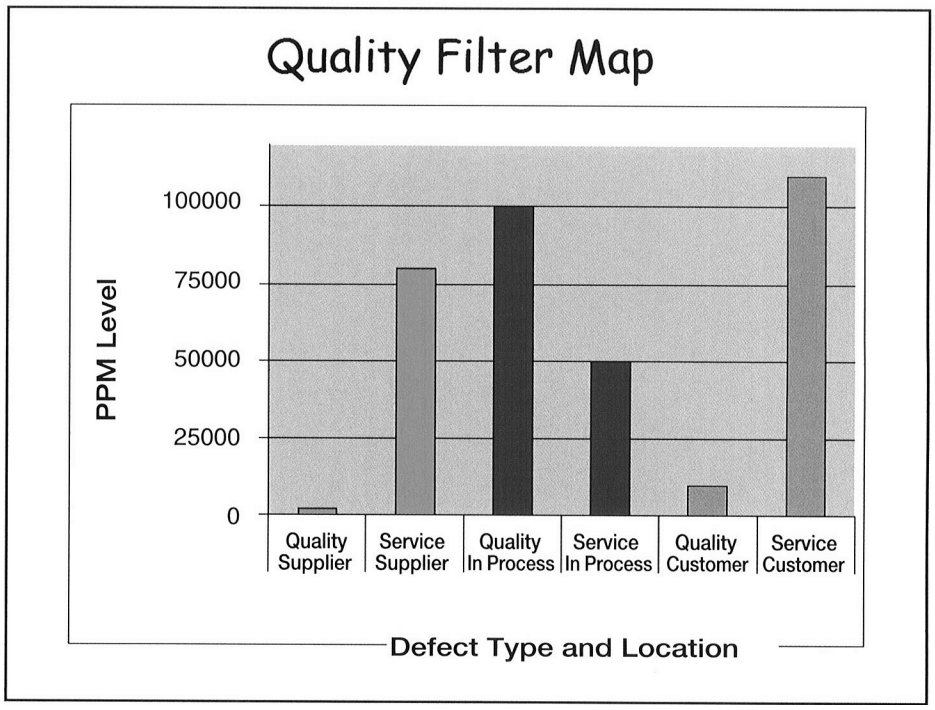
- Populate the map with the tasks or activities using icons for meetings, activities, decision points and documents. Do this in chronological order with the meetings etc spanning the participants or stakeholders involved
- Use R(esponsible), A(ccountable), C(onsult) or I(form) to identify the participants role
- Detail any standards or criteria which need to be in place to ensure first time success of the task
- Mark the major phases of the process
- Complete the time line column, specifying the cumulative time elapsed in days after each activity
- Complete the resource column, specifying the resource required to complete the activity in 'man days'.

On completion of the map a waste audit is performed to identify any wastes in the process and these are then reduced or eliminated to take cost and time out of the process.

The final map to be considered is the Quality Filter Map.

Quality Filter Map

This map is used to identify the type and location of defects within the value stream. Defect data is collected and then recorded and graphed using a spreadsheet. An example is shown as Figure 6.



The map shows immediately the relative ranking of the defect levels for each location and, therefore, allows for easy prioritisation of remedial action. It is ideal for all processes as it ranks information, system and product defects with equal ranking.

In the next article we will look at how we can use the information gained by using these maps to introduce 'flow' into our processes.

Further Reading

The most comprehensive book on value stream mapping is the following title:

MIKE ROTHER & JOHN SHOOK, 'Learning to See: value stream mapping to add value and eliminate muda' *The Lean Enterprise Institute Inc.*

Lean Glossary (Part 3)

Jidoka – See autonamation.

Just-in-Time –
A system for producing and delivering the right items at the right time in the right amounts. A process approaches just-on-time when upstream activities occur minutes or seconds before downstream activities, so single-piece flow is possible. The key elements of just-in-time are flow, pull, standard work (with standard in-process inventories), and takt time.

Kaikaku –
Radical improvement of an activity to eliminate muda, for example by reorganizing processing operations for a product so that instead of traveling to and from isolated "process villages," the product proceeds through the operations in single-piece flow in one short space. Also called breakthrough kaizen, flow kaizen, and system kaizen.

Kaizen –
Continuous, incremental improvement of an activity to create more value with less muda. Also called point kaizen and process kaizen.

Kanban –
A small card attached to boxes of parts that regulates pull in the Toyota Production System by signaling upstream production and delivery.

Keiretsu –
A grouping of Japanese firms through historic associations and equity interlocks such that each firm maintains its operational independence but establishes permanent relations with other firms in its group. Some keiretsu such as Sumitomo and Mitsui, are horizontal, involving firms in different industries. Other keiretsu, such as the Toyota Group, are vertical, involving firms up- and downstream from a "system integrator" firm that is usually a final assembler.

Lead time –
The total time a customer must wait to receive a product after placing an order. When a scheduling and production system are running at or below capacity, lead time and throughput time are the same. When demand exceeds the capacity of a system, there is additional waiting time before the start of scheduling and production, and lead time exceeds throughput time. See throughput time.

Level selling –
A system of customer relations that attempts to eliminate surges in demand caused by the selling system itself (for example, due to quarterly or monthly sales targets) and that strives to create long-term relations with customers so that future purchases can be anticipated for the production system.

Make it Flow: Moving from Batch and Queue to Single Piece Flow
Nigel Wood
Management Services; May 2004; 48, 5; ABI/INFORM Global
pg. 14

Make it Flow: Moving from Batch and Queue to Single Piece Flow

by Nigel Wood

In this month's article we will examine ways in which we can build on our understanding of the Value Stream, or Supply Chain, to achieve the fulfilment of the 4th Lean Principle: 'Make the Product Flow'. The tools identified are those that have been used successfully by Lean Coaches within Boots Manufacturing to improve Overall Equipment Effectiveness and improve the flow of products through the packing process.

First let us begin with a few definitions. Flow is defined in the dictionary as:

To move, as water; to glide smoothly

In applying Lean Thinking we usually prefix this with the word 'continuous', ie uninterrupted. The net result is:

Uninterrupted movement

We should, therefore, see continuous flow as the processing of value from raw materials to final consumer without incurring any form of process delay.

Getting Started

Where do we start? Firstly we need to understand the rate at which the process needs to flow. This we define as the Takt Time.

$$\text{Takt Time} = \frac{\text{Production Time Available}}{\text{Customer Demand}}$$

Consider the following example:

Total Customer Demand = 15000 units per week

Production time available
= 15 hours/day, 5 days/week

Takt Time = (5 x 15 x 60 x 60)/15000

= 18 seconds

In this case the process needs to flow at the rate of one unit every 18 seconds. If we produce at a slower rate than this we will fail to meet the customer's needs and lose sales. Producing at a faster rate will result in unnecessary inventory through increased stock levels.

Having determined the rate of flow for the process we then need to identify the barriers to flow. If we continue to see flow in terms of the movement of water, we need to identify the rocks in the stream that are causing turbulence. These 'rocks' are the wastes in the Value Stream.

In the previous article in the series we looked at tools used to identify the major wastes present. Having identified these we then need to determine the root cause of the wastes. For this it is usual to pick one or more of the following:

5 Whys – asking the question 'why' several times over (usually 5) of a process owner will help get you to the root cause of a problem. Never accept the first answer given; always probe behind the answer.

5W1H – as with 5 Whys ask the questions 'What', 'Why', 'When', 'Where', 'Who' and 'How'. Answering these questions will tease out any issues and help determine the root cause.

Fishbone Diagram – contributory causes are identified and arranged in a hierarchy as shown in Figure 1 opposite. This allows us to identify causal links and dependencies.

A modification of the fishbone diagram known as CEDAC™ is used to record solutions to the problems identified. This is done by recording the issues or problems on the left hand side of each arm of the diagram and potential solutions on the right hand side. The completed diagram is then used as a working document for progressing improvement activity and for the addition of further issues and improvement ideas.[1]

With the root cause of the wastes identified we can determine whether they are inhibitors to flow and therefore require priority improvement activity. Typical inhibitors to flow include:

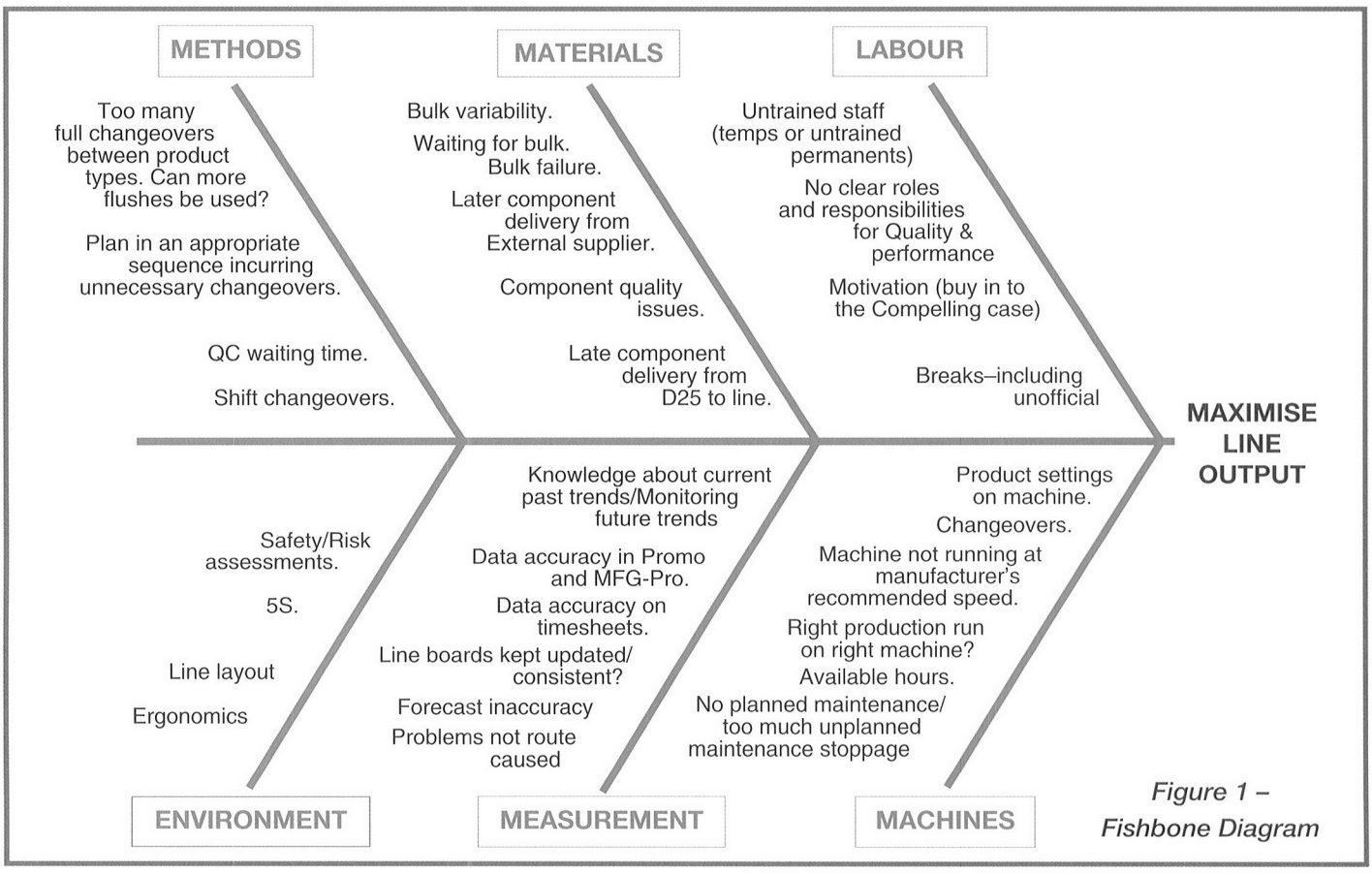


Figure 1 – Fishbone Diagram

- Poor layout of workplace
- Lack of visual controls
- Unnecessary handling
- Poor uptime of machines
- Unbalanced machine or tool speeds

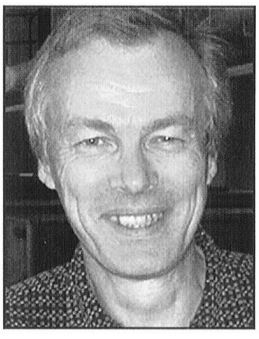
Removing the Inhibitors to Flow

The first three of the above inhibitors can be tackled by the use of 5S. This is a 5 stage process for improving workplace organisation by changing the mindset of those involved to a position where making orderly and standard operations is the norm rather than the exception. The stages used are as follows:

1. **Sort** – Identify and remove unnecessary items from the workplace and classify required items by frequency of use (Runners, Repeaters and Strangers).
2. **Set in Order** – Establish a unique and appropriate location for those required items, providing a simple and visual system of storage and retrieval.
3. **Shine** – Bring the equipment back to as near original condition as possible and implement a system to keep it that way.
4. **Standardise** – Set standards and implement measurable procedures to lock the first 3 S's in place and monitor adherence.
5. **Sustain** – Create a culture of continuous improvement correlated to key performance indicators, demonstrating a vision of the future in line with business goals and strategy.

Within Boots Manufacturing we have found 5S to be a valuable foundation for Lean Management and thus for our improvement programme.

Poor uptime of machines and unbalanced machine and tool speeds is best tackled by the creation of cells in which the work content of all operations is brought into balance through the use of Line Balancing.



Line Balancing

The aim of line balancing is to ensure that the time taken for each operation is in balance with those operations either side and is at, or below, the Takt Time for the product being manufactured. It would be necessary to produce faster than the Takt Time if the production resource was required for the manufacture of other products and there was a limit to capacity available with no option to increase this by working extra hours, investing in duplicate equipment etc. In such a case inventory so created would not be deemed 'unnecessary' but necessary for buffering demand.

The first step in line balancing is to measure all the steps in the production process using a chart such as the example in Figure 2 overleaf.

Information on the process steps, work element, times etc is collected ensuring that the figures are typical and not subject to special circumstances. These are then plotted on a Line Balance Chart similar to that shown in Figure 3.

Fig 1

Process Study

Process Study	Process :-	Observer		Date / Time		Page no :-

Process Steps	Work Element	Observed Times									Repeatable	Cycle time	Notes

A further refinement would be to split out non-valued adding activity from value adding activity as shown in Figure 4. This is used to direct improvement activity ahead of the final balancing calculations.

In Figure 5 opposite we can see an example of a line balance chart for a tube filling line at Boots Manufacturing prior to line balancing. This is a process requiring 6 operations (one operator per operation) varying in length from 4 to 20 seconds. As the Takt time for the range of products produced on the line is 18.3 seconds, the process as it stands could not meet customer demand during the standard hours available for production.

The costly option of overtime working was required to increase the available capacity to meet the current level of demand. In addition to this a significant growth in sales was anticipated, which we were expected to meet without any additional capital expenditure.

The degree of balance of a process can be determined by calculating the Line Balance Ratio. This is done as shown in the following equation:

$$\text{Line Balance Ratio} = \frac{\text{Sum of individual operation times}}{\text{Time taken for slowest op X no of ops}} \%$$

In the case of Packing Line 'X' this would be:

$$\text{Line Balance Ratio} = \frac{5+9+20+9+4+8}{20 \times 6} = 46\%$$

To be fully in balance a ratio of 100% is required so it is obvious that a significant balancing of the elements of the process was required in addition to process improvements.

The next calculation we need to make is that for the Target Cycle Time. This is defined as:

Target Cycle Time = Takt Time – allowance for process variation

This is the time we need to meet for the process if we are to achieve the Takt Time in spite of loss of output due to breakdowns, inefficiencies, quality defects etc.

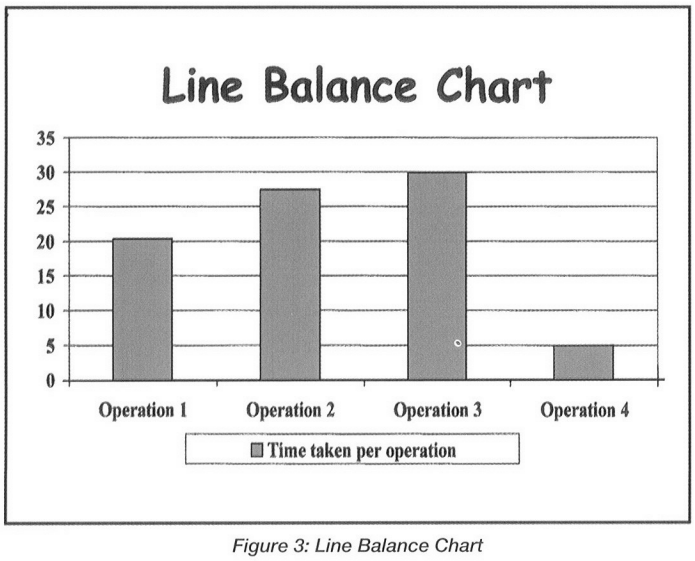


Figure 3: Line Balance Chart

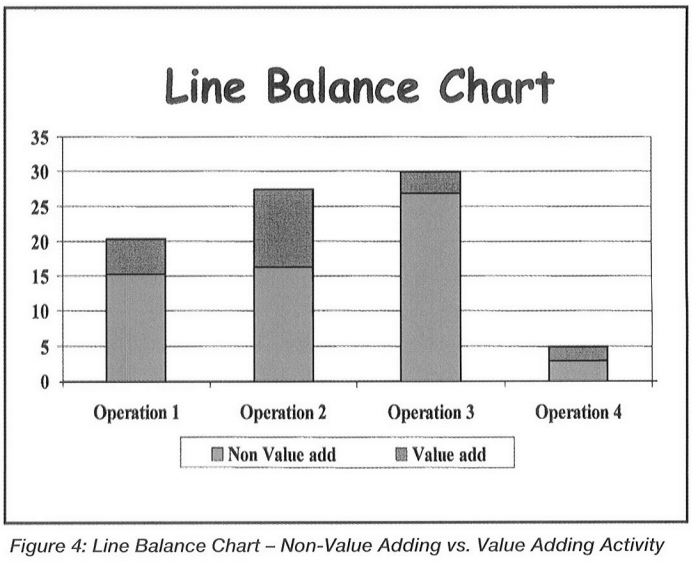


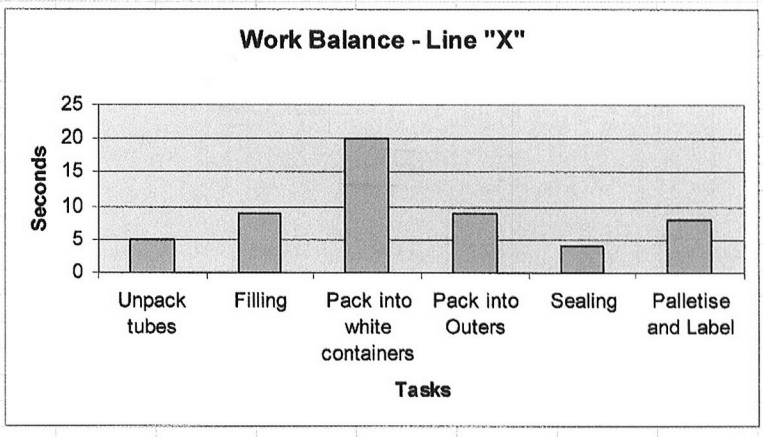
Figure 4: Line Balance Chart – Non-Value Adding vs. Value Adding Activity

Fig 5

Line Balance Analysis for Line "X"

Work Balance Line "X"

Element	Seconds
Unpack tubes	5
Filling	9
Pack into white containers	20
Pack into Outers	9
Sealing	4
Palletise and Label	8
Takt time	18.3 secs
Process based on 12 tubes	
Blue - USA (white cartons 12 per outer)	
Orange - rest (6 per outer)	



To assess the variation of our process we calculate the Overall Equipment Effectiveness. This is made up of the following three elements:

$$\text{Utilisation} = \frac{\text{Available Time} - \text{Downtime}\ \%}{\text{Available Time}}$$

$$\text{Efficiency} = \frac{\text{Total Product Produced}\ \%}{\text{Potential Production in (Avail Time} - \text{Downtime)}}$$

$$\text{Quality} = \frac{\text{Total Product Produced} - \text{Bad Product}\ \%}{\text{Total Product Produced}}$$

Overall Equipment Effectiveness (OEE) =

Utilisation % X Efficiency % X Quality %

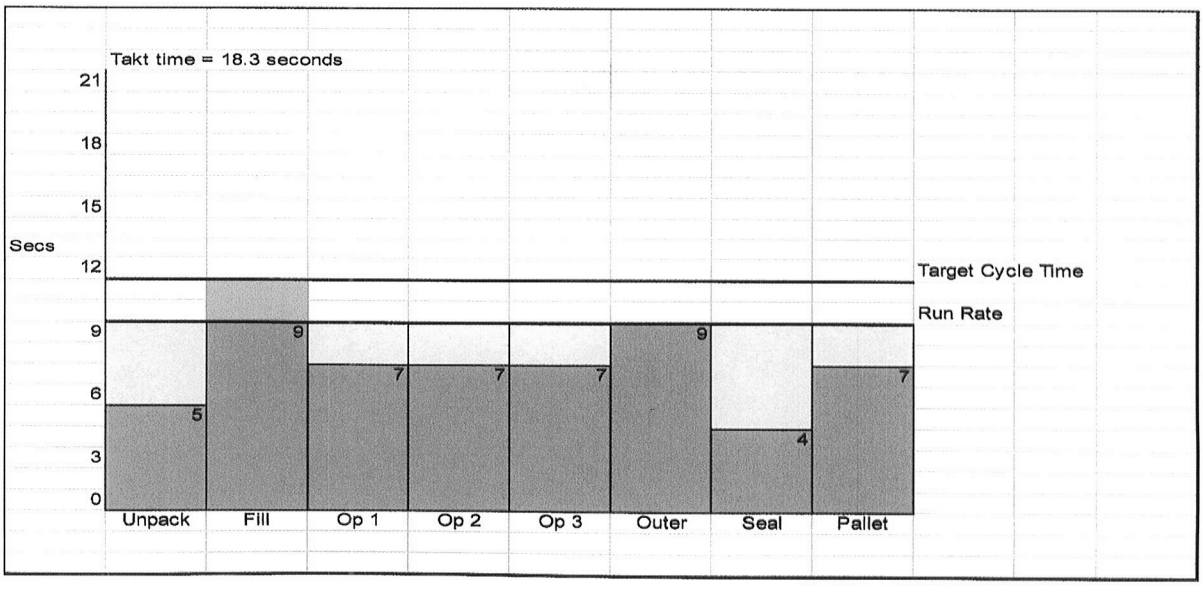
We can now calculate the Target Cycle Time as:

Takt Time X OEE

Prior to improvements the OEE for Packing Line 'X' was 56%. With the Takt Time being 18.3 seconds our Target Cycle Time was 10.2 seconds, ie half the time taken for the longest process element (20 seconds). In terms of both Line Balance Ratio and Target Cycle Time the then existing set up for Line 'X' could not meet Takt Time.

Fig 6

Line Balancing Line "X" Showing Reallocation of Tasks



We used 5S to reorganise the layout of the line and reduced the peaks of work activity by transferring operations between the staff on the line. We also increased the team size to use three people to carry out the longest operation, ie loading the white boxes. In addition we identified the best sequence for packing the products in the range to minimise downtime due to set-up activity. The revised Line Balance Chart is shown as Figure 6.

We trialled the revised process and recalculated the Line Balance Ratio. This became:

$$\text{Line Balance Ratio} = \frac{5+9+7+7+7+9+4+8 \ \%}{9 \times 8} = 78\%$$

The OEE for the improved process increased to 66% resulting in a Target Cycle Time of 12 seconds. As our longest process was only taking 9 seconds we had no difficulty in meeting this and thus achieving the Takt Time required. It also meant that we had created spare capacity, without the need for capital expenditure, which could be used to meet the anticipated sales growth.

In the next article in the series we will look at how we can improve further in making the Value Stream operate at the pull of the customer.

References

A good overview of various tools is to be found in the following:

JOHN BICHENO, **The Quality 75: Towards Six Sigma Performance in Service and Manufacturing, *PICSIE Books*.**

1 RYUJI FAKUDA, **Managerial Engineering,**

Lean Thinking Glossary (Part 2)

Material Requirements Planning (MRP) –
A computerised system used to determine the quantity and timing requirements for materials used in a production operation. MRP systems use a master production schedule, a bill of materials listing every item needed for each product to be made, and information on current inventories of these items in order to schedule the production and delivery of the necessary items.

Manufacturing Resource Planning – (often called MRP II)
Expands MRP to include capacity planning tools, a financial interface to translate operations planning into financial terms, and a simulation tool to assess alternative production plans.

Meister –
A production group leader in a German manufacturing firm.

Milk run –
A routing of a supply or delivery vehicle to make multiple pickups or drop-offs at different locations.

Mittelstand –
Mid-sized and usually family-controlled German manufacturing firms that have been the backbone of the postwar export economy.

Monument –
Any design, scheduling, or production technology with scale requirements necessitating that designs, order, and products be brought to the machine to wait in a queue for processing. Contrast with right-sized tool.

Muda –
Any activity that consumes resources but creates no value.

Multi-machine working –
Training of employees to operate and maintain different types of production equipment. Multi-machine working is essential to creating production cells where each worker utilises many machines.

Open-book management –
A situation in which all financial information relevant to design, scheduling, and production tasks is shared with all employees of the firm, and with suppliers and distributors up and down the value stream.

Operation –
An activity or activities performed on a product by a single machine. Contrast with process.

Perfection –
The complete elimination of muda so that all activities along a value stream create value.

Poka-yoke –
A mistake-proofing device or procedure to prevent a defect during order-taking or manufacture.

Policy deployment –
See hosbin kanri.

Process –
A series of individual operations required to create a design, completed order, or product.

Processing time –
The time a product is actually being worked on in design or production and the time an order is actually being processed. Typically, processing time is a small fraction of throughput time and lead time.

Process villages –
The practice of grouping machines or activities by type of operation performed; for example, grinding machines or order-entry. Contrast with cells.

Product family –
A range of related products that can be produced interchangeably in a production cell. The term is often analogous to "platforms."

Production smoothing –
See heijunka.

Pull –
A system of cascading production and delivery instructions from downstream to upstream activities in which nothing is produced by the upstream supplier until the downstream customer signals a need. The opposite of push. See also kanban.

Quality Function Deployment (QFD) –
A visual decision-making procedure for multi-skilled project teams which develops a common understanding of the voice of the customer and a consensus on the final engineering specifications of the product that has the commitment of the entire team.

What the customer wants: Making at the pull of the customer
Nigel Wood
Management Services; Jun 2004; 48, 6; ABI/INFORM Global
pg. 16

In the previous articles in this series we have worked through the first three of the Lean Principles, – understanding customer value, understanding the capability of a value stream and moving from 'batch and queue' to making the product flow through the value stream.

In this article we look at how we can exactly meet customer requirements – at the pull of the customer.

What the customer wants: Making at the pull of the customer

by Nigel Wood

In the following article we will look at how we can exactly meet customer requirements at the pull of the customer, as opposed to using a push system in which we force product through the value stream to meet anticipated demand.

Pull Systems

Let us start with a definition of 'Pull' – or more specifically – a 'Pull System'. A pull system is a simple, visual method of automating stock replenishment, be it finished product, intermediate components or raw materials. The aim of such a system is to achieve 100% delivery performance in both quantity and timeliness. There are four reasons as to why we would choose to use a pull system:

- To provide an immediate alignment of customer demand
- To regulate stock in the process, thereby facilitating stock reduction
- To automate the demand alignment process
- To allow the use of stock as a buffer against process variability until this can be eliminated.

Similarly there are four occasions as to when pull systems would be used:

- When product demand is predictable or holding stock is a low risk
- To visually signal the need for immediate stock replenishment
- When stock replenishment is manual and complex
- When there is a need to reduce time and resources currently used in the demand alignment process.

Pull systems are not universally applicable and we need to be mindful of their limitations. They are more difficult to apply on irregular, sporadic items. As pull systems are not a plan (they are used to execute a plan) they must not be considered as stand alone systems. Finally, as they are based on replenishment, ongoing demand has to be assumed. In terms of product types they are best used for Runners or Repeaters as we defined in the second article in the series. They should only be considered for Strangers if stock costs are insignificant or immediate supply is essential.

Push vs. Pull

Why should we concern ourselves as to whether we should use a pull system as opposed to the more frequently used push system? We are much more familiar with the latter, especially those of us using MRPII planning systems. As such surely we can use our familiarity to initiate improvements to optimise performance. Unfortunately, push systems have a potentially fatal flaw. Being forecast driven they are, at best, only as good as the forecast. In most companies this forecast is little better than a guess, albeit an informed one. The result is that we manufacture to a plan based on this forecast regardless of actual usage. This is management by opinion.

In sharp contrast, a pull system does not use a forecast, it has no need since it is configured to manufacture and replenish product that has been used. This is management by fact.

Assuming we are to use a pull system, where would we use it and by whom? The system would be used where the stock is being consumed, by the people consuming the stock. A customer picking a product off a retailer's shelf to purchase the item is a trigger for a pull system as it signifies consumption. If this signal is used to ensure rapid replenishment of replacement stock then this becomes a pull system. Repeating these actions back through the supply chain, consumer using, supplier replacing, at each stage of the conversion process, results in a value stream operating as a pull system.

The Workings of a Pull System

A pull system works by replenishing inventory that has been used by a pre-determined, fixed amount. Immediate, visual signals are used to indicate the

Figure 1:

Types of Kanban (Tickets)

Withdrawal Kanban

Item Name:	Prod1
Part Number:	1P4U
Item Description:	Mod 1A
Stock Location:	3B48
Delivery Quantity:	6 Boxes
Delivery Location:	Cell 6

Special Instructions
Fragile do not drop

Production Ordering Kanban

Item Name:	Prod2
Part Number:	2P4U
Item Description:	Chassis
Work Centre:	Cell4
Batch Size:	25
Delivery Loc:	8C54

need either to withdraw a fixed quantity from stock or to produce a fixed quantity. The visual replenishment signal is located at the point of activity. As a consequence the replenishment of stock is integrated with the usage of that stock.

There are a number of types of visual signals. These include:

- Empty spaces
- Empty containers
- Kanban signals (withdrawal and production)
- FIFO of queues in front of work centres.

Examples of withdrawal and production ordering Kanbans are shown in Figure 1 above.

Things to Avoid

Most pull systems fail if we ignore the following potential pitfalls.

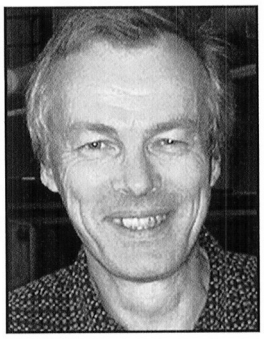
- The replenishment signal is not immediate
- There is no process for a regular review
- The system is solely used as a tool for stock reduction
- There is a lack of continuous improvement targets such as batch size, yield, lead time etc
- 5S Workplace Organisation disciplines are not applied
- The system is not extended to align the whole supply chain.

Setting Up a Pull System

The first step is to calculate the minimum, or safety, stock level required to buffer any variation in the process. Secondly to calculate the replenishment and/or the transit lead time for the product or component. Thirdly, fix the batch size. This will determine the manufacturing stock level and the manufacturing lead time. Finally, one should apply 5S Workplace Organisation principles to visualise all of these levels. Figure 2 is a representation of a pull system with the triangle identifying the trigger point or signal.

In this example the minimum stock level has been set at two units. The delivery/manufacturing lead time is equivalent to the time taken to consume two units. The batch size is six units with the maximum stock level set at eight units.

As the units are consumed the stock level will fall until it reaches the trigger point of four units. During the time taken to produce the batch of six units the stock will have fallen to the minimum level of two units. Delivery of the batch of six units will return the stock level to the maximum of eight units.



The Author

Nigel Wood is a Lean Coach with Boots Manufacturing the manufacturing arm of The Boots Group.
His background includes various roles in Operations Management, Purchasing, Sales and Marketing and Planning.

"Effective management of the value stream results in the reduction of wasteful activities and brings supply in line with customer demand, thereby delivering greater customer value at a lower cost."

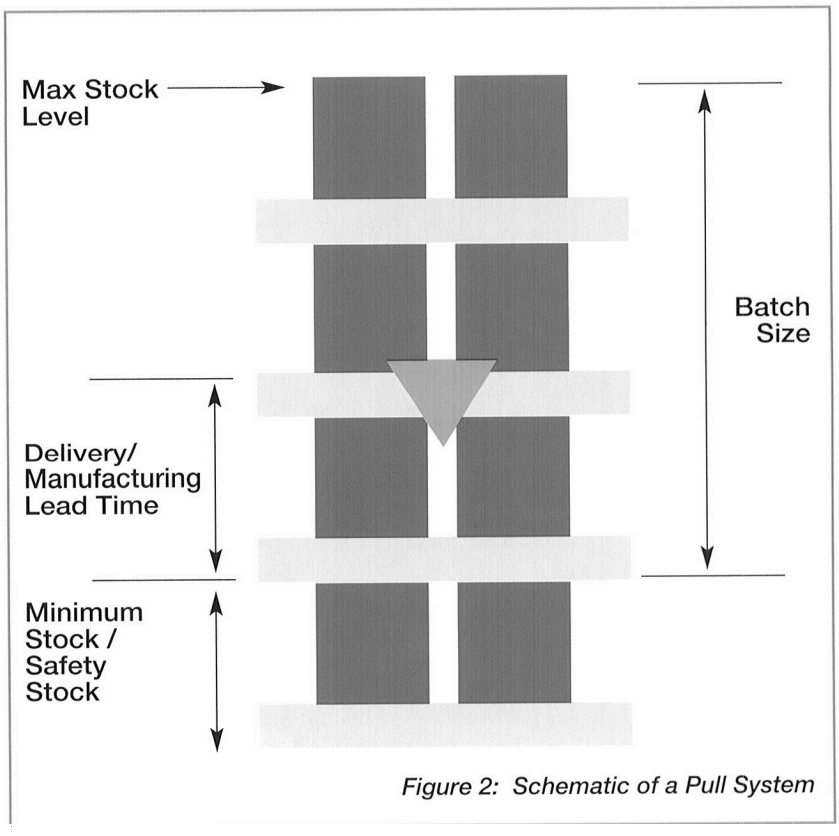


Figure 2: Schematic of a Pull System

- There was no Process Activity Mapping prior to the system roll out
- Multiple sources of supply are used for the same item.

Getting it Right

To help size the system in terms of minimum/safety stockholdings, maximum stockholdings and so on it is necessary to obtain the following data:

- Delivery performance
- Delivery capability
- Estimated usage
- Demand pattern, including fluctuations
- Material lead times
- Takt time
- Equipment reliability and effectiveness
- Manufacturing lead times
- Replenishment lead times
- Delivery frequencies
- Quality performance
- Batch size.

Having sized the system we need to obey or enforce the following six rules:

Rule 1

The subsequent process should withdraw a defined quantity from the preceding process. Any withdrawal without a Kanban is prohibited. A withdrawal greater than the number of Kanbans is prohibited. The Kanban should always be attached to the product.

Rule 2

The preceding process should produce its product in the defined quantities when triggered by the succeeding process. Producing more or less than the Kanban quantity is prohibited. Production must take place in the sequence in which the Kanbans are received.

Rule 3

'Out of specification' or defective parts should never be made or passed on.

Rule 4

The number of Kanbans should be minimised. Ideally there should be one piece flow.

Rule 5

Pull systems should be used to adapt to fluctuations in demand.

Rule 6

The number of parts in a container should be equal to the Kanban quantity within agreed tolerance levels.

There is also an unwritten seventh rule; "it is perfectly in order to produce nothing if nothing is required. Machines can stand idle!"

Targets for Improvement

Once established, a pull system can be used to aid in the reduction of stocks. To do this it is necessary to improve lead times, improve set-up times, remove bottlenecks, reduce batch sizes and eliminate causes of obsolescence such as safety stocks.

A Pull System in Action

At Boots Manufacturing we have found the use of a pull system most effective for the manufacture and supply of tablets to meet the variety of orders from our customers. The process involves the packing of tablets, which have been printed with market specific branding. The base tablet is common to all markets. Figure 3 below is a schematic of the process showing the stages of the process and the flows of product and information.

In this process tablets are packed and either despatched to a warehouse or direct to the customer following Quality Assurance release. Prior to packing the tablets are printed using previously manufactured unprinted tablets. Using our previous materials requirement planning process we experienced significant supply issues with imbalances in our stockholdings of tablets, which could lead to disservice to the customer.

To eliminate these imbalances in stock we have introduced a 2-tier Kanban based pull system as shown in Fig 4 overleaf.

The control of the withdrawal and replenishment of printed tablets is achieved by Kanban 1. Kanban 2 is used to control the supply of unprinted tablets. Rules, batch sizes etc have been set to meet the rate of demand. These are reviewed regularly to ensure that they are still applicable. Stock outs have become a thing of the past and customer service has improved dramatically.

In the final article next month we will look at ways of ensuring our hard-earned gains can be sustained and establish a firm platform for continuous improvement.

Figure 3: Proposed Replenishment using Kanbans

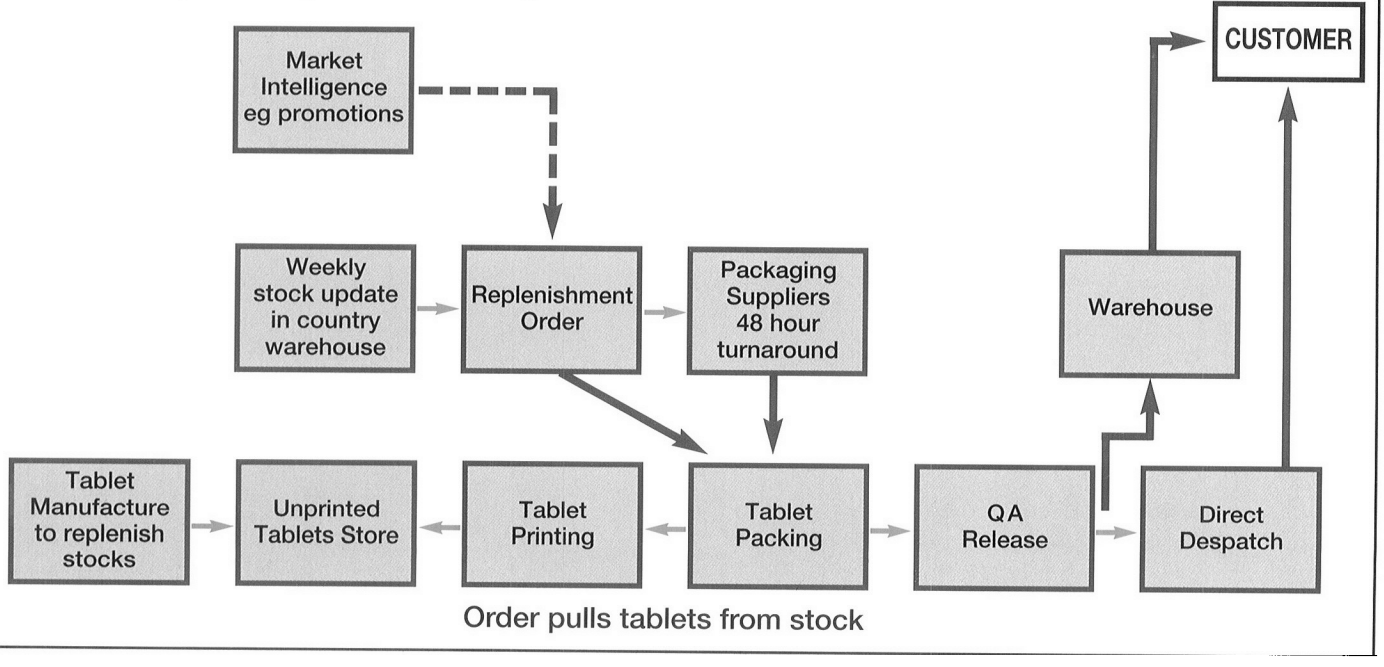
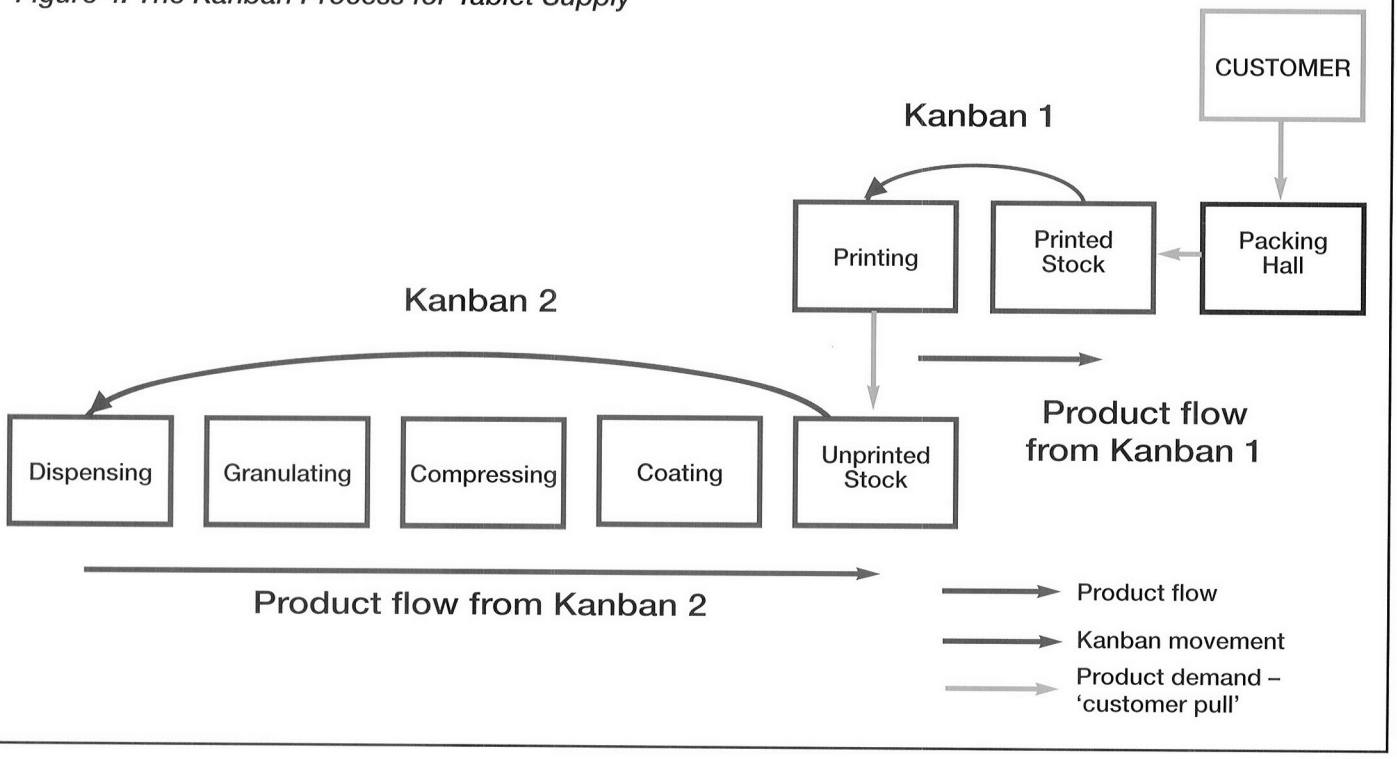


Figure 4: The Kanban Process for Tablet Supply



Queue time –
The time a product spends in a line awaiting the next design, order-processing, or fabrication step.

Right-sized tool
A design, scheduling, or production device that can be fitted directly into the flow of products within a product family so that production no longer requires unnecessary transport and waiting. Contrast with monument.

Sensei –
A personal teacher with a mastery of a body of knowledge, such as Lean Thinking.

Seven muda –
Taiichi Ohno's original enumeration of the wastes commonly found in physical production. These are overproduction ahead of demand, waiting for the next processing step, unnecessary transport of materials (for example, between process villages or facilities), overprocessing of parts due to poor tool and product design, inventories more than the absolute minimum, unnecessary movement by employees during the course of their work (looking for parts, tools, prints, help, etcetera), and production of defective parts.

Single Minute Exchange of Dies (SMED) –
A series of techniques pioneered by Shigeo Shingo for changeovers of production machinery in less than ten minutes. One-touch setup is the term applied when changeovers require less than a minute. The long-term objective is always zero setup, in which changeovers are instantaneous and do not interfere in any way with continuous flow.

Single-piece flow –
A situation in which products, proceed, one complete product at a time, through various operations in design, order-taking, and production, without interruptions, backflows, or scrap. Contrast with batch-and-queue.

Spaghetti chart –
A map of the path taken by a specific product as it travels down the value stream in a mass-production organisation, so-called because the product's route typically looks like a plate of spaghetti.

Standard costing –
A management accounting system which allocates costs to products based on the number of machine hours and labour hours available to a production department during a given period of time. Standard cost systems can encourage managers to make unneeded products or the wrong mix of products in order to minimise their cost-per-product by fully utilising machines and labour.

Standard work –
A precise description of each work activity specifying cycle time, takt time, the work sequence of specific tasks, and the minimum inventory of parts on hand needed to conduct the activity.

Takt time –
The available production time divided by the rate of customer demand. For example, if customers demand 240 widgets per day and the factory operates 480 minutes per day, takt time is two minutes; if customers want two new products designed per month, takt time is two weeks. Takt time sets the pace of production to match the rate of customer demand and becomes the heartbeat of any lean system.

Making it stick: Sustaining your Improvements

by Nigel Wood

In the previous articles in this series we have looked at the first four principles of 'Lean Thinking' and how we can apply these to improve our supply chains by identifying and removing wastes. If we have been successful we will have moved from an unresponsive process full of non-value adding activities to one which flows effortlessly delivering customer value as and when the customer requires it.

But even in the world of Lean the laws of physics still apply! Entropy, or the law by which things inevitably become disorganised, exists and we must put in place actions to prevent this. If we are to move towards the achievement of the fifth principle in which only value adding activities exist and all waste is eliminated then we must build sustainability into our processes. In this article we will examine some of the approaches to be adopted to lock the improvements in place.

A Common Vision in a Common Language

Lesson one about sustainability is that it is not about techniques, it is about people. People bring about change, they are changed and they react to change, both positively and negatively. For a journey of improvement to be successful the people involved need to be with us.

Key to ensuring involvement is a clear understanding as to why the improvement is being undertaken, what it involves, when it is happening and how the results will be measured. All of this can be achieved by using policy deployment. This requires an organisation to set focussed targets, or key performance indicators (KPI's), for improvement and to build plans to meet these. Effective policy deployment is achieved through having:

- A clear vision of the future.
- Targets at local level supporting the business goals.
- Actions prioritised by their impact on meeting the targets.
- Staff at all levels accountable for results.
- Visibility and tracking of the progress being made.

The process involves a cascade of targets and KPI's from company to team level as shown in Figure 1 opposite.

The cascade is a two way process, showing cause and effect from activities at departmental level through to company level. Local KPI's should be set in the language of those involved and should measure things on which they can have direct impact. The reporting of these is by the use of the quadrant chart shown in Figure 2. This chart should be sited in the workplace as close to the point of activity as possible, beside machines, in offices etc. It is used to record trend data, usually in graph form, and local performance. In addition to this any issues are recorded along with actions being taken to tackle them. As such it becomes a working document for the team to monitor progress and is owned and maintained by the team. The charts should be updated on a continuous basis such that they reflect the current position.

Management must support the policy deployment process by engaging in 'Management by Walking About' or MBWA. This involves the regular and active discussion with teams on improvement activities being undertaken, the issues involved and actions being taken. The quadrant charts act as the focus for these discussions.

In addition to ensuring that measures to monitor improvements are made at an appropriate level, Nicola Bateman [1] has identified a number of other enablers for sustainability:

- There should be a formal way of documenting ideas from the shop floor.
- Care should be taken to ensure that operators make decisions in a team about the way they work.
- Time must be dedicated to housekeeping or improvement activity every day.
- Managers should stay focused on improvement activities.

These enablers can be seen as the entry level requirements for sustainability. Moving to a higher level will require involvement of senior managers in improvement activity and to stay focused on improvement by reviewing progress as a whole and not imposing unnecessary initiatives. The company

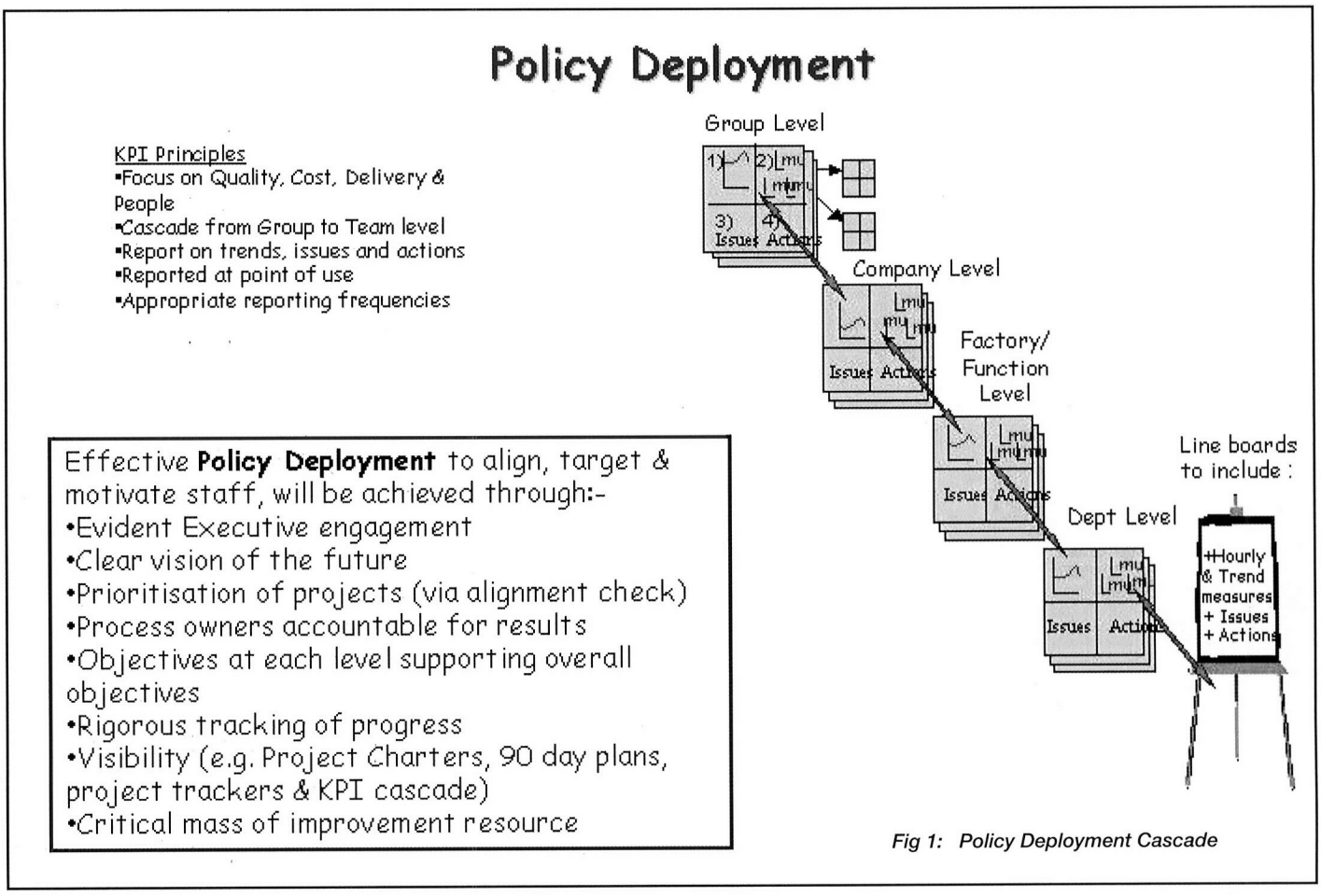


Fig 1: Policy Deployment Cascade

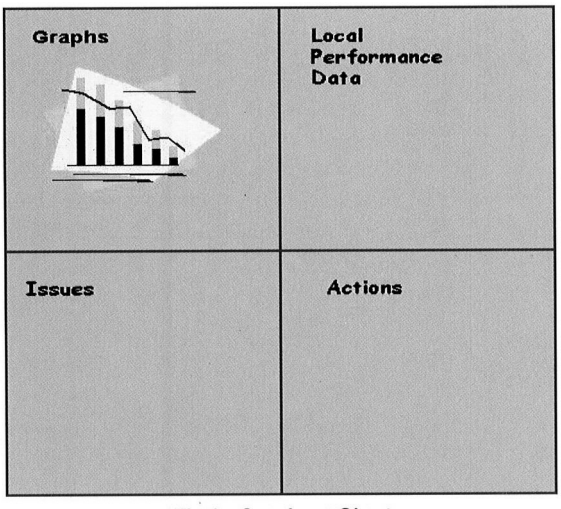


Fig 2: Quadrant Chart

or area should have a strategy so that the people can appreciate the big picture.

For people to be successfully involved in sustainability two things need to be in place; capability (time and resources) and intention (determination, drive and insistence).

Seeing Clearly

Supportive to the engagement and involvement of staff is the concept of visual management. This works on the basis that a picture is much more powerful than words alone and can be used to quickly get home a message and continue reinforcing it, often unconsciously. At Boots Manufacturing we have found the use of information points in the work areas has been most successful. These were originally introduced to display items for policy deployment such as the local KPI's but have now developed to include anything of interest for the teams including publicity for their improvement successes.

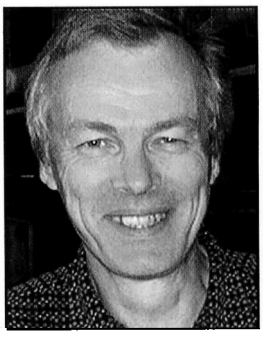
An example is shown in Figure 3 overleaf.

The information points are owned and maintained by the teams and are the focal point for discussions on performance and improvement issues. Figure 4 shows two different alternatives. The left hand image is specifically for managing the 5S process for an area, whilst that on the right includes more general information for the running of a packing line.

The display of information has resulted in greater transparency as to what is actually happening. As a consequence there is greater openness with issues being discussed in a much more equitable manner. Management style has moved from being directive to one of being supportive with mentoring and supporting staff becoming key management competencies.

A Place for Everything and Everything in its Place!

A foundation of Lean is good, effective workplace organisation as achieved by the application of 5S. The consequence of this is that it becomes



The Author

Nigel Wood is a Lean Coach with Boots Manufacturing the manufacturing arm of The Boots Group. His background includes various roles in Operations Management, Purchasing, Sales and Marketing and Planning.

"Management must support the policy deployment process by engaging in MBWA or Management by Walking About."

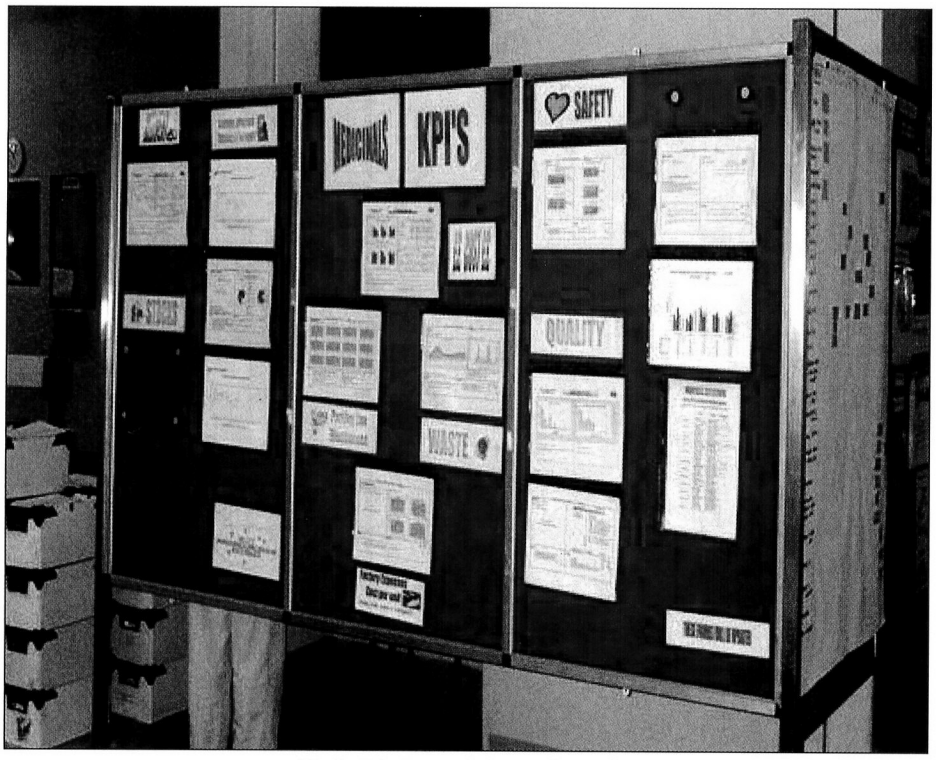


Fig 3: Work area information point

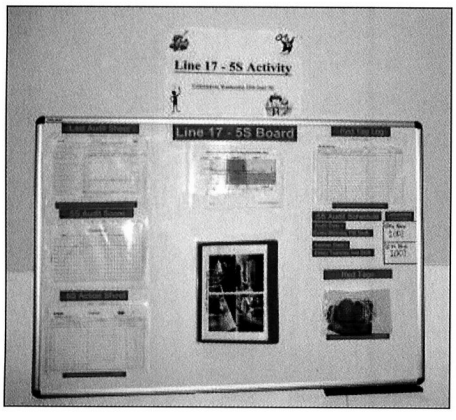


Fig 4: Alternative Information Boards. The image above is specifically for managing the 5S process for an area, whilst that on the right includes more general information for the running of a packing line.

much more difficult to hide problems as abnormalities will stand out resulting in a speedier response to solving the issue. It also becomes much easier to locate items such as tools, spare parts etc through the use of 'shadow boards'. The fact that an item is missing is clearly identified by the fact that the shadow image of that item is visible on the board. When the item is returned the shadow is covered and the person returning the item knows exactly where to put the item by matching it with its shadow.

Within Boots Manufacturing we are increasingly using shadow boards for storing our extensive range of machine change parts as shown in Figure 5.

The image in Figure 6 is that of the single way locators used ensure that the pallets used for stacking finished products are positioned in the correct location and orientation for safe and direct pick up by the fork lift truck drivers.

Seeing What to Do and How to Do It

To ensure that improvements are locked into processes and that repeatability is achieved it is necessary to standardise the process in the form of a standard operating procedure (SOP). Traditionally these have been wordy documents that are rarely consulted beyond their initial

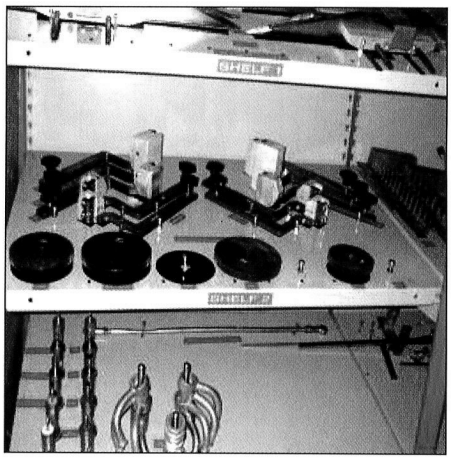


Fig 5: Shadow board for storing a range of machine change parts

creation. To be effective the SOP must be readily available for use and be unambiguous in its content. The solution we have found to be the most effective is to locate the SOP at the point of use and to describe the process in photographic form.

Figure 7 is the SOP for one of our labelling machines. On this the process is described in a few words with the key points identified on the photograph. The SOP is used for training staff in the process and remains on the machine as a constant aid as to what is required. This is particularly useful for staff who may not be regular team members or temporary staff who are employed at times of high demand. An unforeseen benefit of this form of SOP is that it is easier to update following a change than reformatting a text based document. As a consequence our SOP's are now more up to date than has been the case in the past.

Keeping on the Right Track

As with any journey, that involving process improvement requires a regular check of the route map to ensure that we are on track and, if not, what corrective action is required. This is where auditing the process is applicable.

The audit process should involve all levels of the organisation and should be carried out to a defined timetable covering topics such as workplace organisation (5S), safety, process improvements etc. Team members should be checking their progress against their KPI's and project action plans on a daily basis. This can be reinforced by the 5 minute and 30 minute cleans which form part of the 5S process. Departmental Managers should be auditing on a weekly basis with senior

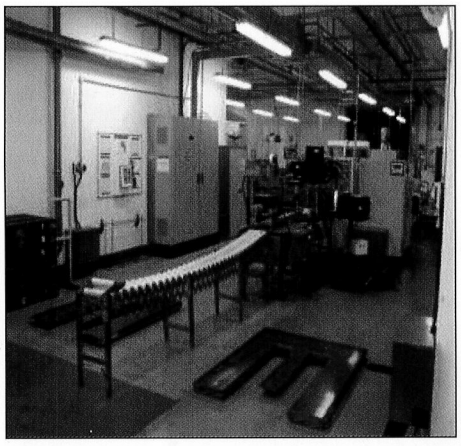


Fig 6: Single way locator used to ensure that pallets used for stacking finished products are positioned in the correct location

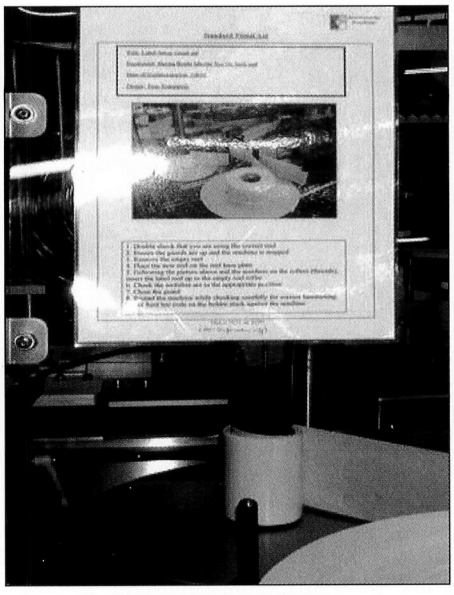


Fig 7: Visual Standard Operating Procedure.

Fig 8 A typical Audit Board

managers carrying out monthly audits. A typical Audit Board is shown in Figure 8.

The results of the audits should be published and displayed on the audit board along with any actions required. By using a scoring system it is possible to quantify the level of achievement of the required standard and successive scores plotted to indicate progress. As improvements are made the audit standards need to be tightened to ensure that progress continues to be made. This then becomes the springboard for further improvement and waste elimination.

Final Thoughts

In the six articles we have touched on the key points of Lean Thinking. Of necessity many things have not been covered or have only been mentioned in passing. A wider reading of the available literature on Lean is recommended [2] but the best way to learn is to try it. So ask yourself these questions. How Lean is your organisation? Where are the wastes in your supply chain? What do your customers value? Start answering these and you are on the way to a more successful future.

Enjoy the journey!

References

1 NICOLA BATEMAN, *'Sustainability'*, Lean Enterprise Research Centre Cardiff Business School, April 2001.

2 JEFF LIKER (Ed), *'Becoming Lean'*, Productivity Press, 1998

Lean Glossary (Part 6)

Takt time –

The available production time divided by the rate of customer demand. For example, if customers demand 240 widgets per day and the factory operates 480 minutes per day, takt time is two minutes; if customers want two new products designed per month, takt time is two weeks. Takt time sets the pace of production to match the rate of customer demand and becomes the heartbeat of any lean system.

Target Cost –

The development and production cost which a product cannot exceed if the customer is to be satisfied with the value of the product while the manufacturer obtains an acceptable return on its investment.

Throughput time –

The time required for a product to proceed from concept to launch, order to delivery, or raw materials into the hands of the customer. This includes both processing and queue time. Contrast with processing time and lead time.

Total Productive Maintenance (TPM) –

A series of methods, originally pioneered by Nippondenso, to ensure that every machine in a production process is always able to perform its required tasks so that production is never interrupted.

Transparency –

See visual control.

Turn-back analysis –

Examination of the flow of a product through a set of production operations to see how often it is sent backwards for rework or scrap.

Value –

A capability provided to a customer at the right time at an appropriate price, as defined by the customer.

Value stream –

The specific activities required to design, order, and provide a specific product, from concept to launch, order, manufacture and delivery into the hands of the customer.

Value stream mapping –

Identification of all the specific activities occurring along a value stream for a product or product family.

Visual control –

The placement in plain view of all tools, parts, production activities, and indicators of production system performance, so the status of the system can be understood at a glance by everyone involved. Used synonymously with transparency.