

Process Improvement PART 1

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1 Process Improvement

Content

This unit will discuss the concept of process improvement and outline a number of improvement strategies for the purpose of reducing waste and enhancing product and service quality.

1.1 Introduction

1.2 Competitiveness

1.3 The 3 P's – Products/Services, Processes, People

1.4 The process

1.5 Waste



1 Process Improvement

1.1 Introduction

We live in a world that is globally competitive. Manufacturing and service industries have gone through major changes in the last twenty years. This is largely due to technological changes, not least of all the adoption of strategic information systems as a means of global communication to source supplies and market products. Organisations that once had relatively secure home markets have found that competitors are able to gain access to their customers with relative ease. Global competitors are offering products and services that match or better national organisations on quality, price and delivery. The facts are that many organisations do not know who their competitors are until it is too late.

To remain competitive, organisations need to fundamentally change the way in which they operate. Whether the organisation is a manufacturer of products, a service provider - private, public or voluntary, the competition is global. Competitiveness demands the adoption of 'world class' practices. Challenging outdated modes of practice is not an option, but an absolute necessity for survival. Improvement goes beyond the product or service. It must encompass the three P's – Products / Services, Processes and People.

The following unit introduces the reader to the five factors of competition and relates this to 3P integrative design – products/services, processes and people. It discusses the scope of 'waste', outlines an improvement framework and goes on to discuss a number of improvement strategies.



1 Process Improvement

1.2 Competitiveness

Competitiveness demands clear strategic thinking and sound implementation. Strategies should be formulated that fully encompass the business environment, organisation values and organisation resources. Thompson (2001) calls this EVR congruence (figure 1.1) in which there is a match between the demands of the business environment - opportunities and threats; organisation values - management culture; and organisation resources - skills, competencies and capabilities.

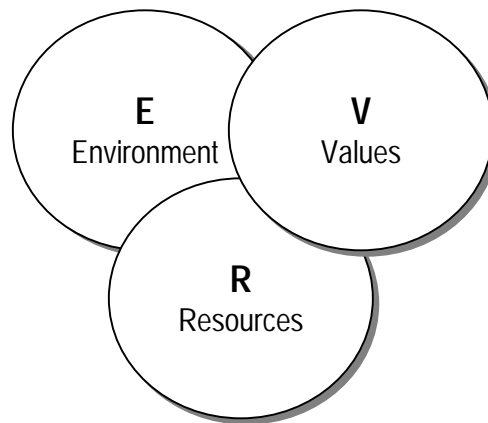


Figure 1.1 EVR congruence

When there is congruence between the business environment, organisation values and resources the company is in a strong position to becoming 'world class' and hence competitive.

Customers are those individuals or organisations we wish to conduct business with. Collectively, they constitute the 'market'. This market forms part of the external environment that is influenced politically, socially and technologically. The competitive factors that are critical for survival within the business environment will vary from sector to sector. However if we take a general view of what is important to most customers we are able to identify five generic performance objectives (Slack *et al*, 2001)

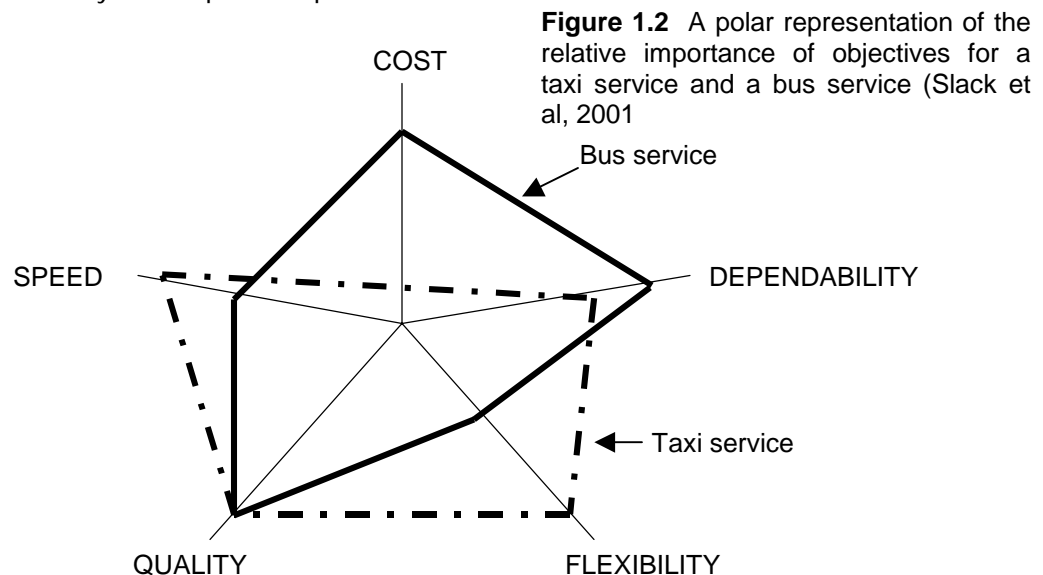
Slack *et al* (2001:44) identifies five performance objectives that are central to organisation competitiveness:



1 Process Improvement

- o Quality
- o Speed
- o Dependability
- o Flexibility
- o Cost

The degree of organisation emphasis will vary from business to business. Organisations large and small, public, private and voluntary need to determine the key success factors for their particular market and specifically for individual key accounts. A useful technique is 'polar representation' which is shown at figure 1.2. The example shown is a profile comparing a bus service with that of a taxi service. In the example shown, the taxi service is more flexible than the timetabled bus service. On the other hand the cost of the bus service is lower than hiring a taxi. To become more competitive the bus service could try looking at ways of becoming more flexible to the needs of the community while retaining a cost advantage. Draw a profile of your own organisation by identifying the degree of importance of each performance objective and then look at how your competitors operate.



If we look at each of the performance objectives in a little more detail we can begin to understand the broad scope of market requirements that the organisation must respond to if it is to remain competitive. It is worth noting that 'nothing is for ever' as environmental pressures and customer preferences change over time. The organisation must ensure it engages with the environment to determine appropriate responses.

We shall now explore the five performance objectives discussed earlier in a little more detail.



1 Process Improvement

QUALITY

Quality has many definitions and equally different customer perceptions of what is considered a quality product or service. In its basic form, the definition of quality is '*fitness for purpose, produced right first time*'. The customer defines what is fit for purpose and the organisation must produce the product or service to the required standard. From an operational perspective the organisation must be effective in determining what the customer requirements are, in other words 'doing the right things' and efficient by 'doing things right'. For many organisations, quality is no longer seen as an area in which competitive advantage can be sought, because many customers see quality and reliability as an absolute prerequisite of the contract. However, delighting customers, by adding value to the product and service will – at least until the competition catch up – make the customer feel s/he has received real value for money.

SPEED

Again we need to be clear of what we mean by speed from a customer perspective. How important is it to the customer that we produce the goods or deliver the services speedily. What sort of time frame is important to them? In a fast food establishment we would expect to be served in minutes. As a manufacturer of spare parts for the automotive industry, speed may mean lead times from time of order to delivery of the product as a matter of days. What is without question is that speed is the current performance objective that many organisations strive to improve. Customers require speedy service, not necessarily because they are impatient, but because speed is linked to 'lean' processes. Customers adopting lean processes where reduced stock is the objective will rely upon speedy replenishment of those stocks to maintain throughput efficiencies. Alternatively, Just-in-Time (JIT) strategies in a stockless production system demands all five performance objectives throughout the supply chain.

DEPENDABILITY

An organisation that is seen by customers to be dependable is an organisation that delivers products and services on time as promised. A bus company, whose buses are always late, cancelled or always full, soon gets a reputation for not being dependable. Over time the bus company is likely to lose customers who have found alternative transport, perhaps to a rival bus company that arrives precisely on schedule. Dependability saves time, money and generates stability.



1 Process Improvement

FLEXIBILITY

Flexibility from a customer perspective falls into four categories (Slack 2001:51).

- o product/service flexibility – different products and services;
- o mix flexibility – a wide range or mix of products and services;
- o volume flexibility – different quantities or volumes of products and services;
- o delivery flexibility – different delivery times.

From an operational perspective, flexibility demands product and processes to be designed in such a way that other performance criteria are not affected. The ability of the organisation to design processes that are flexible and responsive offers opportunities to improve competitiveness. This however is dependent on the relative needs of the customer, but equally, if the organisation is able to offer greater flexibility that breaks the industry / market norm, then competitive advantage can be secured.

COST

The demands of the market for improved quality, speed, dependability and flexibility are not expected to cost more. Organisations can, and do, respond to the performance objectives outlined, but the real challenge is to offer better quality, speed, dependability and flexibility at lower costs than the competition. Of course all things are relative, and in some markets, flexibility may not be as important as keeping the cost of the product or service as low as possible. However, if all organisations just did what everyone else did, then how would the organisation stand out above the rest? The operations manager and his team should be engaged in finding ways to improve the performance objectives outlined at lower costs. This is an area that demands a strategic approach rather than an ad-hoc quality improvement or cost cutting programme. One of the ways in which cost can be reduced - to balance the 'cost' of improved performance - is to eliminate non-value adding activities. There are also other functional strategies that can be implemented that can radically improve organisation performance across all the five areas outlined. These will be discussed later. However, at the heart of any functional strategy the operations manager should be investigating ways in which productivity can be increased to produce products or services that exceed current performance in terms of quality, speed, dependability, flexibility and cost.



1 Process Improvement

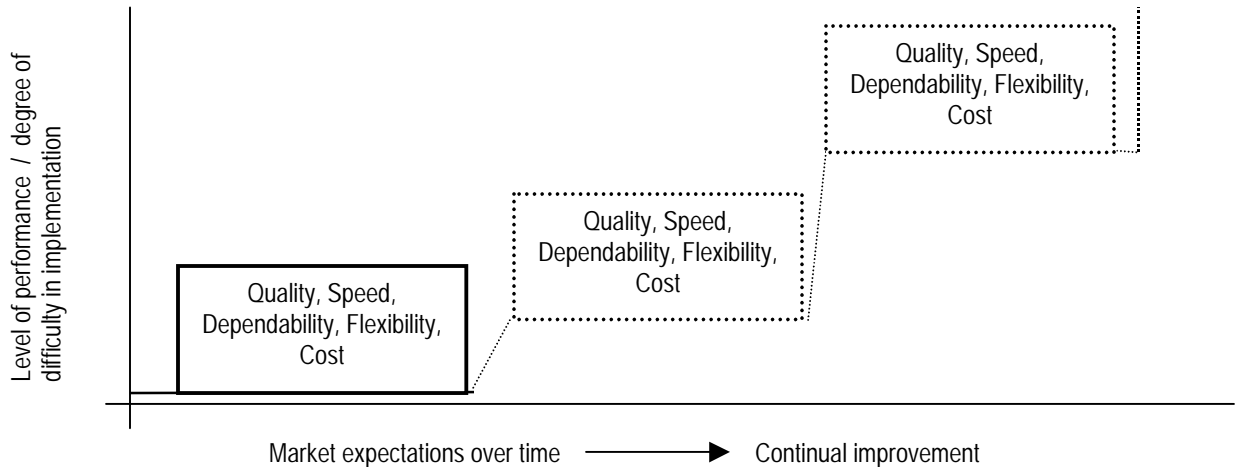


Figure 1.3 Market expectations and implementation

The organisation must formulate strategies at both the corporate, competitive and functional levels to improve quality, speed, dependability, flexibility and cost. The operations function must play a role in all three strategic areas. It is at the functional level where the operations manager will have the greatest contribution to both formulation and implementation. Figure 1.3 represents the five performance criteria and the steps that an organisation will have to take over time in response to market expectations. The first step for many may be relatively easy, however continual improvement may demand radical changes in the way in which operations are performed and this is the reason why it must be incorporated within the strategic decision making process.

FORMULATION AND IMPLEMENTATION OF STRATEGY

All organisations operate in an environment that provide opportunities and pose threats. These opportunities and threats create challenges for the organisation. At the macro level the organisation must formulate clear strategies that result in its mission being achieved. A mission statement documenting the 'vision' of the Chief Executive is a good way of communicating the broad aims of the organisation. Clear objectives must then be formulated to enable the whole organisation to follow a path that fulfils that mission.



1 Process Improvement

1.3 Integrative design

A performance objective important for many organisations is flexibility. Slack (2001:51) defines flexibility as "being able to change the operation in some way." He identifies four types of flexibility, namely:

- o **product / service flexibility** – different products and services;
- o **mix flexibility** – a wide range of mix of products and services;
- o **volume flexibility** – different quantities or volumes of products and services;
- o **delivery flexibility** – different delivery times

The first two examples of flexibility are product and service based. The second pair of examples is processed based. We shall start by discussing product / service, process and human resource (people) design and then relate the concept of 3P integrative design with what Rosabeth Moss Kantar describes as the fast, friendly, focused and flexible organisation.

Flexibility is an operational issue and can lead to competitive advantage. Strategic decision-making at the competitive (specifically product and process design) and functional levels (developing its competencies, skills and capabilities) should be focussed on achieving flexibility. Of course there are degrees to how flexible an organisation can, or wants to be. An oil tanker may not be able to change course or stop as quickly as a speedboat, but then again a speedboat cannot carry bulk crude oil. However, an organisation that has a clear strategy of satisfying the primary requirements of the market can also become more flexible by looking at product and service design; the 'process' that produces the product or service and the skills, competencies and capabilities of the organization – people design. Each can be 'designed' to improve flexibility.



1 Process Improvement

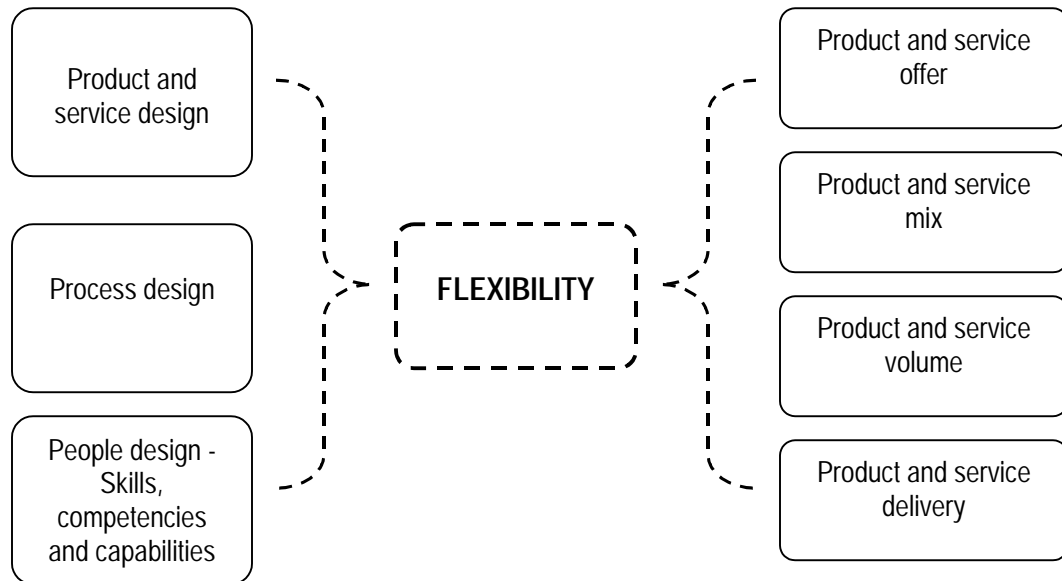


Figure 1.4 Designing for flexibility

Product and service design must be considered in terms of aesthetics – the look of the product or service; its function(s) – what it does; its grade of quality – fitness for purpose; its reliability and the ‘performance criteria’ demanded by the customer (figure 1.4). The organisation must ensure it has the necessary resources and capabilities to produce the product or service in terms of the skills and competencies of its employees. In addition, the organisation must design a process that transforms inputs into outputs effectively and efficiently. The process must be capable of producing the products or services to the required specification, on time and at the right price. From a productivity perspective, the process must be designed to maximise throughput efficiency without affecting the quality and reliability of the product/service. Finally, the product/service should satisfy the various performance criteria such as speed, flexibility and dependability demanded by the customer. Design is therefore a very important aspect to be considered by the organisation and should encompass the product/service, process and people. No longer should the product/service design department work in isolation but should be actively engaged with the operations and human resources functions.

Product / service design, and process design must be considered as one process. 3P integrative design approaches the design of products/services as an activity that also



1 Process Improvement

considers the design of the process. Not only can the operations function become more productive if both product/service and process designs are collectively considered, but the customer will benefit through better products and services. If you consider how the automotive industry has been able to offer customised products, you will begin to understand the importance of integrative design. The Volkswagen group has designed generic 'platforms' on which different body shells with different 'badges' (different models) sit. For instance Skoda and Seat vehicles share the same platform as Audi and Volkswagen vehicles. By designing generic core products that can then be customised, the organisation is able to offer a greater variety of products and increase the mix. Not only can this improve flexibility in the eyes of the customer but also it can be done efficiently from a cost standpoint as the generic design of core products and services can be efficiently produced through a process that is far less complicated. By identifying common features of the product or service (grouping) and then mapping these against a process which in turn has been designed to give maximum flexibility the organisation is able to produce volume 'customised' products and services very efficiently.

Slack (2001) identifies three dimensions on which design can be judged:

- o **aesthetics** – does it look better?
- o **usability** – is it easier to use?
- o **produceability** – is it easier or cheaper to make?

3P integrative design combines the process of designing products / services with the design of the process. Keeping core features of the product and service as simple as possible and then adding all the 'frills and whistles' to the generic design enables customisation and operational effectiveness and efficiency. Both these aspects from a strategic perspective will create competitive advantage.

The third aspect of design is deciding what skills, competencies and capabilities are required to not only design the product and process but to actually produce the product/service. We are of course talking about the people who work for the organisation. It is people that make a difference, the ones that give the organisation that unique blend of creativity and deliverability. Without a well trained and motivated workforce, the product and service will never be as good as it could be. We shall discuss this aspect of human resource management in another unit. For the time being though, consider the concept of designing 'human resources'. What skills, competencies and capabilities does the organisation require to meet the necessary performance objectives - the key success factors. How will it achieve an 'ideal' design in terms of employing a group of people who's task it is to produce products and services? Think about this for a moment and record your thoughts in table 1.



1 Process Improvement

Human Resource (people) Design. How would you develop a workforce that has the necessary skills, competencies and capabilities to produce products and services effectively and efficiently - maximising all performance objectives / key success factors?	
1.	
2.	
3.	
4.	
5.	
6.	
7.	

Table 1 Human resource (people) design



1 Process Improvement

An organisation has two aspects to it - its structure and its infrastructure. The production process has a finite capacity and capability in terms of its size, technology etc. In turn, the infrastructure in terms of how it operates - its systems and the capability of its employees will determine how productive it will be. There are therefore fundamental strategic decisions to be made which will have a bearing on the design of the product / service, the process and human resources.

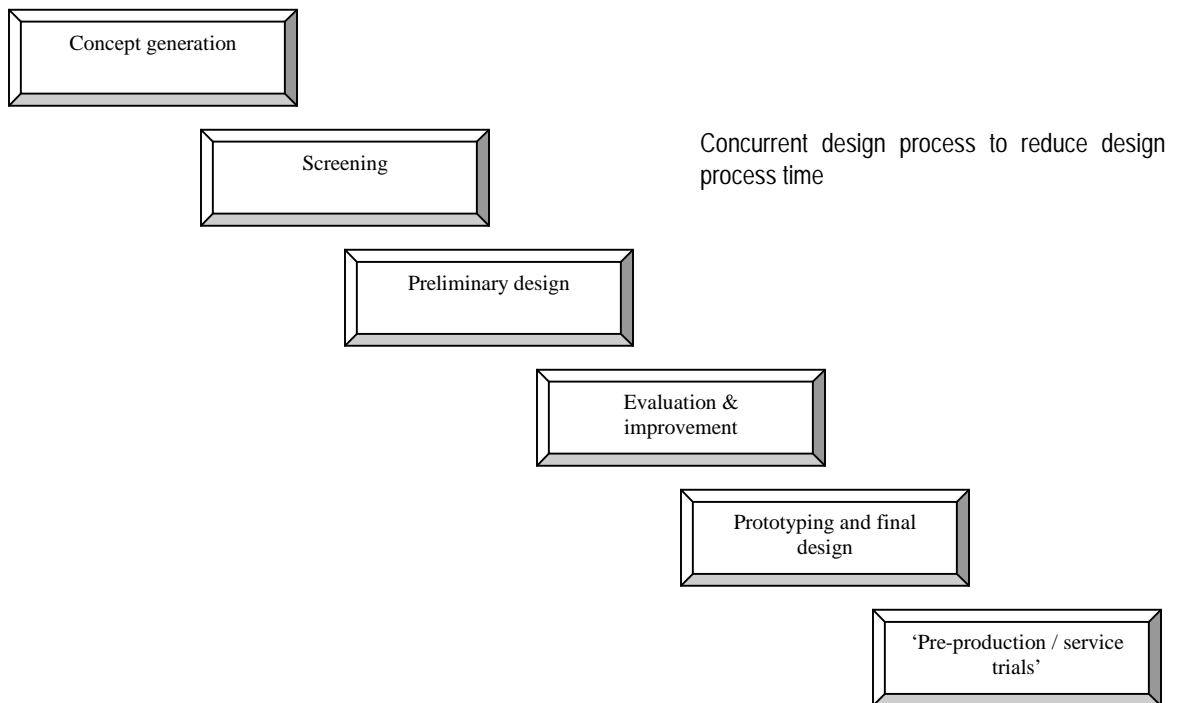
- o New product / service development strategy
 - o Vertical integration strategy
 - o Facilities strategy
 - o Technology strategy
 - o Workforce and organisation strategy
 - o Capacity adjustment strategy
 - o Supplier development strategy
 - o Inventory strategy
- } **Structural strategic decisions**
- } **Infrastructural strategic decisions**

Designing products/services should be considered as a process in which certain logical steps should be taken. This design process is illustrated at figure 1.5. When designing products and services, it is important to consider the process that will manufacture the product or deliver the service. Is the process capable of producing the product or service? What modifications should be made to the process or does the process need to be re-designed. Alternatively, should the product/service be re-designed to fit the current capabilities of the process? The other important aspect to the design process is the skills and capabilities of the workforce. Is there a fit between product/service design, the process and the organisation's skill base?



1 Process Improvement

Figure 1.5 The basic process of design goes through the following stages (Adapted from Slack 2001):



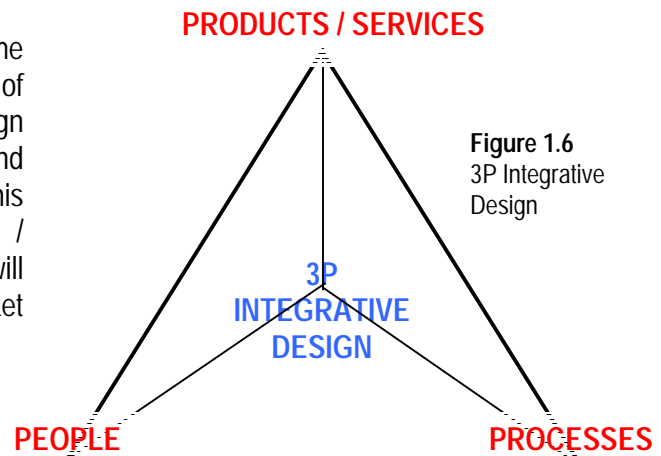
The final stage is important in establishing that the final design works in a real production/service environment. Piloting at this stage enables any fine-tuning to take place.



1 Process Improvement

Integrative design collectively considers the product/service, process and people. Competitive advantage can be secured by considering all three aspects collectively rather than treating each as a separate entity.

Productivity improvements in terms of time and cost must be a fundamental objective of the operations manager. Integrative design draws products / services, processes and people to an organisational focal point. If this design process can itself be systemised / project orientated, then additional benefits will be accrued through faster time to market products and services.



Integrative design should be part of an overall strategy in creating a cohesive organisation, in which all functions work closely with each other, understand each other's needs, and find solutions to achieving overall organisation objectives. Time, and cost are the two challenges for the organisation. By utilising all resources effectively the organisation is able to reduce lead times, eliminate duplication, speed up the decision making process and eliminate non-value adding activities. Many organisations have accrued benefits by approaching the design process as a project orientated activity. In addition, techniques such as quality functional deployment ensure that product design reflects the *voice of the customer*. Other techniques such as value analysis, systematically examine products, services and processes with the aim of improving cost-effectiveness. The aim here is to investigate the function of a system, process, equipment, product or service with the objective of achieving the intended function at the lowest overall cost.

In her book *When Giants Learn to Dance*, Rosabeth Moss Kantar talks about the fast, friendly, focused and flexible organisation. She stresses that“organisations must become focussed on becoming leaner, producing more with less, and investing in areas in which the organisation is strong. The organisation should be flexible in the use of its resources across divisions, across the hierarchy and across all functions. This may mean a different organisation structure that utilises project teams in and outside the organisation. Rewards are given from results and not status. Collaboration takes place outside the organisation. Being friendly involves creating relationships with suppliers and customers. Bureaucracy is dismantled. Acting fast before the opportunity disappears by taking considered risks and a willingness to experiment is encouraged. ‘Ideas scouts’ are developed to create innovative improvements in products and processes. Removing internal competition and creating a framework for team working and collaboration results in synergy throughout all functions”.



1 Process Improvement

Thompson (2001) develops this theme by reiterating the four Fs ... "sustainable competitive advantage does not come from either low costs, or differentiation, or innovation alone. It needs to be fast, friendly, focused and flexible.

"Fast organisations must move at the right time and not be caught out by the competition. New ideas and opportunities from the environment should be seized. The organisation should develop its skills, competencies and strategic capabilities to sustain the competitive gap. However, gradual change is more likely to be more popular with customers. Success takes time as the organisation culture must be appropriate.

Friendly organisations are closely linked to their suppliers and customers to generate synergy through the added value chain. The trend these days is for external collaboration in the form of strategic alliances.

Focused on core skills and competencies, together with a search for new opportunities for applying the skills. Intrepreneurship is fostered to improve skills. Managers need to be strategically aware. Employees are encouraged to own the mission statement. The mission statement must be communicated effectively and understood.

Flexibility concerns the search for continual improvement. Learning organisations share ideas and there is collaboration between all functions and divisions. Performance and effectiveness measures and rewards concentrate on outcomes. Internal synergies through cross-functional teams and special projects in which people are moved around the organisation to spread best practice. The organisation becomes flatter to open up communication channels. Internal constraints between functions and divisions are positively confronted. Employees are empowered. There is a shared organisation vision and purpose to the organisation." Thompson 2001.

Design is the key to competitiveness. Designing organisations to be fast, friendly, focussed and flexible is part of a continual process to achieving world-class performance. The operations manger has a major role to play in formulating the necessary strategies for achieving competitiveness. An organisation vision is only a vision unless strategies are effectively implemented. An organisation that understands the importance of integrative design - designing products, processes and engaging people through communication and involvement will achieve its strategic objectives and *"be the organization that others benchmark against"*.

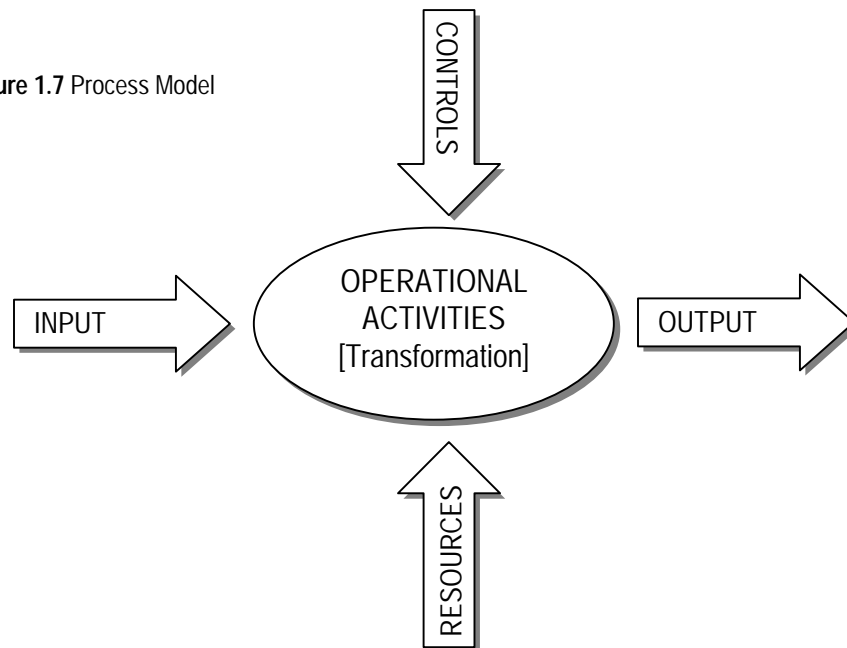


1 Process Improvement

1.4 The process

So what is a process and how can we improve it? A process is simply an input to an operational activity at which point those inputs are transformed with organisation resources and appropriate controls to add value and create a product or service as an output. The illustration below (figure 1.7) shows a simple process model.

Figure 1.7 Process Model



Inputs include materials, technology, information, capital. Outputs include products and services. Organisation resources may include employees, finance, plant and equipment, competencies and capabilities. Control systems may include management systems such as ISO 9001.

The challenge for the operations manager is to efficiently produce products and services in an effective way. Effectiveness and efficiency are equally important at the macro level as well as the micro level. At the macro level we are concerned with the organization as a whole, all its operations that collectively produce the product or service. At the micro level we are dealing with many smaller operations. Figure 1.8 pictorially represents the macro and micro concept. Whether at macro level or micro level, the same 'process' principles are applied – inputs, transformation and outputs.



1 Process Improvement

Television programme and video Production Company

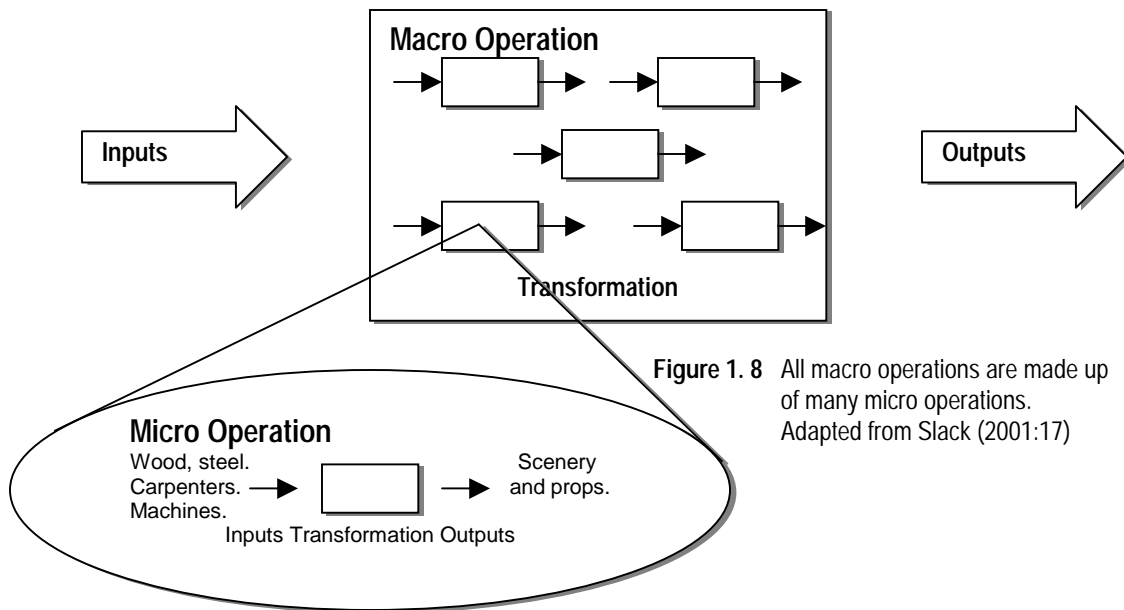


Figure 1.8 All macro operations are made up of many micro operations.
Adapted from Slack (2001:17)

Organisations are therefore made up of different functions each with its own set or sets of micro operations. Within each micro operation there may be a series of further micro operations or activities which again have inputs, a transformation stage and outputs.

At both macro and micro levels the fundamental issues concerning the operations manager are similar in nature. Think about your own organisation and identify what the inputs and outputs are at the macro level and then identify what the micro operations are and their specific inputs, the transformation of those inputs and the outputs.

Slack (2001:16) calls this collection of micro operations as the 'process hierarchy'. No matter what level of the organisation you may be at, the challenge is to operate effectively and efficiently by transforming the inputs to outputs in the most productive way and to gain competitive advantage.

One of the dilemmas for the operations manager is the balance between over-production and under-production. The external environment that is often dynamic and turbulent can affect the flow of inputs to the organization. To safeguard the organisation from this unpredictability, stocks are often maintained in order to 'ensure a steady flow' during the transformation stage. In the case of service industries contingencies are put into place 'just in case' external



1 Process Improvement

influences affect the process. Likewise, the architecture of many organisations is often designed with departments and a hierarchy to perform specialist tasks and to create a management structure through which decisions can be made and controls exercised. Staffing levels are maintained to ensure that if things go wrong, there will be someone to step-in to save the day.

The arguments and reality for many organisations is a policy of either stocking product or over-manning to create either physical or organisational buffers. Far from enabling a steady and uninterrupted flow through the transformational phase and ultimately to the final customer, inefficiencies are created that actually lengthen the time it takes to produce the products or service. In the case of physical stock, that may rely on some form of forecasting – ‘the only thing certain about a forecast, is that the forecast will be wrong.’ Physical stock creates delays and increases lead times. In the case of organisation structures with layer-upon-layer of management and specialist departments, all act as ‘control’ mechanisms and an artificial buffer to speedy decision-making. Operations management should be concerned with eliminating non-value-adding activities in the production of products and services. Non-value adding activities such as an inventory system to control stock, duplication of activities, specialist responsibilities that could be incorporated with other job-specifications and a monolithic hierarchy of management are not conducive in today’s dynamic market place. Safety nets are for the inexperienced trapeze artist not for the operations manager who wishes to engage with both the internal an external environment. Skills, competencies and strategic capabilities are all that is needed to walk the tightrope!

Lean organisations must be designed to fit the type of operations the organisation is involved in. Operations and hence the degree of ‘leanness’ is dependent on four aspects:

- o The volume of their output;
- o The variety of their output;
- o The variation in the demand for their output;
- o The degree of ‘visibility’ which customers have of the production of the product or service (also called the degree of customer contact)

Source: Slack (2001:21)

Organisation buffers, in the form of physical stock and the architecture of the organisation structure, roles, responsibilities etc. need to accommodate these types of operations. This should not however be a reason to remain ‘fat’ in the environmental comfort zone.



1 Process Improvement

1.5 Waste

World class organisations pursue waste with un-relentless vigour. Waste includes:

- o Overproduction
- o Transportation
- o Motion
- o Waiting
- o Processing
- o Inventory
- o Defects

Note that 'defects' – the traditional focal point of the quality department is one of seven waste categories. In their book *The Machine That Changed the World*, James P. Womack, Daniel T. Jones and Daniel Roos (1990) describe how Toyota revolutionized car manufacturing, which the West still strives to adopt. This was no over-night success story. It took thirty-five years to put in place the interconnected system known as the Toyota Production System (TPS).

The manufacturing industry has long recognised the advantages of lean strategies. Lean manufacturing results in higher productivity and profitability (Engineering Employers Federation Report, 2001). There are strong parallels between all manufacturing sectors in terms of production technology principles and management philosophies. Shingo (1988:13) advocates that once a manufacturing organization has identified specific 'fabrication' technologies, then issues of production technology and operations management are generic throughout all manufacturing sectors. Womack *et al* (1990:8) who engaged in a 5 million-dollar five-year study on the future of the automobile, which led to the publication of their book 'The machine that changed the world', state, "the principles of lean production can be applied equally in every industry across the globe".

"Toyota began in the 1950s to establish a new lean production approach to components supply" (Womack *et al*, 1990:60). Techniques such as 'kanban' were adopted to enable a flow of minimum inventory. Reducing unnecessary inventory is only part of the solution to realize waste and improved flow. Shingo (1988:71) advocates "There are many examples of waste in the workplace, but not all waste is obvious. It often appears in the guise of useful work. We must see beneath the surface and grasp the essence".



1 Process Improvement

The essence of lean therefore is to create flow throughout the production system. The difference between 'push', 'pull' and 'flow' is described below:

Push systems – push work through the processes resulting in inventory build-up at each operation.

Pull systems – pulls work from the previous operation and hence are likely to result in less inventory build-up.

Flow systems – a process that is seamless, the ultimate being continuous 'one-piece flow' where production flows one operation to another without inventory build-up.

"The rationale behind going lean centres on creating value and removing waste both inside and between companies" (Hines *et al*, 2002). Taiichi Ohno devised the Toyota Production System (TPS) on the basis of the total elimination of waste (Reingold, 1999:49). In the forward to Non-Stock Production by Shigeo Shingo (1988:xvi), Noram Bodek states "The real basis for non-stock or stockless production, says Mr Shingo, is not kanban, just-in-time, or supplier management, but the absolute elimination of waste, which can be achieved by improving the four phenomena of process: processing (e.g., machining), transport, inspection, and delay. Processing is the only one of these phenomena that adds value to a product; therefore, when Mr Shingo talks about *improving* the other three phenomena he means *eliminating* them to the greatest extent possible." The mindset that is required is therefore to think outside of the box. Bodek goes on to state, "instead of investing thousands of dollars in automated warehouses, why not eliminate the need for inventory? Rather than improve transport methods, why not reduce or eliminate transport operations by improving layout? Instead of hiring one hundred product inspectors (which would improve only the accuracy of defect measurement) why not implement a low-cost system that *prevents* defects at their source and thus eliminates the need for inspection operations? Why tolerate the many different production delays? Shingo eliminates delay by implementing levelled synchronous one-piece flow operations and exploding the myth of the economic lot with the single-minute exchange of die (SMED)" Hines *et al* (2002:7) state customers want value and the challenge for management is to eliminate waste (*muda*) – anything that does not add value to the product or service. This they say includes over-production, defects, unnecessary inventory, inappropriate processing, excessive transportation, waiting and unnecessary motion.

Table 2 outlines some of the techniques that world class organisations utilise to eliminate waste and in turn improve quality, speed, dependability, flexibility and cost performance objectives.



1 Process Improvement

Competitive Indicators	Eliminating 'waste'	
	Performance Objectives	Lean Manufacturing Principles
Quality	Error-free processes. On-specification products and services.	Total Quality Management, Poka-yoke. Kaizen, which Toyota defines as 'constant improvement'
Speed	Fast throughput. Shorter delivery times.	Reduced set up times resulting in reduced lead times. Single Minute Exchange of Die (SMED)
Dependability	Reliable operations. Dependable delivery.	Just-in-time (JIT), having the right parts, at the right place at the time needed.
Flexibility	Ability to change. Frequent new products. Wide product range. Volume and delivery adjustments. Customization	Ability to keep a steady flow without high peaks and valleys. Workers trained to be multi-skilled and machinery designed to be flexible.
Cost	High total productivity. Low price / high margin.	Reduction in inventories and reduced costs throughout the supply chain.

Table 2 Improving competitiveness through lean manufacturing principles
 Adapted from Slack *et al* (2001:70); Reingold (1999:45 – 65); Shingo (1988)



1 Process Improvement

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Useful Links:

Strategic Management by Thompson <http://www.thompsonlearning.co.uk>

Operations Management by Slack *et al* <http://www.booksites.net/slack>