A GENERIC MODEL OF ORGANISATIONAL CHANGE TOWARDS WORLD CLASS MANUFACTURING

by

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Synopsis

Since the start of the 'information age' in the mid-70s, manufacturing industry has experienced major changes in customer satisfaction requirements, market competitiveness, technology advancements, product life cycles and organisational working culture. There has been a constant evolution in new management approaches and tools. Manufacturing companies struggle to keep up with the pace of change and to adapt to new methodologies.

'World class manufacturing' (WCM) was introduced in the early 80s to address this problem. Since then, however, it has been diversely defined and approached. This has created confusion and has left the existence of WCM in question.

The main aim of the research is to create a generic model of organisational change towards WCM. This management model, named the 'birds of change' (BoC), is developed by two means – first the study of existing models / frameworks related to WCM, and second the investigation of four manufacturing firms and their change programmes.

To achieve this aim, several objectives have been set. First a standard definition of WCM needs to be established. Investigations then need to be carried out in the areas of measures of performance (MoPs), prioritisation of actions, culture and dynamics of change.

The industrial applications of the BoC model proved its capacity to translate business strategies into shop floor operations, to facilitate modern WCM principles and tools, to align WCM objectives to appropriate MoPs, and to incorporate a soft structure involving cultural issues. A scoring system has also been developed to supplement the BoC model with the ability to assess a company's change implementation.

In conclusion, a standard definition of WCM was established, and the areas of importance have been investigated. Hence the aim of the research has been achieved, which is to create a model that is generic to the organisational change of any manufacturing company towards WCM.

Dedication

To mom and dad… who always know the importance of education… who always care, love, and who are always sensitive to the needs of the children.

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Glossary

AHP	Analytical Hierarchical Process
BoC	Birds of Change
BoM	Bills of Materials
BR	Business Re-engineering
BSC	Balanced Scorecard
CI	Continuous Improvements
CPC	Central Processing Centre
CS	Customer Satisfaction
DFMA	Design for Manufacture and Assembly
FMEA	Failure Mode Effects and Analysis
HAUK	Hoogovens Aluminum UK
IDEF0	Integrated Definition of Function Modelling
ILM	Integrated Logistics Management
JIT	Just-In-Time
KPI	Key Performance Indicator
MBWA	Managing by Wandering Around
MoP	Measure of Performance
MRP	Material Requirements Planning
MTW	Manufacturing to Win
OC	Organisational Change
OEE	Overall Equipment Efficiency
OR	Operational Research
OTIF	On-Time In-Full
PDQ	Professional Diagrams Quickly
PPM	Parts Per Million
QFD	Quality Function Deployment
ROI	Return on Investment
SCEF	Safer, Cheaper, Easier and Faster
SME	Small and Medium Enterprise
SMED	Single Minute Exchange of Dies
SOP	Standard Operation Procedure

SPC	Statistical Process Control
SUR	Set-up Reduction
TPM	Total Productive Maintenance
TQM	Total Quality Management
WC	World Class
WCM	World Class Manufacturing
WIP	Work in Progress

CONTENTS

CHAPTER 1

Introduction and background

Outline of chapter

Chapter 1 sets the scene of and explains the need to carry out the current research. Phenomena of a new manufacturing era will be introduced to raise a few problem statements, which will lead to the various investigations of this research. The section will (i) highlight the need for change in management approach, (ii) explore the reasons for the failure of change programmes and how these problems had led to the development of a WCM change model, (iii) bring up the question whether WCM is the answer to modern manufacturing management and (iv) introduce Barry's model of a WC organisation and the need to improve the model for practical applications. Finally the chapter presents the aim of the research and the set of objectives that help achieve that aim.

1.1 Introduction

Advanced technology and communication have brought the world close together, making global competition fiercer than ever. To stay in the league of top class manufacturers, innovative product design, high speed and low cost operations, excellent quality and customer satisfaction are, just to name a few, the basic survival elements. The past two decades marked a massive transformation of manufacturing industry. Market competitiveness, customer expectations, management philosophies and organisational structure had gone through an evolution (Tey et. al., 2001 [b]). This evolutionary era began in what is called the 'industrial age' and continues today as the 'information age'. To excel, one needs to analyse the characteristics of industrial and information ages. Those who cannot keep up with the pace of change will lose competitive edge in no time. More importantly, companies must evolve a culture of continuous improvements (CI), innovation and growth (Joynson, 2000; James, 1997). Achieving excellence is not enough. One must be equipped with the ability to continuously challenge the position of excellence in order to outperform competitors. World class manufacturing (WCM) was introduced with the intention of providing this survival kit. "WCM ... was not merely a Madison Avenue buzz phrase, but a blueprint for action" (Kinni, 1996).

Manufacturing companies around the world have implemented various change programmes as an attempt to cope with this transformation. However, many have failed to create an impact or to sustain. It is important to understand why and how these change programmes failed.

Barry (1998) made a significant contribution to this problem when he created a model of a WC organisation. The study of this model and its applications had led to opportunities of further investigations, which became the starting point of this current research.

1.2 New Revolutionary Era -- Change is Imminent

This may sound a cliché but it remains true. Change is the only constant in the equation of the evolutionary world. The change brought up in the question here is not about the change generated as the world naturally evolves, it is the change in management approach that needs to go along with it.

It is now common knowledge that complacency within the business will lead to the fall of a giant. Excellence needs to be re-defined to be applicable to constant improvement and demands of constant change. In a modern business management environment, nothing stays the same and nothing should stay the same (Kotter, 2001). A culture of constant innovation is the key to survival. Adrian McNay, managing director of Frontstep UK, describes the situation in the UK now in the early 21st century: "The manufacturing sector has entered its fourth recession in just over a decade. This is a climate where the pound is strong and there is fierce competition from overseas. Manufacturers now have to look beyond price-cutting and product quality to remain in the game." (McNay, 2001)

Over the past two decades, customers' requirements have changed. Customers are no longer satisfied with standardised products, but products that are tailored to suit each individual's needs. Research carried out in Pilkington Automotives has provided a perfect example. Windshields are made to fit to the exact model of the car in terms of size, thickness, material, tinting and safety requirements. It is often required to add value to the process in order to meet the requirements of their next customer in the chain. This includes fitting an electronic sensor on the inner side of the back windshield. Not only has customer demand increased in its standard, it has to be met with a quick response. Overall, business has changed from mass-production and profit making into close customer relationships. Manufacturing has to be much more flexible to accommodate these requirements.

Change is necessary as competition steers from local towards international. The US manufacturing industry faced severe challenges in the early 80s due to their enormous losses in the market place. Japanese products proved not only superior but were also produced at lower costs. Managers and practitioners were alarmed to make changes (Hayes et. al., 1988). When US industry progressed with Material Requirements Planning (MRP) system, the rest of the world was challenged to make changes to compete with that. International competition will continue to be fiercer and faster. Manufacturers in all parts of the world need to make constant innovative changes to stay in this league.

The most recent trend has been for western companies to move their manufacturing facilities abroad where cheaper labour costs can be obtained. Examples of these countries abroad include those in Eastern Europe, Indian continent, Far East, and South America. On top of this, Drucker (1997) pointed out that from the birth rate of that time, it is an accomplished fact that developed countries will be under-populated for the next 25 years. So unless the productivity of technology, knowledge and knowledge workers is maintained in a competitive position, the developed countries will soon find themselves losing the edge in the international competition.

Other factors that brought urgency into the need to change include: quality improvement, inventory reductions, employee involvement, closer inter-functional linkages, flatter organisational hierarchies and more rapid adoption of new manufacturing technologies (Hayes et. al., 1988).

1.3 Failures of Change Programmes in Manufacturing Industry

Whether due to international competition, increased customer demand or problems in profit making, manufacturing companies around the globe who are still surviving must have realized at some point the need to change. It is hard to find a manufacturing company that has never undertaken some kind of change programme. A change programme normally involves a management decision towards a common goal. Then some sort of action plan gets structured and carried out by a team, a group or the entire workforce. As good as the intentions are which many change programmes possess in the beginning, many of these programmes have been short-lived or underachieved.

Change programmes often fail due to the following factors:

Lack of management support

This is one of the most common factors that lead to change programme failure (Walley, 1992). A decision to change must be accompanied by support in resources. Good will is not enough to carry out changes if the management only pays lip service to them. Change programmes that face this fate end up extremely short-lived.

Lack of resources

In cases where management has all the intentions to change, change programmes often fail due to the lack of resources. This tends to happen to smaller sized manufacturers, where the decision-making of all aspects of the company comes down to only one or two people. Heritage Silverware is a typical example. The entire company, from front office to the shop floor, is constantly short of resources in personnel and time. The shop floor produces a constant mess that no one has the time to take care of, and being tight on cash flow does not help with the situation at all. Change programme started with the best intention and enthusiasm. However, changes take a long time to happen. Even the simplest operation such as printing red-tags for their 5S activities took weeks. 5S targets were never fully achieved, as equilibrium in shop floor tidiness was the best that could be done. Chapter 5 details more on the implementation of WCM activities in Heritage Silverware.

Cynical attitude towards change

People have the natural tendency to reject change. It is human nature to stay in an environment one feels comfortable with. This has been long acknowledged since Machiavelli (1961) stated that there is nothing more difficult and unlikely to succeed than initiating changes, as the innovator makes enemies of all those who prosper under the old order, and receives only "lukewarm" support from those who are generally "incredulous".

Change means bringing in variables and unknowns. To a few people it can be a challenge. To many it is a threat. Often when re-engineering occurs in an organisation, it comes with lay-offs. Hence the workforce cannot help but treat change with fear. The other factors causing the cynical attitudes are (Walley, 1992):

- Lack of total workforce commitment
- Lack of government support
- Failure to address culture
- Foreign competition

Cynical attitude is a major cause of change failures. However, one has to bear in mind, that failures of change also in turn causes people's cynical attitude towards it.

1.4 A Model of a World Class Organisation

The study of Barry's 'model of a WC Organisation' (1998) was the basis for this research. The model was presented in a PhD thesis completed in 1998 at the University of Birmingham (UoB). One of Barry's recommended future works was to further investigate the practical usage of his model. The Integrated Logistic Management research group at the UoB believed that the model could be put to further use in industry, but it required some 'tidying up' in terms of the logic of the model and its many minor details. A proposal was put forward for this work and hence the start of this current research.

Barry's model of a WC organisation was developed through five case studies. A sixth firm that tested the model was Hoogovens Aluminium UK (HAUK), now part of a global enterprise Corus, which also participated in the current research. HAUK collaborated in Barry's research during the final phase and applied the model more extensively than the other five firms. Hence it was agreed that a good starting point to this current research was to continue the application of Barry's model to HAUK and to examine potential modifications and improvements.

The study was concerned with the difficulties encountered when applying the model at HAUK. Initial investigations suggested that these were due to a lack of prioritising the capability of the model, and the problem of understanding and interpreting it.

Barry's model of a WC organisation will be explained in further detail in Chapter 4. Later in Chapter 6, a comparison will be made between Barry's model and a model that will be developed in this research. Modifications and improvements of the model will then be highlighted.

1.5 Research Aim and Objectives

The primary aim of the research is to build a conceptual model that describes a generic organisational change (OC) process towards WCM status and one that is industrially tested.

To achieve this aim several objectives have been set:

- To establish a standard definition of the term WCM for reference throughout the research
- To investigate the role of MoPs and benchmarking in WCM
- To develop a decision-making tool in prioritising actions
- To evaluate the importance of soft issues in change
- To study change management and the dynamics of a change programme

The primary aim is genuine and specific to this Ph.D. research. It can be seen as the main product of the research. The objectives, on the other hand, are to assist in achieving this aim and to provide arguments that support the main outcome of the research. They can be subjective discussions and results of partial investigations into a few argumentative topics.

1.6 Structure and Overall Outline of the Thesis

Chapter 1 sets the scene of and explains the need for the current research. The background of WCM and OC was introduced, highlighting the need for change in manufacturing management approach and the failures of many OC programmes. Barry's model of a WC organisation was taken as a starting point of the research. A primary aim of the research is presented together with several objectives set to achieve that aim.

Chapter 2 outlines the history of manufacturing management, particularly the different characteristics of the 'industrial age' and the 'information age' in order to bring in the topic of WCM. The chapter then presents literature survey mainly in the areas of WCM, OC, and all the related topics such as just-in-time (JIT), total productive maintenance (TPM) and other management approaches, and soft issues such as culture, people and leadership. This chapter outlines a review of the existing literature that relates to, and creates an impact on the current research.

Chapter 3 presents the research design, development and methodologies. It explains how industrial collaborations were set up and what techniques were used. Details are also given on how this research benefited from academic collaborations and other final year research projects. Selection of modelling software and weaknesses of the research methodology are also discussed.

The core findings and outcome of the research are placed in Chapter 4 – first, the concluding definition of WCM. After putting forward four existing and related models / frameworks, a complete model of OC towards WCM is introduced. This is accompanied by a scoring system which evaluates a company's change programme against benchmark standards set in the change model.

Chapter 5 exhibits the case studies and industrial applications of the research. The four industrial collaborators are closely examined in terms of their general backgrounds and specifically their change initiatives towards WCM. The change model was tested in these companies and results are presented here.

These results are then analysed and discussed, to conclude whether the research has achieved its aim and objectives. Chapter 6 revisits all objectives set in the beginning of the research and draws conclusions, based on comparisons made between the new change model and the existing models / frameworks introduced in Chapter 4, and results presented in Chapter 5. Discussions are carried out on major issues to support the conclusions.

Objectives that have not been achieved, or areas of research that have not been investigated, will be included in Chapter 7 as future work. This final chapter suggests further applications of the change model in conjunction with the scoring system, and advocates ways forward to bring this current research to a new platform.

1.7 Summary

Industry is under constant change. Customer requirements have changed towards being more individualistic. Competition has grown from being local to global. Organisations have evolved to have a flatter structure. Manufacturers need to keep up with the change and WCM aimed to provide the answers.

Change efforts have been made around the world for decades. Reasons have been identified for change programmes that have failed:

- Lack of management support
- Lack of resources
- Lack of total workforce commitment
- Culture and attitude of people

Barry's model of a WC organisation, created in 1998, was taken as a starting point of this research. It was believed that there was room to modify and improve the model to benefit industrial applications.

The primary aim of the research is to build a conceptual model that describes a generic organisational change process towards WCM status and one that is industrially tested. To achieve this aim, several objectives have been set. These include setting a standard definition for the term WCM, and investigating the following areas:

- MoPs and benchmarking
- Decision-making / prioritising capability
- Soft issues / culture
- Change management / dynamics of a change programme

Chapter 1 has introduced the need to change the management approach to keep up with the transformation in manufacturing industry all over the world. It has also highlighted the failures of change programmes and the reasons behind them. This has thus set forth the need for the current research.

CHAPTER 2

Literature Survey

Outline of chapter

Chapter 2 aims to indicate the knowledge areas covered in the scope of this research. This is to prepare the readers for the materials that can be found in the thesis, and those that will not be presented in detail. Studies have been carried out on the literature related to the research, particularly in the field of world class manufacturing (WCM) and organisational change (OC). Various definitions of WCM have been investigated and are presented here. The other closely related topics include management approaches such as just-in time management (JIT), total productive maintenance (TPM), total quality management (TQM) and their respective tools, continuous improvements (CI) / KAIZEN and elements of 'soft structure' such as 'culture' and 'people' issues. Before presenting literature reviews on each main topic, the chapter will introduce the history of management in manufacturing industry, from the beginning of the 'industrial age', through the 'information age' until the present day.

This will include the background of manufacturing industry when WCM was first introduced, and what happened later. Characteristics of manufacturing industry are compared between the 'industrial age' and the 'information age'.

2.1 Introduction

World Class Manufacturing (WCM) is a new global phenomena, a new approach to manufacturing management. Literature on WCM has only existed for less than two decades. The history of manufacturing management gives significant clues to trace the birth of WCM. When investigating the historical background of manufacturing management, a good set-out point is to recognise the 'industrial age' and the 'information age'.

One of the objectives of this research is to give a rigid definition to the term WCM, so that the entire research has a reference to base on. Various definitions by academics, practitioners, writers and managers need to be studied.

While WCM remains a relatively new topic, organisational change (OC) has been the subject of academic investigation from the start of the industrial era. Chapter 1 has elaborated the industrial norm of 'change', that change is a constant. OC is a complex issue that involves matters of various aspects and of different nature.

Although the research evolves around the main topics of WCM and OC, it has links to several management approaches that support both streams. Just in time (JIT), total productive maintenance (TPM) and total quality management (TQM) are the few management approaches that have gained widest recognition by the manufacturing industry all over the world. The concept of 'lean' has penetrated management thinkers and washed away the old principles of mass production. Continuous improvement (CI), or otherwise known as KAIZEN in Japanese terminology, has developed to become a philosophy with many tools used throughout the change in industry. The balanced scorecard (BSC) then gave a new insight to a more complete system of measures of performance (MoPs). Six Sigma (6σ) is the latest quality based tool, which requires high standards of competitiveness. One of the objectives of this research is to establish a correlation between WCM and all these other manufacturing management approaches and tools mentioned above.

The subtleness of soft issues such as culture, people and leadership has led to the lack of detail description towards dealing with the 'infrastructure' of a company. There is a lack of direct technical approach to research and to understand the way to work around soft issues. This part of the change process needs a closer look.

The literature survey is presented in such a way that it leads to the arguments used in the later chapters of this thesis. Important findings and theories, which support the author's research and which will be incorporated in the model to be built, are highlighted here.

2.2 Manufacturing Management: the History

Figure 2.1 presents a time chart of the history of manufacturing management. The columns display, in chronological order, gurus or influential authors in the field of manufacturing management. The rows list the primary management approach, or management focus of their literature. Cruising along the chart gives a general outlook of the history of manufacturing management and how management approaches evolved over time.

As mentioned in chapter 1, 1975 marked the beginning of a significant evolution in industry, as it split between the industrial age and the information age. The industrial age is best represented by Frederick Taylor's scientific management theory and by the success of mass production systems pioneered by Henry Ford. Ford made enormous profits by taking skills out of workers. His aim was to create a "factory without workers".

					50s - 70s							80s	
	Fayol	Taylor	Ford	Urwick	Argyris	Woodward	Juran	Deming	Drucker	Skinner	Handy	Kanter	Peters
Mass Production			**										
Scientific Management	*	**											
Quality							**	**					
Cost			*										
Corporate Strategy				*	*					*			
Setting Objectives	*								*				*
Competitive Advantage				*					*	*			
People					*				*			*	**
Culture					*				*		*	*	*
Leadership					*				*			*	**
Organisational Structure						**							*
Customer Satisfaction									*				
Innovation					*				*			*	
Tools													
Change Management	*				*	*			*			*	*
Performance Measures									*				
Continuous Improvement													
Lean													

** Primary focus / contribution of the author

* Secondary focus / contribution of the author

Figure 2.1: General overview of the history of manufacturing management

	80s					90s					
	Hayes	**Porter**	**Schonberger**	**Shingo**	**Gunn**	**Womack**	**Todd**	**Kinni**	**Kaplan**	**Handyside**	**Joynson**
Mass Production											
Scientific Management											
Quality	*		*	*						*	
Cost		**									
Corporate Strategy		**			*						
Setting Objectives					*						
Competitive Advantage	*	**		*				*			
People			*		*		*			*	
Culture					*		*				
Leadership					*					*	
Organisational Structure			*						*		
Customer Satisfaction			**	*		*			*		
Innovation										*	
Tools			*	**	*	*	*				*
Change Management							*	*		*	
Performance Measures			*	*					*		
Continuous Improvement	*		*				*	*			*
Lean			*			*		*			*

** Primary focus / contribution of the author
* Secondary focus / contribution of the author

Figure 2.1: General overview of the history of manufacturing management

The European equivalent of Taylor during that time would be Fayol (1900), who was regarded as the father of European management thinking.

> *"The work of Taylor and Fayol was essentially complementary. They both realised the problem of personnel and its management at all levels is the 'key' to industrial success. Both applied scientific method to this problem. That Taylor worked primarily on the operative level, from the bottom of the industrial hierarchy upwards, while Fayol concentrated on the Managing Director and worked downwards, was merely a reflection of their very different careers."* (Urwick, 1949)

Towards the end of the industrial age, one of the first important writers on manufacturing strategy was Skinner (1969). He addressed his concern that top executives tended to avoid involvement in manufacturing policy making. "Manufacturing was seen by top managers as a routine activity that needed lots of technical details and low level decision making. Manufacturing managers, on the other hand, are quite ignorant of corporate strategy". The connection between corporate strategy and manufacturing was simply high efficiency and low cost, and it did not go far beyond that. As a result, the manufacturing function, which could be a valuable asset and tool of corporate strategy, often became a liability instead.

Since 1975 industry has been undergoing a revolution. World market competitiveness has changed from local to global; product life cycles have shortened; company structures have been flattened. These are just a few of the many changes. At around the same time, Japanese manufacturing industry was advancing with many breakthrough production management techniques such as the JIT manufacturing system, which made Japanese products of higher quality than the rest of the world at that time. Among those who compiled these techniques and principles are Schonberger (1982) and Shingo (1985).

In the early 80s the US market was flooded with foreign products, thrashing the nation's manufacturing competitiveness. As a result, the world of literature concerning manufacturing was bloomed with ideas of change. Among these, classics were Kanter (1983), Peters and Waterman (1982). Kanter investigated the importance of change in culture and innovation in an organisation and the spirit of an entrepreneur; while Peters and Waterman focused on change from the people and leadership point of view.

The term WCM was born in the mid-80s. Hayes and Wheelwright (1984) brought out the idea of pure manufacturing strength, but it was Schonberger (1986) who popularised the name after the publication of his profound book titled "WCM". Since then the term has been interpreted in different ways by different people. Womack et. al. (1990) saw WCM as lean manufacturing systems, whereas Kaplan and Norton (1996) defied conventional performance measurement system by introducing their balanced scorecard (BSC).

The 90s were taken over by lean thinking, quality management and autonomous team working techniques. It has been widely recognised that process improvement is just as important as technological advancements if not more so. Focus has been put on what is called "human centred approach to manufacturing". First of all it is not a rejection of technology; it is linking technology to the important asset of any society – human creativity. It is an enormous effort to restore the skill and creativity needed for the future (Cooley, 1987; Brodner, 1986).

2.2.1 Industrial Age vs. Information Age

The 'industrial age' can be traced back roughly from 1850 to the mid-1970s. Then a new era of industrial revolution started, which is named the 'information age'. One of the earliest literature during this transformation era was that of Townsend (1970). "If you are not in business for fun or profit what the hell are you doing here?" is one of the thousands of humorous and philosophical statements made in his sagacious book "Up the Organisation".

One can also relate this change to the example of Fordism and post-Fordism. Henry Ford pioneered mass production in the early 20^{th} century with the inherent concept of cost reduction and increase in product quality. This mass production system dominated global industry for more than 50 years with huge success (Womack et. al., 1990). Emerging into the information age, manufacturers now need to tailor their production system to one that is agile, flexible and able to customize products to individual requirements. In other words, whether global, regional or local, manufacturers have to be world class (WC).

Figure 2.2 exhibits elements that mark the transitions of the two eras. World market competitiveness has changed from domestic (local) to global. 40 years ago, a plant located in Birmingham would obtain all the raw materials locally. Today, the competition in supplies has become worldwide. Shipping raw materials from another continent has become a norm. Due to severe global competition in the 70s and 80s, the US market was flooded with foreign products and the nation turned from the world's largest creditor to become the largest debtor within 15 years, with the deficit increased to $170 billion in 1986 (Hayes et. al., 1988).

Product life cycles have shrunk significantly. In an increasingly competitive global market, schedules are becoming shorter. Product developments are carried out at great speed. Manufacturers must be able to introduce new product prototypes faster than ever, and be able to change to suit the market demand with quick response (James, 1997). In many cases products that are not launched on time will never reach the right profit levels (Farish, 1995).

The structure of an organisation is generally getting flatter. An organisational chart, which traditionally has a very hierarchical structure, would now have less vertical layers but more horizontal sections. The sense of 'ladder', with employees or workers at the bottom and executives on the top, is now replaced by cross-functional linkages, with people across the organisation possibly addressed as associates, hosts, or crew members (Peters and Waterman, 1982). This can be reflected by the fact that people are now communicated more on a first name basis (Schonberger, 1996). Traditional companies operate with functional specialisation; whereas modern organisations set up cross-functional teams to allow more communication among departments (Kaplan and Norton, 1996).

Production wise, mass production used to dominate during the industrial age until the revolution. Due to the global competition, shrinkage of product life cycles and increase in customer requirements, low cost standardised production has been taken over by highly customised flexible production (Kaplan and Norton, 1996; Brown, 1996). Factories now produce a high variety of products in any volume instead of low variety products in high volumes. Hence the old management technique of "keeping the machines running to ensure workers have enough work to do" does not work anymore. Manufacturers have to "make the right things in the right quantities at the right time" (Handyside, 1997). As products are now much more customised to suit individual needs, products are no longer built to stock but built to customer demands. Production is pulled from downstream customer order rather than pushed from upstream suppliers.

This has substantially changed the management strategies. Production during the industrial age was predictable and stable. Therefore the emphasis had been placed on reducing the need to manage, and management can be done remotely. However, as production progressed to be more flexible and unpredictable, management is needed close to the front line (Handyside, 1997). Management decision has to be made strategically with competitive advantage and customer satisfaction. Manufacturers can no longer work in isolation from customers and suppliers. They now have to form strategic alliances to enhance their capability (Brown, 1996).

The production features of the information age mentioned above have also transformed the characteristics of the new age workforce. Mass production aimed to take skills out of workers; the new JIT and lean manufacturing approach put them back (Cooley, 1987; Dreyfus and Dreyfus, 1986). Operators need to be multi-skilled and highly trained to be able to cope with the whole flexible production environment. Information age workers are expected to be equipped with more knowledge and skills, so that problem solving and machine breakdowns can be dealt with by the operators within the workstation itself instead of by external technical specialists.

Looking at the bigger picture, the primary objective of manufacturing is no longer driving costs down. It is to increase quality, and eventually, cost reduction would follow (Schonberger, 1986). The mindset of management should move beyond edicts, procedures and policies to become principle-based. In the old days innovation was more often referred to as technical improvements; but these days process improvements come equally important (Handyside, 1997). 'Change' had been described as a "pain" during the industrial age; but it needs to be regarded as a form of "growth" for a company to compete in the information age (James, 1997). Motivation was geared by "fear"; but now by "vision". Corporation is now not to be treated like "machines" but rather like a "community". Finally, business should be seen as an "ecosystem" rather than as a "battlefield". All these distinguished characteristics between the industrial and the information age of the manufacturing industry are summarised as a list in figure 2.2.

Manufacturing Characteristics		Industrial Age / Conventional Management	Information Age/ Modern Management	Source
External	**Competitive philosophy**	Superior product design, financial strength, marketing ingenuity	Manufacturing strength (the "ability to make it better")	Hayes & Wheelwright
	Competitiveness, market and suppliers	Domestic, local	Global	Kaplan, Handyside
	Product Life Cycles	Long	Short and shrinking	Kaplan, Brown
	Demand	Stable, known	Unstable, erratic, met by manufacturing capability	Brown
		Demand exceeds supply	Supply exceeds demand	Handyside
	Economy	Fast Growth	Slow Growth	Handyside
Strategy	**Business**	Battlefield	Ecosystem	James
	Corporation	Machine	Community	James
	Management philosophy	Planning & control (edicts, procedures, policies)	Principle-based	Schonberger
		Control	Service	James
		Emphasis on reducing the need to manage	Emphasis on sound management disciplines	Handyside
		Management by remote control	Leadership at the front line	Handyside

Figure 2.2: 'Industrial age' vs. 'information age'

Manufacturing Characteristics		Industrial Age / Conventional Management	Information Age/ Modern Management	Source
Strategy	**Partnership**	Firm operates in isolation	Strategic alliance to enhance strategic capability	Brown
	Management Decision	Short term	Strategic, competitive advantage and customer satisfaction simultaneously	Brown
	Leadership/ Management Ratio	30:70 (substantial management)	70:30 (substantial leadership)	Kotter
Operations	**Organisation Structure**	Top down	Flat organisation	Schonberger
		Functional Specialisation	Cross-functional teams	Kaplan
		Segmentalist	Integrative	Kanter
	Information Flow	Constricted	Free	Kanter
	Cost	Economies of scale	Cost reduction	Handyside
	Communication	Vertical	Horizontal	Kanter
	Product Design	R&D	Product champions	Schonberger
	Competitive Dimensions	Cost-cutting	Cost, delivery, flexibility, quality and capability	Schonberger
	Production Management	Low cost, standardize products	Highly customized products	Kaplan
		Fixed, inflexible production	Flexible, customer-specific production	Brown

Figure 2.2: 'Industrial age' vs. 'information age'

Manufacturing Characteristics		Industrial Age / Conventional Management	Information Age/ Modern Management	Source
Operations	**Production Management**	Long run	Short run	Brown
		Little variety, high volume	Any variety, any volume required by customer	Brown
		Specialised labour and management	Maximised flexibility	Handyside
		Keep machines running and ensure workers have enough work to do	Making the right things in the right quantities at the right time	Handyside
		Big batches – long production runs	Small batches – more changeovers	Handyside
		Efficient	Effective	Handyside
	Inventory	Build to stock	Build to customer order	Brown
	Problem Solving	Reliance on technical specialists	Reliance on all employees	Handyside
	Supply Chain	Poor buyer, supplier relationships	Strategic partnerships	Brown
	Workforce	Unskilled	Multi-skilled, highly-trained	Brown
		Employees	Contractors, experts, consultants, joint-venture partners	Drucker
		Direct Labour	Knowledge workers	Kaplan
	Manufacturing Flow	"Push" from upstream suppliers	"Pull" from downstream customer orders	Kaplan, Handyside

Figure 2.2: 'Industrial age' vs. 'information age'

Manufacturing Characteristics		Industrial Age / Conventional Management	Information Age/ Modern Management	Source
	Manufacturing Flow	In-process stockpiling before bottlenecks	Minimise inventories and throughput times	Handyside
	Performance Measures	Financial (sales, profit)	Non-financial (Inventory turnover, customer satisfaction)	Schonberger
	Manufacturing objective	Cost	Quality	Schonberger, Handyside
	Innovation for Improvement	Technical Innovation	Process Improvement	Handyside
Soft Issues	**Change**	Pain	Growth	James
	Motivation	Fear	Vision	James
	People	Employee, Worker	People, crew member, hosts, associates	Peters
		Hierarchy	First name basis	Schonberger
	Employee	Treated as children	Treated as peers, adults	Peters, James
	Learning organisation	Text books	People contribution	Schonberger

* Sources taken from Brown (1996), Drucker (1998), Handyside (1997), Hayes and Wheelwright (1984), James (1997), Kanter (1983), Kaplan and Norton (1996), Kotter (2001), Peters and Waterman (1982), Schonberger (1986; 1996)

Figure 2.2: 'Industrial age' vs. 'information age' – the transition of manufacturing characteristics

2.3 World Class Manufacturing (WCM)

This section is divided into two parts. The first focuses on the definition of WCM found in the literature, and the second part covers the general concepts related to this field.

2.3.1 Definitions of WCM

The effort of defining WCM was once described using the analogy of blind men touching an elephant. Each time one of the blind men touched a different part of the elephant he had a different perception of what the elephant looked like.

<u>*How it was born*</u>

When investigating the origin of the term WCM, it is commonly known that the initiators were Hayes and Wheelwright (1984). It has always been claimed that it was their concept of building manufacturing strength -- "the ability to make it better", as a competitive weapon which led Schonberger to formalise the term WCM in his profound book.

> *"One that fulfils the customer's demands for high quality, low costs, short lead times and flexibility by adopting the appropriate tools and techniques, rapid and continual improvements..."*
> (Schonberger, 1986)

However, this concept of building manufacturing strength has existed long before the 80s. Skinner (1969), one of the best remembered management gurus, has suggested the importance of utilising manufacturing since the 60s. Moreover, building manufacturing strength is not the only core concept embedded in the definition of WCM.

Best in the world?

Since the first official publication of defined WCM, academics and practitioners have come up with various definitions. 'World class' literally carries the implication of global competition. Manufacturers now face vicious threats to survival from competitors all around the globe. Based on this argument, a world class manufacturer has been regarded as "being the best in the world" (Todd, 1995), which has been challenged that no one can be best in the world in all aspects, and no one can be constantly the best in any of these aspects (New and Swejczewski, 1995), having "the ability to compete anywhere in the world" (Wireman, 1990), "possessing best practices, equalling or surpassing best international companies" (Voss, 1995) or surviving the "enhanced capabilities of existing firms, as well as the emergence of new entrants from all over the globe" (Brown, 2000).

> *"Being the best in the world in terms of costs, quality, productivity and delivery performance"*
> (Todd, 1995)

> *"It is debatable whether the best results (world class) across all fronts will ever be actually found in a single firm"*
> (New and Swejczewski 1995)

> *"The ability to compete anywhere in the world, and then to be able to meet and beat any competitor anywhere in the world with product, price, quality and on-time delivery."*
> (Wireman, 1990)

> *"Possessing best practice in total quality, concurrent engineering, lean production, manufacturing systems, logistics and organisation... achieve operational performance equalling or surpassing best international companies... best practice will lead to superior performance and capability, this in turn will lead to increase competitiveness"*
> (Voss, 1995)

> *"World class meant being better than others; now it merely means being able to compete at all in a business world that is more intense than ever before due to the enhanced capabilities of existing firms, as well as the emergence of new entrants from all over the globe"*
> (Brown, 2000)

Continuous Improvement (CI)

Some emphasize the essence of CI in WCM (Schonberger, 1986; Urban, 1989) by describing it as "a continuous pilgrimage towards an ideal, not a static goal" (Brower, 1992) and a "never ending journey" (Barry, 1998).

> *"World class manufacturers differ from an average manufacturer in their continuous striving for improvements in quality, costs, lead-times, customer service, and general responsiveness"*
> (Urban, 1989)

> *"World class manufacturing will control costs and improve quality, deliveries, and asset management. While most costs come up front, continual trade-offs may be required, because world class manufacturing is a continuous pilgrimage toward an ideal, not a static goal. In sum: The search for perfection never ends"*
> (Brower, 1992)

> *"Even when an organisation can hold its own against the best in the world, the pace of change is becoming so great that without constant efforts to keep on top, an organisation can all too quickly find itself losing out to more dynamic competitors"*
> (Barry, 1998)

Primary Objectives in the Definitions

The most mentioned element in defining WCM is the set of WCM objectives to be achieved (Schonberger, 1986; Urban, 1989; Wireman, 1990; Brower, 1992; Harmon and Peterson, 1992; Todd, 1995; Barry, 1998). They can be categorised into:

- Quality
- Costs
- Innovation and design

- Productivity (includes flexibility, dependability, agility and lead times)

- Customer satisfaction (includes delivery performance, service and responsiveness)

> *"The plant that produces and ships customers' exact daily requirements each day is world class. This must be done with quick response to changing market demands without large anticipatory inventory."*
> (Harmon and Peterson, 1992)

Harrigan (1993) suggested that not a single objective should be neglected. "The adjective 'world class' has come to mean being the very best – "Ostensibly in every value-creating activity at every step in the value chain that a firm engages in". However there are many examples where a company needs only one remarkable advantage to excel over its global competitors, as suggested in the definition "Being better than almost every other company in your industry in at least one important aspect of manufacturing." (Hayes et. al., 1988).

Related Soft Issues

It is important to state that WCM status is pursued without neglecting the infrastructure of organisations: culture, innovation, management and employee involvements, resources and environment (Feigenbaum, 1991; Kinni, 1996) and combining them with corporate strategies, vision statements and competitive factors (Greene, 1992; Chan, 1993).

"WC companies:
1. *are consistently good under all conditions*
2. *set aggressive targets and stretch targets*
3. *effectively resource their people and systems to reach their goals*
4. *have innovation in management*
5. *sell the company as hard as they do their products or services*
6. *measure the right things right"*

(Feigenbaum, 1991)

> *"Transformation to world-class manufacturing is strategic planning and working towards 3 core strategies: customer satisfaction, quality and agility, using six supporting competencies: employee involvement, supply management, technology, product development, environmental responsibility and safety and corporate citizenship. It is a long-term evolution needing commitment from managers and every other employee. It also requires investments in organisational resources and radical change in the culture and structure of the workplace."*
> (Kinni, 1996)

> *"[WCM companies are] those companies which continuously outperform the industry's global best practices and which know intimately their customers and suppliers, know their competitors' performance capabilities and know their own strengths and weaknesses. All of which form a basis of continually changing – competitive strategies and performance objectives"*
> Greene (1992)

> *"For world class manufacturing, the ultimate goal is to attain a market level for products which will ensure their future prospects and leap-frog the competition... Companies can go 'beyond world class'... has to win the hearts and minds of customers through 'lead-marketing-manufacturing'... is achieved when a company exploits its core competencies and manufacturing capabilities in order to produce innovative products which capture the imagination of its customers"*
> Chan (1993)

Related Tools

WCM has also been related to several state-of-the-art philosophies and tools such as TQM, concurrent engineering and lean manufacturing (Voss, 1995; Womack et. al., 1990; Hanson and Voss, 1993, 1995).

> *"Uses less of everything – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires far less than half the inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products."*
> (Womack et. al., 1990)

"World class results are based on survey data where firms are asked to rate their manufacturing practice and performance against a range of fronts... quality, lean production, logistics, organisation and culture, manufacturing systems and concurrent engineering... scored above 80% on practice and 80% on performance against these fronts were rated as world class"
(Hanson and Voss, 1993,1995)

Related Performance Measures

Oliver et al (1994, 1996) argued that there should be a standard set of performance criteria in industry to identify world class plants.

"To qualify as world class, a plant had to demonstrate outstanding performance on measures of both productivity and quality... units per labour hour=95/100, %failures at final inspection and test=0.03..."
(Oliver et. al., 1994)

"Identify world class plants using a consistent set of performance measures"
(Oliver et. al., 1996)

The author would like to quote two particular definitions that seem to capture the more complete picture of WCM:

"The continuous improvement of manufacturing performance to a position of excellence, which satisfies customers, shareholders and employees. Achieved by means of innovative measures and the use of integrated proven tools and techniques by trained and capable employees, within a strategically planned and visionary framework"

(Williams, 2000)

A "manufacturing management philosophy, which focuses on: (1) Continuous improvement in manufacturing processes from the employee and the management's perspective, (2) Clearly defined manufacturing goals and objectives, (3) The satisfaction of customer requirements, (4) Developing better ways to do the job right the first time, (5) Educating and training for new challenges, (6) Simplifying work processes, and (7) Eliminating bottlenecks which hinder productivity"

(Edosomwan and Johnson, 1996)

2.3.2 Concepts of WCM

The preamble of the WCM can be traced back to Skinner's (1969) work when he questioned the conventional management of delegating too much decision making power to lower levels in the manufacturing area without much linkage to corporate strategy. It was said that this had neglected manufacturing as a competitive weapon. He suggested a top down approach where manufacturing policy has to be defined before operations can be broken down and carried out.

This concept of gaining competitive advantage through manufacturing strength was resurrected in the early 80s. Hayes and Wheelwright (1984) pointed out one of the most significant changes in manufacturing competitive philosophies in the information age – that superior product design, financial strength, and marketing ingenuity have now been replaced by one of pure manufacturing strength – "the ability to make it better". "Manufacturing can be a competitive weapon, and can make a company WC". He then divided the manufacturing role in a business into four stages, from being reactive and restricting a company's success (stage 1), to being proactive and bringing competitiveness to the organisation (stage 4), which should be ultimately achieved. This is very much an agreeing statement to Skinner's (1969) putting manufacturing back to a competitive role in corporate strategy.

Schonberger made the term WCM official two years later (Schonberger, 1986). The term was defined by him as "CI in all the manufacturing objectives: quality, costs, productivity and manufacturing capability / flexibility", where CI was taken from a Japanese developed concept KAIZEN (see section 2.5). A decade later, Schonberger gathered data from 140 manufacturers in nine countries and revealed that financial performances are not the sole key indicators to the rise and fall of industry, but rather inventory turnover and customer satisfaction (Schonberger, 1996). Then he redefined WCM with 16 customer-related principles, which can be summarised as the following:

- Involve customers in planning activities
- Rapid CI in all manufacturing objectives
- Simplify operations and reduce variation
- Train and reward employees, involve employees in strategic planning
- Monitor performance and align with customer requirements
- Promote every improvement

All the above principles should be "customer focused, employee driven and data based". The criteria should be weighted against and re-consider options if violated. Scores will fall back due to changes so CI is vital (Schonberger, 1996).

Meanwhile, Porter (1985) analysed a firm's competitive position by assessing its 'value chain' – all the activities it performs and how they interact. "A firm gains competitive advantage by performing these strategically important activities more cheaply or better than its competitors". He also pointed out that there are two competitive advantages a firm must possess: low cost, and differentiation.

> *"Competitive advantage is a function of either providing comparable buyer value more efficiently than competitors (low cost), or performing activities at comparable cost but in unique ways that create more buyer value than competitors and, hence, command a premium price (differentiation)." (Porter, 1985)*

Manufacturers will have to achieve WCM status to compete effectively in the global markets. Gunn (1987) observed hundreds of manufacturing companies in the United States, Europe and Japan. He concluded that companies were not responding well to changes because the company's culture ignored manufacturing and viewed it as only a cost centre. The missing elements are:

- vision on future manufacturing industry,
- lack of leadership action and,
- an implementation process for the above to improve competitive advantage.

He was one of the first to outline a blueprint for a WCM framework -- from creating a vision and strategy, linking it to shop floor actions, to implementing the WCM programme. The importance of team building and training was also highlighted.

In Hayes later publication (Hayes et. al., 1988), requirements were set for identifying WC organisations: "WC companies outstand themselves by producing faster responses to market changes, intertwining design of product with manufacturing, and continually improving facilities, support systems and skills". He responded to the changes in the information age and agreed that the long established problems of the US companies can be solved by quality improvement, inventory reduction, closer interfunctional linkages, flatter organisation hierarchies and more rapid adoption of technologies. All these responsibilities should start from management.

Since 1990, Industry Week had been compiling profiles of American plants that were believed to have achieved excellence. In the search for these excellent plants, it was recognized that "core competence in manufacturing is a key source of competitive strength… manufacturing expertise should be viewed as a strategic weapon" (Kinni, 1996), which has echoed the very first concept of WCM voiced by Hayes (1984). The book outlined nine essential components to becoming 'best plant':

- Customer focus
- Quality
- Agility
- Employee Involvement
- Strong supplier relations

- Technology
- New product development
- Green manufacturing
- Community Involvement

These components need to be unified by senior management with strategic planning. Planning is an indispensable part of the process that needs commitment of the people and leadership to set the direction (Kinni, 1996).

Todd (1995) regards WCM as one of the many terms of own inventions. Depending on the company's circumstances, the revolutionary change can be lean production, JIT, or total quality. It was agreed that all these are about attacking waste in time, people, inventory, customer's goodwill and people's skills, as suggested by Womack et. al. (1990), Schonberger (1986) and many other WCM authors.

Just like many others, Todd's WCM approach evolves around planning strategies, involving people and then developing effective systems. His idea of progressing towards WCM can be found related to the following topics:

- Strategy and marketing
- JIT
- TQM
- Total employee involvement
- WC information systems
- Managing the change

Finally Todd provides practical examples of how WCM actually works. He emphasises the importance of taking small step changes, and that most times if WCM does not work it is due to human factors or the resistance to change.

Hill (1993) argued that a business approach that seeks a prescriptive solution does not work. Instead a development of manufacturing strategy should be made linked to the market. Farish (1995) provided his version of WC products:

- Focus on customer needs and make products that people want
- Encourage and motivate staff to work together well in teams with the same goal of producing the best possible product
- Bring about and maintain a company culture which makes this possible and makes full use of all the skills and ideas that people have to offer
- Introduce technology and systems which support these three overriding objectives

Williams (2000) investigated manufacturing companies in the Caribbean (Barbados in particular) and carried out tests using Barry's model of a WC organisation (Barry, 1998). The objective was to find out what would happen when a framework developed in the UK was brought to an environment with a different background. Manufacturing in the Carribean is different due to the cost of labour, cost of imported raw material and energy, government regulations and technologies to say the least. Observations were made on major issues such as quality, strategy and productivity to decide on the needs to improve. Improvement methods suggested in Barry's framework were then taken to tackle these needs. The work shows good confidence that the Caribbean manufacturers can be taken on the path to greater productivity and competitiveness, ie. world class.

In the effort of creating a framework of WCM aimed towards Mexican companies, Mayet (2001) derived that outstanding firms possess the following practices:

- A remarkable customer approach based on simple but timely flow information
- Active problem-solving structures and strong teamwork habits on the shop floor
- An organisational approach based business rather than hierarchical processes, focused on the elimination of waste and non-value activities

- Time is considered a key strategic measure of performance (MoP)
- Exceptional consistency between business strategy, tactics, customer service achievements and good financial results are sustained over many years

The other significant finding of Mayet's work was one of correlating financial results with the score of his WCM framework (more in chapter 4).

2.4 Organisational Change (OC)

Before pursuing the field of OC, one needs to understand the many reasons for resistance to change. The fundamental explanation for the obstacle of change initiatives goes way back to Machiavelli (1961) when he stated that people feel secure and comfortable with the already existing state. Changes pose as a threat to them. Kotter (2001) added to the reasons for the resistance to change:

- Lack of confidence in management / change initiator
- Lack of a convincing vision to describe the breadth of change
- Ignorance of the people
- Lack of space, resources and training facilities
- Fear of a boss or a penalising performance appraisal system
- Discouraged by failing change programmes

As in who are most likely to resist change, it has been traditionally recognized that employees in the middle or lower down the chain are the ones who react against change. They fear that their hard-won knowledge of systems and processes – a knowledge that they feel keeps them in their jobs – will become redundant, and they with it. However nowadays those at the bottom of the hierarchy are more receptive to change because they see the inevitability of it. They often understand the need for change as pressured by customers.

CEOs and executives are, on the other hand, the biggest force in dragging their feet in some companies (Kotter, 2001).

The basic structure of OC had already been suggested by Fayol way back in 1900. Undertakings of an OC, which was described as "administrative apparatus", must comprise these elements – The survey, the plan, reports and statistics, minutes of meetings, and the organisation chart (Fayol, 1900). Todd (1995) concluded that a successful OC must have the capacity to translate business strategies into shop floor operations, and then incorporate people and an effective system to manage the change.

Together with Peters, Kanter (1983) was renowned for leading change in US manufacturing in the early 80s. Her work unfolded a new context for OC:

- Where segmentalism prevails, companies stifle their own potential for greater innovation. Companies must seek to switch to an integrative mode.
- The key is to encourage entrepreneurial behaviour, and employee involvement leading to productive, responsive changes. These can be stimulated through a company's structure, culture and rewarding system.
- Three sets of skills are needed to manage this integrative, innovative environment:
    - "Power skills" to persuade others to invest in new initiatives driven by an "entrepreneur"
    - Ability to manage team and employee participation
    - Understanding of how change is designated and constructed in an organisation

After investigating 43 companies, Peters and Waterman (1982) identified eight characteristics shared by the companies in forming the culture of excellence:

- A bias for action – getting on with it
- Close to the customer
- Fostering innovation and nurturing 'champions'

- Productivity through people
- Hands-on, value-driven: management showing its commitment
- Stick to the knitting: stay with the business you know
- Simple form, lean staff
- Simultaneous loose-tight properties; autonomy in shop floor activities plus centralized values

Later in Peters's and Austin's "A Passion for Excellence" (1985), they gave practical suggestions for the role of managing an organisation. They printed a valuable set of actions that seem to be common sense but is never quite rightly achieved, as they claimed "the obvious is not often so obvious!" This management blueprint is called 'managing by wandering around' (MBWA). By that they meant constantly out on the shop floor asking questions, and getting people together. It describes customer and supplier relations, leadership, people and innovation relations. Peters and Austin emphasised the importance of leadership at an early stage to create a unique set of cultural attributes which incorporates the values and practices of great leaders.

Obolensky (1994) investigated various change efforts according to four factors:-

- Impact across the whole organisation and the extent of strategic change
- Potential gain of the projected future state
- Perceived pain of the continued status quo
- Perceived need for change by senior management

He compared nine different change programmes (figure 2.3) in terms of the four factors mentioned, and put them in comparison of scales. 'Business re-engineering' (BR) is on top of the scale. This means that when the scale of a change programme becomes large, BR is often needed to provide the solution. This dramatic change to an organisation has a great impact on culture. However, it is essential for an organisation to fulfil four variables before taking on such radical implementations:

- Very painful status quo to urge people to move forward,
- The projected benefits of the business must be credibly clear,
- Leadership has to be convinced about the desperate need to change, and
- The impact needs to span across the entire organisation and not just parts of it.

A typical BR programme aims to first disassemble the traditional top down functional structure to a team working environment. The final goal is to then create 'fluid' teams of people who focus on specific processes and projects. These teams are networked using IT, and the organisation links strategy, technology and people to ensure flexibility and responsiveness to change.

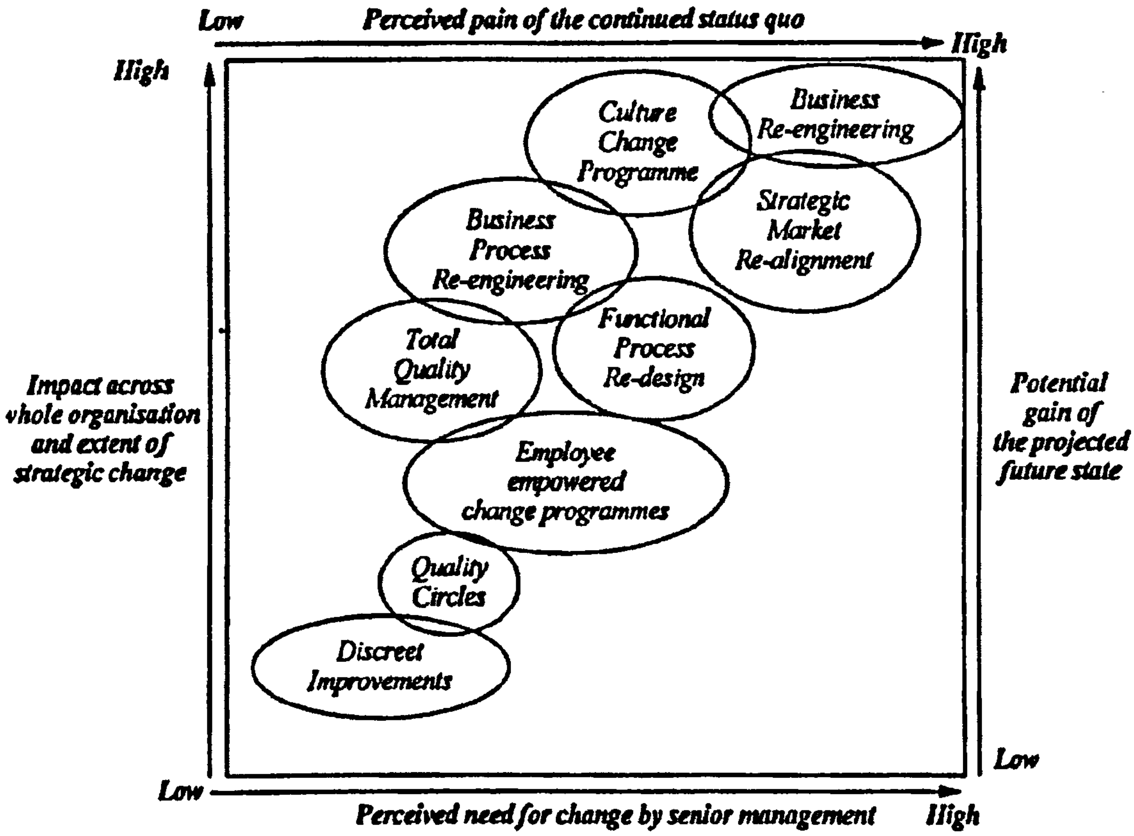


Figure 2.3: Business Re-engineering represents a large change programme (Obolensky, 1994)

Mayet (2001) presented a few observations on OC practices that can influence bottom line results:

- WCM implementation depends on how top management understands the governing variables of business performance
- Hierarchical organisational structure leads to the lack of teamwork at upper layers of the organisation and affects the responsiveness to corrective actions in operative and service areas
- Complexity of WCM implementation arises when the practices are related to the value stream (e.g. ISO, cell manufacture) rather than one operation approach (e.g. quick change-over)
- A good level of standard procedures, as opposed to informal information flow, presents a bigger potential for best practice

2.5 Just In Time (JIT), Lean and Agile Manufacturing

JIT, whose origin is generally attributed to the work of Shingo working for the Toyota Motor Company of Japan in the 1960s, has become a core-concept of Japanese production management and productivity management, and has been subsequently emulated by many western countries (Barry, 1998).

Most widely used definition of JIT is that of Schonberger's (1982):

> *"Produce and deliver finished goods just-in-time to be sold, sub-assemblies just-in-time to be assembled into finished goods, fabricated parts just-in-time to go into sub-assemblies and purchased materials just-in-time to be transformed into fabricated parts"*

JIT is also seen as an approach to move steadily towards 'The Five Zeros' (Bicheno, 1994): "Zero Paper", "Zero Inventory", "Zero Downtime", "Zero Delay", and "Zero Defect".

However, beneath the desired output of a JIT system set forth in the definition, there are many underlying principles and subsequent levels of goals that go alongside it. As a production strategy, JIT works to reduce manufacturing costs and markedly improve quality by waste elimination and more effective use of existing company resources. As the definition suggests, JIT should not only be applied to achieve improved delivery to external customers. Manufacturers should expand their thinking to apply JIT to internal customers (ie. next process down the line).

Hall (1983) believed that companies that have failed to achieve great benefits from JIT have invariably failed to see JIT as a total approach involving the full set of techniques and principles. The elements generally considered essential to JIT implementation are:

- Attacking waste (time, inventory, motion, defects)
- Reducing lead time / set-up time
- Small batches
- Multi-skilled workers
- Quality at the source
- Preventive maintenance
- Kanban / pull production scheduling

Tools of JIT

- SMED – Single Minute Exchange of Dies is a technique to reduce set-up times by transferring internal activities into external activities so they can be done outside the set-up time.

- KANBAN – the word simply means signboards and cards. KANBAN is a visual management tool used to communicate between processes when a delivery is made and when parts are needed. At Rexel, one of the companies under research collaboration, this is done via fax facility, and that's why the technique is addressed as 'faxban'.
- Layout – This is a key JIT facilitator because it makes small lots or even one-piece flow possible. The overriding JIT layout is to move machines and processes closer together, as soon as the opportunities arise. This is to reduce inventory levels in order to decrease lead times and improve quality.
- POKE -YOKE – Fail-safe mechanism that eliminates troubles associated with defects, lack of safety and reduces the need of attention by operators
- ANDON – Trouble lights that expose abnormal conditions in the factory so corrective action can be taken immediately

JIT vs Traditional Manufacturing

Brown (1996) summarized the effect JIT has on operations (table 2.1). The JIT approaches, as opposed to some traditional manufacturing approaches, will form the basis to follow for WCM principles later incorporated in the model.

	Traditional Manufacturing Approaches	**JIT Approaches**
Internal Factors		
Quality	A specialist function; acceptable levels of rejects and rework – an inevitability that failures will occur	Right first time; on-going pursuit of process improvement by everybody down the line
Inventory	An asset, part of the balance sheet and, therefore, part of the value of the firm, buffers necessary to keep production running	A liability, masking the operational performance by hiding a number of problems
Batch sizes	An economic order can be determined to show the balance between set-up time and	Batch sizes must be as small as possible, aiming toward a batch size of 1

	production runs	
Materials ordering	Determined by the economic order quantity	Supply exactly meets demand in terms of quantity; delivery is exactly when required
Bottlenecks	Inevitable; shows that machine utilisation is high	No queues – production at a rate which prevents delays and queues
Workforce	A cost which can be reduced by introducing more automation	A valuable asset, able to problem-solve, who should be supported by managers
External factors		
Lot sizes	Large, just in case, covering several weeks production	Small, JIT for daily production
Delivery	Not linked to manufacture, often erratic	Synchronised for production
Number of suppliers	Several – used to play off one against another	Few, often single-sourced
Purchasing agreements	Short-term; threat of withdrawal from buyer	Long term and 'certain'; often exclusive agreements
Nature of Buyer/Supplier relationship	Stressful; little dialogue; win/lose scenario	Mutual commitment; constant exchange of communication; win/win approach
Pricing	Tricks on both sides; changing and volatile	Fixed by mutual agreement
Proximity	Physical proximity is irrelevant	Physical proximity is vital

Table 2.1: Traditional manufacturing vs. JIT manufacturing

JIT vs. Lean Manufacturing (LM)

Eliminating waste is the essence of JIT. On the other hand, the aim of LM can be seen as translating waste elimination into customer satisfaction. This involves simultaneous attack on the four dimensions of competitiveness: product performances, quality, cost, and time (Sohal et.al., 1993).

Characteristics of LM also to a large extent overlap with JIT (Womack et al, 1990):

- Integrated production, with low inventories throughout, using JIT management
- Emphasis on prevention, rather than detection of poor quality

- Production is pulled in response to customers, rather than pushed to suit machine loading or other in-house ideas of scheduling
- Work is organised in teams, using multi-skilled workforce problem solving to eliminate all non-added value
- Close vertical relationships, integrating the complete supply chain from raw material to customer

LM contains working goals which relate to using less resources and cutting costs while improving quality. This research summarised a lean working environment as the following: safer, cheaper, easier and faster – otherwise known as an SCEF environment.

Lean vs. Agile

Lean production delivered much success in the late 20th century by achieving cost savings through its elimination of waste (Ohno, 1988). However, there are many other volatile markets where the order winner is 'availability' rather than 'cost'. This has led to the emergence of the 'agile' paradigm typified by quick response and high customisation (Aitken et. al, 2002).

Leanness, as mentioned in chapter 1, is about doing more with less. The term is often used in connection with lean manufacturing (Womack et. al., 1990) to imply a "zero inventory", JIT approach. The great success of lean production can be traced back to Toyota. However a study at Toyota encountered the paradoxical situation where vehicle manufacture is extremely efficient with throughput time in the factory, yet inventory of finished vehicles can be as high as two months of sales (Christopher and Towill, 2000 [b]).

Leanness by itself will not enable the organisation to meet the precise needs of the customer more rapidly. It has been argued (Christopher, 2000) that lean concepts work well where demand is relatively stable and hence predictable and where variety is low.

Conversely in those contexts where demand is volatile and the customer requirement for variety is high, a much higher level of agility is required.

An agile supply chain has been defined as "gaining competitive edge in volatile markets through rapid responses in and rapid reconfigurability of the supply chain" (Van Hoek, 2001). Meanwhile it also contains characteristics very closely linked to WCM principles:

- Short service window
- High customisation
- Sense and respond rather than make and sell
- Primary design principles are processes rather than products

Having become competitive based on cost (a 'lean' attribute), the supply chain is now being challenged on its availability performance (an 'agile' attribute). This has been demonstrated in the PC marketplace (Christopher and Towill, 2000[a]).

A case study in the lighting industry indicated that 'lean' and 'agile' are not mutually exclusive paradigms and may be married to advantage (Aitken et. al., 2002). An investigation at Cranfield University suggested that a hybrid supply chain, which encourages lean (efficient) supply upstream and agile (effective) supply downstream, can bring together the best of both paradigms (Christopher and Towill, 2000 [b]).

2.6 Total Productive Maintenance (TPM)

TPM is a Japanese invention of a company-wide programme to increase productivity and reduce equipment-related costs by means of systematic maintenance and autonomous work teams (Nakajima, 1988). The Japan Institute of Plant Engineers defines the following five objectives of TPM.

- Maximise equipment effectiveness (improve overall efficiency, by increasing equipment availability, productivity and performance).
- Develop a system of productive maintenance for the life of the equipment.
- Involve all departments that plan, design, use or maintain equipment
- Actively involve all employees - from top management to shop floor workers.
- Promote TPM through 'motivation management' or autonomous group activities.

TPM focuses on equipment losses, failure and deterioration, and aims to eliminate them through a variety of maintenance techniques. Any activity performed that "finds and corrects any condition that may cause machine failure before such a breakdown occurs" is a preventive maintenance (Barry, 1998). Such activities may include equipment cleaning and checking, or basic maintenance such as lubrication of mechanical parts. Preventive maintenance is planned and performed at regular intervals. It can be scheduled at convenient times during production, for example when production is slow, so as to cause the least amount of disruption to the production schedule. It extends the life of component parts by keeping the equipment in 'as new' condition. Performing equipment maintenance has the effect of not only increasing equipment availability and productivity, but also minimising unscheduled breakdowns or downtime. It also minimises costs and increases profitability.

A maintenance activity carried out by the operators on their own machines is autonomous maintenance. It requires operators to be more aware of the condition of the machine from day to day. They should be able to detect more serious problems that may need advanced actions, at which point they can alert maintenance staff in advance to perform maintenance at a convenient time during production. This can be done using some diagnostic techniques such as vibration monitoring.

For TPM to work effectively, it is essential to address the appropriate attitudes of the workforce (Wireman, 1990):

- People power - using people as the project drivers, constantly striving for improvement and being able to empower others to do the same.
- Ownership - of equipment and processes so that changes and improvements are carried out by the operator. Ownership of an area or a machine gives the operator responsibility for its condition.
- Teamwork - working together as a group to eliminate equipment problems through combined knowledge and being able to attack the problems from a variety of angles.
- Transfer of knowledge - between team members and across teams so best practice is transferred, making use of all the knowledge and information available to address the problem and find the best solution.
- Standards - set by the workforce to create a commitment to fulfilling them. With guidance these standards can be set high and still attained.

2.6.1 The Tools of TPM

The 5Ss

The 5Ss are the Japanese terminologies for housekeeping principles, namely "Seiri, Seiton, Seiso, Seiketsu and Shitsuke". This research translated the 5Ss into a more user-friendly version known as follows:

- Sort (Seiri) – removing any unnecessary items from the production area.
- Segregate (Seiton) – "A place for everything and everything in its place".
- Shine (Seiso) – keeping the machines clean at all times and check the machine regularly, so that the condition of the equipment can be easily appraised.

- Standardise (Seiketsu) – recording the practices of the first 3Ss and producing SOPs
- Sustain (Shitsuke) - making the principles a way of life.

There are defined tasks allocated to each of the 5Ss, to ensure that the principles are followed. Therefore, the 5Ss can be broken down to create a checklist (Sordy, 1999).

Red Tagging

Red tags are visual indicators that improvements or corrective actions are required. A red tag is attached to the item requiring attention. It acts as a reminder to push the actions through the improvement process. An amber tag indicates the waiting state, a period for which the improvement is under surveillance to check that the correct action was taken. Once the period of checking has elapsed, the amber tag can progress to green if no further action is required, or return to red for further action.

Failure Modes Effects Analysis (FMEA)

This is a systematic review process concerned with how the asset may fail to fulfil its function (partially or completely), and defines the equipment potential failure modes (Nakajima, 1989). It concentrates on the equipment and the processes it performs. To help the user trace back the cause of the problem, often a listing of component parts, or bill of materials (BoM), is required. It is a tool that can be used to direct the planning of the maintenance activities for the provision of asset care.

Overall Equipment Effectiveness (OEE)

This is a measure based on the availability of equipment. OEE measurement breaks down machine efficiency into the availability of equipment, the performance rate and the quality rate, by focusing on losses associated with (Nakajima, 1988):

- Availability
  1. Breakdowns e.g. time and quantity loss.
  2. Set up and adjustment losses.
- Performance
  1. Idling and minor stoppage losses.
  2. Reduced speed losses.
- Quality
  1. Quality defects and rework
  2. Start up losses, e.g. until the process has stabilised.

By analysing these in turn, areas for improvement can be identified. Figure 2.4 illustrates an example of calculating OEE. All the three availability factors are multiplied together. Therefore, the overall OEE figure is always lower than the lowest of the three. So even if there were two high percentages, one low performance will result in a low overall figure. To ensure high OEE, all the primary factors have to be taken as of equal importance. It is unrealistic to expect an OEE of 100%, but one of 70% or 80% is a realistic achievement.

2.7 Total Quality Management (TQM)

Quality should run throughout every business, from the person who answers the phone, to the delivery of the products; from design to manufacture; from purchasing to sales. This is where the word 'total quality' comes in place, as it means achieving quality in all areas of the business. The primary objective of TQM is to create a culture where quality comes first of all the other manufacturing objectives, and to develop a mindset that works with quality improvement as a top priority.

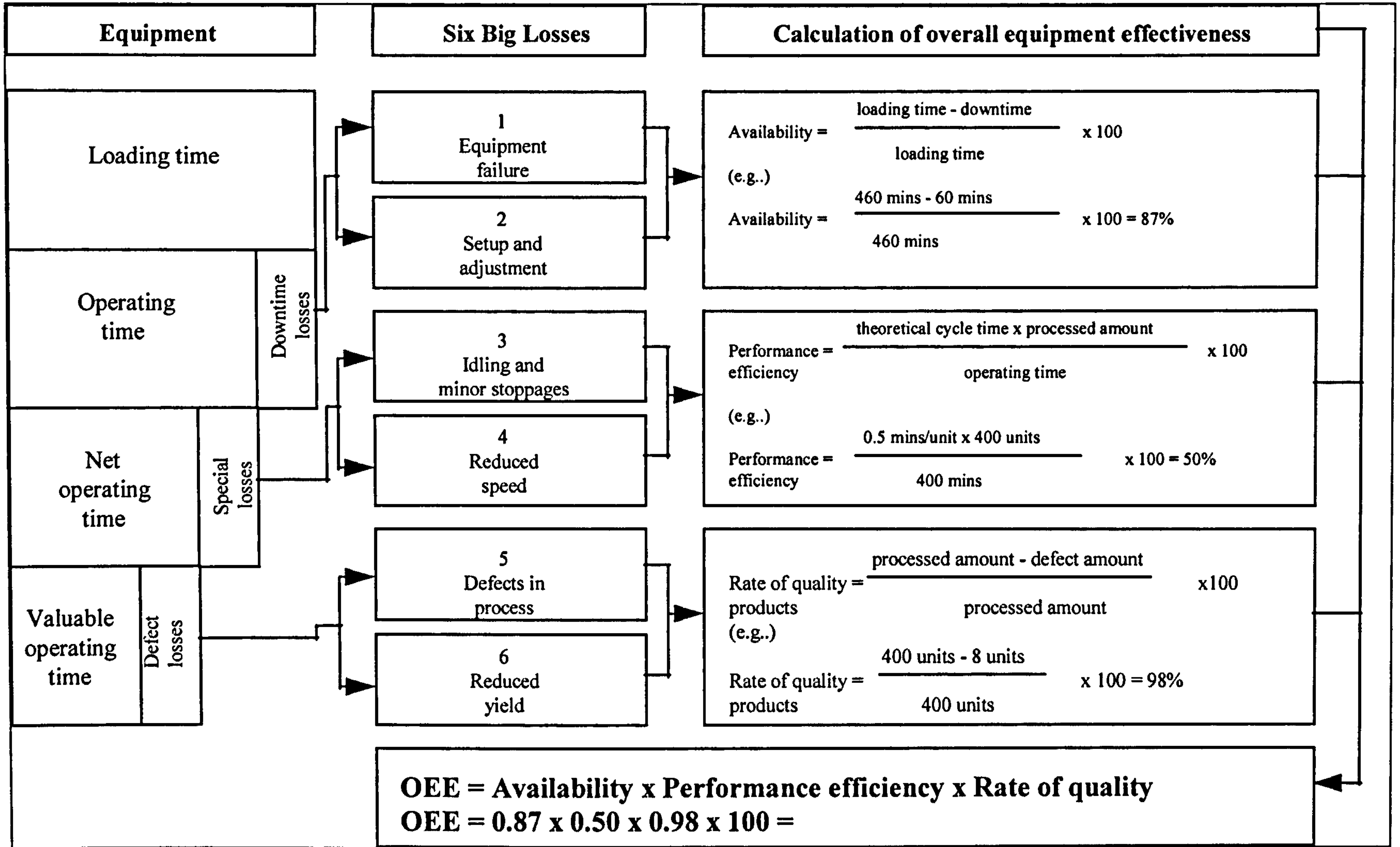


Figure 2.4: An example of Overall Equipment Efficiency (OEE) Calculation

One of the first profound quality approaches is that of Deming. The Deming cycle, also named the Plan-Do-Check-Act (PDCA) cycle, still remains a classic systematic improvement tool of quality (Deming, 1982, 1984). The Deming prize was established in 1951 for Japanese companies to compete for annually. It accounted for major improvements in quality, and was only opened to non-Japanese companies in 1984. Deming is revered internationally for his simple principle that quality is lost through variation. He also believed that quality is about people and not products; and that 85% of production faults are the responsibility of management and not workers (Kennedy, 1991).

The seven basic tools for quality control (pareto analysis, fishbone diagrams, stratification, tally charts, histograms, scatter diagrams, control charts) are still very widely used in industry today. These fundamental tools, together with statistical process control (SPC), allow a company to control their performance towards being WC without relying on financial figures and customer complaints. Another significant quality guru was Feigenbaum, also considered to be the "Father of TQM" and the pioneer of the quality cost model. Feigenbaum (1956) manages quality and costs as complementary objectives. "The Japanese have taught us that cost and quality do not lie at the opposite ends of the spectrum. In fact, the only way to be a low-cost producer is to be the high-quality producer" (Gunn, 1987). This supports the TQM philosophy of getting it "right first time".

One of the main objectives of TQM is to eliminate waste. A standard set for quality performance is "zero defect", and the suggested measurement of quality is the price of non-conformance (Crosby, 1979). In Storey's "New Wave Manufacturing", Dawson summed up TQM in six main characteristics (Storey, 1994; Dawson and Palmer, 1993):

- Total employee involvement
- Utilisation of CI implementation steps
- Application of quality control techniques

- Use of group problem-solving techniques
- Focus on 'internal' and 'external' customer-supplier relations
- Create and sustain high-trust relationships and employee co-operation

2.8 Continuous Improvements (CI) / KAIZEN

"Show me a company that's uninterested in CI, and I'll show you a company that may not be in business by the beginning of the 21st century" (Bodek, 1995).

CI is otherwise known as KAIZEN, which is the Japanese terminology literally meaning "change to be better"(actual character 改善). In the beginning, KAIZEN carried a Japanese anatomy of the term, mainly due to the entire set of Japanese created techniques and principles that come with it. Many of Japan's economic advances over the past 20 years have been attributed to KAIZEN. However in modern days, both these terms are regarded as the same.

The concept of CI is best described by practitioners at Pilkington (another company under research collaboration):

> *"Your business is running just fine. Sales are right where you want them. Your blood pressure is as stable as your workforce. But... you know the operation could run more smoothly... could run better. If you could only put your finger on it!!"*

Processes run at Pilkington suggested that 75% to 85% of process is consumed by wasted time. CI involves identifying waste by focusing on time as a common denominator. In a CI programme, it is important to pick an initial project that will yield success quickly. This is so that the workforce can see the benefit of the implementation. An essential part of CI is to gather people's power to identify opportunities for change. Implementation is the most vital part of the exercise. Most CI programmes fail when management encourages improvement efforts but does not implement the changes.

Imai (1986) has broadened the philosophy of KAIZEN to a way of life. "Be it our working life, social life, or home life – it deserves to be constantly improved". People continually improve aspects of their lives to create a better, more comfortable environment. Some do to survive the natural evolution. In recent years, the competitive manufacturing environment has created an alarm for CI to become crucial for companies to survive in the evolutionary era of manufacturing industry. Thus it has become a concept that has been widely researched and developed. Joynson (2000) elaborated the CI learning process with figure 2.5. The 4As represent stages of the learning process starting with 'avoid', then goes to 'aware', 'adapt' and 'achieved'. The stages are self-explanatory. The main point here is that when one gets to the 'achieved' stage, it is simply execution of action, which relates to the preparation of standard operating procedures.

Avoid	~~Act~~/~~Think~~
Aware	~~Act~~/ Think
Adapt	Act / Think
Achieved	Act / ~~Think~~

Figure 2.5: The 4As – Continuous Improvements Learning Process

Ansuini (1990) described KAIZEN as an improvement engine of an organisation that is essential to survive through competition. "It's imperative that this improvement engine, in whatever form it takes, be as simple as possible". CI is an example of "dynamic capability" (Teece and Pisano, 1994). Dynamic capability is not simply possession of assets but a collection of attributes built up over time in highly "firm-specific" fashion which provides the basis of achieving competitive advantage in an uncertain and rapidly changing environment.

Basic implementation steps of CI (Barsky, 1995):

1. Create executive council and staff, develop vision statements, goals and strategies
2. Conduct executive training with principles, implications, requirements and the understanding of the change effort
3. Conduct audit
4. Prepare gap analysis
5. Develop strategic quality plan
6. Employee communication and training programmes
7. Restructure the organisation
8. Establish teams
9. Create measurement system and set goals
10. Revise compensation, appraisal and recognition system
11. Launch external initiatives and share experiences with external groups
12. Review and revise

2.9 The Balanced Scorecard (BSC)

For many years, arguments have surfaced that the traditional financial accounting model is no longer sufficient to measure the success of information age companies. Intangible assets such as customer satisfaction, employee skills, process capabilities and so on have become increasingly critical for today's and tomorrow's competitive environment. The BSC (Kaplan and Norton, 1996) is a measurement system that complements financial measures with non-financial measures that drive competitive performances. The scorecard views organisational performance from four perspectives, and suggests the respective measures:

- Financial (return on investment and economic value-added)
- Customer (satisfaction, retention, market and account share)
- Internal business process (quality, response time, cost and new product introductions)
- Learning and growth (employee satisfaction and information system availability)

The scorecard is balanced between external measures (shareholders and customers) and internal measures (critical business process, learning and growth); past measures and predicted future measures that drive performance; quantifiable measures and intangible performance drivers.

The BSC is a framework for integrating measures derived from strategy, enabling transformation of vision and strategy into tangible objectives and measures. The real power of the BSC is revealed when used as a strategic management system, by using the measurement focus of the scorecard to accomplish critical management processes such as:

- Clarify and translate vision and strategy
- Communicate and link strategic objectives and measures
- Plan, set targets, and align strategic initiatives
- Enhance strategic feedback and learning

which all agreed with the basic organisational change (OC) process suggested by Fayol (1900).

Kaplan and Norton (1996) emphasised the importance of linking non-financial measures to financial ones, and not to get carried away with new change programmes such as quality, innovation, customer satisfaction and employee involvement. Such programmes may not achieve tangible payoffs as they should if managers fail to link them to the bottom line financial results. Evidence can be seen from a few Baldridge award winners who experienced financial problems.

2.10 Six Sigma (6 σ)

Variability increases the likelihood of defects, both manufacturing and administrative. The defects can cause rework and scrap, increased costs and delays, and ultimately lack of capability to meet customer expectations. 6σ is a business process that enables companies to increase profits dramatically by streamlining operations, improving quality, and eliminating defects or mistakes in everything a company does, from filling out purchase orders to manufacturing airplane engines. While traditional quality programmes have focused on detecting and correcting defects, 6σ encompasses something broader – it provides specific methods to re-create the process itself so that defects are never produced in the first place (Harry and Shroeder, 1999).

6σ is known as the most powerful breakthrough management device of the new age, given the name "darling of Wall Street". Companies that have adopted 6σ and have claimed success include Allied Signal and General Electric. Many others now make 6σ the cornerstone of their strategic plan.

Most companies operate at a 3σ-4σ level, where the cost of defects is roughly 20% to 30% of revenues. By approaching 6σ -- less than one defect per 3.4 million opportunities, the cost of quality drops to less than 1% of sales because the highest quality also results in the lowest costs. When GE reduced its costs from 20% to less than 10%, it saved a billion dollars in just two years – money that goes directly to the bottom line. 6σ is the ultimate performance after reduction in variability. It aims at defect-free processes that deliver error-free services and products to customers and shareholders (Tennant, 2001).

6σ has the same element as TPM and TQM, that is the empowerment of workforce and workers taking charge and pride in their jobs. Those closest to the work discover more effective and profitable ways of working. Another similarity in the principles is the importance of MoPs. The foundation of 6σ uses metrics to calculate the success of everything an organisation does. Without measuring a company's processes and its changes to these processes, it is impossible to know where you are or where you are going. 6σ tells us:

> *We don't know what we don't know.*
> *We can't do what we don't know.*
> *We won't know until we measure.*
> *We don't measure what we don't value.*
> *We don't value what we don't measure.*

2.11 Soft Structure – Culture, People, Leadership, Management and Communication

Over the years, manufacturing industry has been increasingly alarmed by the importance of infrastructural elements. After an extensive research in the industry, Hayes et. al. (1988) concluded, "we have never seen one (company) that was able to build a sustainable advantage around superior hardware alone… and it is impossible for a company to 'spend' its way out of a competitive difficulty."

The world's famous diasnostic tool – the McKinsey 7S framework, introduced by Peters and Waterman (1982) to analyse an organisation, consists of both hard and soft structures. Style (management), strategy, skills (corporate strengths) and shared values were the soft issues among the elements laid out in the framework; structure, staff and systems being the hard structure.

Culture

A comprehensive review of organisational culture can be traced back to Handy (1976), who set the concept of culture in such detail that most succeeding literatures can relate to it. Corporate culture was generally defined as "a strong system of informal rules that spells out how people are to behave most of the time" (Deal and Kennedy, 1982). It predetermines its employees' behaviour, but over time this behaviour reinforces the culture so that it continues to reproduce the behaviour that led to success in the past (James, 1997). Simply, most would describe culture as "the way we do things around here" or "the way we think about things around here" (Williams et. al., 1994). Maull et. al. (2001) presented an agreeable statement to the author's point of view of treating culture as a distinguishable element in OC due to its 'soft' nature:

> *Organisational culture provides a people-centred, theoretical perspective on the management of change that is seen to offer some insight into the "intangible" nature of organisations and their behaviours: a contrasting approach to the traditional management view of organisation (formal structures, rules and procedures and rational arguments)*

Culture has a significant impact on OC. It affects the day-to-day operations of the workforce as individuals and as a whole. It is the basis of how an organisation organizes itself, treats its staff and handles its relationship with customers and suppliers. As it is also believed to have worked well enough to be considered valid, culture is taught to new members as the way to behave, thus perpetuating organisational survival and growth (Schein, 1984).

The Hermes project was a world-wide research that was carried out to investigate differences in national cultures, and how these differences affect social sciences, management styles. The project showed that the same results can be achieved in different countries by using methods appropriate to the local ethnic culture (Hofstede, 1980). The research yields significant outcome until today.

Handy (1995) responded to this theory of national differences with the four Greek Gods of management he used to symbolise culture (Handy, 1978). "An organisation is not culture in itself, but rather a mix of God". It was emphasized that the theory of cultural blend or propriety must take account of the 'settings' (nations, jobs), as one will thrive only when the right culture is found for the situation. And when the world changes, one has to adapt a different culture, which is what is known as a culture shift or culture revolution.

People

Todd (1995) stated that people are the key to achieving and then maintaining a WC goal. The launch of WC initiatives should bring noticeable improvements within a few months. However if the company fails to get the people involved, it will fail to maintain the lead in the increasingly competitive world market. Todd's agenda in getting people involved consists of the following elements:

- Cross-functional team work
- Overcome resistance to change
- Step change and CI
- Quality circles
- Empowering people
- Restructuring to reduce number of management levels
- Recognition and rewards

Kinni agreed to empowering people, when he claimed that it has been a "long-overdue recognition that empowered employees can be a powerful antidote to bloated corporate bureaucracy" (Kinni, 1996). Trust can also be gained by empowerment. Gaining trust is the recipe for reaping people's maximum ability (Peters and Waterman, 1982). That is why IBM claims 'respect for the people' as their main organisation philosophy.

Willing to train the workforce is the pre-requisite to setting expectations on their performance. The training of people should not be switched on and off because profit appears to be lessening and costs need to be cut. Being granted practical autonomy, people are more likely to take pride in their jobs, increasing innovation and productivity (Gilgeous, 1997; Walley, 1992).

History has seen that many successful change programmes resulted from "gaining extraordinary outcomes through ordinary people" (Peters and Waterman, 1982). People have the hidden spirit of "champion" in them. If anything can stir up that evolutionary change in culture and innovation, it is the ability of leadership to bring the "champion" out of people.

Another "people power" concept by Kanter (1983) is one about "corporate entrepreneur" – described as someone who:

- can find opportunities for innovation in nearly any setting
- can help their organisation to experiment on uncharted territories and to move beyond what is known into the realm of innovation.
- operates at the edge of their competence, allocates resources and attention more to what they do not yet know than to what they already know.
- measure themselves not by the standards of the past but by visions of the future
- do not allow the past to serve as a restraint on the future

Kanter (1983) addressed the people or organisation that discourage changes as "segmentalists". Segmentalism is what keeps an organisation steady, changing as little as possible; but segmentalism also makes it harder for the organisation to move beyond its existing capacity in order to innovate and improve. On the other hand, there are people or organisations that are change-oriented, encourage free flow of ideas, empowerment of people to act upon innovation, and always operate at the edge of their competence. This, which has become the central of Kanter's ideal to turn around the US industry, is called the "entrepeneurship", or the "change masters". As mentioned before, entrepreneurial spirit is stifled in a segmentalist environment, the nourishment of corporate entrepreneurs must begin with corporate leaders building a more "integrative" organisation.

A more scientific approach towards understanding people is a pilot modelling methodology for human performance recently developed at Cranfield University, UK (Baines and Kay, 2002; Baines et. al., 2000). The research, which had gained industrial input from the Ford Motor company, intended to model the relationship between direct workers, the environment they work in, and their outcome performance, using Artificial Neural Networks (ANN).

Perhaps unfortunately, the number of people in manufacturing organisations will inevitably have to decline. Former finance and site director of Ferodo – Walley (1992) revealed that throughout the 80s, Ferodo doubled its sales using 35% fewer people.

Leadership and Management

Leadership plays the following role in an OC (Kanter, 1983):

- Prime mover
- Strategic decision maker
- Making participation work
- Providing rewards and feedback

Kotter (1995) presented his argument that in a sense, the difference between leadership and management has nothing to do with hierarchy, but the way people act. Management is needed to run things, to hold current systems together, and to manufacture products. Large-scale organisations demand considerable management. In a "slower moving world, where organisations had strong market positions or were buffered by monopolies or national protectionism… this is easy and people manage themselves quite well". They can get away with not much leadership. However, as the world speeds up in its pace of change, more leadership from more people is needed to keep up with it, "companies that have struggled with that, that are still basically over-managed and under-led, are going under".

Later Kotter (2001) suggested that successful change programmes need 70% leadership and 30% management. The average company's change management that goes about it the other way (30% leadership and 70% management) does not work particularly well.

Communication

Traditionally, communication in an organisation has been hierarchical. Lower level employees execute what is passed down from top management, and they often do not have the opportunity to take part in any decision-making. Information had always been flowing in the vertical direction. This organisational structure does not involve any inter-dependency between leaders and the others in the organisation. It is "formal" and it "does not connect people enough" (Kotter, 2001). It has been advocated that in order to make the whole thing work, "you need other kinds of relationships running horizontally and between people in different departments and divisions or offices".

The communication system resulted from the structure of an organisation has changed through time, and this had been appropriately described by Obolensky (1994) in figure 2.6. The traditional hierarchies of an organisation mentioned earlier can be illustrated as 'chimneys'. This had later been altered to having process teams that involves personnel from each department ('grids'). The ultimate transformation is to a network of teams inter-linking each other, forming a triangle of people, strategy and technology (triangulated networked 'bubbles').

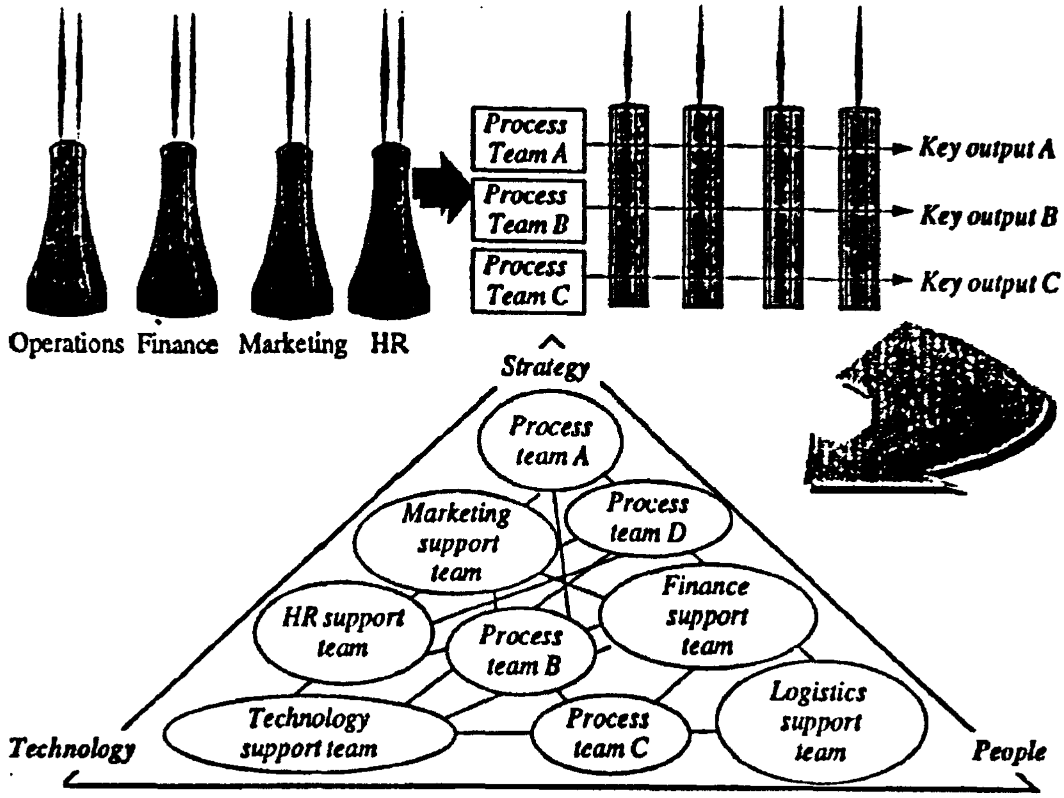


Figure 2.6: 'Chimney' to 'Grids' and then to 'Bubbles' diagram (Obolensky, 1994)

2.12 Summary

Manufacturing industry went through a '2nd industrial revolution' in the mid 1970s, when the 'industrial age' transformed into the 'information age'. Mass production dominated the industrial age, and then gave way to mass customisation, which took place thereafter. Massive transformations between the two eras include:

- Global competition; advanced technology; customer satisfaction
- Product life cycles shortened; products made to order not made to stock; production pulled from customers rather than pushed from raw materials
- Flat organisational structure instead of hierarchical; Inter-functional project teams
- Lean thinking, quality management and autonomous team working culture; multi-skilled and empowered workforce

- Corporate strategies linked to manufacturing strategies

The definition of WCM consists of many elements. Academics and practitioners have defined the term from various approaches:

- World class with the connotation of being "best in the world"
- Continuous improvement as the essence
- Achieving all primary objectives: costs, quality, productivity, flexibility, workplace improvement, health and safety
- WCM as a set of tools
- Culture, leadership, people and other soft issues
- WCM defined via MoPs

The concept of WCM had been embedded in the literature since the 1970s, but was re-lived by Hayes in 1984 and the term was popularised by Schonberger in 1986. The term WCM has been mentioned as a general buzzword in some literature. The pre-amble of this research is to recognise WCM as a management approach. Unlike TQM, TPM, JIT or similar established management approaches, WCM does not yet have a constraining set of principles and steps to follow. It does not even yet have a universal definition, which led to the objective of defining WCM as outlined in chapter 1.

There are existing theories, principles and frameworks suggesting how WCM should be achieved. Concluding from the literature research, WCM is a management approach that contains the following elements:

- Rapid CI to fulfil manufacturing objectives such as quality, costs, productivity, flexibility, customer satisfaction, environmental issues, health and safety
- An implementation process that begins with setting strategic visions and translate them into shop floor actions with a rigid progress monitoring system using appropriate tools, and MoPs

- Employ characteristics of the information age, simplify operations through process improvement techniques and effective organisational structure; fully utilise resources and human skills
- Total involvement from top management to shop floor employees, integrating the change to the specific work culture of the environment

To take on WCM initiatives an organisation needs to undertake some kind of change programme. The first step towards OC is to identify the potential factors causing change efforts to fail. Human's natural tendency to resist change is the first barrier, followed by management's attitude and how the change initiative is brought on. There are several suggestions to bring about change:

- Strong leadership right from the start
- Create and communicate vision
- Getting people involved
- Assess the organisation's culture and the appropriate scale of change

The early OC framework ("administrative apparatus") proposed by Fayol (1900), and Todd's (1995) argument of translating business strategies into shop floor operations were the main basis that will be used to introduce the model later in the thesis. OC is closely linked with soft structure. Soft structure is often what creates the vital impact in terms of OC towards WCM, and this impact is created via leadership more than management. The management approaches laid out by Peters and Waterman (1982), and Kanter (1983), regarding leadership, people and culture issues, formed the soft structure of the model.

Obolensky's (1994) study is useful for identifying the scale of a change programme. BR represents an OC of a large scale, hence tools of BR can be consulted when a company requires big culture shifts for a WCM implementation. Meanwhile, during the implementation of an OC towards WCM, Mayet's (2001) observations in how OC affects bottom line results can be employed as a checklist.

JIT, TPM, TQM, 6σ and LM overlap with one another to a certain extent. The literature review concluded that they share a few common elements:

- Elimination of waste and non value-adding activities
- Empowerment of employee, multi skills and team working
- Quality improvement as a core issue
- Each containing its own set of tools
- Require total commitment and management support

These elements essentially become principles of a WCM undertaking.

The employment of any of these initiatives has to follow the implementation steps of CI to be effective. CI (or KAIZEN) is the essence of WCM. Taking rapid and small steps, getting people involved, picking a pilot project that yields results quickly is how CI works in attacking bottlenecks in a company's operation.

The balanced scorecard (BSC) provides a measurement system that drives competitive performance. It combines financial and non-financial measures, and creates a balance between internal and external measures. BSC can be a basis for setting up MoPs for a WCM framework.

All the above (JIT, TPM, TQM, CI, BSC, 6σ) management approaches are embraced in the entirety of WCM philosophy. This research regards WCM as the way forward for OC, the key to achieving successful change implementation in a manufacturing environment. These various management approaches are used as parts of the WCM undertaking depending on the needs of the specific manufacturing environment. How they are integrated into the whole WCM model will be further illustrated in section 6.6.1.

Soft structures such as culture, leadership, people, innovation and communication have been identified as issues that cannot be neglected in terms of OC. Competitive advantage does not come solely with investment in hard structure / technology. Important lessons learnt are summarised as the following:

- The implementation of WCM requires an appropriate adaptation of culture shift
- A successful change programme relies on getting people involved via empowerment, trust, rewards, re-structuring, and investment in training
- Substantial leadership is needed to keep up with the fast pace of change
- Promote horizontal / cross functional communication

Chapter 2 has outlined the detailed investigations carried out in WCM, OC and all the related topics, hence has set a rigid platform to create a model of OC towards WCM, which is the aim of the research.

CHAPTER 3

Research Methodologies, Apparatus and the Development Process of the Change Model

Outline of chapter

Chapter 3 presents the research methodologies and apparatus used throughout the research period including the utilisation of software. First, it introduces the detailed design of the research process. The core of the chapter lies on the development process of the change model, which is explained in four phases. The chapter then outlines the set-up of industrial collaborations and the techniques used including interviews, observations, projects and case studies. The following sections describe the academic research collaborations and supervision of undergraduate final year projects and Master's projects, which also contributed largely to the current research. Finally, weaknesses of the research methodology are highlighted.

3.1 Introduction

Every WCM implementation needs strategic planning. The change model developed in this research (which will be described in detail later in chapter 4 as the 'birds of change' (BoC)) is a blend of inputs from existing theories and principles, and industrial trials and errors. Like all the other management models, the development of this model has been through many phases. It is useful to find out the developing path of the model and to trace where the inputs have come from. The vehicle used to develop the model (in this case a modelling software) also needs to be carefully selected.

The main product of the research is a management model that needs to be applied in an industrial environment. Hence first of all, it is essential to seek sufficient and appropriate industrial collaborations. What are the criteria to select the right companies / collaborators? How do the collaborations get set up? What happens during a collaboration programme? And what techniques are required to carry out such tasks efficiently? The following sections will answer these questions.

In addition to industrial input, this research also benefited from academic research collaboration. The research sought other research done by academia so data can be shared and comparisons can be made. It is important to describe the use of these other academic input without violating genuity of the objective of this research.

Separate projects were carried out to investigate branches of this research. These were usually in the form of final year projects undertaken by undergraduate and Master's students. Certain common practices need to be followed to make sure these projects get carried out in industry with good supervision and provide valid and useful data to support the current research.

There are always other ways of approaching a research project. Hence, methodologies employed in a research must be justified, and weaknesses have to be identified.

3.2 Research Design and Development

As this research commenced as a follow-up to Barry's Ph.D. (1998), the research methodologies had been pre-defined from the beginning. The preliminary objective of the research was to identify areas in Barry's model that need modification. Research methodologies similar to those used by Barry were followed. This is to produce parallel work so comparisons can be made and flaws from Barry's model can be rectified. The comparison and the proposal for the modification will be elaborated further in chapter 4 and chapter 6.

After assessing resources and restrictions, a research plan was sketched as follows (figure 3.1):

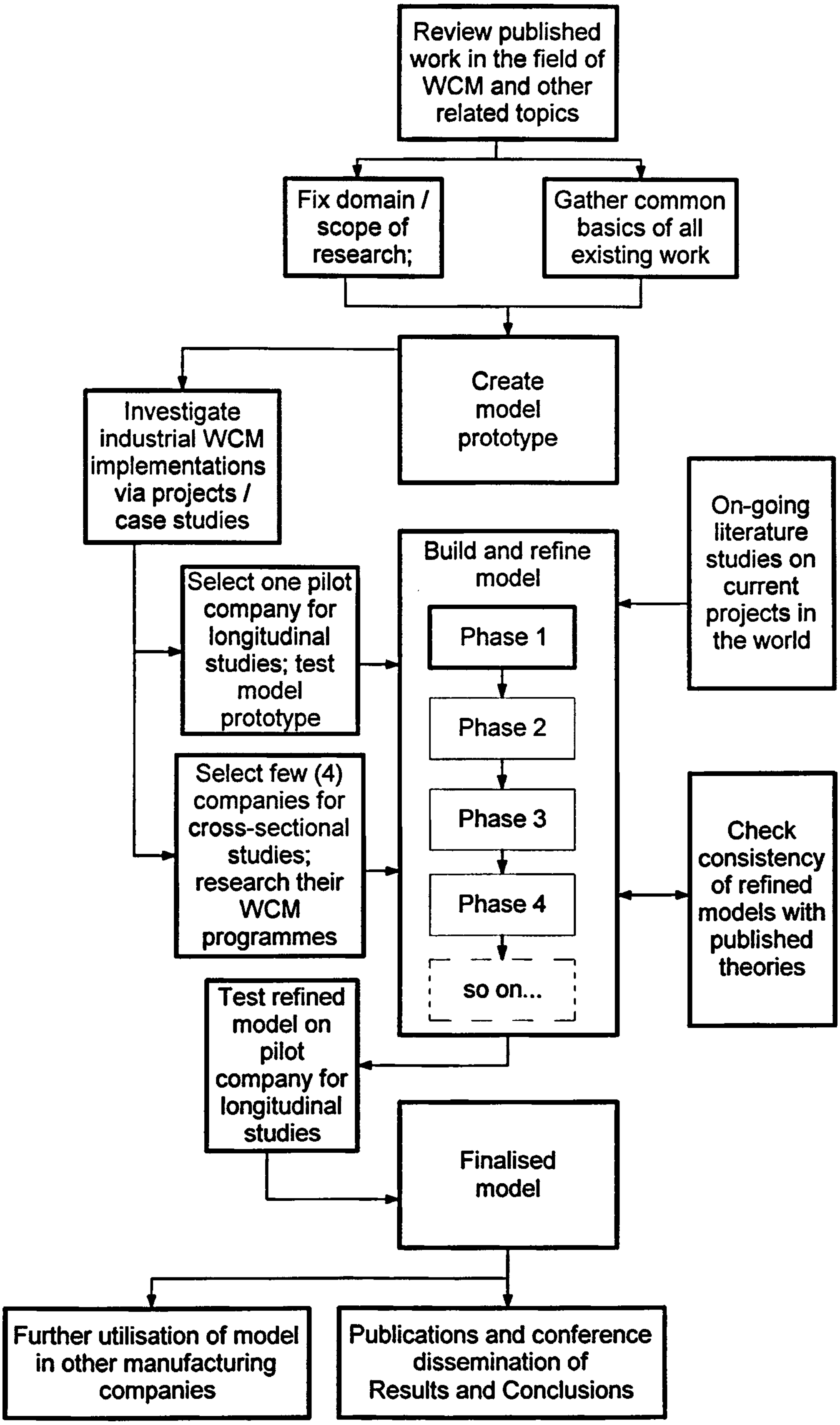


Figure 3.1: Detailed design of the current research process

Phase One

As mentioned earlier, the preliminary objective of the research was to investigate Barry's model and identify areas that could be improved (this will be further discussed in Chapter 6). Having reviewed all the literature on WCM and gathered common theories, a prototype of the improved model was built with the following initiatives (figure 3.2):

- The model would follow a sequential nature
- The model contains some kind of feedback loop to provide the sense of CI
- The model would harness WCM elements in terms of an OC
- The model aims to translate business strategies into shop floor implementations

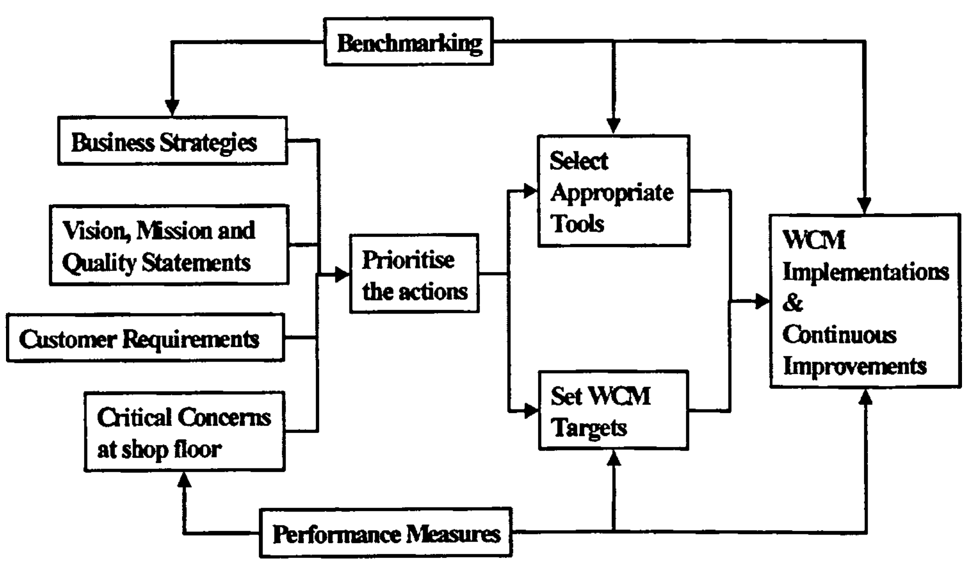


Figure 3.2: Prototype of the change model

Phase Two

One of the inputs to build and refine the model comes from continuous investigation into literature on current WCM projects, which have contributed to the later stages of the model development (figure 3.3). The literature had led the author to conclude that:

- The model elements can be segregated into 3 categories, which later developed into: input environment, project environment and process environment
- Activities in each 'environment' can be broken down into more detailed activities

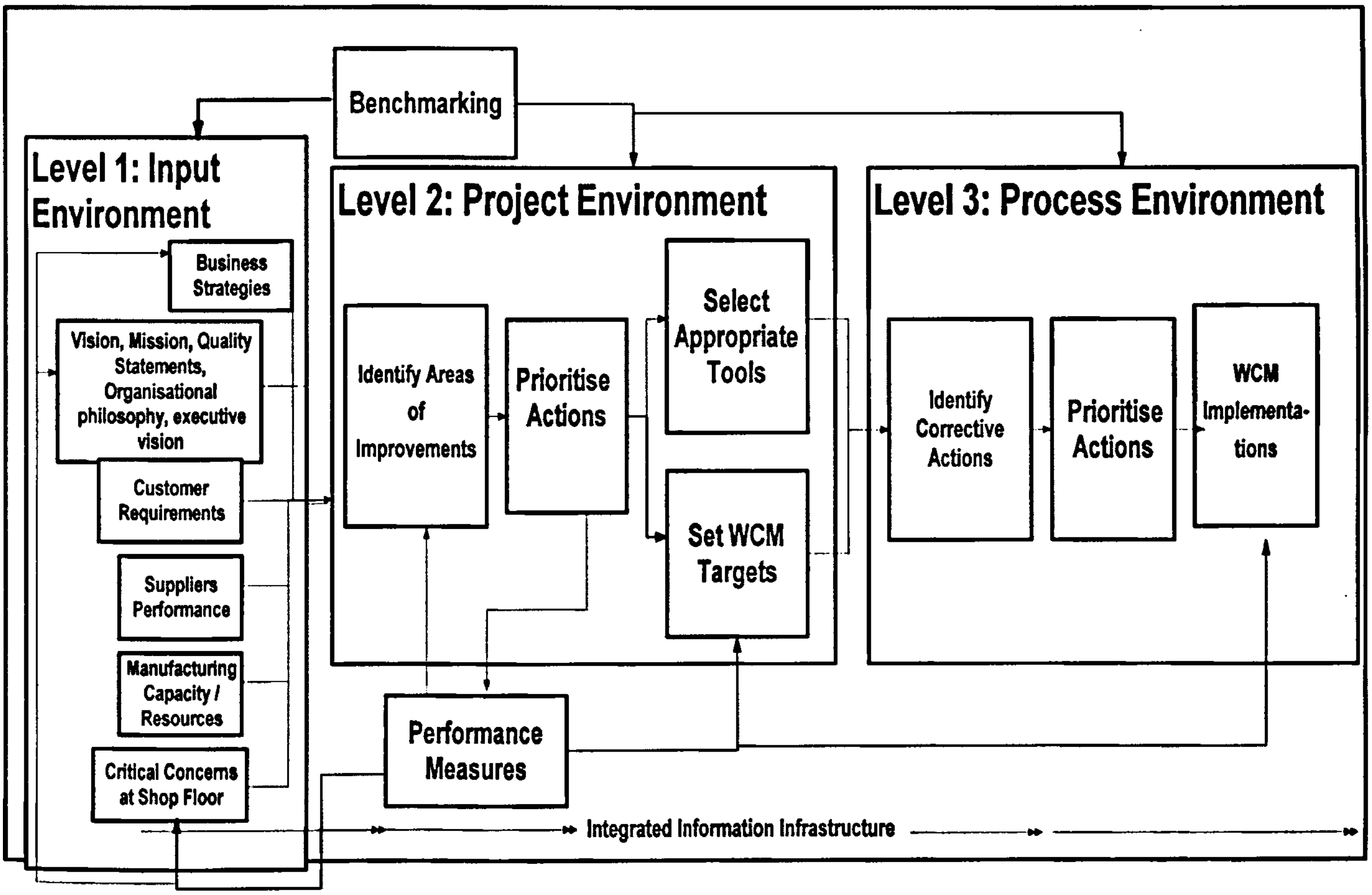


Figure 3.3: Model refined at phase two – grouping activities in three levels 'input environment', 'project environment', and 'process environment'

This prototype appears as 2-dimensional. However, this will not be sufficient to show the complexity of the model. Investigations were carried out to find out about modelling for 3-dimensional figures. The methodology of an IDEF0 model (Marca and McGowan, 1993) serves this purpose. Figure 3.4 illustrates a typical IDEF0 model. The top-level platform is 2-dimensional, so are the 2nd and 3rd platforms. The 2nd level is a trajectory of one activity from the top level A2, and the 3rd level is one of 2nd level A23. This IDEF0 concept provides allowance for complexity, creating a 3-dimensional vision; yet keeps each level simple and easily manageable.

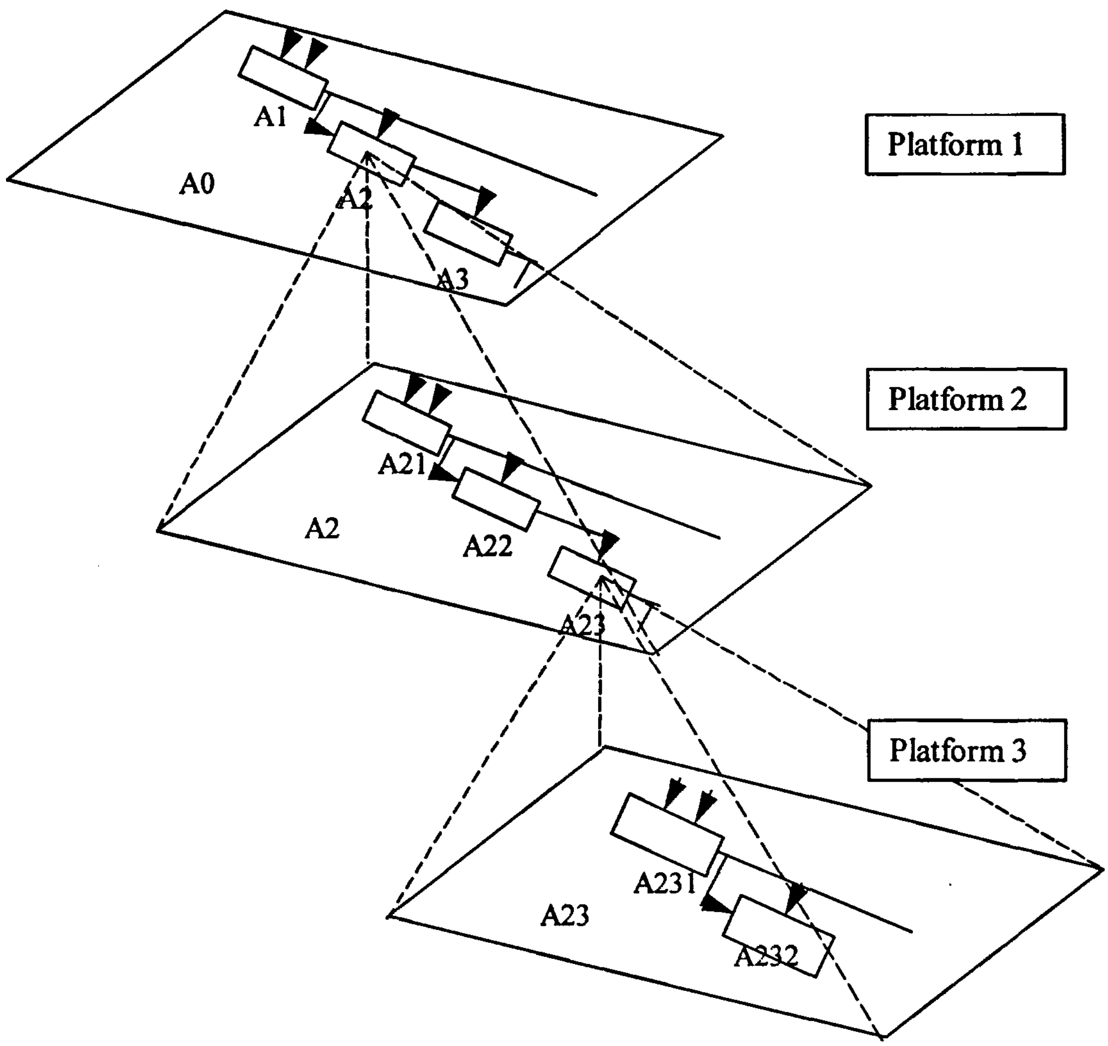


Figure 3.4 The IDEF0 function level modelling methodology

Phase Three

The model built in this research utilises the IDEF0 modelling concept mentioned above. In this instance, the model prototype (presented in figure 3.2 and a more developed version in figure 3.3) represents one level (platform) of the IDEF0 model. Each activity can then be broken down to another platform / level if the complexity of the model requires it to be sub-divided. Figure 3.5 illustrates this concept of sub-model.

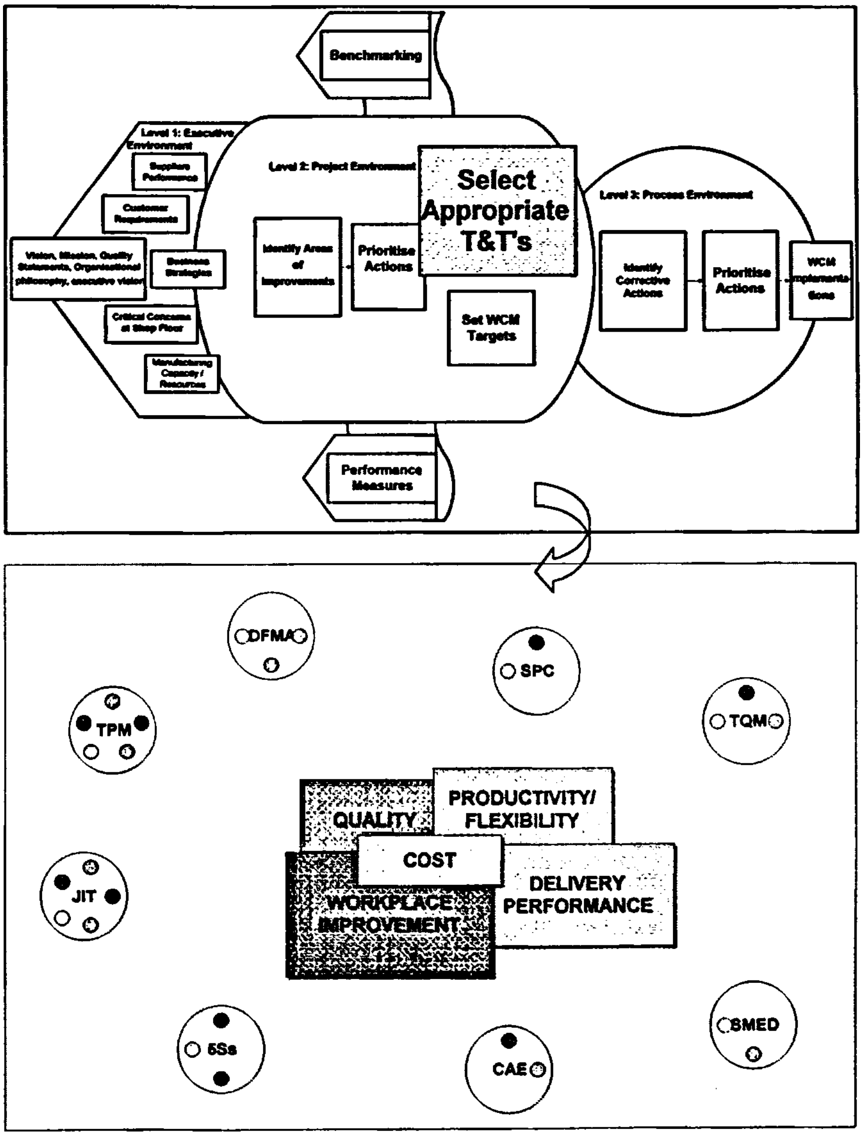
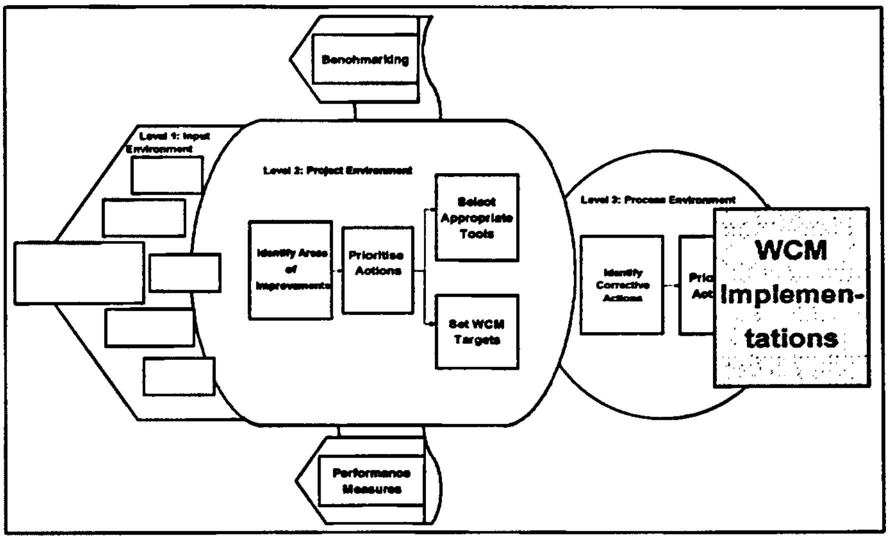


Figure 3.5: Sub Model – Selection of Tools

Figure 3.5 shows how one of the core activities of the model – 'select appropriate tools', can be developed into a sub-level model that demonstrates the activity in more detail. Figure 3.6 illustrates the sub-level model of 'WCM implementation' by presenting a standard progress report. The highlighted 'box' in both figures represent the specific activities that are related to the corresponding sub-model.



Heritage WCM Progress Report

Week 1: 23, August, 0(

No	Corrective Actions	Responsibility	Target completion date	Progress (%) 10	20	30	40	50	60	70	80	90	100	Actual completion date	Comments
1.	Prepare red-tags [SORT]	Ben	Wed 30/8												Make 200 red tags and train operators on its usage
2.	Photography (polishing shop)	Ben, Tey	Wed 30/8												Take pictures at each stage using digital camera
3.	Clear shelve no 1 [SORT, SEGREGATE]	Harry												23/8	Well done!
4.	Set-up machine - automatic [SORT]	McD	20/10 (2 months)												
5.	1 sort, 1 segregate, 1 shine	Ben	Wed 30/8												Gather sheets answered by operators, summarise
6.	Delivery performance data [PM]	Mireille, Tey	On-going												Retrieve previous and current delivery details, produce delivery lead-time for the past 2 months
7.	Process cycle time analysis [PM]	McD, Tey, Mireille	Wed 30/8												Discuss methods of performance measure

Next meeting:- 30/08/00 @ 1100	Previous meetings	Date Time	
WCM Innovator:- Martin Tey	WCM Team:- Martin Tey, Martin McDonaugh, Mireille, Ben, Harry		

Figure 3.6: Sub Model – WCM Implementation Report

Phase Four

The model now consists of three dimensions, after introducing a sub level of models in phase two. A new phase of development was established when the research began to consider the soft structures of change. The soft structure issues such as culture, people and leadership govern the entire change process from a level above. A change programme is not complete without these soft elements. They are the governing elements that can transform the company at present to a higher ground – towards the 'ideal' WCM company. This has created a new 'platform' level on top of the process platform from the prototype created in phase one.

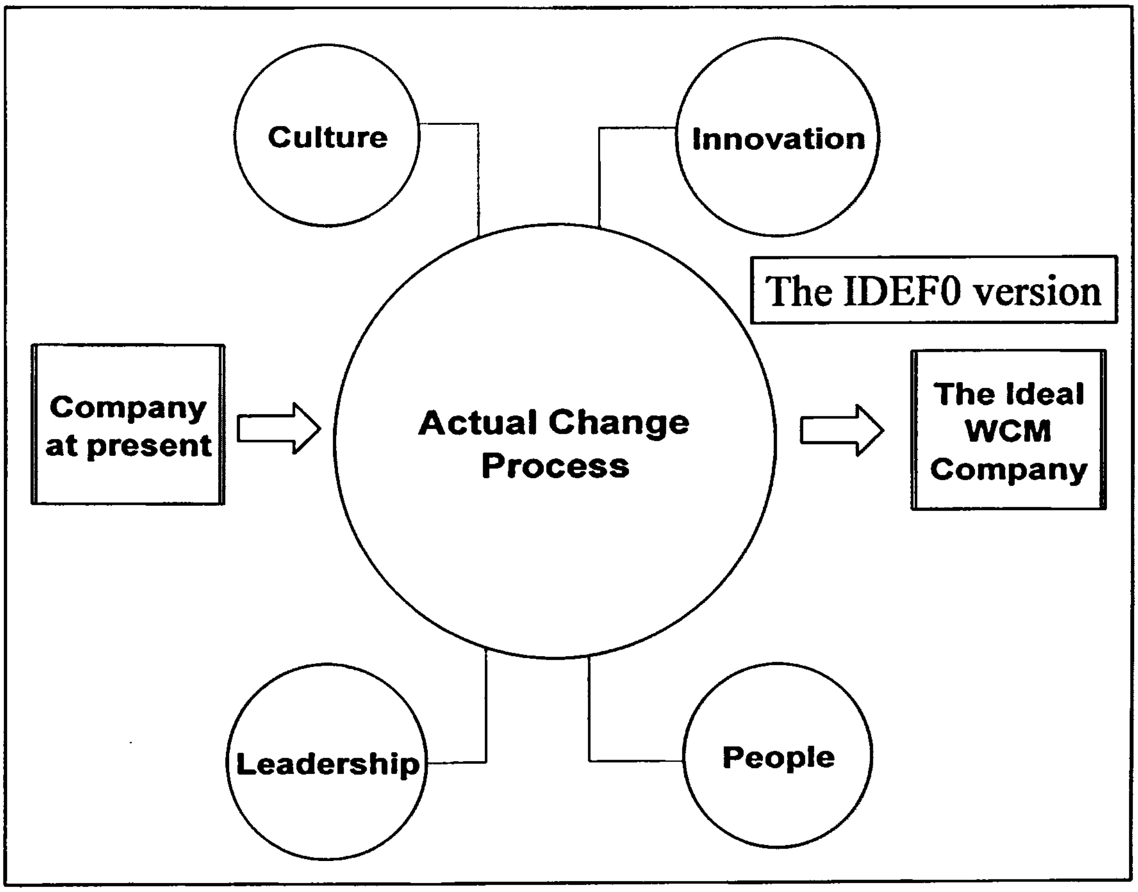


Figure 3.7: 'Birds of Change' beyond KAIZEN Bird

3.3 Software Utilisation

The main objective of the research is to model a management process. Structured Analysis and Design Technique (SADT) is a graphic notation and an approach to system description used extensively for business processes and enterprise modelling. Due to its generality and power, the application of SADT is far-reaching – defence, communication, manufacturing, project design and control (Marca and McGowan, 1993).

What has been used in this research is a subset of SADT, named IDEF0 (Integrated Definition of Function Modelling), which was created by the Integrated Computer-Aided Manufacturing Programme of the U.S. Department of Defense (Wu, 1994). This research utilises the theory and methodology of IDEF0, to simulate a comprehensive 3-dimensional management model to convey the concept of what will be introduced as an OC process towards WCM. The illustration of an IDEF0 function level, which allows top-down structured decomposition, is given in figure 3.5, whereas figure 3.8 shows the basic building block of each IDEF0 level.

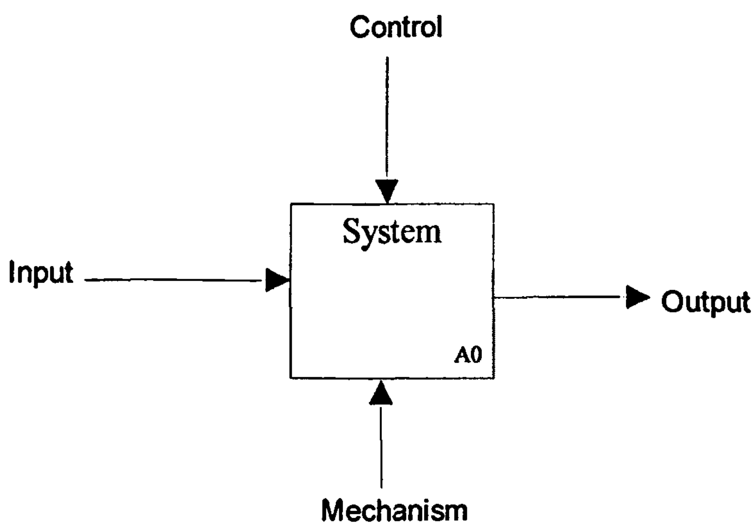


Figure 3.8: Basic building block of an IDEF0 model: the function

The actual modelling tool mostly used in this research, however, is a flow chart software -- Professional Diagram Quickly (PDQ), which allows speedy process modelling.

3.4 Research Collaboration - Industrial

Development in the manufacturing management field relies heavily on practical matters. The manufacturing environment contains many variables and is getting ever more complex. Hence research carried out in modern times on manufacturing strategies, production, operation management and related areas has nearly all been empirical. An example of a general empirical research method is taken from the work of Flynn et. al. (1990) and translated into a useful approach in this research:

- Establish the theoretical foundations
- Select research design
- Select data collection method
- Implementation
- Data analysis

This approach is a basic outline of the research method. The detailed design of the empirical approach to this research was presented in figure 3.1

First the selection of companies followed a careful consideration of the research design. It was decided that the sample companies taken had to be both cross-sectional and longitudinal:

- Cross-sectional – sample over a number of subjects, situations and in this case, organisations

- Longitudinal – focus on small number of subjects, situations or in this case, organisations, but carry out the investigations over a longer period of time.

During industry collaborations it is important that the researcher obtains vital data within the restricted resources available. This means getting to the right person at the right time, asking the right questions, observing the right thing and acquiring the right documents. The day-to-day business running can not usually afford an abundance of time for academic research. The way academic research benefits industry is often by combining practical matters with theory, and theory takes time to develop. Production on the shop floor is not something that 'goes by the book'. Hence it is useful for the researcher to acquire skills of getting the wanted results as quickly and as easily as possible.

3.4.1 Techniques used on the Industrial Collaborations

Specific techniques need to be utilised when conducting industrial collaborations, to ensure the research is correctly undertaken, and data is collected efficiently and effectively. There are standard techniques to employ under certain circumstances. The ones chosen for this research are described below:

Background studies

The background of each company was carefully studied before the case study began. Reading company brochures or former reports, checking out websites and emailing correspondence are the means to achieve this aim. As mentioned before, the companies were chosen to fit a wide spectrum of characteristics. It was with this intention that the case study companies were sought. Background of the companies includes the product, size, turnover, customers etc. The background information of utmost interest is the company's engagement in WCM implementation and their progress at the time of the research.

Company Visits

In all the research collaborations, a main contact in the company was assigned to the university researcher. This contact played the following role:

- Helped arranging the researcher's visits to the company
- Supervised the researcher during his / her visit
- Exchanged information with the researcher, and directed him / her to the appropriate personnel for specific information
- Set up meetings for the researcher with the related company's personnel, or presentations to be done by either party

It is important for a visit to be scheduled on a production day, so the researcher gets to see the happenings on the shop floor. The visit would normally last half a day, during which the researcher is mostly accompanied by a main contact from the company. For the rest of the time, the researcher would be interviewing other personnel or having a general 'walk-around' on the shop floor, either to collect data or make observations. At the end of the day, the researcher is looking to collect as much data, to interview as many personnel, and to make as many observations as possible.

Interviews

An interview is the best way to obtain information in this research. This is because data required in the research is more about methodologies, decision-making process, Tools rather than technical figures. Hence a fair amount of research input can be gained through a good session of 'chat' with a personnel in the company who has a vast amount of knowledge on the topic of change towards WCM. Subjects to interview include:

- Executives (directors, CEOs)
- Managers / assistant managers (GMs, manufacturing / production / change managers)
- Team leaders and members (vertical / horizontal teams; functional / project teams)
- Other personnel (eg. cell leaders, operators, CI champions etc.)

An interview with a machine operator is just as important as one with the CEO. As much as the visionary strategy the executive may have, it has to be translated into corrective actions and is dependent on the performance of a shop floor operator. All members of the workforce are able to provide useful information presuming the WCM change implementation has a total top-down commitment.

Almost all interviews were carried out in person. Telephone interviews were done with the manufacturing manager of Colgate-Palmolive, Malaysia, because a factory visit was not arranged. Generally, a dynamic approach is employed while interviews are carried out. The university researcher plans a trip to the company / plant, during which he / she goes from one person to another in an informal manner to conduct an interview. Length of the interview varies from minutes to hours, depending on the amount of information needed. The main aim is to perform interviews without greatly interfering with the work of the interviewee. It is common for an interview (or rather called short chat) to take place on the shop floor, where machines are running and noise is expected. It is an art to master for the interviewer to get information as accurate and in as short a time as possible, in an environment that can sometimes be unpleasant.

Observations

This is a vital part of research. Observations enable the researcher to understand utilization of Tools, to spot potential problems and bottlenecks, as well as to capture the cultural behaviour of the company. Visually observing the plant is the most efficient way to analyse change and improvements. One distinct advantage of the observation technique is that it records actual behaviour, not what people say they said / did nor what they believe they will say / do (Joppe, 2000).

On the other hand, the observation technique does not provide us with any insights into what the person may be thinking or what might motivate a given behaviour / comment. This type of information can only be obtained by asking people directly or indirectly.

During observation it is important to make a mental picture of the shop floor. Few things to be observed to contribute to this research are:

- Layout of the manufacturing production cells
- Automation or special tools installed
- Number of workers, and types of machines
- Machine and operator utilisation
- Material flow, WIP
- General tidiness of the work place, floor markings and safety precautions
- Implementations relating WCM and OC (e.g. KPI charts, KANBAN, progress reports etc.)
- Workforce attitude and communication

There are several ways of classifying observation methods (Joppe, 2000) depending on the concerns of the outcome. Characteristics of the observations carried out in this research are outlined below:

- 'Non-participant': touring the shop floor and observe implementation without being part of it (Pilkington, Rexel, CORUS); 'Participant' in the case of Heritage, as researcher engages in the actual change process
- 'Obtrusive': shop floor workers can detect the observation as researcher observes in the open
- 'Natural settings': behaviour or happenings are observed when and where it is occurring, production system is very much a real life situation, therefore it is not often recreated for observation purposes
- 'Structured': observations are carried out with specific objectives in mind, and usually a checklist is being used (e.g. in an activity sampling exercise main focus is on the machine uptime and operator availability). However, the outcome of the observation often involves unstructured observation as well (in this instance, it is also observed why operators are not at work, under what circumstances they leave their workstation and what they do instead).
- 'Direct': The observation done as it occurs and not recorded.

Projects and Case Studies

When a project is set up, the researcher then plays an important role in implementing the changes. He / she would normally be allocated a place (working desk or computer) in the company / plant. The research collaboration with Heritage Silverware involved a 5Ss project. The six months project aimed to bring the company to a kick-start of WCM awareness and implementation of WCM tools.

A project is a mutual agreement between the researcher and the manufacturing plant. The company seeks to benefit from the project and the researcher contributes to academic work. A team is set up to plan and implement changes, conduct meetings and monitor progress.

The difference between projects and case studies lies in the depth of research. Case studies allow the researcher to observe implementations, record data, and use the results to compare with already existing theories. Projects are different from case studies in the sense that the researcher gets involved in the actual implementations of the change programme. New ideas can be tested and the researcher is given more responsibilities. He / she is commissioned to advise the management and workforce concerning improvement actions. Resources will be allocated to these actions. When the change model is concerned, case studies will provide inputs to develop the model; whereas projects will allow the model to be actually tested in the workplace.

3.5 Research Collaboration - Academic

Another form of research collaboration is among the academics. In this particular research, a special research group was formed to give mutual support to one another. The Integrated Logistics Management (ILM) group in the University of Birmingham (UoB) consists of eight members at the time of the research, among which four were engaged in WCM studies. Dr. Glyn Williams, a lecturer at the UoB, launched a WCM project within the Caribbean manufacturing industry in 1998 and later started a consultancy company based in Barbados. Two research students under his supervision carried out investigations on

Barbadian practice in WCM. The ideas, theories, results and data were shared with the research currently taking place in Birmingham, UK.

The model of a WC organisation created by Barry (1998), another member of the research group in UoB, was tested in some Caribbean manufacturing companies. Subsequently, results obtained and new inputs generated were fed back to the ILM group. These had a significant impact on the current research aiming to create a WCM change model based on Barry's model.

Apart from being on a different continent, research in the Caribbean industry brings invaluable input due to the difference in economic climate, product nature, consumer requirements, governmental regulations, working culture and so on. WCM is relatively new to Caribbean manufacturing environment. This research has opened up new dimensions and has contributed largely to the research carried out in this field at the UoB.

3.6 Final Year Project Supervision

The research has been supported by results obtained from four other projects. These projects were carried out by undergraduate final year students or postgraduate students undertaking Master's degree.

(i) TPM at Hoogovens Aluminium (Sordy, 1999)

(ii) MoPs at Corus (Baker, 2000)

(iii) MoPs and Benchmarking at Rexel (Thorburn, 2001)

(iv) WCM model for small and micro businesses in the Caribbean (Nurse and Williams, 2001)

(v) Interim system for VISTA production control information (Rizky, 2001)

The role of the researcher in each of these projects includes:

- Giving advice to the FYP student on areas of research: This is based on, first the company needs and second, how the project fits into current research (on OC towards WCM)
- Supporting and supervising the project: This includes weekly meetings to discuss progress. If required, set up an initial contact for the student with the company
- Sharing information: For a start the researcher provides the student with current literature references, and work done in the area. Later in the project, the student in return would feed back new information, data or results
- Keeping the project in contact with current research: This is to make sure that the student follows the designated track because the project is aimed to support partial data needed for the current research
- Administer report writing and presentation: The student will need to write a report and present results to both the academic examiner and the industrial collaborator. The researcher is responsible for helping with these aspects

3.7 Weaknesses of the Research Methodology

This research involved four industrial collaborators. Those that took part in this study represent a spectrum of the industry with a vast diversity in terms of company size, their products, organisational structure and WCM engagements. However, to draw conclusions on only four case studies may be potentially risky. The research also managed to include the Caribbean industry, but this does not justify a world-wide application.

In order to achieve a generic application, the research required companies with diverse characteristics. This has been achieved and will be illustrated in Chapter 5. However, the four industrial collaborators were established based on availability. The diversity of the companies was obtained rather by chance than by selection. Hence, this could lead to potential flaws to the outcome of the research.

Finally, it was mentioned in Chapter 1 that the research set out by taking Barry's model and aimed to improve it by making modifications. This work is based on the assumption that Barry's research methodology was appropriate for this research. Again, this can be presented as a weakness in the research methodology.

3.8 Summary

A detailed design of current research is drawn incorporating its main activity – building of a change model, with literature review, industrial collaborations, and investigations of existing works.

The development of the BoC model went through four phases. A prototype of the change model was created, with the preliminary objective of modifying Barry's model, during phase one. The activities were then grouped in sequence into three implementation areas namely input, project and process environments. Here was when the need arose for the model to expand into a 3-dimensional one. The IDEF0 modelling ideology was then applied in phase three and a layer of sub-models was built. Another layer then came on top of the prototype in phase four to make the model structure complete.

In terms of modelling, the ideology of SADT and IDEF0 was utilised. However, PDQ flow charting has been used for the actual creation of the models in graphic form.

This research employs the principles of empirical research, as it involves industrial practicalities to a large extent. Among four industrial collaborations, one was carried out as a project and three as case studies. The techniques used within these industrial collaborations included company visits, background studies, interviews, observations, data collection and analysis.

On the other hand, valuable inputs were acquired through academic collaborations taking place both within the UK and in the Caribbean region. The research gained more support from project supervisions of undergraduate final year and postgraduate Master's students. Five separate projects were carried out to test theories and to attain data and results in the aspects of TPM, OEE, MoP, WCM, and production control.

The research bears several potential weaknesses. Four industrial collaborators provide limited evidence and this may affect the conclusions drawn. A bigger sample size would have better substantiated the results. In addition, the collaborators were established by availability and not by selection. Finally, following Barry's model and methodologies to commence the research may also harness potential flaws.

CHAPTER 4

'Birds of Change': A Model of Organisational Change towards World Class Manufacturing

Outline of chapter

Chapter 4 presents the primary research outcome, first the finalised definition of WCM. Then four existing models / frameworks related to WCM are introduced, before illustrating the main product of the research – a model of organisational change (OC) towards WCM. The model, named 'Birds of Change' (BoC), is explained in three sections: (i) Overview of the model – 'JIN Bird', which comprises the "soft" elements that sustain the main process of change, (ii) Main body of the change model – 'KAIZEN bird', which illustrates the entire change process in sequence, and (iii) The sub-models that relate tools, WCM objectives, and measures of performance (MoPs). To put the model into use, a scoring system was developed to evaluate change programmes in manufacturing plants. The chapter follows by giving details of this supplementary scoring system, named the "change indicator".

4.1 Introduction

Having presented a large sample of existing definitions of WCM in Chapter 2, a final definition of WCM by the author will be laid out. This definition will be the one used throughout the thesis.

Having studied various WCM related works, it is evident that WCM as a management approach needs to be taken to another level of detail. Following is a set of questions that led to the development of the change model:

- What constitutes the difference between WCM and other conventional tools used to assist manufacturing management?
- Is there a designated route, or a set of principles to be followed, to approach excellence in manufacturing operations? If yes what are they?
- What identifies a world class (WC) company? Or, what determines whether a company is moving forward in pursuing WC status?

There are many various interpretations of WCM, as outlined in Chapter 2. There is, therefore, an urgency to put all WCM principles and tools together. What better method is there than a comprehensive management model that:

- shows sequential steps of change towards a WCM organisation,
- embraces all the related concepts and essence of WCM,
- is academically proven and practically feasible,
- works as an effective visual tool,
- supports buy-in from executives to all levels of the organisation and,

- applies in all manufacturing environments

There are already plenty of WCM or related models or frameworks created by academics, practitioners and managers in organisations, or business consultants. To justify the need to build a new model, first there is the need to examine existing models and identify their shortcomings. Secondly, it is known that WCM can be approached from many different angles. Hence the goal is to build a model that is generic to different manufacturing plants, and a model that allows each individual manufacturer to customise on and create their own WCM paths.

As shown in Chapter 3, the model to be built will have different levels and dimensions. Hence the model needs to be presented in various sections; and at the same time all the sections should be linked with one another.

The model will need to be put to test at some point. There has to be a way to assess the use of the model and the impact it generates. In other words, rather than putting forward a management model and simply claiming that it works, solid and visible results are needed. The best way is to create an appraisal system which the industry can use to measure the model. One conventional practice is that of a scoring system.

4.2 Final Definition of WCM

In the quest for a genuine definition used throughout this research and one that forms the domain for the concept of WCM, the author has adapted the core concepts from various publications and focused on what are seen in industry as the important factors. Throughout the remainder of this thesis, WCM will be taken as:

Gaining competitive advantage through manufacturing strength. This is done by establishing strategic vision, creating an innovative environment and an effective organisational structure, integrating employees and management, utilising appropriate tools, and sustaining a culture of continuous improvement in the following areas: cost, quality, productivity, customer satisfaction and health and safety.

A company can be WC if it achieves WC status in manufacturing, marketing, supply chain management etc. However, the focus here is making a company WC through manufacturing. Manufacturing can be a competitive weapon. It can make a company WC. Pilkington Automotive pretty much said it all by naming it "manufacturing to win" (MTW). WCM is not about being the best. It is evaluating the company's strength at present, and constantly seeking the best way to change towards being better. The key is to continuously improve shop floor process methodologies to enable things to be done easier, faster, cheaper and safer (SCEF), in order to outperform the best competitors internationally in all the following manufacturing related factors: quality, cost, productivity and delivery performance. Many are in agreement with WCM being a dynamic and an on-going process.

4.3 Existing WCM Frameworks

The main product of this research is a management model which will help change manufacturing organisations to become WC. Similar attempts have been made in recent years, as it has been recognised that producing frameworks to present the whole idea of WCM is beneficial to manufacturing industry. A framework / model incorporates definitions, concepts, principles and tools.

All the existing frameworks approach the topic of WCM from various points of view. This section will examine four of them, all of which had significant influence in the development of the final change model – BoC. The four frameworks in the study, all developed in recent years, are listed in the following:

- Barry's model of a WC organisation (1998)
- Gilgeous's manufacturing excellence framework (1997)
- Barsky's WC customer satisfaction (1995)
- Obolensky's approach to business re-engineering (1994)

Other recent works in this area were studied, but only four were picked. Selection of these models is based on the following requirements:

- The model / framework has been fully developed and is not at a hypothetical stage
- The model / framework has been published as academic research, and it is not a commercial package
- The model / framework has been tested within industry
- The model / framework embodies a complete functional change in the business. In other words, the model can stand on its own as far as changing towards WCM is concerned

In this section, the models / frameworks will be presented and their primary objectives / principles will be discussed. This will then lead to the introduction of a model that has been developed in this research – the BoC model. The distinct significance of the BoC model can be shown only when comparisons are made with these existing models / frameworks. The comparisons will be made later in Chapter 6.

4.3.1 Barry

Barry's model aimed to create a picture of a 'WC' organisation on the basis of CI. It outlined the business functions that should be of primary concern to an organisation moving towards being WC. Figure 4.1[a] shows the global overview of the model which consists of 17 activity 'boxes' each representing a core business function (e.g. measures of performance). Arrows are linked between the activities to show potential paths through the framework. Each path begins at activity 1 – WCM and works its way through to the bottom. Along the way the company goes through activities relevant to WC implementations. Below each of the core activities there is another level in the framework (an example shown in figure 4.1[b]) containing all the related elements of the specific activity. The elements (e.g. OTIF, OEE) sum up as a checklist to be taken into account. After completion of one designation path, the framework is taken right back to the beginning and the process starts all over again. It is working through these paths continuously in a circular way that an organisation finds out more about its needs, strengths and weaknesses and works towards achieving WC in all aspects.

Barry's model of a WC organisation was developed through the study of five companies, and finally tested in a sixth, ie. Hoogovens Aluminium (at present CORUS). Despite current research to investigate the model, it is now being utilised as a vehicle for advancing towards WCM in the manufacturing sector in Caribbean countries, Barbados in particular (Williams, 2000). The model serves as a base to set benchmark standards. It has been used to audit 73 companies in the Caribbean region and identify highly achieving, or WC companies (Williams and Marshall, 2001).

The model provides an organisation with a useful checklist of the important elements that ensure WC status. It also helps an organisation to understand correlations of these different elements. However despite the many practical usage and apparent advantages, the study of Barry's model brought up a number of points to ponder:

- Firstly, the model needs 'tidying up'. Some elements overlap / repeat whereas some have not been defined.
- The 2nd level of the framework presents as a checklist in most cases. There is hardly any significant relationship between the elements. This raised the query of the reason for the existence of this level.
- The global overview is to be followed in a circulatory manner, where arrows give hints to the potential paths. However, there is no specific logic to the paths so again the level appears to resemble a checklist.
- The major contribution of the model is to present elements and activities of primary concern to a WC organisation. However, there is not much of a clue as to how a company chooses from the many elements / activities. It will not be affordable to take on every element and activity, and taking on wrong tools can also prove costly in terms of resources.

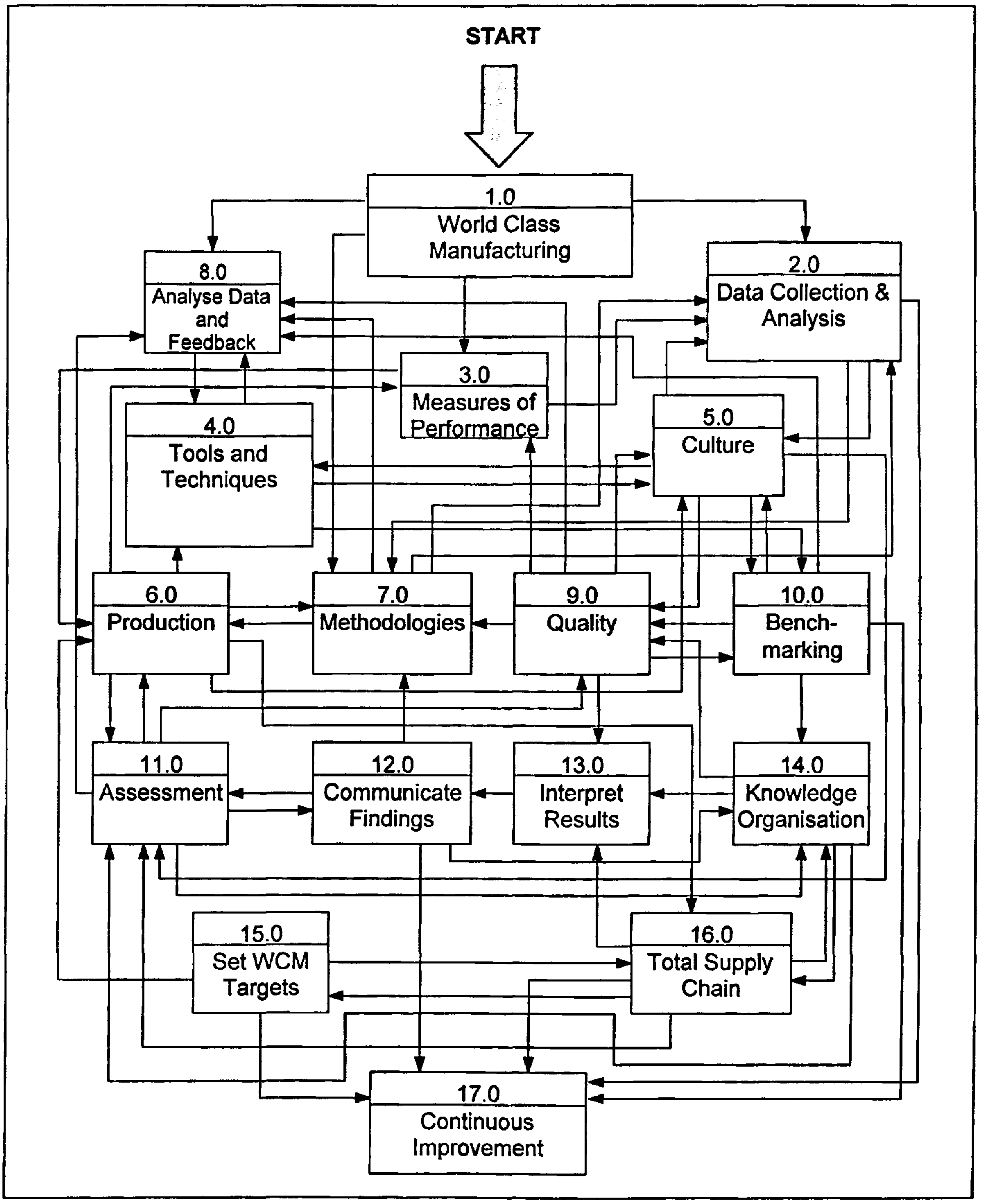


Figure 4.1 [a]: Barry's Model of a World Class Organisation – the global overview (Barry, 1998)

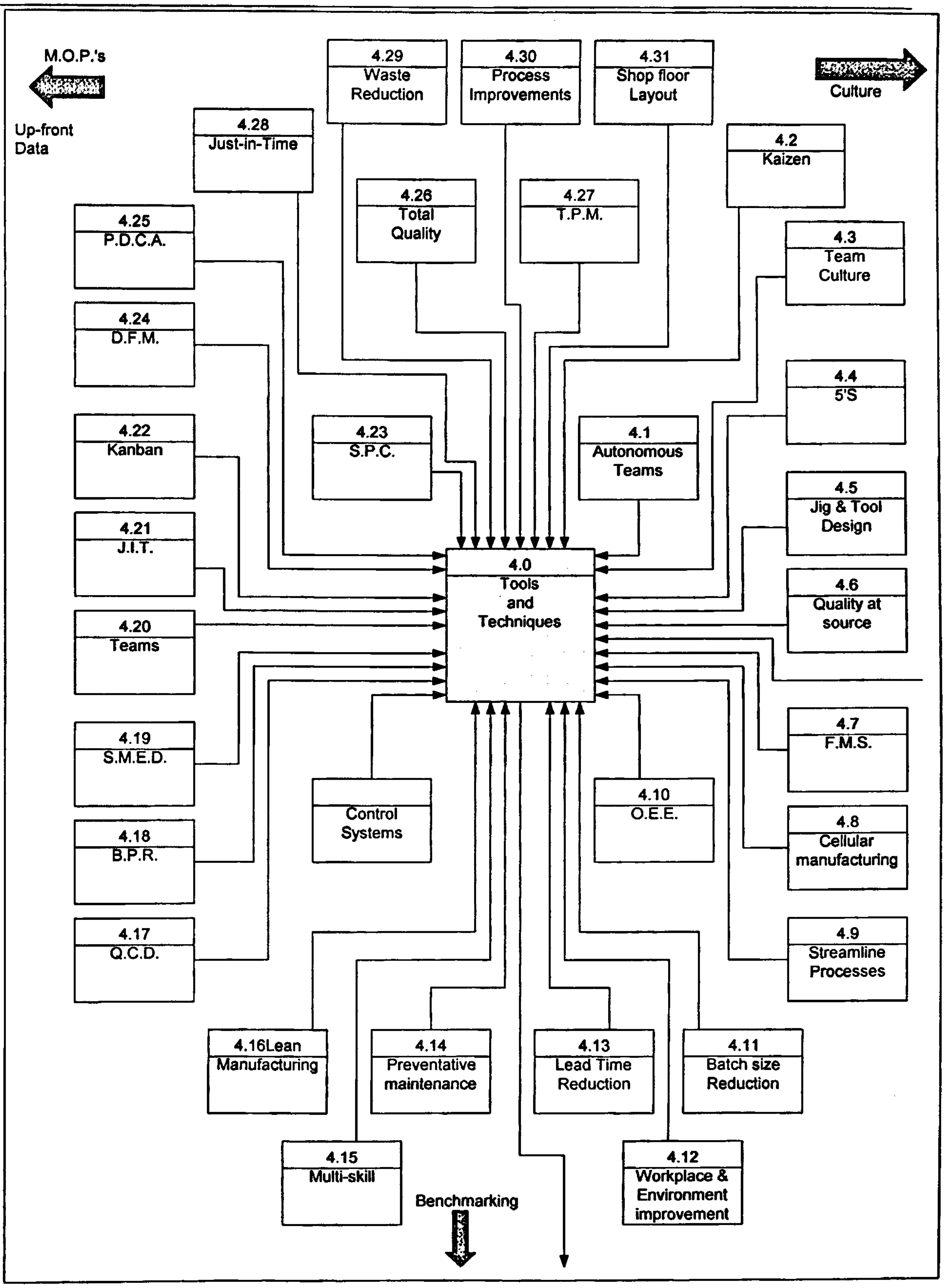


Figure 4.1 [b]: Barry's Model of a World Class Organisation – sub-model for tools and techniques (Barry, 1998)

4.3.2 Gilgeous

Gilgeous's framework (1997) of manufacturing excellence was created at the University of Nottingham, and developed via industrial case studies with seven companies based in the UK. First, on the very top of the framework, four factors affecting corporate strategy were recognised, namely shareholders, customers, markets and economic climate.

Gilgeous's research was set to focus the corporate strategy from the customers' perspective. The secondary level of the manufacturing excellence framework shows four manufacturing performance objectives: quality, cost, delivery and flexibility. These objectives were believed to form the basis of excellence in a manufacturing company. A lower level presents eight 'initiatives' for achieving the four main objectives. Lying at the bottom of the framework are lists of tools to support each one of these initiatives. These tools are called 'enablers' because of the nature of their usage. The enablers are practical, simple operations to help achieve innovations. Due to constraints in space only the first set of enablers is illustrated.

Gilgeous's framework of manufacturing excellence provides a link right through from the strategic level to activities that contribute most to manufacturing excellence. It is claimed that to date, the majority of writers have focused more on the actual process of developing a manufacturing strategy rather than the strategy content.

Gilgeous also suggested that manufacturing should move from reactive to proactive towards overall business strategy. The main aim of the framework is to provide a means by which manufacturing managers could identify exactly what operations they should emphasise and be competent in, in order to achieve high performances in business strategy as defined from the customers' perspective.

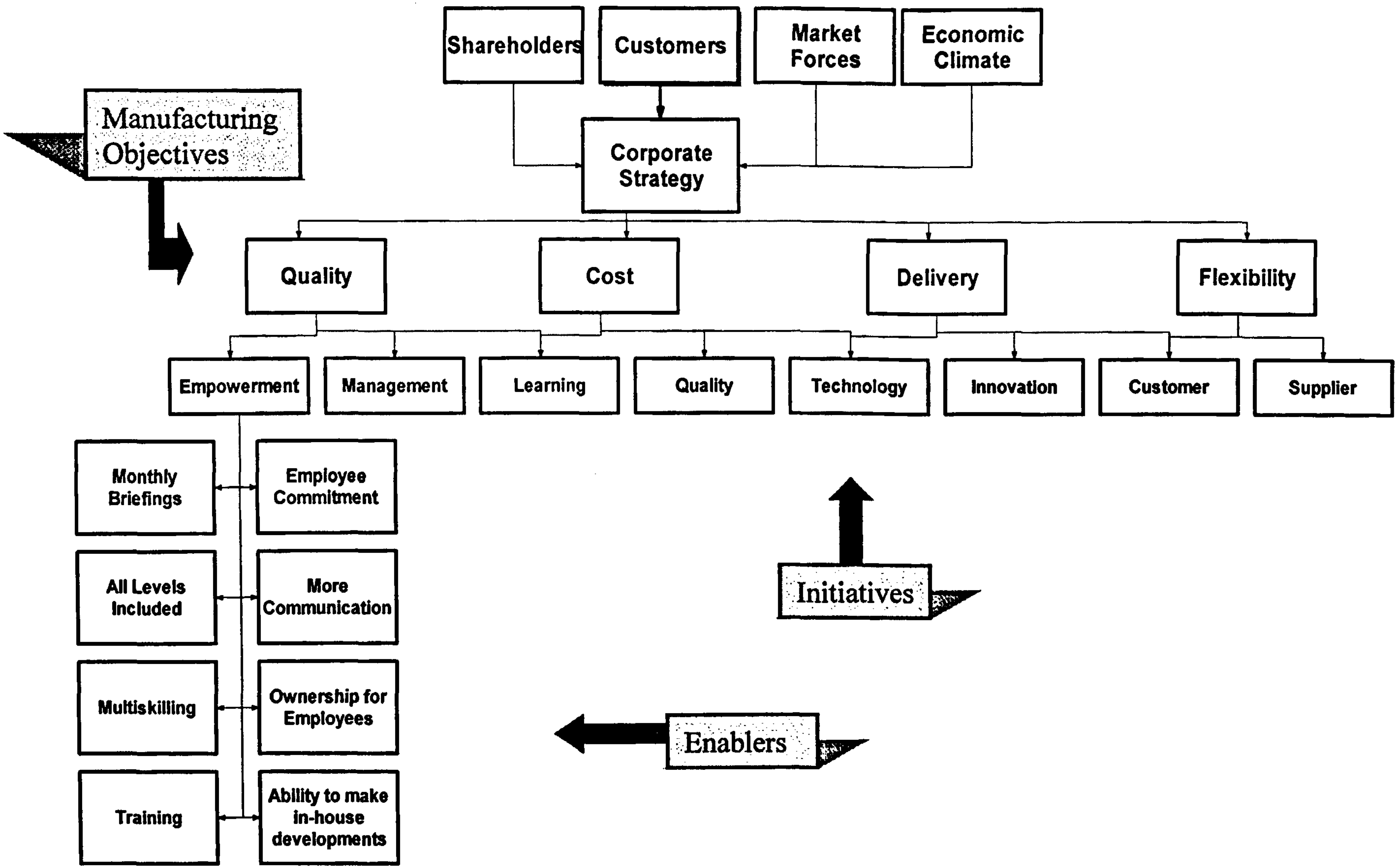


Figure 4.2: Gilgeous's Manufacturing Excellence Framework (Gilgeous, 1997)

4.3.3 Barsky

Barsky's model (1995) is another example of the increasing attention that industry is giving to customer satisfaction, just like Malcolm Baldrige's grading criteria gives customer satisfaction 30% of its weight, twice as much as any of the other six sections. Service is distinguished from customer satisfaction. Service is only a part of it, and good service does not guarantee satisfaction. Barsky first identified customer satisfaction priorities as being the following:

- Right product
- Right time
- Quality
- Service

and then outlined the general barriers that restrict efforts to please customers:

- Product
- Personnel
- Bureaucratic
- Technology
- Managerial
- Cost-related

With these Barsky developed a customer satisfaction strategy to help organisations gain competitive advantage. The principle is that WC companies understand what satisfies their clientele the most and utilise this information in customer programmes and employee training to promote customer loyalty. This requires aggressively seeking customer, employee, and competitor input on a frequent basis. The model gathered data from 250 organisations representing 15 different countries. These created diverse management and labour practises that drew the achievement of WC customer satisfaction. The model demonstrates the most crucial steps for building customer satisfaction by defining each problem and highlighting current cases found in various industries such as hotels, restaurants, banks, airlines and manufacturing. It provides the core concepts that have proven successful for WC organisations.

The model suggested a CI approach towards implementing and delivering a customer satisfaction strategy (customers include internal and external) designed for the needs of one's organisation.

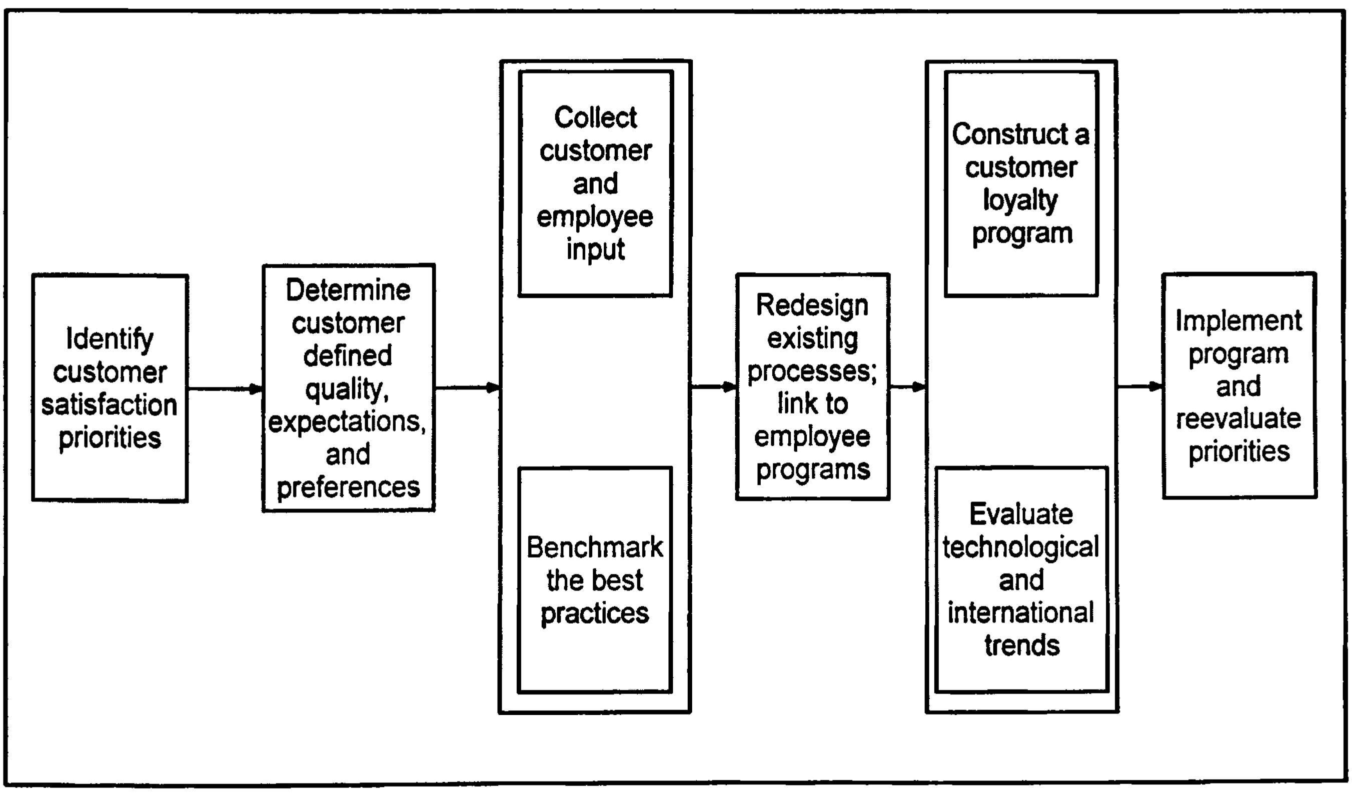


Figure 4.3: Barsky's Customer Satisfaction Model (Barsky, 1995)

4.3.4 Obolensky

As described in Chapter 2, "business re-engineering" is perceived as a change programme of the largest scale (Obolensky, 1994). Obolensky's four steps to business re-engineering reflect the most common practice of a change programme. The model is straightforward and should be the basis of a KAIZEN implementation. Further development of the business re-engineering model involved 11 case studies across UK, US, Europe and Australia.

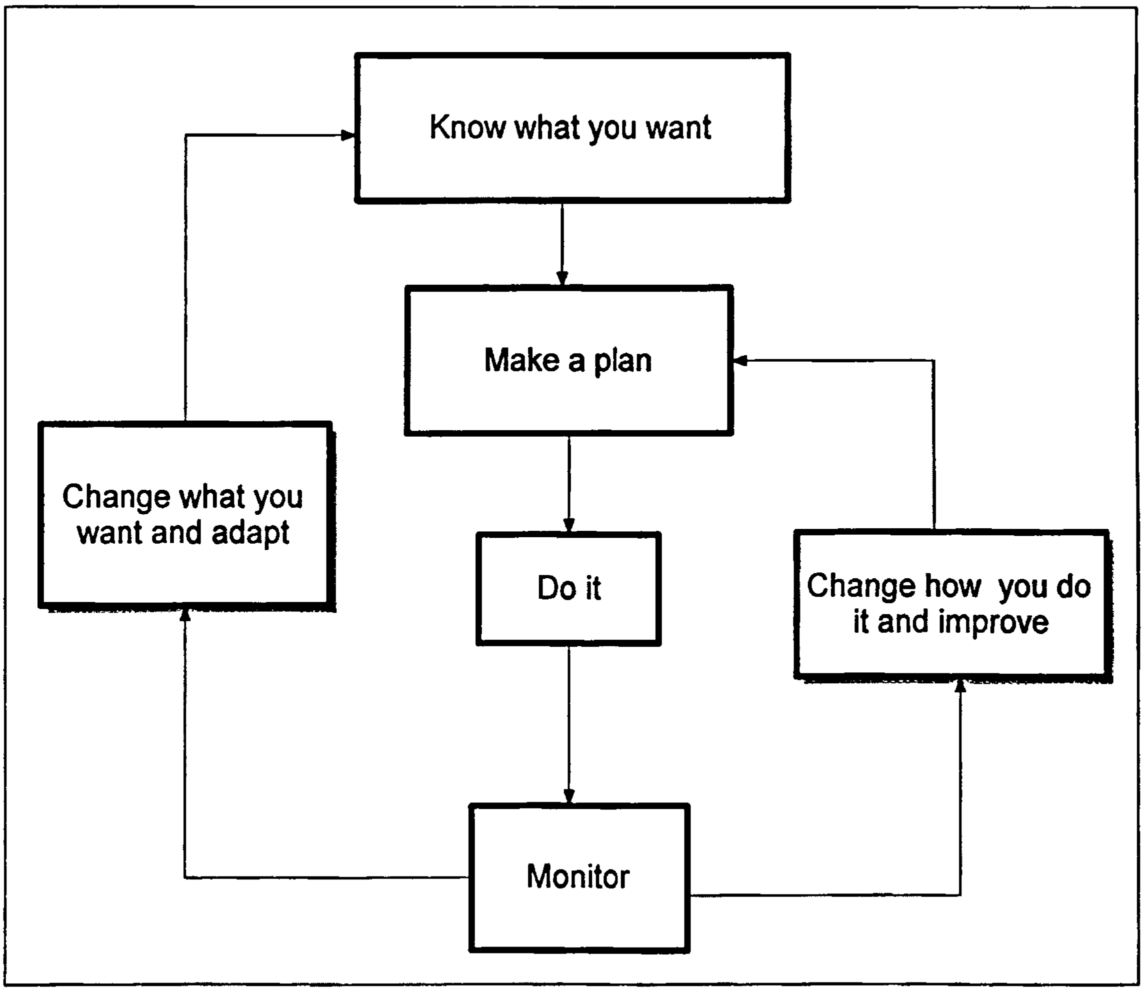


Figure 4.4: Obolensky's Four Steps to Business Re-Engineering (Obolensky, 1994)

4.4 Introducing the 'Birds of Change' (BoC) Model

BoC is a conceptual model developed on the basis of several practical case studies, and tested in one manufacturing plant. The modelling is done using Professional Diagrams Quickly (PDQ) modelling software designed by Patton & Patton Software Corporation.

The basic layout of the model is a visual illustration of a bird in its forward flying mode (figure 4.5). This carries a metaphorical purpose to represent the main principle of WCM -- continuous improvement (CI) and forward movement.

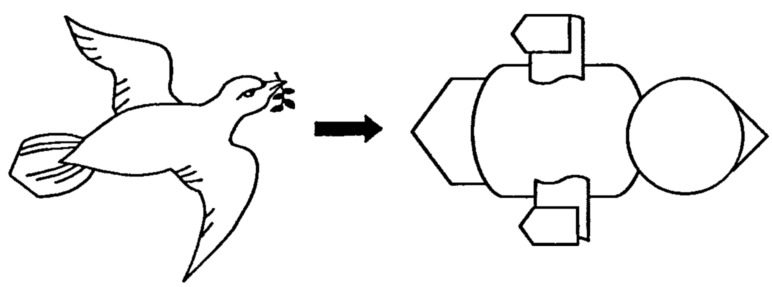


Figure 4.5: BoC -- Metaphorical representation of the change model

The model gathers core findings of the research and demonstrates a generic change programme of a company wishing to attain WCM status, and it comprises three major components:

- JIN Bird -- 'JIN' means 'human' in Japanese (the character 人), and hence the short terminology is used to name the 'bird' which describes people and the culture issue of a change programme, also known as the soft structure. The term is also used in conjunction with the more widely known Japanese term KAIZEN, which comes next in the model (figure 4.6)

- KAIZEN Bird -- the actual change process and all the activities involved, also known as the hard structure (figure 4.7)
- Sub-models -- relationship between elements and activities of the change model (figure 4.9 and figure 4.10)

The model embodies five fundamental objectives:

- To translate business strategies into operations
- To facilitate modern WCM principles, philosophies and tools
- To align WCM objectives with modern tools and appropriate MoPs
- To set up MoPs and benchmarking as feedback of change progress
- To incorporate a soft structure of OC

To demonstrate that the model is generic to all manufacturing organisations, the research aims to produce case studies and industrial applications that prove that the BoC model can be applied to manufacturers:

- of different sizes
- of different product ranges
- no matter how long they have been engaged in WCM activities
- no matter what tools they employ
- in different parts of the world

4.5 JIN Bird: Overview of an Organisational Change (OC)

This model functions like an IDEF0 model (Mayer et. al., 1994). Table 4.1 shows the matching elements of an IDEF0 model and the BoC model. A note here is that since WCM is defined as a never-ending journey, the output of the change programme as the ideal WCM company has to be seen as a forever moving target, i.e. no one should expect to have achieved an ideal WC position.

IDEF0 Model	JIN Bird
Input	Company at present
Output	Ideal WCM company
Core Activity	Change process
Controls	Culture ←→ Learning Organisation ←→ Innovation
Mechanisms	Leadership ←→ Communication ←→ People
Purpose	To produce a generic model of an organisational change towards WCM
Viewpoint	WCM change initiator

Table 4.1: Matching elements of the overview model JIN Bird to an IDEF0 model

JIN Bird carries primarily the soft structure / infrastructure of an organisation. To understand the meaning of soft structure, the easiest way is through its comparison with the hard structure. Hard structure refers to the physical facilities, technologies and resources, or what are commonly known as 'bricks and mortar'. Soft structure elements refer to management policies and systems that determine how the bricks and mortar are managed. These elements can be wrapped up under the following headings:

- Culture
- Learning Organisation
- Innovation
- Leadership
- People
- Communication

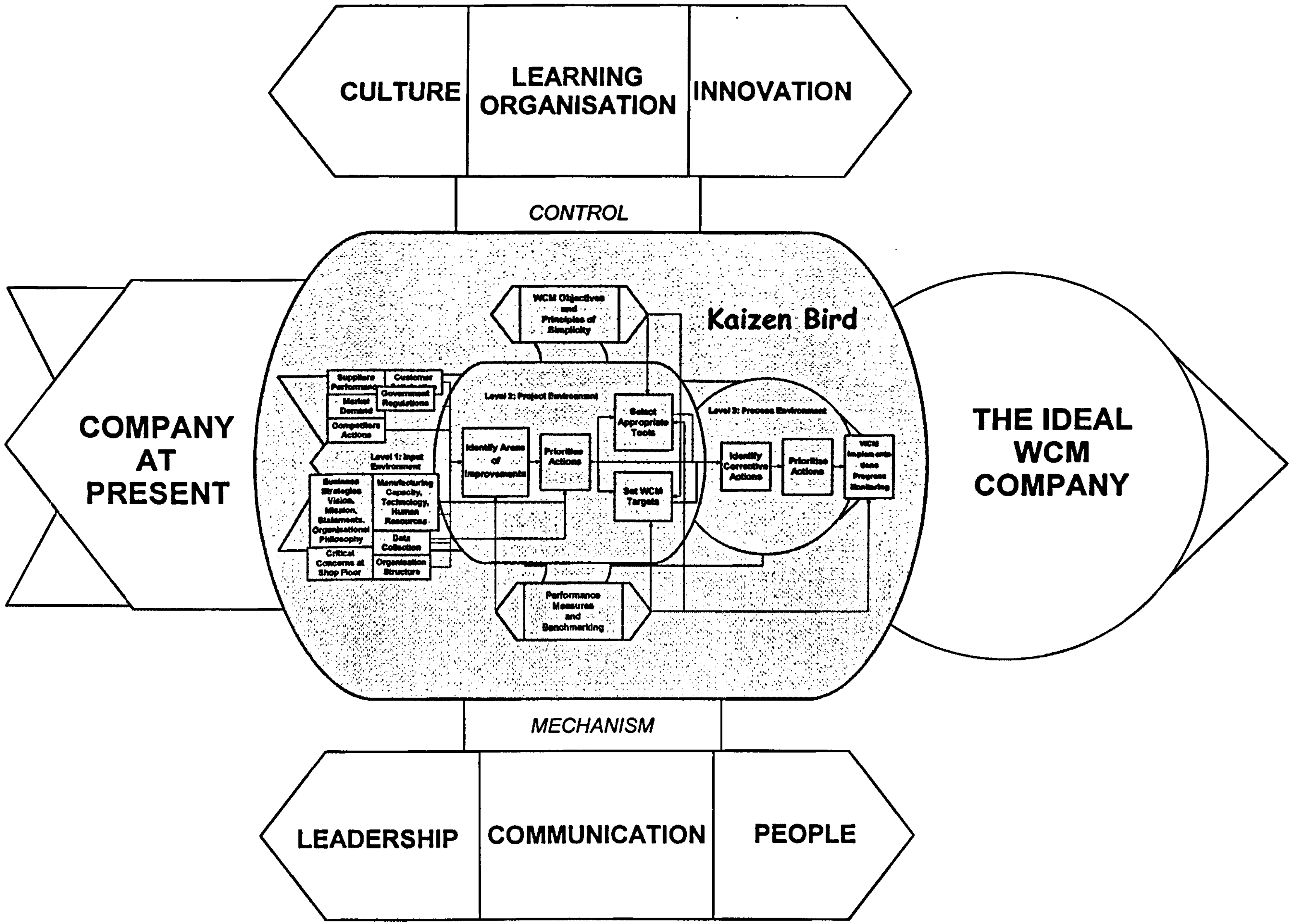


Figure 4.6: JIN Bird -- Overview of a Generic Organisational Change Model Towards WCM

4.5.1 Culture ←→ Learning Organisation ←→ Innovation

Dealing with soft issues is never easy. Transforming attitudes, practices and policies (infrastructure / soft structure) is never as straight forward as making structural changes such as facilities, locations and technologies. "Our fascination with the tools of management obscures our apparent ignorance of the art" (Peters and Waterman, 1982). Management is an art. Tools do not always solve all the problems. There is no formula to create a workplace with the right culture, ideal workforce attitude and a constant flow of innovative ideas. However, fostering a culture of CI in the workplace and promoting innovation, are at least as important, if not more, as seeking the right solution to the problems faced.

As culture has often been presented as an abstract concept to understand, this research has translated it in a very simple sense – "the way we used to do things around here". Culture is the governing element of organisational behaviours. It involves attitudes of people, how they respond and react to problems and situations. It is very people oriented. Culture governs all operations of the company – from how workers are treated to how the customers and suppliers relationship are dealt with; from the empowerment of the workforce to the decision making process. Having teams operating on a no-blame improvement environment is an example of culture.

Culture can be originated from a strategy. When people have turned strategies into a daily way of working, it becomes a culture. In that context, if a company is to change a certain way of working, the best starting point will be to establish a new strategy, or re-engineering. Take for example, company X that decided to set customer satisfaction as the top company success factor. If the strategy proves to be successful, this will develop into a culture. Operations will soon evolve to be customer satisfaction oriented. This will be elaborated further in section 4.5 – KAIZEN Bird.

When a culture proves successful in many places it is recognised as 'best practice'. One of the main objectives of benchmarking exercises is to observe other's culture and to copy the successful practices. As we all know, successful culture is subjective to the company's circumstance. Best practices for one manufacturing plant do not necessarily work in another.

This research acknowledges the existence of the argument that organisations do not function in the same way, with the same efficiency, in different national or ethnic cultural settings (Hofstede, 1980).

However, the approach that has been taken in this research is that advancing to WCM is culturally independent (in the sense of national and ethnic differences). All elements of the BoC model, and that includes WCM principles, objectives, success factors, CI activities and tools, should be followed with no bias in national or ethnic cultural differences.

This argument can be backed up by Shingo's (1985) conclusion when he viewed the differences between Japanese and Western management. He compared the differences in terms of 'work motivation' and 'work methods'.

> *"Adopting Japanese system in terms of 'work motivation' would surely be difficult due to differences in historical background and national character. Yet 'work methods' can be introduced relatively easy and such imports will rapidly result in increased management success. Improvements in this realm (work methods) deserve priority consideration and exploration."*

If each national or ethnic group has a different model to follow in order to achieve WCM, the effort of creating a generic model would have been trivial. If this is the case, multinational organisations would not have had so much success implementing standard practices in different cultural environments. Benchmarking would have been a waste of time. Hence, while agreeing that best practices for a company do not necessarily work in another, one should remember that this is due to the attitude of workforce, physical facilities and resources, training and education. It should not be seen as a result of national and ethnic differences.

In response to the question whether some cultures are better than others at implementing change in a fast-moving world, Kotter (2001) pointed out that the same patterns can be found anywhere. However they do collide when it comes to these two factors:

- Speed: "If the whole rhythm of a culture is slow, and that's relatively central to the way things are done, then there will be real problems in a modern world that is moving faster and faster"
- Education: "If there were a culture that did not value education very highly, this would be problematic because increasingly... jobs are more and more complicated and there is increasing information technology."

Learning and growing is a constant necessity of an organisation. New products, new process innovation, new technology and new market demands are information that require updating, not only to managers, but everyone on the shop floor. There are constantly new things to learn about any job for anyone, and these new innovations are appearing quicker than ever. "Knowledge is different from other resources. It makes itself obsolete, so that today's advanced knowledge is tomorrow's ignorance" (Drucker, 1997). If a company stops learning and growing for a while, it will soon find itself lagging behind its competitors.

This is why everybody in the business now realises the importance of creating a 'learning organisation'. A learning organisation is one in which people at all levels, individually and collectively, are continually increasing their capacity to produce better results (Karash, 1994-98). A group of senior managers are sent to take up a course in ISO 9001, so they will be equipped with the skills and knowledge to push the company forward to a higher standard of health and safety. A strategic manager, after visiting its consultant plant, learned that it is time his own plant implement a KANBAN system. An experienced loading worker did a benchmarking exercise and discovered a much easier way of loading, which he had not thought of before.

To create a learning organisation, management needs to be flexible with the workforce, and willing to empower workers in their operations. The company must also invest in learning and technology. Once the practice of learning has been cultivated, the entire company then fuses into a centre full of process improvers.

The intranet is now widely used to share information, data and knowledge across an organisation. At Pilkington, every process improvement is posted on the company intranet, together with the details of the methodologies and tools. This is to promote instant learning – a contribution to a learning organisation, and more importantly, communication. For example, on the intranet, the UK office will be able to find out process yields achieved by the US plant every month. Among companies, every little process achievement is communicated by means of performance charts and progress reports, such as SPC and KPI sheets.

There are scepticisms existing in the literature about organisational learning. Here organisational learning is mentioned with the assumptions that (Argyris and Schon, 1996):

- the learnings are "desirable" towards OC
- hence the learning is not just a meaningless notion but is always beneficial
- real world organisations are capable to learn in actuality as in principle

Innovation, in contrary to what people usually perceive as technological advancements such as computers and microchip or nuclear devices, has more significance as new ideas are used in processes and services. Corresponding to the context of OC towards WCM, innovation refers to new ideas or methodologies generated in the following areas (referred to as the 4Ps): products, policies, people and process improvements.

4.5.2 Leadership ←→ Communication ←→ People

Similar to culture, the people problem is hard to tackle but can never be ignored. Modern companies are aware of that, and most implement people programmes. During this era when the pace of change is faster than ever, leadership has become inevitable. Someone needs to lead the change. Successful change programmes come with substantial leadership (Kotter, 2001).

As mentioned in Chapter 2, a leader in change plays the following roles:

- Prime mover
- Strategic decision maker
- Making participation work
- Providing rewards and feedback

Communication here refers to the interaction of people, internally between different levels of the organisation and externally along the supply chain. As the structure of the organisation becomes less hierarchical, communication becomes more horizontal. This kind of communication proves more effective as people feel that they are working as a team, rather than following orders. By communication it also means "telling people what we're up to". In a traditional workplace, management keeps the workforce constantly guessing. They only have to do what they are told, hence conflicts often occur due to misunderstandings and suspicions. Nowadays, management should keep an open policy.

People are probably the most important key in all implementations. People make it work, or they bring it down. Drucker (1997) predicted that the productivity of knowledge workers would be the decisive factor in the world economy for most industries in the developed countries. Quoting a Nissan manager "Stop worrying about progress through technology and start thinking about changes and improvements through people. It will cost less and get you further" (Walley, 1992).

Mainly in the UK, and now expanded internationally, 'Investors In People' is the standard achieved by organisations of all sizes and sectors who are committed to improving business performance through the development of their staff. It is no longer sufficient to have only a training officer to provide necessary skills to the workforce. It is time to master the art of communication between leadership and people. Investor in People is recognised as the basics to bring out the potential of people for the benefits of the business. Four key tasks in the Investors in People programme are:

- Planning for the skill needs of the business; communicating business objectives
- Developing the role of the line manager
- Developing all employees to meet the business objectives
- Managing the training process

Where people are concerned, there are few checkpoints to bear in mind alongside the effort of creating a WC organisation:

- People have champions in them (Peters and Waterman, 1982). Give them the power and space to develop. Set up appropriate rewarding system so make their work recognised
- Culture influences people and people in return change culture. So when the two are not uplifting each other, re-engineering is needed to make impact
- People are the most important asset in an organisation. Before making massive investments in technology, it is worth investing in people first
- People need to gain trust, respect, and security. Foster a "no blame" culture in the organisation, approach everyone in a non-hierarchical manner, and tailor company policy to put people as top priority

All in all, one can argue that these are all common sense. However, "the obvious are sometimes not so obvious" as Peters and Austin claimed (1985).

4.6 KAIZEN Bird: Overview of a Change Process

Focusing on the core activity in the overview model, the change process holds an underlying model of its own (figure 4.7). This model, also called the KAIZEN bird (where KAIZEN is the widely used Japanese terminology meaning continuous improvement), presents itself as a bird embraced in the body of the 'mother bird' – JIN Bird (figure 4.6). It illustrates the complicated matter of change in a general manner. This model is designated to be followed in a sequence which simulates the natural forward movement of the bird, i.e. left to right in the picture. The actual change process normally travels through 3 levels:

- Level 1: Input Environment
- Level 2: Project Environment
- Level 3: Process Environment

Each of these levels will be explained in detail in the following sections.

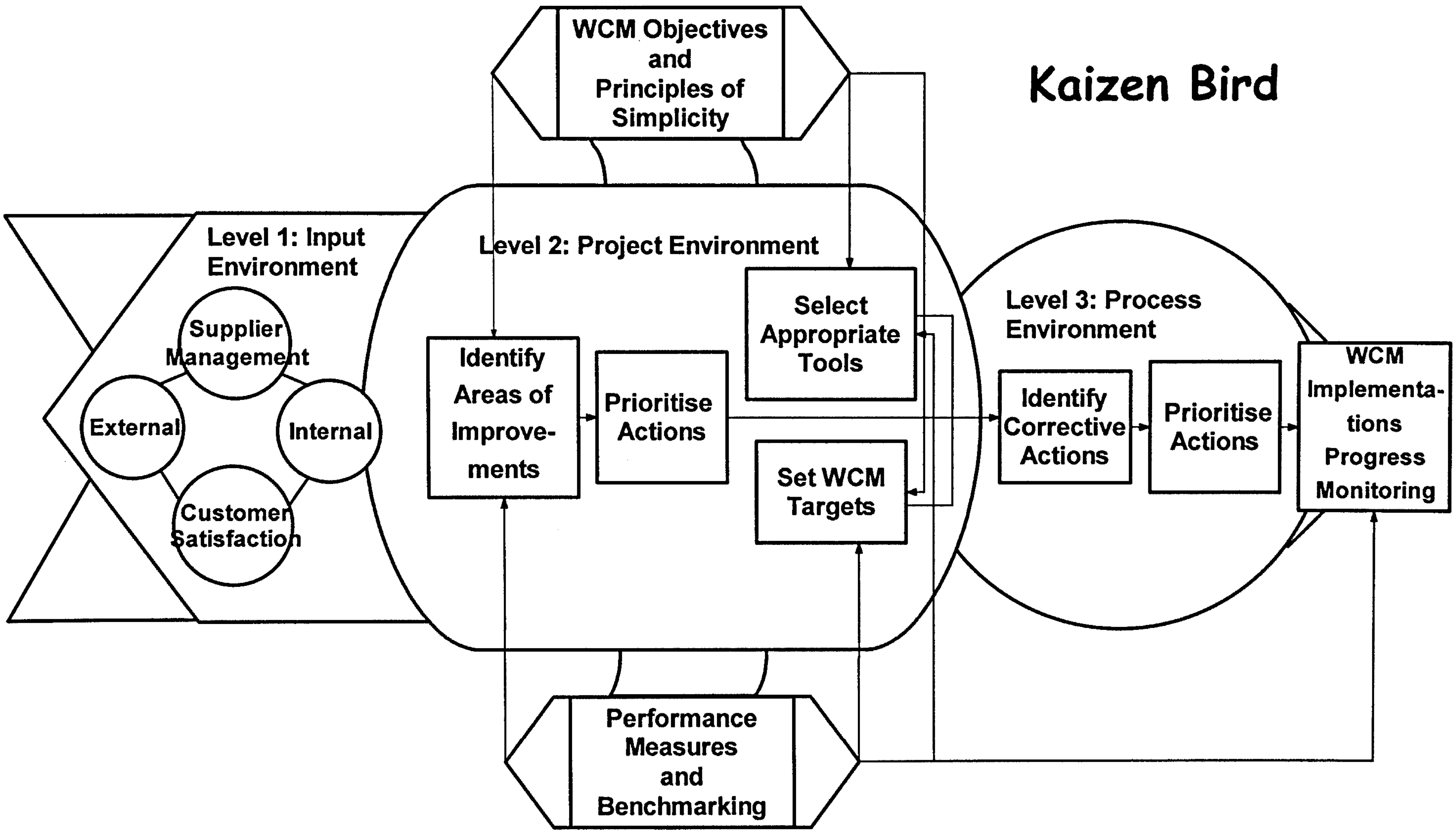


Figure 4.7: KAIZEN Bird – Actual Change Process Model in WCM Implementation

4.6.1 Level 1: Input Environment

Before a company begins its change implementation, some basic investigations to be carried out would be to:

- Acknowledge economy situation, government policies, global competition and other external influences
- Understand customer requirements and market demands
- Evaluate suppliers' performances
- Obtain employee feedback on operations and job satisfaction
- Develop critical shop floor concerns
- Assess manufacturing capacity, resources, and financial performance
- Establish business strategies and vision

A structured change programme should begin at what is recognised in the model as the 'input environment'. It consists of all areas of consideration in which a company forms its critical success factors. These can be internal inputs such as manufacturing capacity, resources and critical shop floor concerns (obtained from management and employees), and vision and mission statements delivered by the executives. Equally important are the external factors such as economic climate changes, market demand, government regulations and competitors' actions. For instance, formation of the Free Trade Areas of America (FTAA), which will take place before the end of 2005, will create a huge impact on the future of manufacturing in the Caribbean sector. Hence when forming WCM strategies one cannot ignore this crucial external factor. Nevertheless, inputs from important stakeholders, such as the customers and the suppliers, should be taken into consideration. Figure 4.8 presents these components in four categories, forming a loop for a company's assessment purposes. These factors included in the 'input environment' frequently counter influence each other. This research believes that a company should never stop assessing these components to continuously establish a new set of critical success factors.

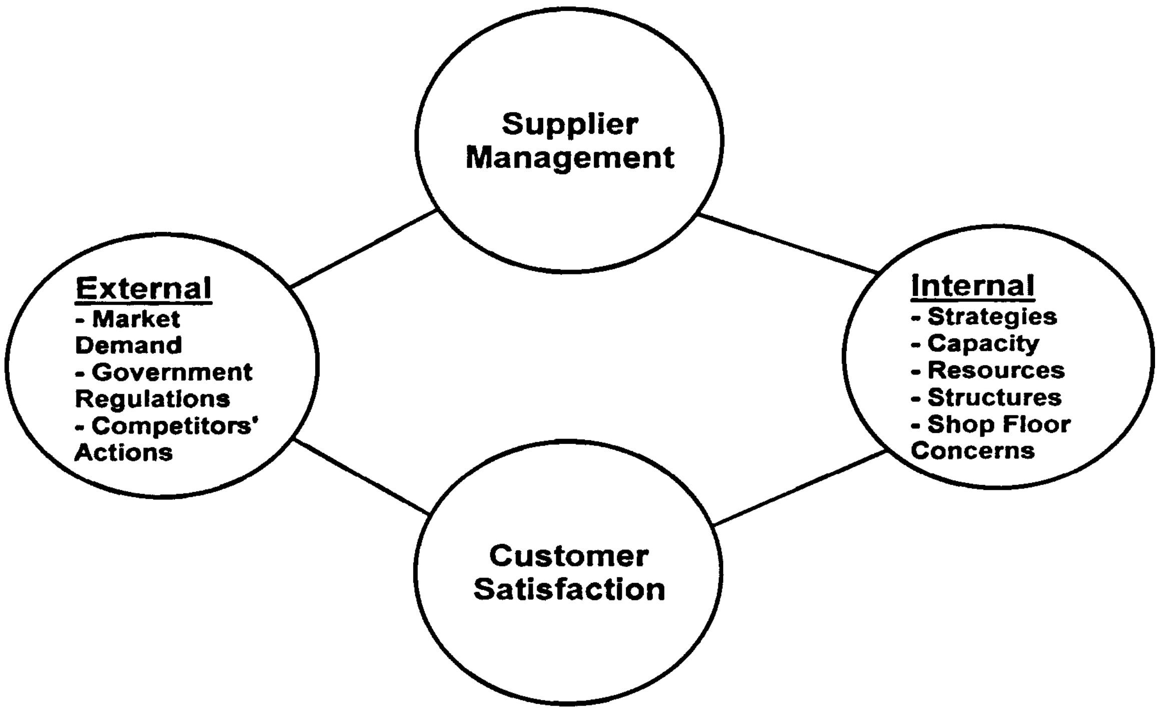


Figure 4.8: Assessment loop in KAIZEN Bird Level 1 'input environment'

Table 4.2 presents a list of questions corresponding to each component set in the assessment loop. By answering these questions, decision makers would be able to shape the company's critical success factors -- what exactly does the company need to create competitive advantage. This is the starting point of a change process, and it is almost the process of tailoring a company's change programme, before any implementation takes place. "Each journey to excellence must be customised to fit the unique culture and structure of the company" (Kinni, 1996). This freedom of customising the change process of a company is incorporated in the change model itself.

KAIZEN Bird Level 1: Input Environment	
Suppliers' performance	What can be done to help make suppliers more competitive, in return making the company more competitive?
Customer satisfaction	What can be done to team up with the customers, understand their needs and discuss means of achieving quick responses to fulfill them?
Internal Factors	**Vision statements / strategies** What is the company's vision statement -- the ultimate set of goals which is communicated throughout the workforce, and which change activities are related to?
	Manufacturing capacity/ resources Does the company have enough capacity, both technological and human resources, to support changes and ensure continuous improvements in the implementations?
	Critical shop floor concerns What are the bottlenecks in the factory and what can be done about it to achieve lean objectives (i.e. making operations safer, cheaper, easier and faster)?
	Organisational Structure Is any effort currently being made to flatten organisational hierarchies, creating close inter-functional linkages, and transforming segmented structure to an integrative one (i.e. team based)?
External Factors	**Market demands** Is the industry experiencing any kind of extreme market condition where change wouldn't matter much?
	Government/ regional regulations Have government/ regional regulations imposed any restriction or significant influence on the manufacturing sector and therefore the business?
	Competitors' Actions What are the competitors doing that gives them the competitive edge over us? What can we do to respond to that and what can we learn from them?

Table 4.2: External and internal factors in KAIZEN Bird Level 1 'input environment'

4.6.2 Level 2: Project Environment

Planning is an indispensable part of the WCM process (Fayol, 1900). With the inputs from level 1 ('input environment'), the change process arrives at level 2 'project environment', where the management team builds a list of 'areas of improvement'. Due to practicality, not all the improvements can happen at the same time. Therefore, the list needs to be assessed and prioritised. When the selection process gets complicated, decision-making tools can be used. Depending on the degree of complication and the number of factors considered, the tools suggested are analytical hierarchical process (AHP) (Golden et al, 1989; Labib, 1996), priority mapping (Robinson, 1998), or just simple pareto analysis and a possibility decision. Often though, decisions are made out of executives' or management's intuition. After the areas of improvements are prioritised, it is then necessary to select appropriate tools and set corresponding targets.

Select Appropriate Tools

This research investigates the tools used in industry, which all fall under the big umbrella of management philosophies such as JIT, TQM and TPM. The effort to list all the tools can be exhaustive, and the list grows over time, but the few frequently brought up are SMED, Kanban, 5Ss, FMEA, SPC, JIT layout, set-up / changeover reduction etc. (see Chapter 2 for further details on tools).

A tool is defined as whatever is used to carry out a task in order to achieve certain objectives. Here a tool can be a structure, a set of techniques, or a combination of these. Each tool aims to make improvements in one or more of the following six WCM objectives: quality, cost, customer satisfaction, productivity / flexibility, workplace improvement and health and safety (see section 4.5.4). It is important that tools are selected for a specific purpose, that is, to achieve a certain improvement. They should not be chosen because the other companies are implementing it, or because it is the industry's latest trend.

A sub model (see section 4.6) is created to present the inter-relationships between the tools, represented by the management philosophies they belong to, with the six WCM objectives. Therefore, based upon the supporting sub-model, tools are selected depending on the current areas of improvements prioritised.

Set WCM Targets

This does not only refer to financial targets. All targets set here must correspond to areas of improvements prioritised previously, and relate to the WCM objectives (section 4.5.4) and tools selected. Here there are two types of targets: one in the form of MoPs, another in the form of international standards or awards.

Targets set in the form of MoPs are essential in a change programme, as they set a base for the next level of improvement. They have to be achievable and realistic. It is no use for a company with an OEE figure of 15% to set its next month's target to 80%. Although the target might beat its competitors, it is just not going to happen. Financial targets are often not set here because there is no direct link between WCM implementations to a company's financial performance. Logically, successful WCM implementations will drive costs down, increase quality, reduce wastes and satisfy customers better, which will all increase the company's profit. However the relationship is complex and often not justified. More on MoPs and financial performance will be discussed in section 4.5.4.

To name a few, international standards and awards are QS9000, ISO 9000 and ISO 14000, Malcolm Baldrige Award, Deming Prize and Shingo Prize. These awards and prizes started at different times in different regions of the world. As they contain specific sets of criteria for excellence and carry international recognition, companies tend to adopt any one as a shortcut to WC status. However, as each of these awards and prizes focus on different elements of business and manufacturing functions (e.g. customer satisfaction, human resources, quality, process planning, leadership and people etc.), the benefit of blindly adopting and achieving an award is largely in doubt (Mayet, 2001).

4.6.3 Level 3: Process Environment

One of the main objectives of the change model is to translate business strategies into shop floor operations. Process environment is where these operations take place. The primary elements are identifying corrective actions, prioritising actions and monitoring progress. One reason why change programmes fail is that the process comes to a standstill at the end of 'project environment' (level 2 of the KAIZEN Bird). Executives take on big ideas, or management decides to implement some kind of WCM programme, but it has never been translated into specific actions. Big targets cannot be accomplished if they are not broken into small and achievable actions. Milestones and deliverables are essential to CI activities.

Identify Corrective Actions

Corrective actions are specific tasks that contribute to fulfilling the areas of improvements in level 2. For example, if workplace improvement is identified as a main area of concern, and 5Ss is selected as the enabling tool, the corrective actions can be sweeping the floor, putting tool shelves in order, removing machines or red-tagging items. There are two ways of generating corrective actions: the forward mechanism and the backward mechanism (figure 4.9). With the forward mechanism, concerns are raised and the causes are analysed before a set of corrective actions are established. However, the backward mechanism works in a way whereby actions are generated before identifying their relevant potential improvements. There is a difference in reasoning logic, but both mechanisms work well in their own ways.

Concerns → Causes → Corrective actions [Countermeasures]

Forward mechanism

Corrective actions → Reasons → Potential improvements

Backward mechanism

Figure 4.9: Forward and backward mechanisms in generating corrective actions in KAIZEN Bird Level 3 'process environment'

Corrective actions here include preventive actions. If the 'concern' (see figure 4.9) is to prevent process faults or machine failures, or if the 'potential improvement' is to reduce scrap or machine downtime, then the corrective actions become preventive actions.

Prioritise Corrective Actions

Basically, the principle of this action is the same as prioritising areas of improvement mentioned earlier in level 2 'project environment', and the tools recommended to carry out prioritisation apply here. However, as the decisions to be made in level 3 'process environment' are much smaller, the prioritisation becomes easier and less necessary. Therefore decisions can often be made based on budget and the resources available.

WCM Implementations Progress Monitoring

A monitoring system is essential for successful change implementations. To monitor change programmes, meetings and progress reports are required. Meetings are held for two reasons: to discuss problems and to communicate progress. WCM meetings ensure that KAIZEN principles are followed throughout the implementation. The team carrying out the meeting is specific to the task involved, but usually includes the management, project leaders, cell leaders, operators, and members of each function.

Progress reports keep track of a WCM programme by updating progress and communicating it among team members. A typical progress report consists of the following:

- Concerns, causes, and corrective actions identified (using forward or backward mechanism as shown in figure 4.9)
- Responsibility of each individuals from the team
- Start date, expected and actual completion date
- Indication of implementation progress
- Performance charts related to the actions
- Problems, rewards, and causes of failure

The use of Key Performance Indicators (KPI) is an effective monitoring system which guides and tracks the overall performance of a business, with the intention of facilitating CI through team management (see figure 4.10). KPI has been developed to enhance the regular management business review meetings carried out by focused teams. It uses a standardised format that includes:

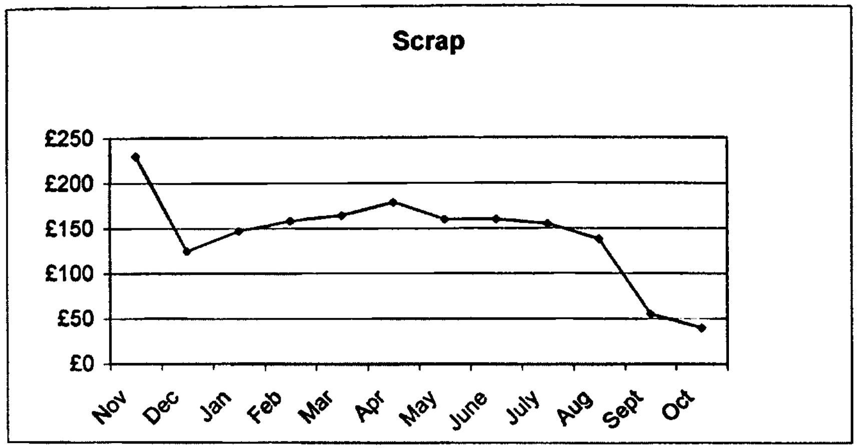
- Trends and targets (e.g. scrap level, delivery performance)
- Pareto (causes of failures and their significance),
- Corrective actions (including progress indicator, target, and responsibility)
- Results (data reflects results of the corrective actions, completion date highlighted).

The visual indications and standardised format speed up communication and promote "speaking with data". Information shown on a KPI sheet, such as the key measurement chosen, reflects the company strategy and mission statement.

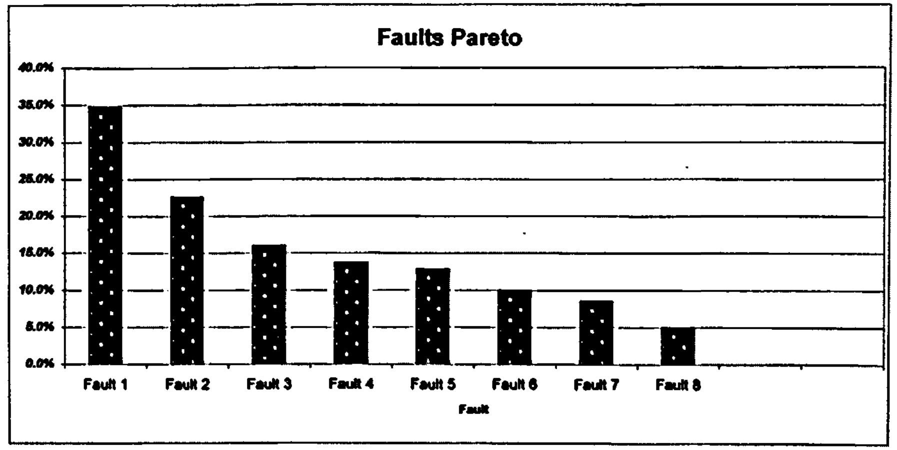
Key Performance Indicator

March-01 **Subject: Scrap** **Product Alpha** **M.Tey**

Trend Analysis



Faults



Corrective Actions

C.A.R No.	Problem Description	Corrective Action	Resp	% Complete
101	Fault 1	Action 1	ms	
102		Action 2	ms	
105	Fault 2	Action 1	mt	
107		Action 3	mt	
112	Fault 3	Action 2	ymg	
116	Fault 4	Action 2	ms	
117		Action 3	ps	
122		Action 8	ms	
129	Fault 6	Action 1	ps	
130		Action 2	ps	
131		Action 3	ajk	
148	Fault 7	Action 6	ymg	

Cut Off dates 2000 2001

C.A.R No.	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
101																								
102																								
105																								
107																								
112																								
116																								
117																								
122																								
129																								
130																								
131																								
148																								

Cut Off Point

Figure 4.10: An illustration of Key Performance Indicator (KPI) as WCM implementation monitoring system

4.6.4 'Wings'

The 'wings' of the KAIZEN bird carry the most vital components of the change process – WCM objectives and principles on one side; MoPs and benchmarking on the other. These are neither controls nor mechanisms, from the IDEF0 point of view; but such as wings of a bird, they play the role of guiding and supporting elements that must be integrated into the entire change process.

WCM Objectives and Principles

What is most remarkable about the WCM philosophy is its emphasis on organisational innovations and techniques, rather than the traditional focus on manufacturing competitiveness such as better automation technology, more sophisticated computerisation, and product R&D.

WCM objectives here refer to the six aspects:

- Quality
- Costs
- Productivity / flexibility
- Customer satisfaction
- Workplace improvements
- Health and Safety

All improvement initiatives are related to one or more of these objectives, and the objectives need to be achieved simultaneously. The importance of WCM objectives has been highlighted in the previous section. When selecting tools and setting targets, it is important to link with the objectives. Section 4.6 elaborates on the author's attempt to link tools to WCM objectives.

There is a non-exhaustive list of WCM principles. Schonberger (1996) proposed 16 principles of WCM from the perspective of customer satisfaction. Constantly growing people is the key to success (Joynson, 2000). Peters and Austin (1985) sees managing-by-wandering-around (MBWA) as one of the ways to go.

CI is the crux of WCM implementation. The research believes that to successfully carry out WCM initiatives, principles of CI have to be followed:

- Small and rapid step changes
- Selecting a pilot project that yields positive results quickly
- Getting innovative ideas from people
- Management support is crucial, especially at the beginning
- Attack the biggest non value-adding activities first, especially the time wasters

WCM also combines the essence of JIT, TPM, lean manufacturing, TQM, and many other modern management approaches. All the significant elements found in these approaches are framed into the big picture of WCM principles. As Chapter 2 concluded, many elements actually overlap and counter support one another. Hence, the principles of implementing WCM initiative, adding on to those of CI, can be suumarised as follows:

- Empowerment of employee, multi skills and team working
- Quality improvement for cost effectiveness
- Require total commitment and management
- Working towards a SCEF (i.e. lean) operational environment
- Strict alignment of strategies, MoPs and corrective actions

Measures of Performance (MoPs) and Benchmarking

The other wing of the KAIZEN bird denotes MoPs and benchmarking. No improvement programme will work without these two elements, as they play an important role in (Oakland, 1999):

- measuring success against organisation vision and objectives
- tracking progress on each significant change activity
- identifying strength and weaknesses in each area of entire change process
- comparing performance against internal standards (previous results) or external standards (best practice)

Conventional management relies heavily on financial figures (e.g. sales, profit) to measure success. However this is now regarded as somewhat insufficient. The study of the balanced scorecard "was motivated by a belief that existing performance measurement approaches, primarily relying on financial accounting measures, were becoming obsolete" because it was believed that the approach hinders organisations' abilities to create future economic value (Kaplan and Norton, 1996). In a WCM change environment, solely utilizing financial measures is not entirely accurate and can be discriminatory. It can take years for physical improvements to show up on the financial figures. Measures directly related to WCM objectives are needed. However, debates have been raised as to how WCM can be justified if it cannot be shown to directly affect a company's 'bottom line results'. In the pursuit of this matter, a recent piece of research (Mayet, 2001) has established a correlation between financial measures with the scoring of a WCM framework. It was found that return on investment (ROI) and cash flow as % of sales are two financial business performances that best reflect the impact of WCM practices. Hence it was concluded that a WCM framework scoring system helps to track business performance and its interpretation can be associated with financial measures.

Meanwhile, current research shows that the MoPs within WCM can be categorized into:

- Productivity / flexibility (e.g. lead times, machine up-time, inventory)
- Quality (e.g. scrap, rework)
- Customer satisfaction (e.g. delivery performance, support, warranty returns)
- Employee involvement / people measurement (e.g. absenteeism, staff turnover, incentives and involvements)

A supporting project of this research investigated co-relations between MoP and tools in the context of WCM (Thorburn, 2001). A comprehensive list of MoPs was produced together with the corresponding standard calculations (table 4.3).

In research carried out recently by Frontstep UK, 31% of manufacturers questioned said that improving customer service is the most important factor in determining success over the next two decades. Price (28%) and the ability to deliver on time (22%) – the traditional method of keeping up with the competition – are seen as less important (McNay, 2001).

Some MoPs have several elements combined in one figure, OEE being a good example. It measures the availability, performance of machines and quality (Nakajima, 1989). OEE is an important tool in TPM implementation.

ACCOUNTING	Method of Calculation
Added value per unit	Sale value-total cost of manufacture
Capital Productivity	Total fixed assets/no. of units produced
Creditors ratio	Creditors/purchases
Debt ratio	Total debt:total assets
Debtors turnover ratio	Debtors ratio/average daily credit sales
Expenses to sales ratio	Operating expenses:Income from sales
Finance cost ratio	Finance charges:Income from sales
Fixed assets as a percentage of sales	(Fixed assets/Income from sales) *100%
Gross profit ratio	Gross profit:Income from sales
Net profit ratio	Net profit before tax:Income from sales
Quick assets ratio	(Current assets-stock-long term debtors):Current liabilities
Ratio of fixed assets to current assets	Fixed assets:current assets
Return on capital employed	Net profit after tax/Capitol employed
Turnover ratio (assets)	Income from sales/Total assets
Working capital ratio	Current assets:Current liabilities

PERSONNEL AND MARKETING	Method of Calculation
Absenteeism rate as a percentage	(No. of hours absent/total possible hours) *100%
Average daily sales	Total sales value in period/no. of days in period
Delivery Performance	(deliveries on time/total no. of deliveries)*100%
Mean no. of items in system over no. of customers in system	(No. items in system in period/length of period)/no. cust.
Number of accidents per month	Recorded figure in accident report book.
Number of customer complaints per month	Recorded figure
Number of suppliers (primary and general)	Recorded figure
Personnel costs as a percentage of total sales	(total wages and supporting values/total sales)*100%
Ratio of maintenance to production labour	Total maintenance man hours/total production man hours
Sales per person	Income from sales/no. of employees
Turnover ratio (inventory)	Cost of sales/Inventory
Training index	Total number of hours spent training personnel
Training Matrix	ILU board

Table 4.3: Measures of Performances and Methods of Calculation [Page 1 of 2] (Thorburn, 2001)

PRODUCTION	Method of Calculation
(Production Quantity - Throughput) /Rate of Production	(Production Quantity- Throughput)/Rate of Production
Availability ratio	(Load time-down time)/load time
Average idle time	Total idle time during a period/length of period
Average issues	No. of issues during a period/length of period
Average job lead (or flow) time	Total lead time during a period/length of period
Average stock levels	No. items in stock during a period/length of period
Average wait time	Total wait time during a period/length of period
Change over time	Total change over times/no. of changeovers
Cycle time analysis	No. of operating cycles during a period/length of period
Equipment utilisation ratio	(Total output achieved/max possible production)*100%
Good Production	(No. scrap units made/total units produced)*100%
Lead time for first batch to exit	Recorded value
Lead time for whole of batch	Recorded value
Line Efficiency	(Current production rate/capacity rate)*100%
Line inefficiency	Inverse of line efficiency
Maintenance index	Maintenance cost/total plant investment
Manufacturing cycle effectiveness	Processing time/throughput time
Manufacturing lead time (MLT)	Sumof (no. of units in batch*all times)for all machines
Mean number of assemblies in progress	Sum of base part hours/total assembly time
Number of breakdowns per month	Recorded value
Number of breakdowns per week	Recorded value
Output per unit input	Recorded value
Overall Equipment Effectiveness	Availability*performance*quality
Percentage of capacity in use	(Current scheduled work/capacity)*100%
Performance rate	(Processed quantity*cycle time)/operation time
Production capacity	no. workstations*no. shifts*hours in each shift* prod rate
Production rate	1/average production time for a machine
Production speed	Total units produced in a period/length of period
Quality Rate	(Units produced-scrap)/Units produced
Queuing to manufacturing time ratio	Time queuing/(no. of machines* operation time)
Service level	(No. of items available on request/no. of requests)*100%
Schedule performance	(No. of orders shipped/no. of scheduled shipments)*100%
Scrap parts per million	Recorded value
Scrap rate	Total scrap parts during a period/length of period
Space utilisation ratio	Area usefully used/total available space
Stock as a percentage of sales	(Inventory/income from sales)*1005
Throughput efficiency	(Throughput/Operating expense)*100%
Throughput time	Processing time + Inspection time+Movement time + Waiting/storage time
Total Production	Recorded value
Utilisation of Machinery	either 1) output:capacity or 2) time used:time given
WIP	Total work been processed or scheduled to be processed in the factory
WIP as a fraction of average queue length	WIP/ave. queue length
WIP ratio	WIP/no. of machines operating

Table 4.3: Measures of Performances and Methods of Calculation [page 2 of 2] (Thorburn, 2001)

A basic rule of thumb is to measure only what is needed. The same applies to benchmarking exercises. The outcomes of the measures need to be justified against the cost of implementing them. As mentioned earlier, translating vision statements and business strategies into operations is one of the main objectives of the change model. MoPs should therefore make sure the actions measured are aligned with the strategies. Research carried out in the participating companies suggested that the key performance indicator (KPI) is a good representation of MoPs as it links results to strategies as well as corrective actions (figure 4.10).

The idea of benchmarking is to seek industrial best practice to gain competitive advantage. In the context of WCM, benchmarking comes in these forms:

- Internal benchmarking – within the boundary of the same company, usually between departments. This is the most direct and economic means of benchmarking, and a flow of free and open communication is easily achieved. However, the benefits may be low as breakthrough ideas are not easily sought.
- Competitive benchmarking – as the subject being a direct competitor, benchmarking can only be carried out in non-essential areas, or the result is often a figure rather than a solution. This is a more unpopular exercise these days.
- Strategic benchmarking – this is perhaps the most beneficial benchmarking exercise used widely today. A company benchmarks against partners in the same 'group' (e.g. a multinational corporation), or even along the supply chain (customer / supplier). All parties aim to achieve mutual improvements, and usually share similar processes.
- Generic benchmarking – this type of benchmarking activities aim at particular processes. Hence the partners in study do not have to be in the same industry. This can bring innovative changes due to wide range of sources.

4.7 Sub-models

As mentioned earlier in Chapter 3, the BoC model replicates the IDEF0 concept of presenting various 'layers' of a model. The top two layers have been introduced – JIN Bird as the highest platform and KAIZEN Bird as the second. Beneath the second platform lies another layer, made of two sub-models:

- Sub-model I – WCM tools vs. objectives (figure 4.11)
- Sub-model II – WCM tools vs. MoPs (table 4.4) (see Appendix A for the complete 6-page matrix)

The sub-models aim to interpret the complexity of the KAIZEN Bird (the second layer) by elaborating the relationships between its elements. Sub-model I provides a guideline in which WCM objectives can be achieved by each tool. The purpose is to support management's decision on which tools to take on. For instance, when Corus intended to improve its workplace condition, the management could trace the sub-model and found that possible tools to employ would be those that come under TPM, JIT, 5Ss and 6 Sigma. Sub-model II on the other hand describes all the MoPs involved in each tool (Thorburn, 2001). These MoPs are each accompanied by their methods of calculation, which have been presented previously in section 4.5.4 (see table 4.3). This allows management to gain a quick overview of the implementation that is about to take place, and hence makes it easier to estimate the available resources and capacities. Using the above example, if Corus then goes ahead to take on TPM, the list of MoPs (from average idle time, maintenance index, OEE, to ratio of maintenance to production labour) and their available calculations comes into use straightaway. Sub-model II is the product of a final year project supporting current research and Appendix A shows the rest of the results.

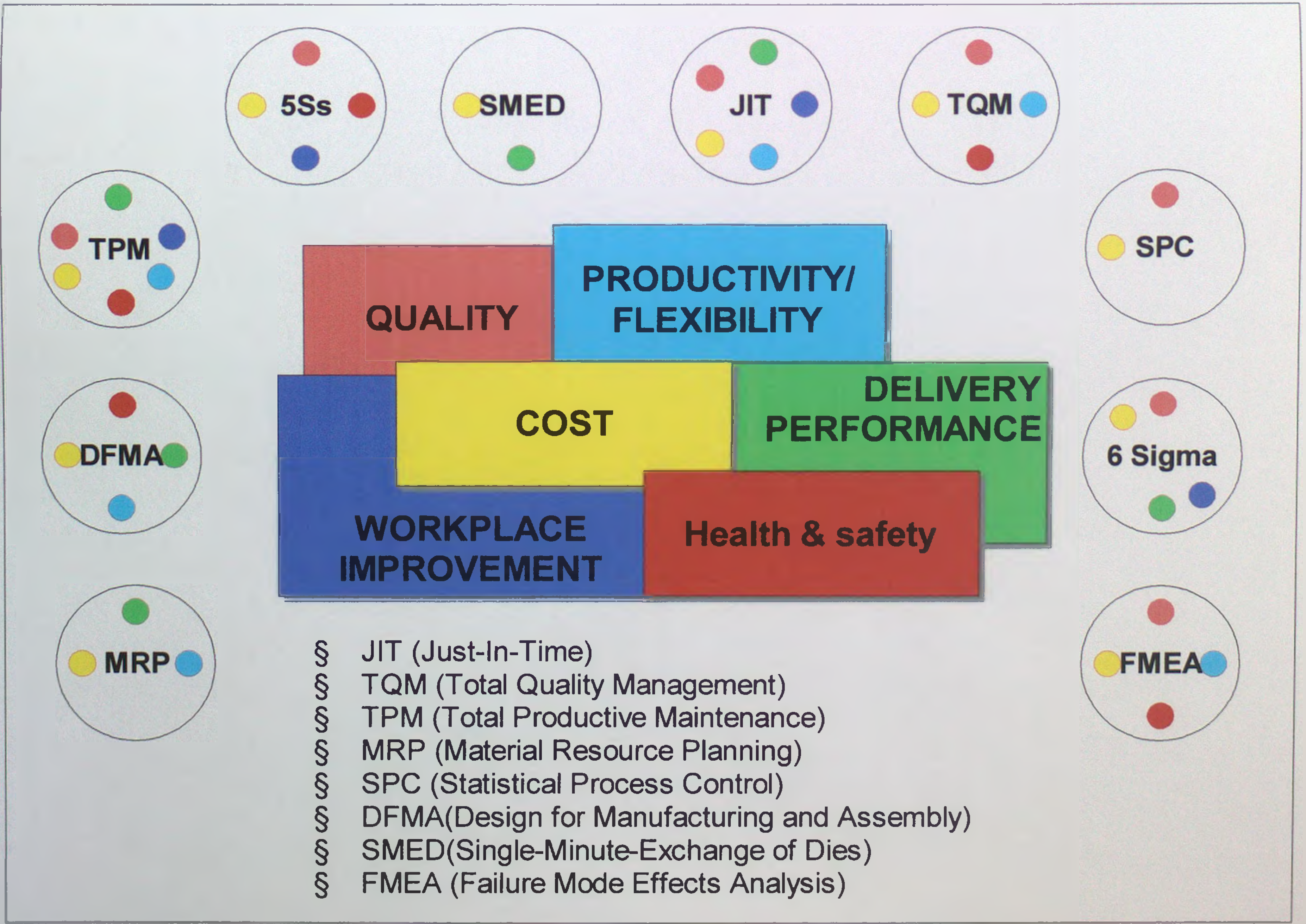


Figure 4.11: Sub-model I -- Relationship between WCM Tools and Objectives

Aspect to be Monitored	JIT	TQM	TPM	5Ss	SPC	DFMA	SMED	QFD
Availability rate	*					*		
Average idle time	*		*			*		
Average issues	*					*		
Average job lead (or flow) time	*					*		
Average stock levels	*							
Average wait time	*							
Change over time						*	*	
Cycle time analysis							*	
Equipment utilisation ratio		*				*	*	
Good Production		*			*			
Job earliness over job tardiness		*						
Job wait time variance								
Lead time for first batch to exit	*					*		*
Lead time for whole of batch	*							
Line Efficiency	*			*	*	*		
Line inefficiency	*			*	*	*		
Maintenance index			*	*				
Manufacturing lead time (MLT)						*		
Mean number of assemblies in progress	*							
Number of breakdowns per month			*					
Number of breakdowns per week			*					
Output per unit input						*		
Overall Equipment Effectiveness		*	*				*	
Percentage of capacity in use	*	*		*				
Performance rate	*							
Probability of system being empty								
Probability of system being full								
Production capacity								
Production rate								
Production speed								
Quality Rate		*			*	*		*
Queue length variance								
Queuing to manufacturing time ratio								
Service level		*						
Schedule performance	*	*						
Scrap parts per million		*			*			
Scrap rate		*			*			
Space utilisation ratio				*				
Stock as a percentage of sales								*
Throughput efficiency								
TIP (time in process) ratio	*					*		
Total Production								
Utilisation of Machinery		*						
WIP	*							
WIP as a fraction of average queue length	*							

Table 4.4: Sub-model II -- Relationship between WCM Tools and MoPs

4.8 Change Indicator: Scoring the Change Programmes

The model BoC has been tested in four manufacturing plants. The plants range from one that has been through successful business re-engineering, whose employees continuously challenge the quality of their jobs in a dynamic and exciting environment, to one that finds itself struggling between making changes and meeting production schedules, whose management is constantly under pressure. To measure the success or failure of the change implementation carried out using BoC as the navigator, the author established a scoring system named the 'change indicator' (Tey et. al., 2001[a]).

The change indicator is established to evaluate a company's change towards WCM. The evaluation is done by auditing any change programme against BoC, which is seen as the benchmark standard. It is simply an assessment tool to tell whether or not the company has been implementing its change programme effectively via the aid of the BoC model. Another example of such an assessment tool can be found in the audit write-up of Barry's model used at 73 companies in the Caribbean countries (Williams, 2003).

It is important to note that the change indicator carries significance only with the assumption that the BoC model is generic. Otherwise the change indicator will subsequently not represent the true measure of a generic change programme.

4.8.1 The Scoring Matrices

The change indicator is made up of four matrices, each one a scoring sheet. The scoring matrices are constructed for:

- Matrix L1: KAIZEN bird level 1 – input environment (see table 4.5)
- Matrix L2: KAIZEN bird level 2 – project environment (see table 4.6)

- Matrix L3: KAIZEN bird level 3 – process environment (see table 4.7)
- Matrix 'Wings': KAIZEN bird wings – WCM objectives and principles, MoPs and benchmarking (see table 4.8)

All scoring matrices share the same format except Matrix L1. The matrices contain a set of criteria in which a score is considered appropriate for a particular activity. This is due to the fact that in these areas, each 'box' represents an activity. Whereas in level 1 – input environment, each 'box' stands for a factor which a company assesses to decide whether or not actions need to be taken. Usually this is carried out by asking a list of questions. Hence in Matrix L1 scores are awarded to each question rather than to the closest fitted criteria.

The change indicator does not cover the evaluation score of the JIN bird. It will be unrealistic at this stage to score a company's approach to soft issues such as culture and innovation. An organisation's cultural attribute, how a company's communication system works, how a leader brings out the entrepreneurship of its people and how eager the workforce is to learn to take charge of their tasks and improve on them, are very subjective. Together with measuring the intangibles, this aspect will be included in future work.

Stage	Score	Description
Avoid	0	This issue has never been brought to question
Aware	3	This issue has been / is now being brought to attention and there is plan to resolve
Adapt	6	The company is fully aware of this issue and it is currently being acted upon
Achieved	10	The company has an established history of dealing with this issue efficiently

Categories of L1	Issues leading to company's success factors	Score
Supplier management	Are suppliers' performances being measured (quality, delivery etc.)?	
	Are standards set for suppliers' performance?	
	Are supplier relationships managed and documented?	
Customer satisfaction	Is there a good effort of communication with the customers to understand their needs?	

	Is customer satisfaction being monitored by means of survey, interview or etc.?		
	Is there an allocated time and resources towards customer satisfaction and improvements?		
External factors	*Market demands*	Is the company aware of current market needs and market competitive factors?	
	Government regulations	What are the government regulations or regional political factors that have significant impacts on the business?	
	Competitors actions	Is the company aware of its competitors' strengths, and their actions in attracting customers?	
Internal factors	*Vision/ Mission statements/ Management's vision/ Business strategy/ Organisation philosophies*	Is there a vision / mission statement known to the entire workforce and the customers? Is there an underlying set of organisation philosophies/ principles known and followed by the entire organisation?	
		What is the management's vision / strategies of change towards world class manufacturing?	
		What is the company's business plan (5-year plan for example) taking into account all the above factors?	
	Critical shop floor concerns	What are the factors hindering shop floor processes from becoming an efficient and productive working environment? What are the main concerns/ problems regarding working towards SCEF (Safer, Cheaper, Easier, Faster) operations?	
	Manufacturing capacity/ Technological and human resources	Is there sufficient manufacturing capacity, technological or human resources to carry out the change currently undertaken?	
	Organisation structure	Does the company structure allow sufficient inter-functional communication? Does it fit to the modern principle of flat organisation? Does it have a horizontal team based structure to deal with short term change implementation?	
	Data collection	Is the data collection system capable of generating data for the major operational performance measures (quality, cost, time, productivity)?	

Table 4.5: Change Indicator -- Scoring Matrix for KAIZEN Bird Level 1 'input environment'

Score	Identify Areas of Improvements/ Company Success Factors	Prioritise Actions	Select Appropriate Tools	Set WCM Targets
0	No specific improvement areas identified. Only the matter of running production and making money	Nothing done to prioritise any actions	Do not recognize any tools in the document, operate in traditional way	No targets are set. No performance measures are generated. Only financial targets (sales, profit)
3	Areas of improvements identified after assessing the external and internal inputs from Level 1; however some are not exactly aligned with the inputs Less than half of all the input factors are being considered	Actions are prioritised without specific evidence; only from the executive's knowledge and preference	Utilising some tools but without specific reasons. "Do it because everyone else does!" or "seems necessary to keep up with the modern techniques"	Few operational targets (quality, cost, time, health and safety, personnel) are set, but not persistent with performance measures
6	Areas of improvements are identified as a direct result of assessing the external and internal inputs from Level 1. More than half of the input factors are being considered Becoming a SCEF operational environment is nominated as an area of improvement	Decisions on prioritising actions are made in a WCM project team meeting Actions are prioritised due to constraints (e.g. time, capital, available resources)	Tools are chosen to support specific areas of improvements and to achieve specific manufacturing objectives Some tools are not aligned with the company's specified success factors	Realistic operational targets are set persistent with the performance measures, efforts are made to assure target achievements Targets are set to achieve international standards (ISO, Baldridge, Deming etc.) New targets are continually set for a SCEF operational environment

10	Areas of improvements are identified as a direct result of assessing the external and internal inputs from Level 1. All of the input factors are being considered in detail Becoming a SCEF operational environment is nominated as an area of improvement	Prioritisation of actions carried out by WCM project team as mentioned above Taking into considerations not only constraints (financial, technological and human resources), but also company's strategic vision Plus using one or more analytic methodologies to decide, e.g. pareto analysis, Analytical Hierarchical Process, Priority Map or other OR approaches	Tools are chosen and modified to support <u>ALL</u> areas of improvements and to achieve specific manufacturing objectives Tools are selected to fit WCM principles and to create a lean / SCEF operational environment Tools are aligned with performance measures	Targets are reassessed during WCM project team meetings, to ensure they are achieved, maintained, and regularly re-established. Targets are set to achieve international standards (ISO, Baldridge, Deming etc.) New targets are continually set for a SCEF operational environment

Table 4.6: Change Indicator Scoring Matrix for KAIZEN Bird Level 2 -- Project Environment

Score	Identify Corrective Actions	Prioritisation of Actions	WCM Implementations Progress Monitoring
0	No corrective actions identified for the following reasons: ➤ Change programme stops at 'project environment'. Strategies, vision, or targets are not translated into specific actions ➤ Management pays lip service to change initiatives ➤ Change programme does not get support from workforce ➤ Change facilitator tries to carry out activities as an individual	Nothing done to prioritise any actions	There is no progress meeting or report of any sort concerning organisational change towards WCM
3	A number of actions are carried out in relation to the identified areas of improvement (Level 2), but these actions are developed out of the facilitator's intuition. There are partial use of the "forward mechanism" or the "backward mechanism", again, these can be out of intuition and not recorded	Actions are prioritised without specific evidence; only from the executive's knowledge and preference	Meetings are carried out on rare occasions, and only involve management and no one of the shop floor Reports are rarely done and only include financial performances, or the overall progress of big projects, without breaking down progress of smaller actions
6	More than 50% of the prioritised areas of improvements (Level 2) are translated into an identifiable set of specific actions The set of corrective actions/ countermeasures are generated using a kind of "forward mechanism" after carefully analyzing the	Decisions on prioritising actions are made in a WCM project team meeting Actions are prioritised only due to constraints	Meetings involve not just management but shop floor people (e.g. team or cell leaders) The reports keep a record of the corrective actions, the progresses and the people responsible for the actions Meetings and reports are regular in the

	concerns and causes OR The set of corrective actions prompt the establishment of a corresponding set of potential improvements using the "backward mechanism" The corrective actions are in the simplest possible operational form	(e.g. Time, capital, available resources) or the executive's knowledge and preference	beginning phase of change programme, but it falls away at a later stage due to ➢ Too little change occurring to make meetings and reports worthwhile ➢ Progresses are not well communicated
10	<u>ALL</u> the prioritised areas of improvements (Level 2) are translated into an identifiable set of specific actions The corrective actions are in the simplest possible operational form There is full utilization of either the "forward mechanism" or the "backward mechanism" or both The generation of corrective actions ➢ Employs the theory and practices of the tools which are put to use ➢ Takes into consideration the available resources and expertise to perform them	Prioritisation of actions carried out by WCM project team Taking into considerations not only financial, technological and human resources, but also the inputs from Level 1 Plus using one or more analytic methodologies to decide (Pareto, Analytical Hierarchical Process, Priority Map or any other OR approach)	Meetings are regular and involve not just management but shop floor people (e.g. team or cell leaders) A progress report generated regularly includes ➢ Corrective actions, target and actual completion dates and individuals in responsibility ➢ Improved outcomes of the corrective actions, ➢ Performance measures charts as a result of the corrective actions ➢ Why certain corrective actions did not work out Reports are circulated among the entire workforce, progesses are well-communicated and are fed back to Level 2 "identifying areas of improvements"

Table 4.7: Change Indicator -- Scoring Matrix for KAIZEN Bird Level 3 'process environment'

Score	Performance Measures / Benchmarking	WCM objectives / Principles of Simplicity
0 – 5	➢ Performance measures only in forms of financial measures (sales, profit and accounting figures) ➢ No benchmarking activity, aware of competitor's strength but no significant effort is made to find out more	➢ Unaware of the objectives to form a WC firm, only the most basic business objectives (e.g. Lower cost to increase profit) ➢ Unaware of WC principles of simplicity, continuous improvement or lean working methodologies
5 – 10	➢ Basic performance measures (cycle time, delivery time etc) and mostly done manually, not generated automatically and regularly ➢ Simple benchmarking activities with close competitors (product costs, product feasibility etc)	➢ Aware of the basic objectives (cost, quality, productivity) and work towards them in the company's own traditional way ➢ Implementations more likely to be one-off big progress rather than small steps continuous improvements ➢ Each operation is generally carried out with one or two lean working principles (safer, cleaner, easier or faster)
10 – 15	➢ World class performance measures, including tangibles and intangibles, are regularly generated and show up to 4 WCM objectives ➢ Performance measures are in conjunction with tools / operations within the company ➢ Competitive benchmarking activities carried out on products and processes, internally between departments and externally with competitors ➢ Occasional benchmarking activities in forms of visits to suppliers / customers	➢ Constantly aware of the 6 WCM objectives, and active in working towards up to 4 of them at a time ➢ Find new / innovative ways of achieving objectives, including utilising modern tools ➢ Continuous improvement working culture, small steps at a time but regularly making progress ➢ Each operation is generally carried out with two or more lean working principles (safer, cleaner, easier and faster) and with waste attacking culture ➢ Strategies / vision /mission statements are translated into shop floor corrective actions

15 - 20	➢ World class performance measures, including tangibles and intangibles, are regularly generated and show all WCM objectives and completes the balanced scorecard ➢ Performance measures are in conjunction with tools / operations within the company ➢ PM acts as an indicator to WCM implementation progress, and a feedback to identifying the new set of company success factors (KAIZEN Bird Level 2) or corrective actions (KAIZEN Bird Level 3) ➢ Regular external and internal benchmarking activities carried out in all WCM areas of interest; regular benchmarking visits to customers / suppliers / business alliances ➢ Standard benchmarking procedures recorded, benchmarked data being analysed and feedback to identifying company success factors (KAIZEN Bird Level 2) and corrective actions (KAIZEN Bird Level 3)	➢ Company working towards all the 6 major WCM objectives at all times ➢ Company using at least one tool / technique to support each of the 6 major WCM objectives ➢ The tools are utilised to full potential, and they help achieve targets successfully ➢ Company's operations are abide with all the principles of simplicity outlined in the research ➢ Constantly achieving continuous improvements, elimination of waste / non value-adding activities and a lean working environment (safer, cleaner, easier and faster) ➢ Strategies / vision /mission statements are translated into shop floor corrective actions; all operations are aligned with company's up-front success factors

NB: The scoring of the 'Wings' needs to be supported by:
(i) Correlation between WCM tools and MoPs
(ii) Correlation between WCM tools and Objectives
(iii) WCM principles of simplicity

Table 4.8: Change Indicator -- Scoring Matrix for KAIZEN Bird 'Wings'

4.8.2 Method of Scoring

To make the scoring system simple and easily communicated, the score range is made out of either 10 or 20. This score range is then divided into 4 score categories according to the four autonomous steps 4As: 'avoid', 'aware', 'adapt' and 'achieve' (Williams, 1999). Where a score category meets an activity in the matrix there is a set of criteria listed in point forms, describing state of the change activity which deserves the specific score. The company evaluates itself by comparing their own change activity at the time with the given criteria, then scores accordingly. In-between scores are allowed (e.g. If company A weights its activity 'set WCM targets' to be in between stages of 'aware' and 'adapt', a score between 3 and 6, such as a 5, can be awarded).

The change indicator outlines the change characteristics of different companies, from where nothing literally exists ('avoid') to the stage of industry's best practice ('achieved'). Obviously activities carrying the criteria that fits a perfect score (10 or 20 in each case) are regarded as 'best practices'. Therefore, despite evaluating a company's change towards WCM, the change indicator also provides a guideline for the company to benchmark themselves against best practices and make progress.

The indicator is also able to highlight the problem areas and activities that hinder change, allowing the company to know its strengths and weaknesses. The overall weighting of the change indicator score is shown in Figure 4.12. This system is simple and straightforward. Scores can be taken individually or summed up. Total change indicator score evaluates the overall success of a company's change effort, but it is certainly not the only score to be examined. Management, and the personnel involved should be looking at scores of each activity / area, measure the gap between its current progress and best practices, then CI actions to achieve the target.

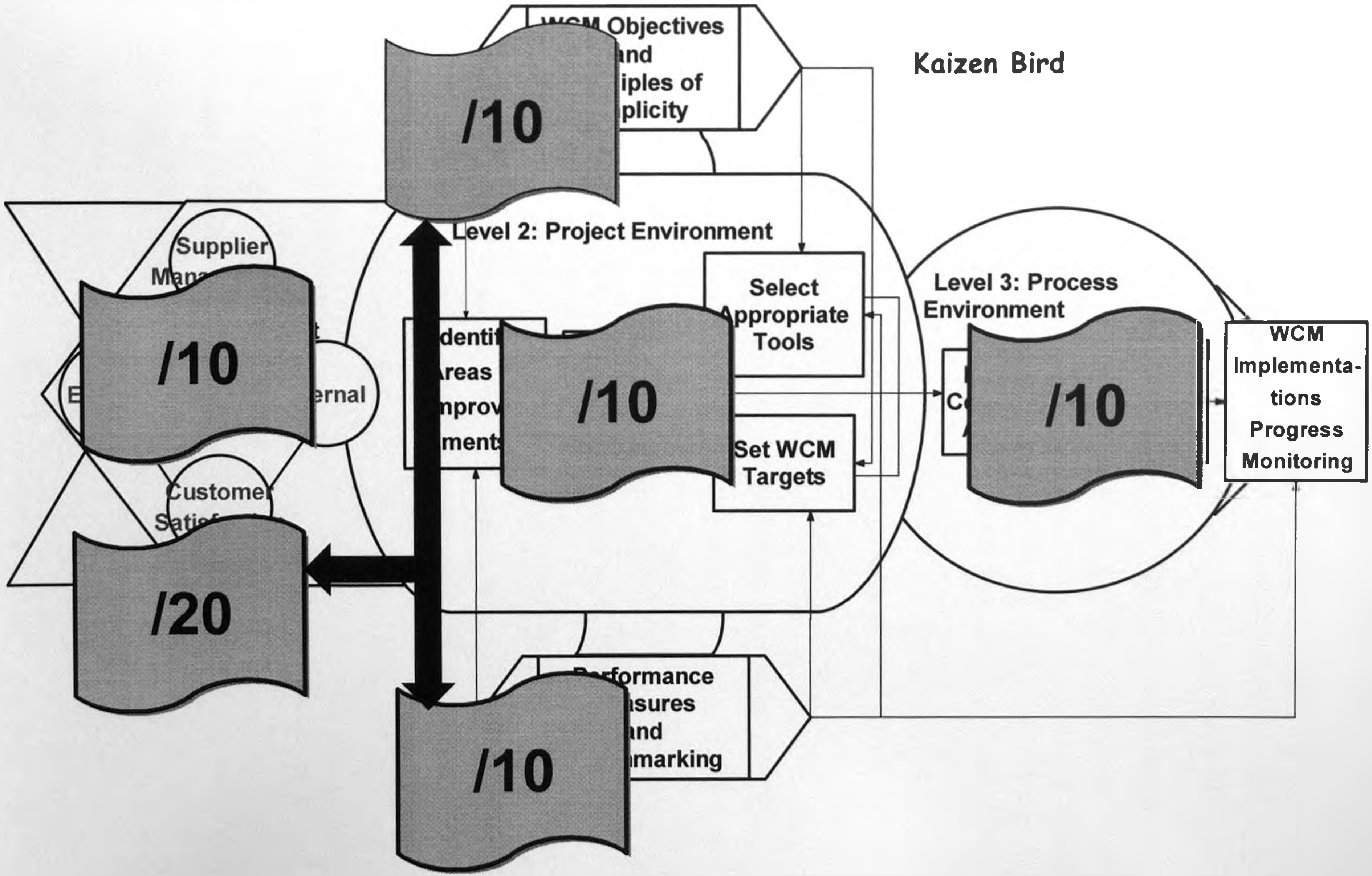


Figure 4.12: Weights of scores within the Change Indicator

The scoring system is designed for each area but it is not aimed at a certain group of personnel. The ultimate structure of work is flat, team-based and cross-functional. Therefore each area of change should involve members from different departments. The scoring is thus effective in the way that it targets an activity of the change and not the people involved.

Justifications and weaknesses of this scoring method will be further discussed in chapter 6 (section 6.5.1).

4.9 Summary

A final definition of WCM has been produced to provide a point of reference to the entire research and the thesis. This definition has been developed from investigating various definitions in the literature. It comprises all the essential elements and describes the way WCM is perceived throughout this research.

The research investigated existing models / frameworks related to OC and WCM, before justifying the need to create a new model which fulfils the specific objectives of this research. Four published models / frameworks are presented. Each of them focuses on different aspects of WCM and OC, but all of them carry significant contributions to the field.

The 'birds of change' (BoC) model gathers core findings of the research and presents them through a visual illustration of a bird. It is created with these fundamental objectives:

- To translate business strategies into operations
- To facilitate modern WCM principles, philosophies and tools
- To align WCM objectives with modern tools and appropriate MoPs
- To set up MoPs and benchmarking as feedback of change progress
- To incorporate a soft structure of OC

The BoC model is shaped by the following three major components:

- JIN Bird – as an overview of the change model, describes soft structure overriding the entire change process
- KAIZEN Bird – core of the change model, where the actual change process and implementations are outlined
- Sub-models – as a sub-level of KAIZEN Bird, describing the correlation between elements of the change process

The model outlines all elements needed to carry out a WCM change programme, including the hard and the soft structures. It provides sequencial steps to the entire process of WCM implementation, from forming an executive vision statement to monitoring shop floor corrective actions. The model also presents the important principles that need to be followed to achieve WCM status. In summary, BoC is sufficient as a guide to carry out a WCM change programme. The information that needs to be outsourced includes:

- WCM tools
- International benchmarking standard
- External and dynamic factors such as market demand, customer requirements and government regulations.

The 'change indicator' is a scoring system specifically designed to measure the success of a company's utilisation of the BoC model. The scorings are done by assessing a company's performance in every change element outlined in the model, and measure the performances against the best practices found in the research. The scoring matrices each represent a designated area of the KAIZEN Bird. This measurement system allows a company to assess the strengths and weaknesses of its change programme towards WCM. The validation of the change indicator as a true measure of a company's change programme is built on the presumption that the BoC model is generic across different manufacturing environments.

CHAPTER 5

Case Studies, Results and Model Applications

Outline of chapter

Chapter 5 introduces the participating companies in this research. The four companies (Heritage, Rexel, Pilkington and Corus) formed a spectrum of companies with diverse backgrounds and characteristics, which will be explained in detail. These characteristics, which will be compared, include company structure, the company's chosen framework of change, management's vision, dynamics of change, change culture and manufacturing bottlenecks. The main content of the chapter is to outline the world class manufacturing (WCM) undertakings of each company and their different change programmes during the period of current research. The chapter then describes the utilisation of the model 'birds of change' (BoC) at the four participating companies, plus its use in the context of Caribbean industry. Finally the chapter presents results in terms of general outcomes, measures of performance (MoPs) and scores of the change indicator.

5.1 Introduction

As explained in chapter 3, due to the need for practicalities, research of this nature requires empirical data obtained from industry. What needs to be planned beforehand is the range of the types of companies to be sought – everything from size, product, physical location... to organisational structure, manufacturing strengths and weaknesses. Decision upon the size of samples was based on getting adequate diversity in order for the research to represent a generic application. The next imperative step was to make sure that the research focuses on the change programme towards WCM in the selected companies.

The change model -- 'birds of change' (BoC), presented in chapter 4, is the main vehicle used in these case studies. The model suggests evident ways of achieving WCM and reaching the heart of business strategy. The sequential nature of the model makes its utilisation easy. The objective is to show how the companies' change programmes fit into the BoC model. Each company has its unique way of implementation. To show the generic nature of the model, it should demonstrate that not only can the model be applied to companies in the UK, but also companies in other continents around the world. So the question is whether BoC has the capacity to accommodate all the different circumstances.

The use of the model in industry will not prove anything if no conclusion can be drawn on results achieved. There are many ways to present the results. One can obtain visual results from the physical changes of the manufacturing plant and culture shifts of the organisation. Others would utilise the more evidential way via MoPs. The 'change indicator' was designed to co-ordinate with the BoC model and to measure the success of a company's change towards WCM. This scoring system, provided that BoC is a generic model, should play the role as a generic scoring vehicle for all companies and therefore make results comparable between cases.

5.2 Companies' Backgrounds, Change Programmes, and their BoC Model Applications

The four main participating companies represent a wide range of diversity, allowing generic conclusions to be drawn at a later stage. Table 5.1 best summarises the different background and characteristics of these companies. However, each company is detailed in the following sections.

One of the objectives of the BoC model is to provide a visual management guide towards WCM change programme. Change activities are carried out following the BoC model. By understanding the basic principles and background of the model, all the important and recent information of the change programme can be inserted into the model. This enables the information to be communicated among management, team leaders and members in a quick and effective way. The model can easily be updated on paper and referred to during discussions and meetings.

	Rexel	Pilkington	Corus	Heritage
Size (no. of employees)	250	500	54	25
Products	Business Machines (Shredding, laminating, photocopying machines)	Glass (car windows, windshields)	Aluminium (to customer's required sizes and shapes)	Tableware (make-to-order)
Organisational Structure	Few hierarchies, mostly flat; partially integrative; cross functional teams formed occasionally	Flat, partially integrative, cross-functional teams formed for temporary projects	Top down; partially integrative; functional specialisation	Top down; segmentalist; functional specialisation
Change characteristics	Change is norm, plant experiencing extensive and rapid improvements in layouts, process time reductions and quality assurance, workforce subjected to a transformation of change culture led by continuous improvement (C.I.) manager	Change is driven by the world wide organisation as a whole, the plant is practicing excellent continuous improvements after a dramatic re-engineering, entire workforce seeking ways to challenge quality and break through high performance measures	Change has happened but not justified, tools are adapted, implemented but positive results are rarely obtained, merging has negative impact in change, however the plant is set for a re-engineering	Change has been halted by production and business expansion, plant operated in the traditional way, change culture takes time to be introduced and adapted
Vehicle/ framework for change programme towards WCM	Continuous Improvement programme facilitated by the C.I. manager	Manufacturing To Win (MTW) programme, composed for the entire organisation, communicated through intranet	Barry's Model of a world class organisation; William's 4 autonomous steps to WCM	Tey's birds of change towards WCM

	Rexel	Pilkington	Corus	Heritage
Bottleneck in change	Bringing the entire workforce into the culture of constant transformation and improvements	Integrate the plants implementations to MTW programme to excel as one PILKINGTON world wide	Lay-offs resulted from merging interrupted change projects and affect morale	Lack of resources, cash flow problems, lack of inventory information and performance measures
Main WCM activities	5Ss activities in shaft production; health and safety; environment; employee benefits; supplier management	Manufacturing improvements (team building and KAIZEN); environment, health and safety; standardisation; new model introduction; learning & communication	Critical concerns audit, TPM, OEE, SPC, 5Ss, FMEAs, Production modelling and simulations	Set up data collection system, 5Ss on shop floor
Management's vision	Health and Safety → Productivity → Quality → Environment	5Ss → TPM → Team based structure → 6 Sigma	Improve financial performance → benchmarking → customer satisfaction → business excellence scheme	Data collection on component stock and system input → 5Ss → WCM implementations

Table 5.1: Four participating companies in current research and their characteristics

5.2.1 Heritage Silverware

Heritage Silverware is a local tableware manufacturer based in Birmingham. The company employs 25 people and the company structure is simple. At the launch of research the company had one designer, one accountant and one operations manager. The director and the assistant director took on all other responsibilities including purchasing, marketing, personnel, scheduling and shop floor operations.

Heritage Silverware manufactures very customized tableware products. The company's objective has always been to satisfy customers by manufacturing to very detailed requirements, producing bespoke tableware in a very short lead time. Like most manufacturers, Heritage faces international competition. In order to gain competitive advantage, the company has to achieve better customer satisfaction by reducing cost and improving delivery performance.

One of the biggest problems faced was to identify the location and number of component stocks. Time and money are wasted in purchasing or making components or parts that already exist somewhere in the factory. Therefore it was recognized that cost reduction could be most effectively achieved by acquiring a components tracking system. This was then identified as the primary area of improvement (as described in KAIZEN Bird Level 2 'project environment').

Heritage is aware of the competition and the need to change in order to survive. In the effort of carrying out changes, the company takes in university researchers and employs teaching company associates. At the time when WCM was introduced to Heritage Silverware, two projects have been recently completed. One of them was on a coding system of the products (Marcias, 1999). The other project, which aimed to set up a computer IT system for production control, was first carried out by a teaching company associate and was later supported by another project (Rizky, 2001) to build a coordinating interim system. All of these projects were related to the company's primary area of improvement, and worked as part of the BoC model implementation to advance towards WCM.

The WCM proposal was accepted and the implementation kicked off in March 2000. A WCM team was formed by the company's director, assistant director, operations manager and the researcher (as WCM initiator). Weekly meetings were held to monitor progress of the implementations. After assessing the primary concerns of the company, the WCM team developed a vision of the change programme:

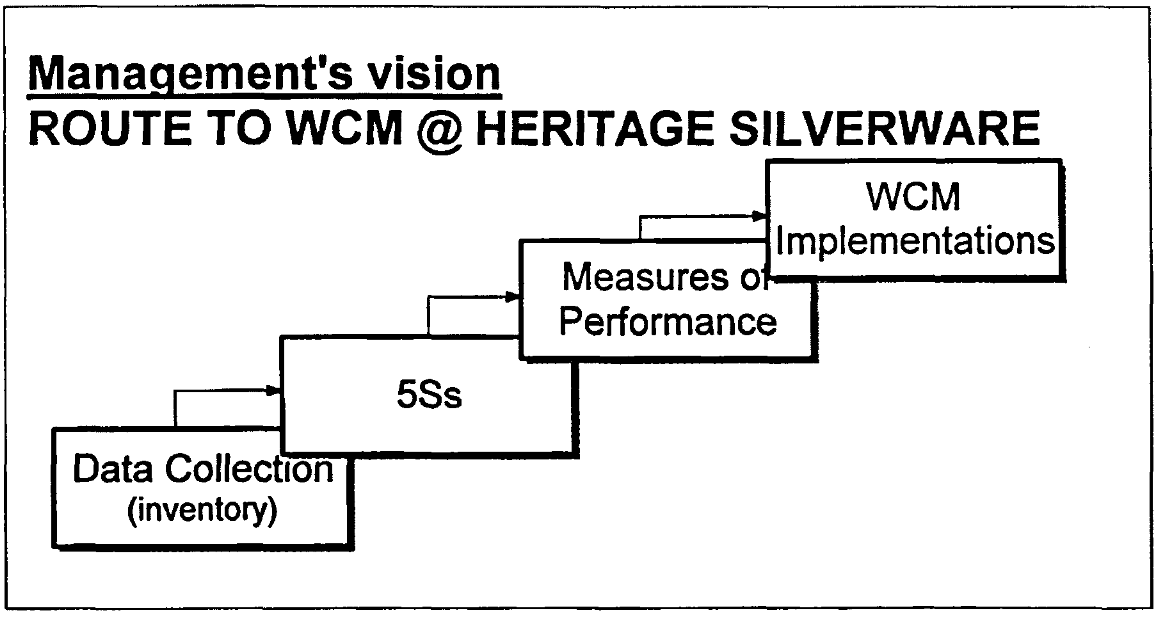


Figure 5.1: Management's vision towards WCM at Heritage Silverware

The primary concern of the initial WCM implementation was to tidy up the shop floor. There was a massive amount of tableware components, tools and machines lying around. This was when the TPM tool 5Ss came in handy. Red-tagging of the items allows 'sell, use or bin' decisions to be made. It was decided that to implement 5S principles effectively, they had to be translated into the simplest operational form. Therefore, using the 5Ss terms created in Rexel, simple objectives were formed:

- Sort (Seiri) – What can we get rid of?
- Segregate (Seiton) – A place for everything and everything in its place
- Shine (Seiso) – Creating a spotless workplace
- Standardise (Seiketsu) – Develop a standard to maintain and monitor the first 3 Ss
- Sustain (Shitsuke) – Make it a way of life!

As far as MoPs are concerned, the company was still, at the time of this research, depending on manual purchase orders and delivery information. MoPs play a vital role in moving towards WCM, and the company was receiving wake up calls that in order to gain competitive advantage against its competitors, it needs to take its utilisation of MoPs to a higher level. The first MoPs that the team planned to generate were delivery performance and process cycle times, as these are easy to generate and provide useful measures.

Assessing the company's current standpoint and its immediate needs, an outline of the implementation of WCM was sketched in the beginning:

- Team building and understanding of 5Ss
- Select one area for pilot study of the 5Ss implementation
- Workforce awareness and training
- Generate basic MoPs: lead time, delivery performance
- Total implementation and CI in the entire company

For training and education purposes, 5 workshops were carried out in the early stage of the project. The workshops, conducted by the WCM initiator and supported by the management and participated by everyone on the shop floor, were:

- Workshop 1: Introduction to WCM and its relevance to Heritage
- Workshop 2: 5Ss and the implementation plans at Heritage
- Workshop 3: Performance Measures at Heritage
- Workshop 4: Change Management at Heritage

Until the company has a proper data collection system to handle their inventory information, a set of useful MoPs in place, and an awareness in embracing 5Ss principles, it would be a struggle to compete in the WCM environment.

The research got on to a good start. Executives and shop floor people were welcoming to new ideas. After a successful 'clean up' of the pilot area – polishing shop, the 5Ss kicked off in the other job shops. Workforce seemed to be aware of the idea of WCM, and was willing to do what was told to support the idea. However, the research soon found its resistance. The project managed to carry out the first 3Ss, but had problems sustaining the practice. The main blame of this stagnation was the lack of resources. A breakdown analysis can be summarised in table 5.2:

Factors	Results
➢ Personnel heavily involved in production to fulfil outstanding orders	➢ Lack of time commitment to WCM
➢ Insufficient human resources	➢ Personnel need to cover jobs outside their own domains
➢ Irregular/seasonal incoming order	➢ Heavy production during peak season. WCM changes cannot be carried out.
➢ Lack of systematic production scheduling ➢ Lack of planning according to capacity and human resource	➢ Insufficient human resources ➢ Delivery date unfulfilled
➢ No standard operating procedure	➢ Shop floor often gets cluttered up ➢ Inefficient 5Ss implementation
➢ Lack of an innovative workforce	➢ No WCM innovation on the shop floor

Table 5.2: Why some WCM initiatives are not happening? – A breakdown of reasons

Despite the resistance encountered, the project did achieve some results:

➢ Implementation of 3Ss in most of the shop floor

➢ MoPs generated (cycle times and delivery performance)

➢ Total awareness of WCM initiatives

BoC Model Application at Heritage Silverware

Figure 5.2 shows an example of using the BoC as a visual management tool to carry out WCM change process in Heritage Silverware (the rest can be found in Apprendix B [1]). The important elements of current strategies and implementations are recorded in the appropriate areas (activity boxes) of the model. This information was updated weekly and discussed during short meetings among the WCM team. The updated model is displayed on the board for visual reference so everyone knows what is going on in terms of WCM implementations.

In this instance, the up-front improvement areas are decided as follows:

- Data collection for component stock
- Information system set-up
- Improve delivery performance
- Reduce supplier dependence

These are presented in level 2 of the KAIZEN Bird. Having these primary success factors in mind, the WCM team began the process of selecting the appropriate tools, and the MoPs needed to be carried out. It was decided that by carrying out the 5Ss activities most of these objectives would be tackled in a short period of time. MoPs that are needed included delivery performance and throughput time.

Figure 5.3 illustrates a progress report done weekly on the corrective actions carried out in Heritage Silverware on the WCM undertaking (more can be found in Appendix B [2]). Other than the meeting dates and the team members, the report consists of the corrective actions in different categories, a bar showing progress of the implementations, the individuals responsible for the specific task, and comments on how well the task is being carried out.

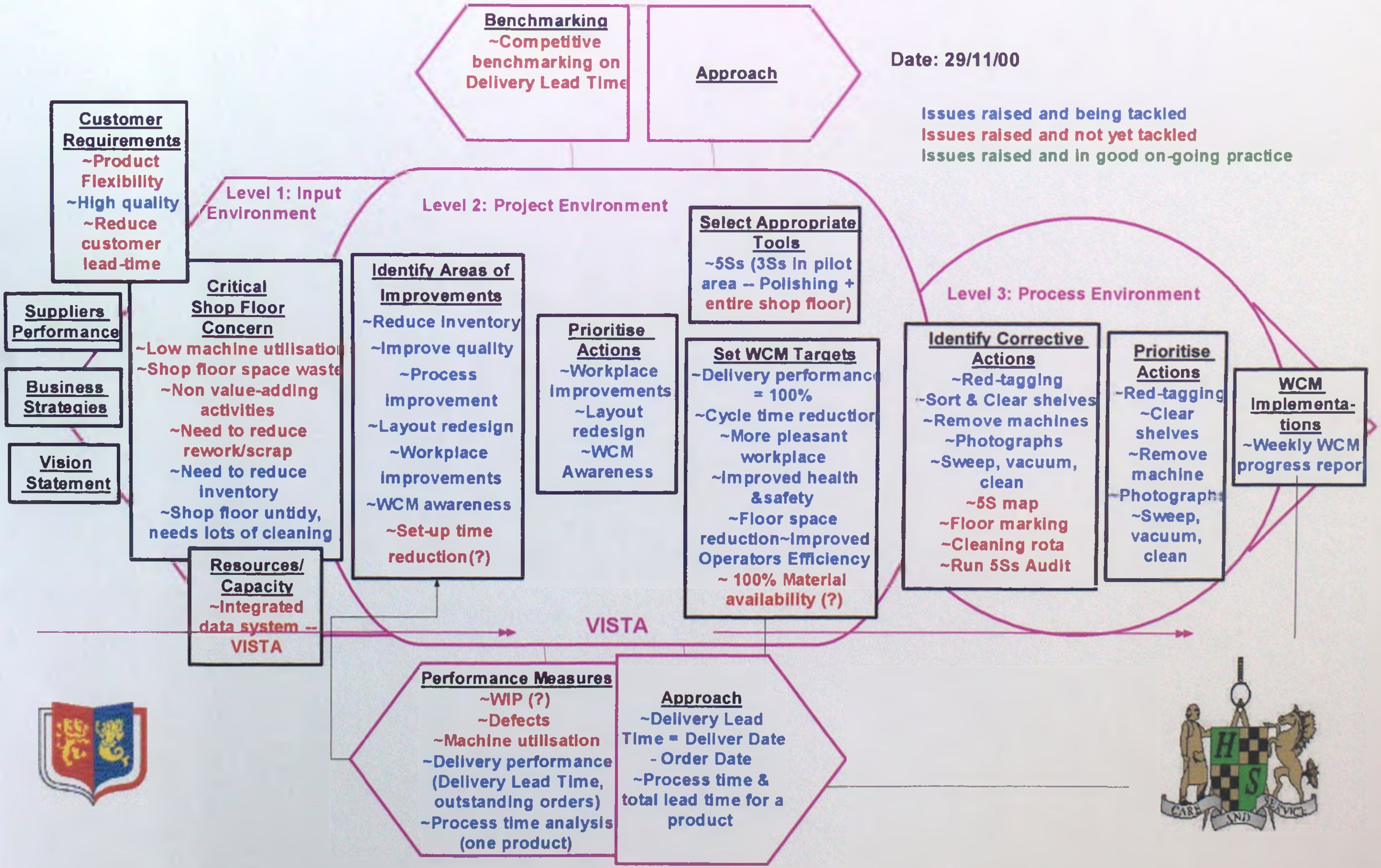
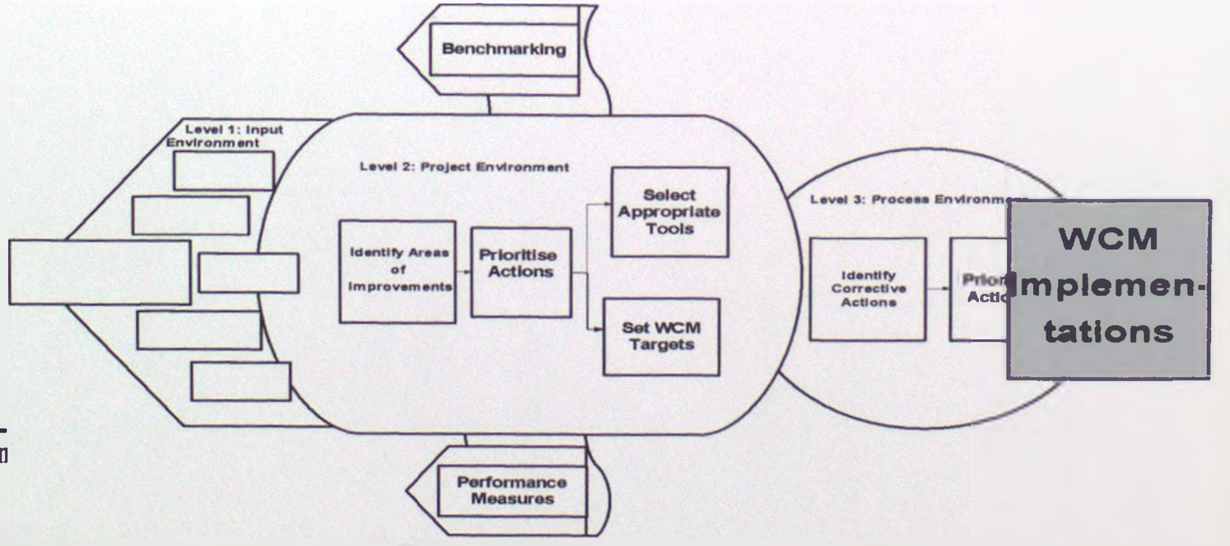


Figure 5.2: An example of using BoC model at Heritage



[CA]Corrective Action [PM]Performance Measures/ [IE] Input Environment				0	date	
** [CA] Red tagging activity on machines, tools, shelves etc. (entire shop floor starting from polishing)	Ben, McD, Mir	22/01/01 (2 mnths)				6 machines in making shop have been red-tagged. Decision has to be made: sell, use or bin them.
[CA] Polishing shop re-layout (5S map) "SORT+SEGREGATE"	McD, Ben, Tey					Need to take a "walk down the shop floor", and Sort. Need to be done after removal of all unutilised machines and shelves
** [CA] Clear tool shelves "SORT" & "SEGREGATE"	Ben, Mir, Harry	24/11 overdue				❖ Get rid of the unused mops on the shelves ❖ Place mops in trays according to their different uses
[CA] Prepare red-tags "SORT"	Ben, Tey	Wed 30/8 overdue			22/11	Red tags ready for 5S activity
[CA] Photography (polishing shop)	Ben, Tey, Pip	On-going				Take photographs of clean workplace as "STANDARDISE" activity
[PM] Delivery performance data	Mir, Tey, Ben	On-going				Excel format. Tey generating lead time, no. of outstanding orders regularly.
[PM] Process cycle time analysis	McD, Tey, Mir, Ben, Chin	Wed 06/09 overdue				Decided to choose a product (product name?) and analyse process time manually. Need actual lead time plus waiting, moving, to stock time
** [IE] Business strategies	McD	Wed 25/10 overdue				McD to come up with business strategies and put them down on paper.

Meeting:- 29/11/00 @ 1100	Previous meetings	Date Time	23/08 1400	30/08 1300	04/10 1245	18/10 1200	25/10 1100	01/11 1300	15/11 1400		Next meeting:- 05/12/00

** Up front issues discussed last week. Actions should be taken to tackle these first!

Figure 5.3: A case at Heritage Silverware – WCM implementations progress monitoring in KAIZEN Bird level 3 'Process Environment'

5.2.2 Rexel Business Machines – ACCO

Rexel Business Machines belongs to ACCO-Europe, a world-wide organisation. The Droitwich plant employs 250 people, and the annual turnover is £36 million. Rexel is a popular brand for stationery products, although it mainly produces business machines such as photocopy machines, laminating and shredding machines.

Early 1999, ACCO faced international competition and it saw the need to be WC to stay at the leading edge. Attempts to push the entire plant into a culture of change included the Bronze award. The award scheme aimed to bring the company to WC status on a continuous improvement (CI) basis. The programme was initiated by a CI manager and carried out in the form of an employee award scheme, which comprises three phases of WC implementations, namely the bronze, silver and gold.

Bronze Award

This implementation involved employees from all departments (although the emphasis is on the shop floor). The idea was to create an inter-departmental competitive environment to improve in several areas. Every department would then compete to achieve the award. Once the whole plant achieved Bronze award, it will then move on to the higher requirements: silver and gold award, where gold award would consist of what was regarded at that time as the industrial best practices.

The change programme utilises visual management rather than the conventional "post mortem" type of progress control. Visual control enables problems to be visible as they occur and makes immediate corrective actions possible. Among the many tools used are the 5Ss, TPM and OEE (see chapter 2 for more references).

A standard audit is run by a facilitator each week to assess the departments for the bronze award. The following shows the outline for the audit (Tey and Duffill, 2000):

- Achieve the first two components of the 5Ss technique (sort and segregate):
- Introduce an agreed number of standard operating procedures (SOP):
- Examine layout and logistics for efficient and effective product manufacture
- Business related team boards
- Implementation of ILU training boards (example shown in figure 5.4).

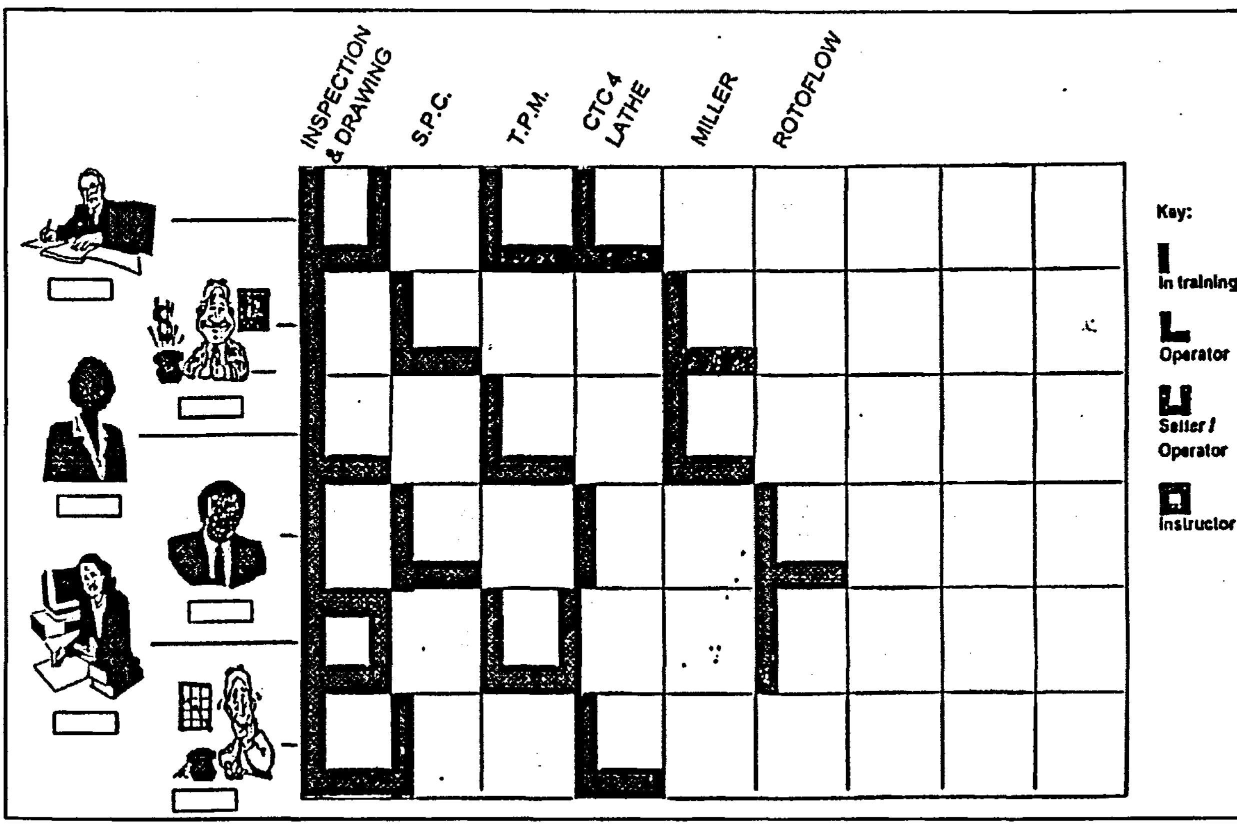


Figure 5.4: An example of ILU training matrix

This research studied the Bronze award and its relevance to WCM. The Bronze award was a collective implementation of a WCM change programme with specific company success factors, tools, corrective actions and a set target identified. Figure 5.5 illustrates how the implementation of the Bronze award audit system fits in the BoC model.

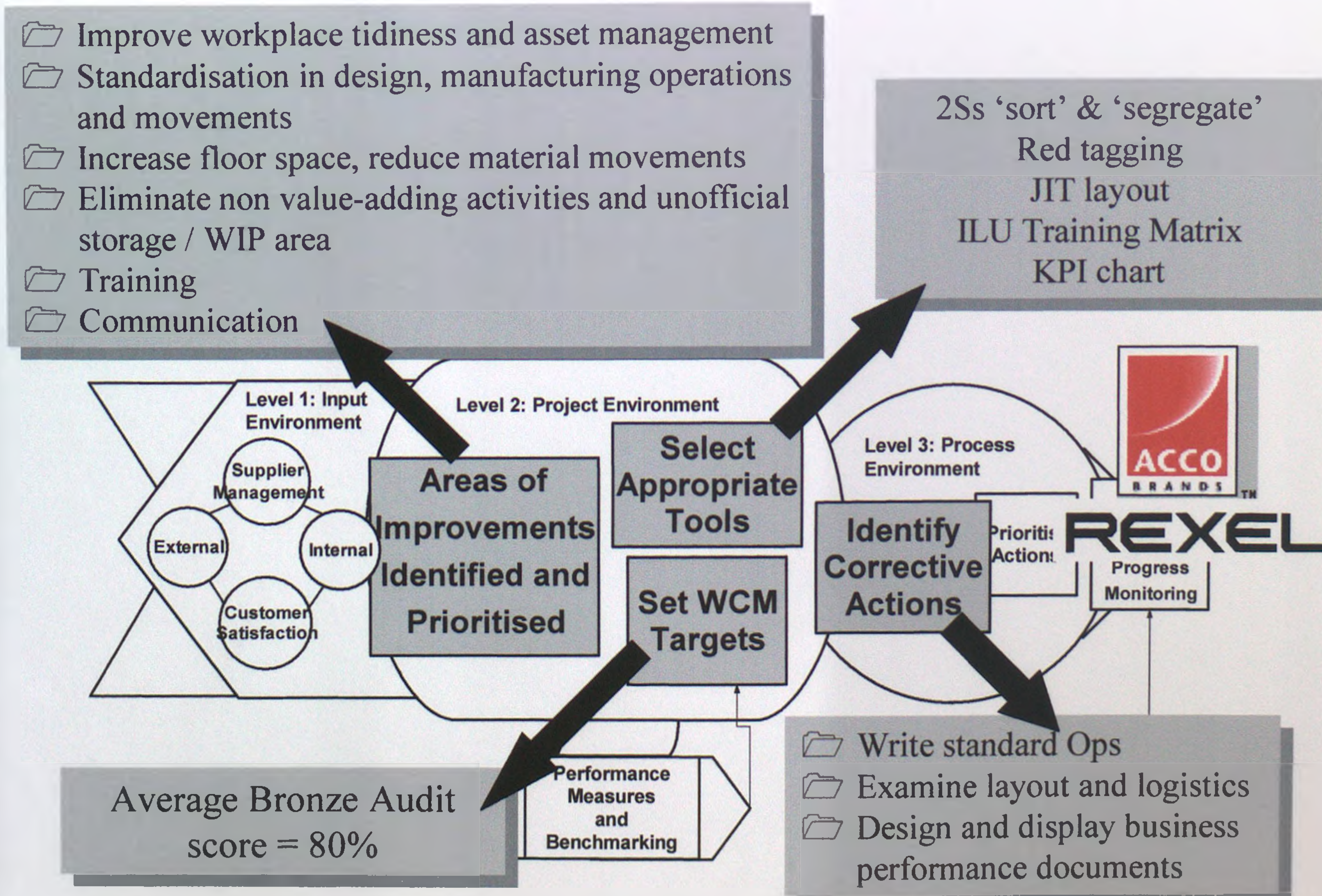


Figure 5.5: BoC Application at Rexel -- the Bronze audit and its relevance to WCM

New KAIZEN programme

Since spring 2000, the primary mover of the change programme in the plant was a new manager who brought in KAIZEN ideas from his previous Rover plant. This CI manager took on the job and put a lot of ideas into action, mainly 5Ss practices and visual management tools. The Bronze award ceased together with the change of management, although the company was well into achieving a plant-wide Bronze award.

The new KAIZEN approach took on a vision as follows:

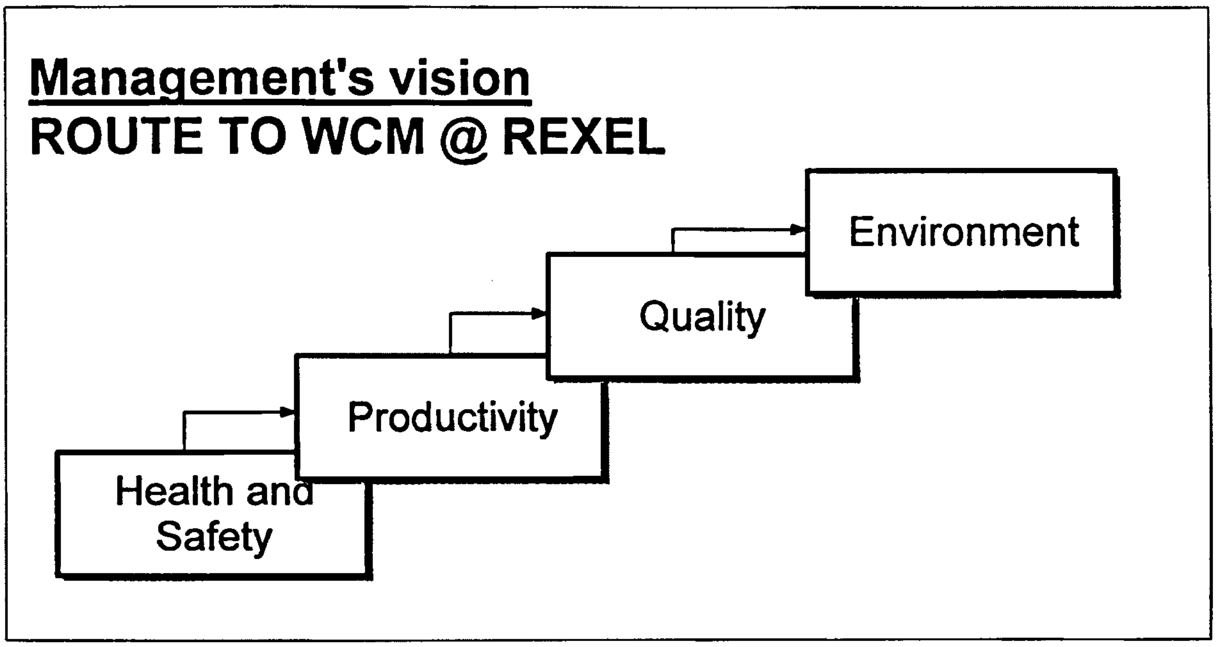


Figure 5.6: Management's vision towards WCM at Rexel

- In terms of health and safety, Rexel implemented ISO 9001 and ISO 14001
- To improve productivity, each job process is studied in the levels laid out as shown in figure 5.7.
- The process studies lead to investigation of faults and development of corrective actions. The bottom line of these improvements should be reflected by MoPs (eg. scrap rate).
- Key Performance Indicators (KPI) are to show details of these improvements on a report page so it can be communicated among the workforce.

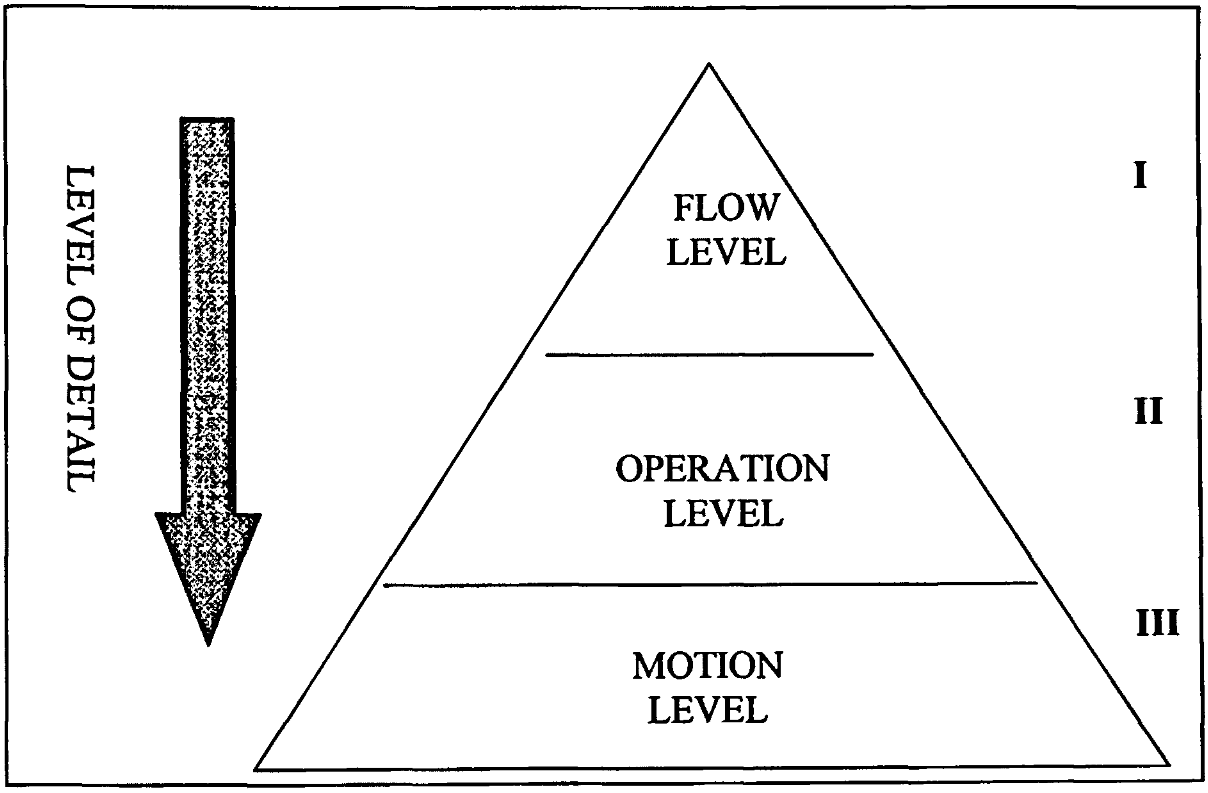


Figure 5.7: Studying a process – levels of details

BoC Model Application at Rexel

The first application of the BoC model at Rexel has already been illustrated in figure 5.5, where it showed that the Bronze award is a WCM initiative and therefore fits into the model. More examples of using BoC at Rexel are presented in figure 5.8 and figure 5.9. One displays evidence of how internal factors are assessed (activity in KAIZEN Bird level 1) to form a set of improvement areas (activity in KAIZEN Bird level 2). The latter shows that improvement areas are eventually translated into simple shop floor corrective actions. The potential improvements identified suggest that this is an implementation of workplace CI.

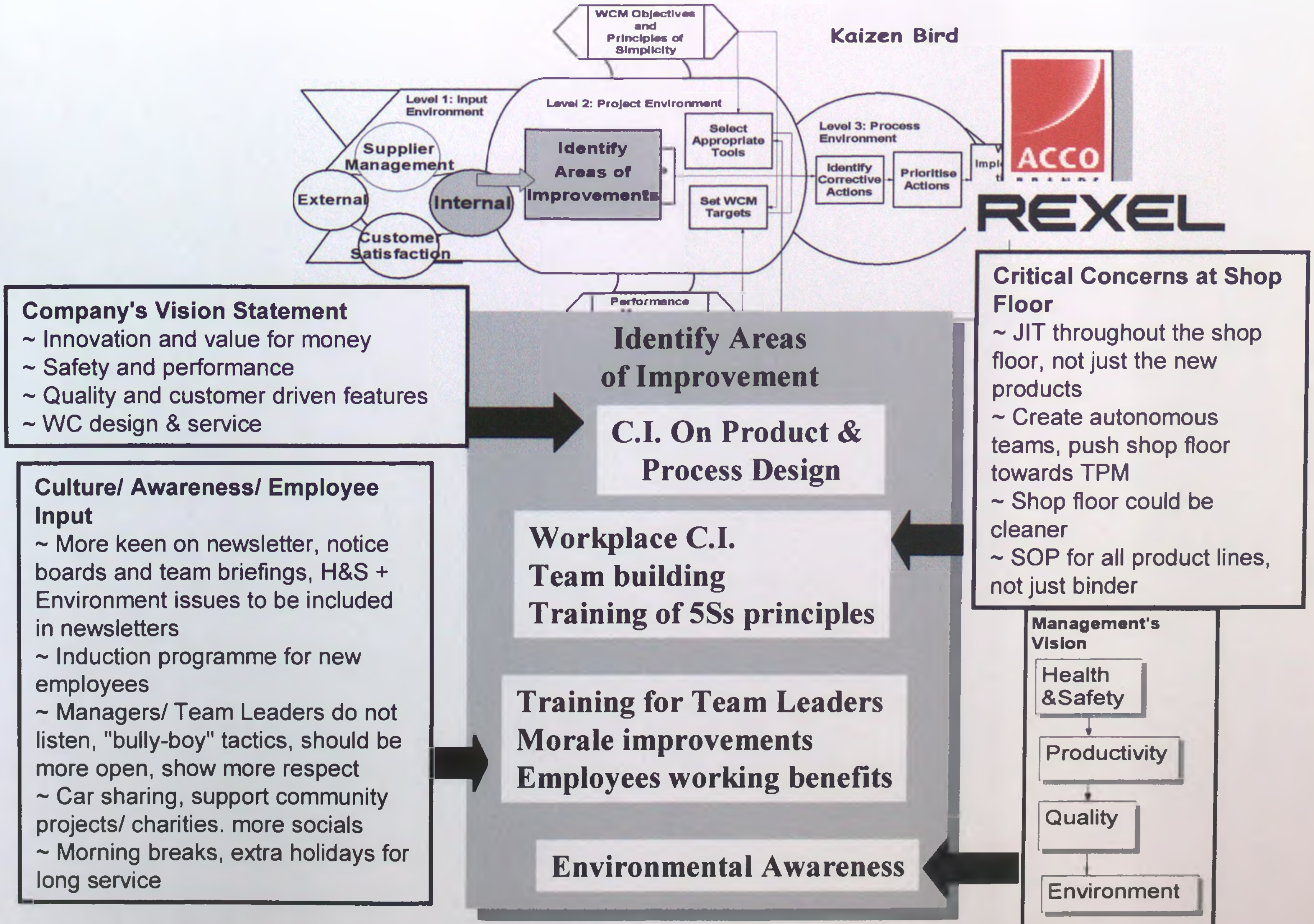
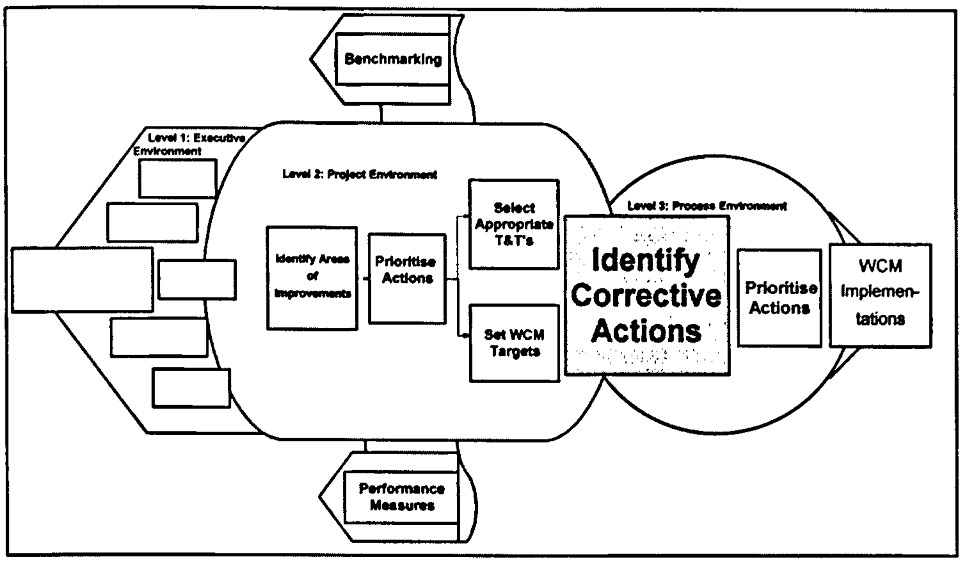


Figure 5.8: BoC Application at Rexel -- Assessing Internal Factors (L1) before Identifying Areas of Improvements (L2)



Identify corrective actions		Potential improvements
Use bright bar instead of black bar for cutter shaft production	→	Reduction in process time and material handling
Stop using doubled reeled material for sized cutter shafts	→	Cost reduction
Identify 1st 5s project	→	Area to become model for 5Ss
Training of 'Sort'	→	Workers to have 5S knowledge & skills
Red tags creation	→	For next red-tagging activity
Remove all stock from stores agreed with production control	→	Stock write-off
Identify & purchase tooling cabinets & workbenches	→	To 'Segregate' tools

Figure 5.9: A case at Rexel – Activities in KAIZEN Bird level 3 'process environment'

5.2.3 Pilkington Automotive

Pilkington Automotive used to be a glass manufacturer named Triplex, but is now a division of a global organisation. Its plant in King's Norton specializes in glass. Compared to the other companies under research, Pilkington had the best-developed WCM system. At a glance the plant looks clean, with KANBAN signs everywhere – an important requirement of a world class (WC) plant. Underneath the spotless surface is a well-established and documented system of change towards the standard of excellence. All WCM (otherwise addressed as MTW – Manufacturing To Win) implementation programmes are posted on the intranet from the Headquarters in America. The flat organisational structure and horizontal communication are visible from the physical layout of the office. Managing Director, human resource, engineering director, strategic manager are all seated in one big office, steps away from one another. There are no "behind-the-closed-door" secrets.

Management's Vision

Figure 5.10 indicates the route to WCM laid out by the manufacturing strategic director. The four steps towards a WC achievement are represented by four significant tools of modern manufacturing management: 5Ss (see Chapter 2), TPM, problem-solving teams (or known as autonomous teams), and the 6 Sigma. The success of 5Ss can be justified by the spotless appearance of the shop floor. At the time of research the plant has achieved a good practise in TPM and established a few problem-solving teams. 6 Sigma was regarded as the ultimate way of pursuing excellence, due to the precision in quality required in 6 Sigma.

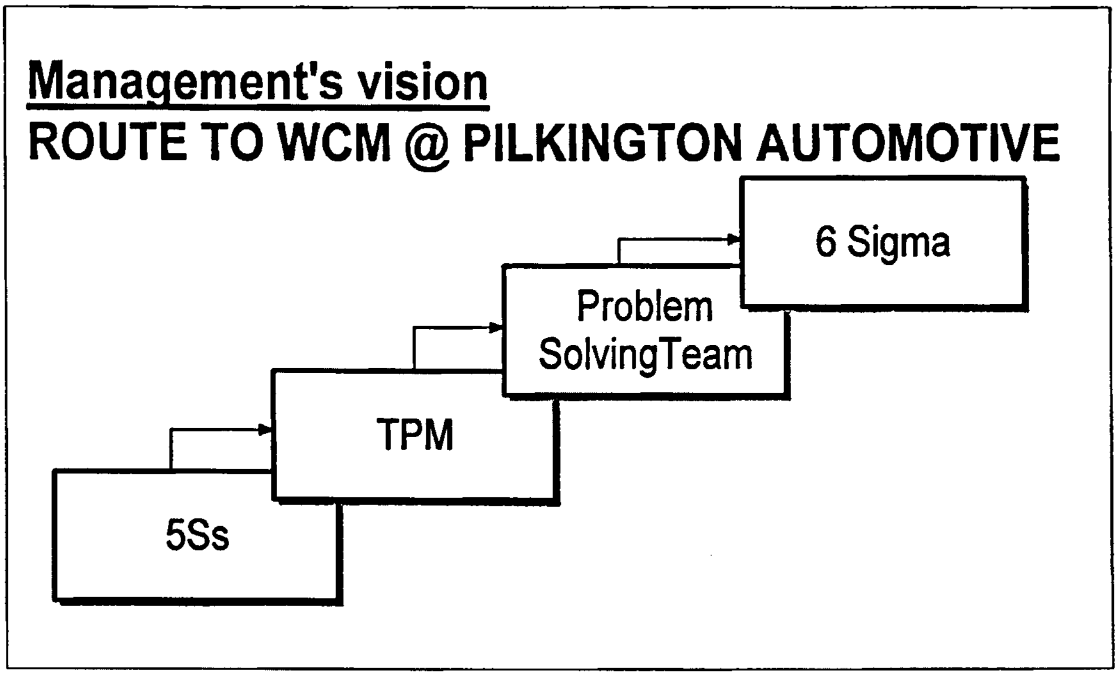


Figure 5.10: Management's vision towards WCM at Pilkington Automotive

"Manufacturing To Win" (MTW)

In recent years, Pilkington has been constructing a programme of improvement named MTW. The programme is uploaded on the company's intranet site, accessible by all staff as an effective means of communication. The initial version of the site was meant as a library, which only contained manuals, procedures, tools etc. It was later updated so that it is also capable of containing live data and information, such as the manufacturing monthly report. The MTW site is seen as a shared vision and mission of not just the one company, but the entire Pilkington network all over the world.

MTW programme is composed of the following "walls", which can be seen as the company's success factors / areas of improvement:

- Lean Organisation
- Learning and Communication
- Manufacturing Improvement
- Quality System

- Health and Safety
- Manufacturing Standards
- New Model Introduction
- Standardisation
- Support Team

Each and every one of these 'walls' is built by an increasing number of 'bricks' (figure 5.11). The idea is to build the walls by adding relevant and useful elements (e.g. adding audit / benchmarking report as a new task to the 'manufacturing improvement wall') so the wall lasts for the years to come.

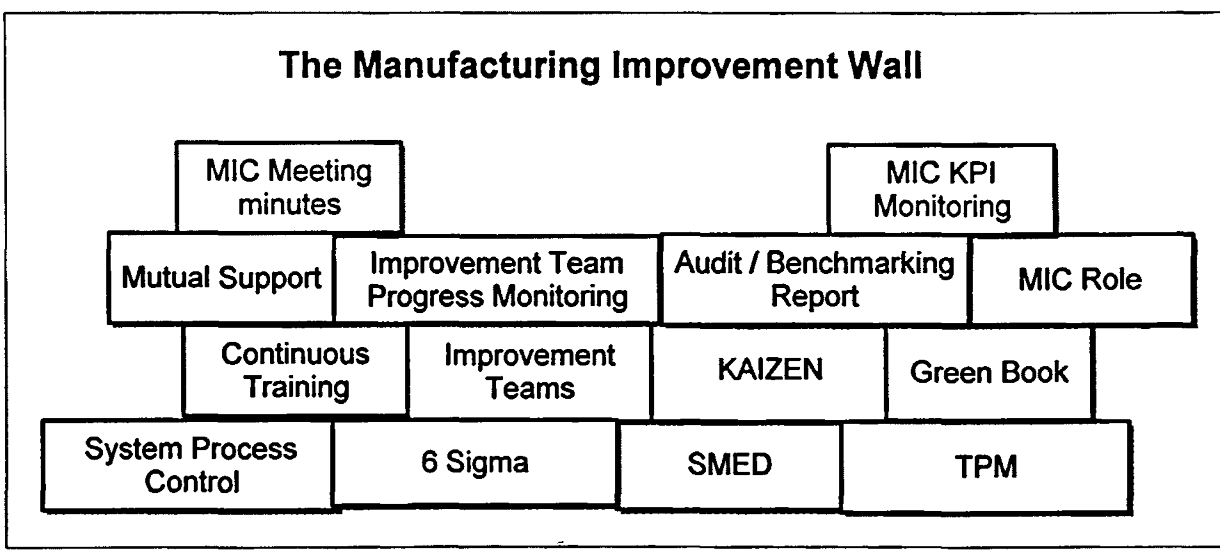


Figure 5.11: Walls to build for manufacturing improvements at Pilkington

MTW programme is carried out following these four principles:

- Simpler: Pilkington is committed to "Building One Pilkington", not a federation of companies, with common standards and exploiting the synergies that the whole group can create.
- More focused: The organisation needs to concentrate only on the activities in which it can win and divest in the under-performing businesses.

- More efficient: in reaching excellence in manufacturing, raising the performance of the least productive plants to that of the best, making quality products for the customers at the lowest cost, becoming as competitive as the best competitors.
- Lower cost: Reduce overheads, simplify company structure, eliminate any duplication of functions and activities.

With these elements and principles, Pilkington Automotive formed its straightforward objectives:

- Implement restructuring programmes to improve competitiveness, increase yields, reduce PPM levels below customer expectation
- Establish standard policies, processes and procedures across Europe
- Start up new products and plants right first time, in an efficient and co-ordinated system
- Restructure organisation and principles in order to facilitate and accelerate the motivation, the determination and the capability of employees to meet customers' and shareholders' expectation
- Increase the consciousness of everybody to the full application of the health and safety rules of the group
- Emphasise quality in all operations

These objectives, principles and "walls" (or areas of improvement), when translated into the BoC model, become elements of the big picture of WCM change programme. Figure 5.12 demonstrates the relevance of MTW programme and WCM using the model.

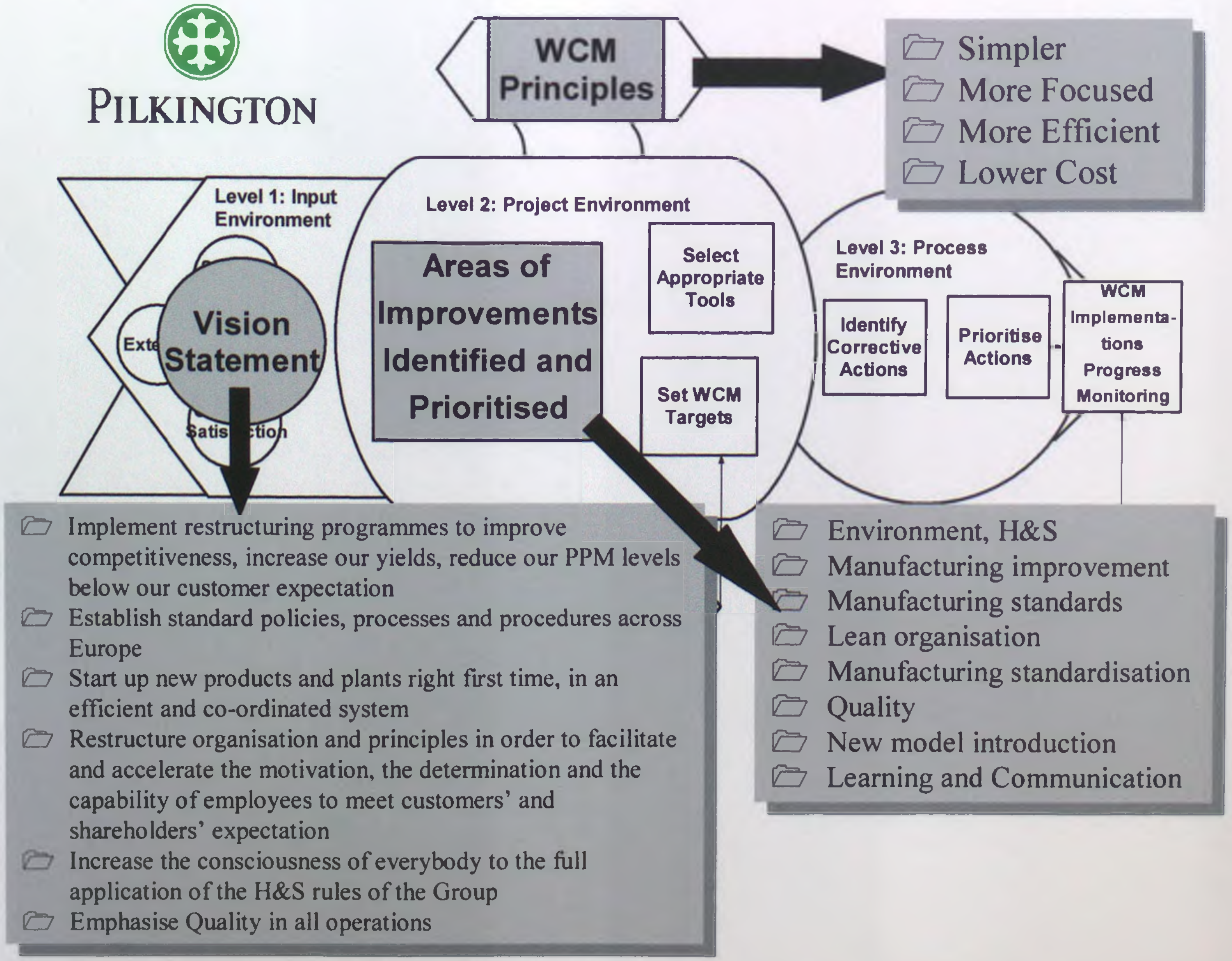


Figure 5.12: BoC Application at Pilkington -- "Manufacturing To Win" programme and its relevance to WCM

BoC Model Application at Pilkington

Figure 5.13[b] shows a KPI sheet of an implementation for fault reduction (inside marks on BOSS). The sheet contains data and charts for MoP (inside marks trend), fault analysis (causes for scrap), and a progress monitoring table for corrective actions. All the vital information related to this implementation is displayed on one page, thus speeding up the understanding of data and enhancing the efficiency of meetings. Applying the information here in the context of the BoC model, the elements included here are shown in figure 5.13[a]:

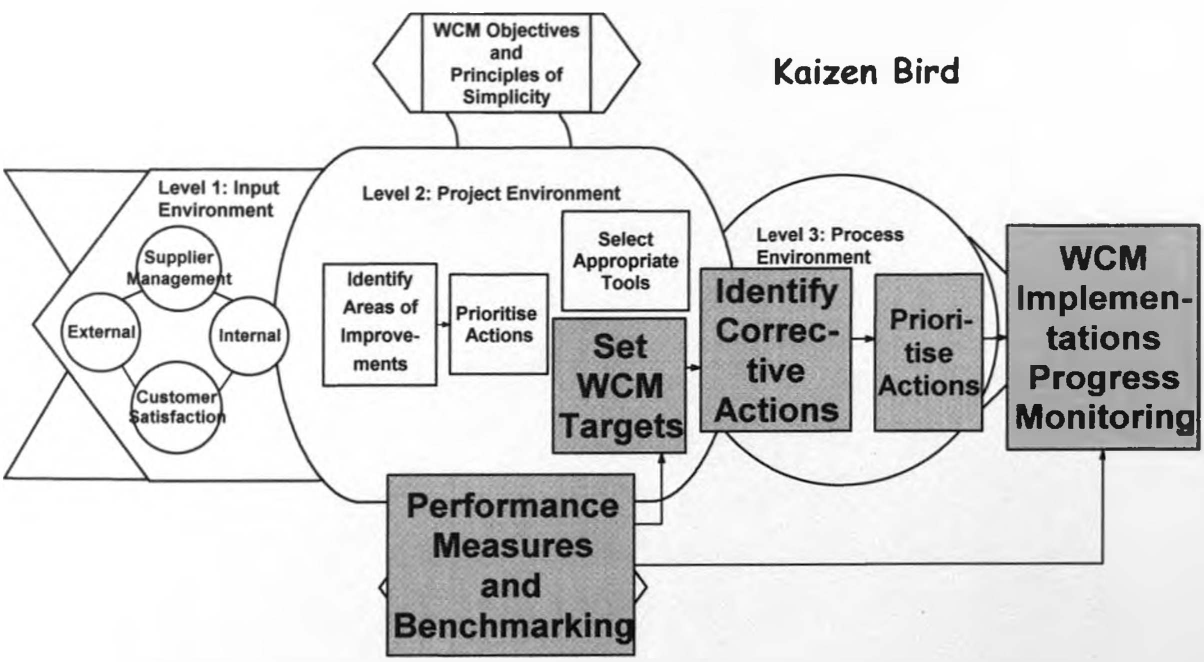


Figure 5.13 [a]: An example of the 'Birds of Change' (BoC) model application at Pilkington – implementation progress indicated on a KPI sheet

Inside Marks Reduction BOSS

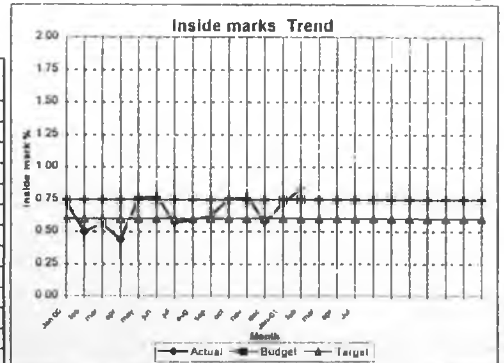
Assembly Team

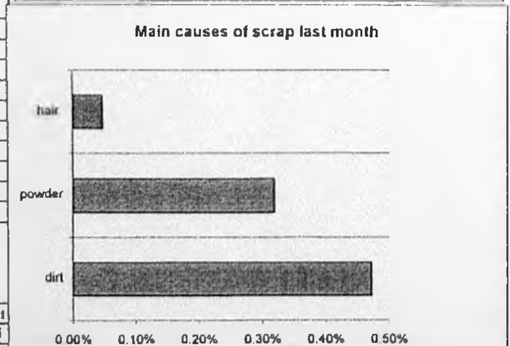
Period: 1998 - 2000

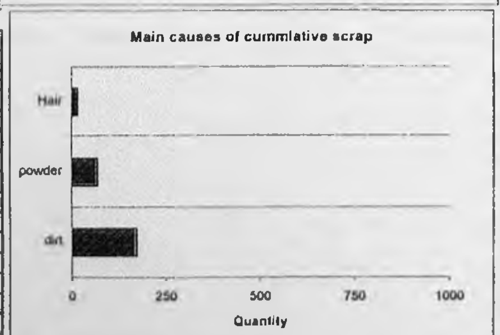
	Actual	Budget	Target
Jan 00	0.73	0.75	0.60
feb	0.50	0.75	0.60
mar	0.56	0.75	0.60
apr	0.44	0.75	0.60
may	0.76	0.75	0.60
jun	0.78	0.75	0.60
jul	0.57	0.75	0.60
aug	0.59	0.75	0.60
sep	0.63	0.75	0.60
oct	0.75	0.75	0.60
nov	0.78	0.75	0.60
dec	0.58	0.75	0.60
Jan-01	0.72	0.75	0.60
feb	0.84	0.75	0.60
mar		0.75	0.60
apr		0.75	0.60
Jul		0.75	0.60
		0.75	0.60
		0.75	0.60
		0.75	0.60
		0.75	0.60
		0.75	0.60
		0.75	0.60
		0.75	0.60

Period: 2000 -2001

	Month	Cumulat
Input	64082	80006
Output	61483	79381
Scrap	2599	625
Yield	95.94	99.22
dirt	302.00	172.00
powder	204.00	68.00
Hair	30.00	16.00
total	536.0	
	0.84%	
dirt	0.47%	
powder	0.32%	
hair	0.05%	







Responsible Person

Team	Team Leader
Assembly	Keith Palmer Jonathan Whitney Operators

Summary of Actions

N°	Action Description	Start Date	Progress % 25 50 75 100	Compl. Date Forecast	Compl. Date Real	Who To Do
2	Standardise cleanroom procedures and clothing etc	06/05/99		01/05/00	02/05/00	JW
3	New profile of brushes ordered	10/05/99		01/04/00	02/04/00	JW
4	Contact Pilkington Austria about success of laminar flow clean area	01/06/99		30/06/00	01/07/00	PH
	Findings					
	Pre_nip 1 static bar blower drive u/s replaced 6/05/99	14/05/99		06/05/99	06/05/99	JW
	static levels ok					
30	Leaking roof & steam pipe over hot room caused 250 extra scrap	07/10/99		17/10/99	20/10/99	JW
31	Trs scrap figures adjusted	30/10/99		30/10/99	31/10/99	GH
32	New cutting table installed /room painted/ assembly room painted reason for high mark	23/12/99		06/01/00	07/01/00	JW
33	Direct online contactor to be fitted to air blower after brushing	01/01/00		01/05/00	02/05/00	ED
34	Waiting delivery of new brushes	25/04/00		29/05/00	30/05/00	JW
35	Reprogram x200 & hs models	26/04/00		30/05/00	31/05/00	JW
36	New vacuum system	27/01/00		31/08/00	01/09/00	Jw
37	Straighten w frames, set each pair to a datum fixture/ pre nip 2 & 1	18/08/00		04/09/00	05/09/00	JW
38	Reprogram brushing all models nip 2 with new vacuum system	01/07/00		16/08/00	17/08/00	JW
39	Reprogram brushing all models nip 1 with new vacuum system	21/07/00		16/08/00	17/08/00	JW
40	Investigate x200 inside marks	03/10/00		11/11/00		
	Final inspection now stamping glass to identify who inspects it.	12/05/00		15/05/00	16/05/00	JW/JP
	30/5/2000 investigation team launched final /assembly working together	30/05/00		30/7/200	30/7/201	JW/JP
						JW
13	Remove sackline	28/05/99		09/06/99	09/06/99	JW/AC
14	Solutia to be contacted over (hot umbrella corrosion)	28/05/99		30/06/99	30/06/99	CB
15	Vinyl cutting table cleaning routine(clean room vacuum required)	29/05/99		25/07/99	26/07/99	JW
16	110v sockets required assembly room	06/06/99		30.06/99	30.06/100	JW
17	Provide air lock pre_nip 1	07/05/99		15/06/99	15/06/99	AC
18	Improve assembly cleaning routines (provide 2 clean room vacuums)	08/05/99		30/09/99	01/10/99	JW
	Actions (Long term)					
19	Collect data (analyse inside marks)	08/06/99		30/10/99	30/101999	JW
20	Contact philips lighting	01/07/99		01/08/99	02/08/99	JW
21	Solutia meeting 12th july to discuss marks	02/07/99		02/08/99	03/08/99	jw
	New actions for this month					
22	Fitted replacement brushes	15/07/99		20/07/99	21/07/99	PJ
23	Commision brush index program	16/07/99		17/08/99	18/08/99	DS
24	Install colour 180 Philips tubes in assembly from	17/07/99		30/12/99	31/12/99	JW
25	Install colour 180 philips tubes assembly inspection conveyor	18/07/99		30/12/99	31/12/99	JW
26	Viewing stand check brushing effectiveness prenip 1/2	17/08/99		20/09/99	21/09/99	JW
27	Create check sheet to monitor powder removel nip 1/2	20/07/99		21/01/00	22/01/00	JW
28	Develop data collection system final inspection	05/101999		15/09/99	16/09/99	JW
29	Paint assembly room	06/09/99		18/12/99	03/01/00	jw

1	Check operation and effectivness of anti static bars pre nip 1/2	28/04/99		01/06/99	30/06/99	JW
9	Price for hot room airconditioning ducting to stainless steel and trunking	17/05/00		30/06/99	01/07/99	jw
5	Check static levels of vinyl (shaping machine)	01/05/99		29/05/99	29/06/99	JW
6	Order extra brushing frame holders	15/05/99		12/06/99	12/06/99	JW
8	Order extra set of brushing frames for future leher models and current	16/05/99		29/11/99	30/11/99	JW

Figure 5.13 [b]: An example of the 'Birds of Change' (BoC) model application at Pilkington – implementation progress indicated on a KPI sheet

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5.2.4 Corus – Hoogovens Aluminium UK

Hoogovens Aluminium UK (HAUK) was traditionally an aluminium stockist and distributor. This research is involved with one of its regional distribution centres – the Hemel Hempstead branch. 85% of the aluminium was sourced from its own mills and the plant had very limited opportunity to add value to the commodity products.

As an effort to upgrade their service to put them ahead of the competition, HAUK turned the plant into one with manufacturing capabilities. Basic cutting equipment was bought including guillotines, slitters and band saws. Rather than delivering the nearest standard size aluminium to their customers, they could fulfill their customers' exact needs.

The cut to length service became a great success and they soon invested in more cutting equipment to increase the range and volume of manufacturing operations that they could perform. In 1995, HAUK decided to integrate all their processing at the one site. The Hemel Hempstead site was chosen as it was the largest and housed the majority of the machines. It became the Central Processing Centre (CPC).

By 1997, HAUK realised it was time to take a critical look at their manufacturing processes to improve their quality and performance issues. This had to be achieved to give them a competitive edge in the market place. This is when they contacted the University of Birmingham. The first concrete step towards WCM was taken when the Performance Efficiency Group (PEG) was set up. The group consisted of a member from each department to ensure a wide range of skills, technical and general CPC knowledge, experience and interests. The group considered all CPC activities from a critical standpoint, and attempted to propose ways in which it could move to a position of strength and excellence. HAUK utilised CI principle of the 4A's – autonomous steps (Williams, 1999):

- Awareness – basic education of tools

- Advancement – initiative, responsibility and accountability transferred
- Ability – demonstrable improvement, competence and financial impact
- Achievement – targets surpassed and continuous improvement carries on

The 4As were later used in all CI implementations in HAUK. Small and rapid improvements were made to obtain credibility, which would then create a drive for longer-term objectives.

At the time, all HAUK processing was performed at the CPC. More manufacturing and value-adding activities were being sought. The company became more customer and competitor driven. This had the following effects:

- Production volumes increased dramatically.
- Increasing strain was put on the equipment and operators.
- Resources became stretched to the full, plus little manufacturing expertise in the processing centre – a commercial manager was doubling as the manufacturing operations manager
- Every job was being rushed through as urgent to keep up with sales targets.

As a result, some problems started to appear:

- Quality problems – not only were sub-standard jobs being sent out, but they were increasingly sent out late
- Overall productivity was low
- Wasted time and error
- Confidence of some customers needed enhancing

As part of the research investigating WCM opportunities at HAUK, an activity sampling was carried out to examine machine and operator utilisation on the shop floor (see Appendix C for full report). Results taken from all the four cells showed low overall machine utilisation of 26.79%. Five machines had 0% utilisation. Operator utilisation was also low. This resulted in a low OEE figure. SMED and SUR were recommended to amend the long set-up and changeover time in two of the cells.

The findings of the activity sampling were one of many that led to the set-up of a critical concerns audit. This was an intensive and participative set of team sessions, with both individual and collective responsibilities (Williams, 1999). Seventeen audit areas were examined and a number of critical concerns were established. These critical concern audits, together with a TPM project carried out by a final year student (Sordy, 1999), triggered the implementation of tools including 5Ss, FMEA, OEE, red-tagging, preventive maintenance, and autonomous teams.

Later HAUK experienced a huge business transformation, as it merged with British Steel to become a bigger group – CORUS. The merging, in contrast with what has been intended and anticipated, has not brought much benefit to the original plant in Hemel Hempstead. Not only has it not improved profit, the layoff of 16 employees (out of the 54) has reduced workers' morale. The lack of human resource led to a compromise of customer demands. Resources were stretched, systems became chaotic, and quality problems started to appear. The already lack of manufacturing expertise and the low utilisation of machines and operators did not help the situation. The WCM initiative was in question, as it did not show an impact on the bottom line results. A study was set up to investigate the relationship between WCM activities and financial performance (Barron, awaiting dissertation).

At that point, the management at the Hemel Hempstead plant decided to employ the following route of WCM (figure 5.14):

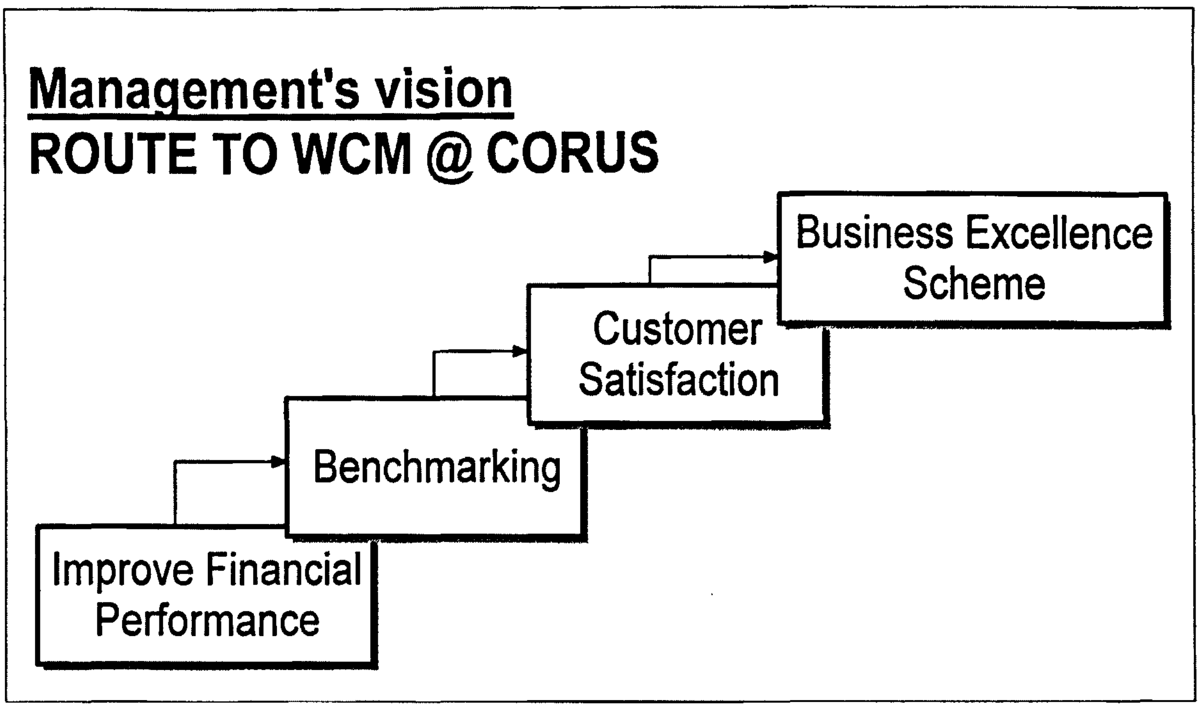


Figure 5.14: Management's vision towards WCM at CORUS

Figure 5.15 presents the case study at Corus using the BoC model. The highlighted activities span from level 1 of the KAIZEN Bird ('input environment') to level 2 'project environment' and then to level 3 'process environment'. In level 1, some of the issues mentioned earlier fit into the model as factors to be considered when identifying areas of improvements. This set of improvement areas is then translated into a set of actions, in simple operational form. Obviously, the real implementation of WCM is more complex than this, but the figure provides an understanding of the BoC model as a model of OC towards WCM.

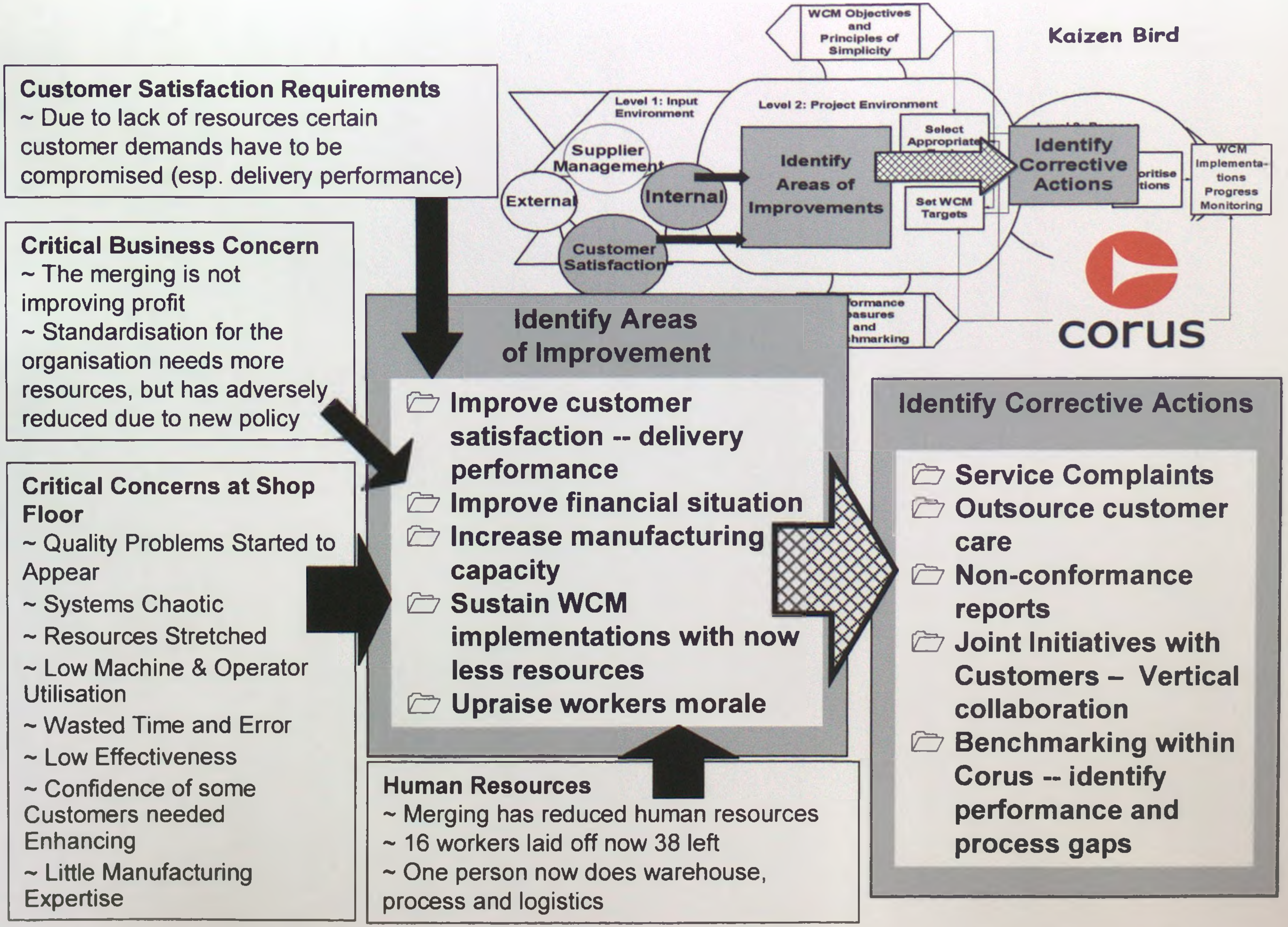


Figure 5.15: BoC Application at Corus -- KAIZEN process from 'input' to 'project' to 'process' environment

BoC Model Application in Barbadian Manufacturing Industry

As mentioned in chapter 3, this research had acquired inputs via the academic collaboration with research carried out in some Barbadian companies. Due to the difference in economic climate, political situation, government regulations on manufacturing industry, labour cost and market demands, manufacturers in Barbados have different focuses in terms of making WCM improvements as compared to UK companies. Table 5.3 presents an example set of concerning issues of these Barbadian companies and how they link to Barry's WCM framework (Williams, 2000).

Issue	Observations	Needs	Improvement Methods Derived from Barry's WCM Framework
Productivity	Concerns over low productivity, downtime and work flow	➢ Synchronise work ➢ Schedule jobs ➢ Maintain machines ➢ Reduce set up	➢ Point (6)*, better plant layout, put in simple scheduling methods ➢ Point (6), team work for red tagging, TPM, set up time reduction, use of OEE measures
Housekeeping and Waste	Companies studied tend to have untidy work places and exhibit waste: effort, stock, energy and cost	➢ Make the work place tidy and clean ➢ Make tools and equipment easily accessible ➢ Eliminate non needed stock and energy wastage	➢ Points (4), (6), (9) & (14), use team based 5S methods, red tagging ➢ Point (6), inventory control, set up stock locations ➢ Point (6), "light out" policies, no non productive running of machines

* These 'points' need to be referred to Barry's framework (1998)

Table 5.3: Concerning issues from Barbadian manufacturing companies and their linkage to the WCM framework (Williams, 2000)

The table contains issues that need to be addressed in the company, accompanied by the proposed solutions, tools and targets. This information should be conveniently transferred into the BoC model, given that the model represents a generic implementation of

WCM. Figure 5.16 shows how this has been done. A WCM implementation of a different economy climate, government regulations, market demands and so on does not make the model application redundant. It can be deduced from this point that the BoC model has the capacity to simulate WCM implementations of different manufacturing circumstances. The generic nature of the BoC model is again demonstrated.

5.3 Results

To show the results of the companies after using BoC and the accompanying change indicator, three approaches are chosen:

- General outcome
- Measures of performance (MoPs)
- Scores of the change indicator

5.3.1 General Outcome

The general outcome refers to the before and after situations of applying the change model to the company. By January 2001, Rexel had accomplished a total implementation of 3Ss across the company, and 4 out of 11 departments had achieved the Bronze award. At Heritage the following results have been drawn as general outcomes:

Before	**After**
➢ Inventory problem due to lack information on stock	➢ Stock components labeled and recorded
➢ Shop floor untidy floor space not fully utilised and problems were hidden	➢ Shop floor being tidied using 3Ss
➢ Culture shows lack of CI	➢ CI principles carried out in most jobs and job-shops
➢ IT problem -- non-systematic information on order and delivery	➢ Order and delivery information in co-ordination with inventory information

Table 5.4: The before and after situations of the WCM change project at Heritage

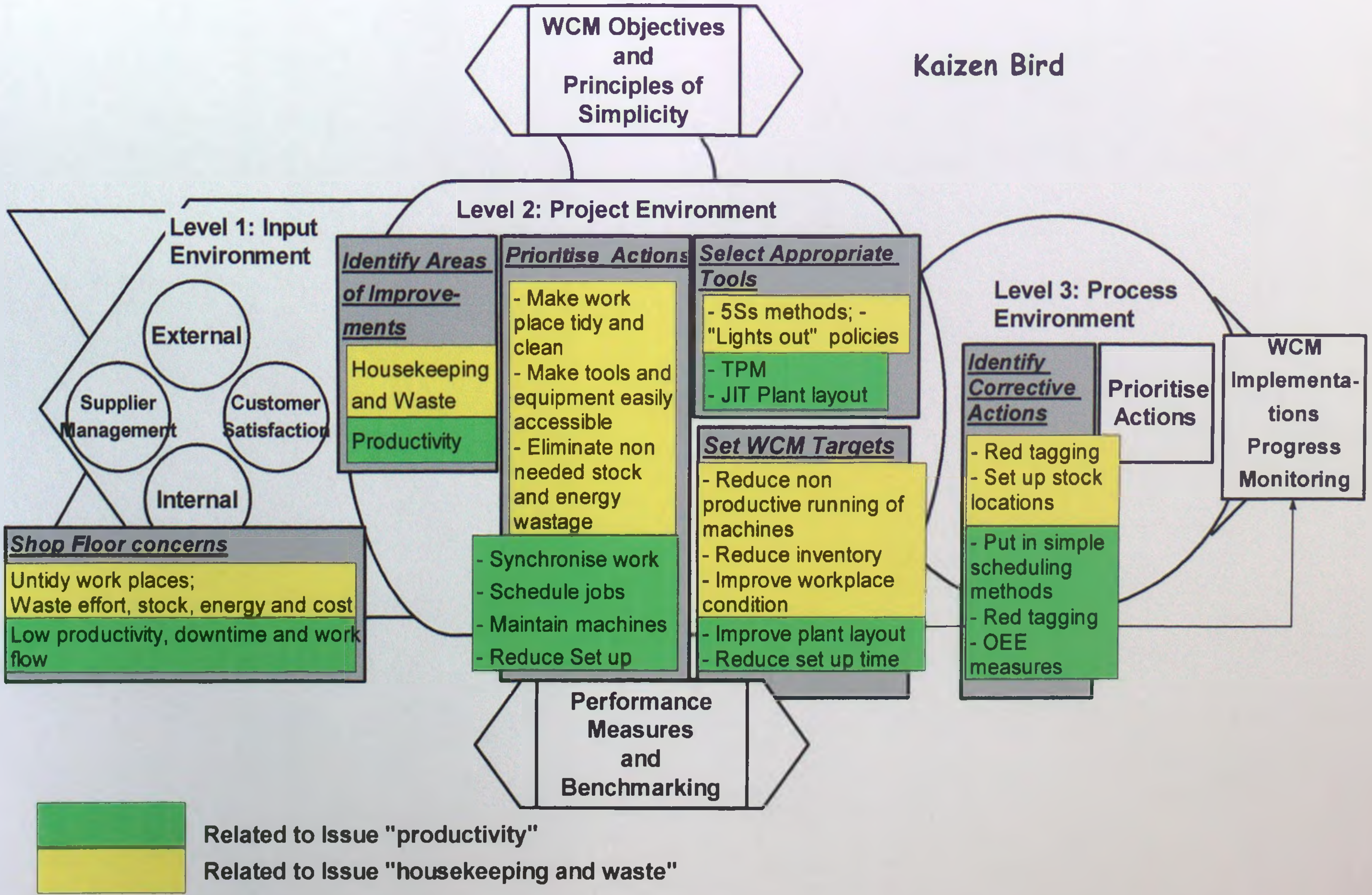


Figure 5.16: Applying Barbadian companies' WCM concerns to the context of the 'birds of change' model

5.3.2 Measures of Performance (MoPs)

MoPs can be as simple as a cycle time analysis, or as complex as an OEE calculation. As mentioned in Chapter 4, MoPs for WCM tend to refer to non-financial performances due to the lack of direct links between WCM implementations and bottom line results. MoPs are important in WCM as they provide a guideline on how the company is performing, in terms of productivity, customer satisfaction, employee management, or bottom line financial performance.

This is when the research encountered complications. As substantial as MoPs are, they do not seem to apply in this research as a comparative factor due to the following reasons:

1. The companies under research do not have the same set of MoPs (as shown in table 5.5). Some companies are even just beginning to generate WCM measures.
2. To generate generic measures across the industry is extremely difficult, given that different companies produce different components, hence the productions and operations are very much different.
3. Even if one common set of MoPs is generated for these companies, the significance in comparing them is doubtful, unless there is firm ground to believe that the MoPs are direct results of a specific WCM initiative. For example, an improvement in delivery performance can be a reduction in lead time due to a changeover improvement after applying SMED technique; however it can also be the result of increase in raw material quality, increase in stock, or even an additional shift.

Table 5.5 shows a summary of MoPs used in the participating companies, and some examples of improvements over the period of research when WCM implementation took place.

Company	MoPs	Improvements
Rexel	PPM, labour productivity, OEE, delivery performance / service level, scrap, warranty levels, financial (cost breakeven), stock value, direct labour efficiency	➢ Delivery performance: nearly 100% in year 2001 ➢ Productivity: increased by 5-10% since the launch of the new KAIZEN programme ➢ Finished good stock: down from 1200k to 472k between year 2000 and 2001
Pilkington	Yield, uptime, changeover average time (Lehr), productivity, work cost, parts per million (PPM), lost time accident rate, lost-work-day-rate, warranty performance (faults %), scrap	➢ Productivity: increased performance by reducing number of man/min/piece from 17.3 in 1999 to 11 in 2001 ➢ Yield: steady increase from 87.1% to average 91% from 1999 to 2001 ➢ Scrap level: dramatic fall of PPM from 1,563 (in year 1999) to 59 (in year 2001)
Heritage	Process time cycle, delivery performance, stock value	➢ Delivery performance of all goods was being generated in percentage ➢ Stock value will be generated upon the completion of data collection project
Corus	OEE, cycle time analysis, delivery performance	➢ OEE figure was only starting to be calculated during the time of research

Table 5.5: Measures of Performance used in participating companies and improvements after the implementations of WCM

Due to the reasons outlined above, this research subsequently reallocates its focus onto another measure – the scores of the change indicator. After all, the objective of this research is to measure how well the companies are changing, not how well they are performing in general. The change indicator will enable a comparison across companies in terms of their performances in OC towards WCM.

5.3.3 Change Indicator Score Sheets

Whilst both general outcome and MoPs show only the indirect result, the change indicator is specially designed to show the direct outcomes of using the model.

The four matrices follow (Table 5.6, 5.7, 5.8 and 5.9) each displays a score sheet of an area of KAIZEN bird, in a particular company, at a particular time. For comparison purposes, the scorings presented are all taken at one specific time (in this case January, 2001) when all the four companies are engaged in current research. The four companies were scored in all the four areas of KAIZEN Bird, which makes 16 matrices in total. Four of the 16 matrices are presented in this chapter whilst the rest are placed in Appendix D. Scores of all participating companies in all areas of the model will be summarised, analysed and discussed in chapter 6 (section 6.3).

Indicator's Score Sheet

Description: **Level 1 – Input Environment** Company / Plant: **Heritage Ltd**

Date: **Jan 2001**

Stage	Score	Description
Avoid	0	This issue has never been brought to question
Aware	3	This issue has been dealt with in the past but without much success
Adapt	6	This issue has been / is now being brought to attention and is being acted upon
Achieved	10	The company has a successful history / has established an efficient solution of dealing with this issue

Categories of Input Environment	Issues leading to company's success factors	*Score*
Supplier Management	Are suppliers' performances being measured (quality, delivery etc.)?	*3*
	Are standards set for suppliers' performance?	*6*
	Are supplier relationships managed and documented?	*3*
	Sub-score	***4***
Customer Satisfaction	Is there a good effort of communication with the customers to understand their needs?	*6*
	Is customer satisfaction being monitored by means of survey, interview or etc.?	*4*
	Is there an allocated time and resources towards customer satisfaction and improvements?	*4*
	Sub-score	***4.7***

External Factors	***Market Demands***	Is the company aware of current market needs and market competitive factors?	*4*
	Government Regulations	What are the government regulations or regional political factors that have significant impacts on the business?	*2*
	Competitors Actions	Is the company aware of its competitors' strength, and their actions in attracting customers?	*6*
		Sub-score	***4***
Internal Factors	***Vision/ Mission Statements Management's Vision/ Business Strategy/ Organisation Philosophies***	Is there a vision / mission statement known to the entire workforce and the customers? Is there an underlying set of organisation philosophies/ principles known and followed by the entire organisation?	*7*
		What is the management's vision / strategies of change towards world class manufacturing?	*8*
		What is the company's business plan (5-year plan for example) taking into account all the above factors?	*6*
	Critical Shop Floor Concerns	What are the factors hindering shop floor processes from becoming an efficient and productive working environment? What are the main concerns/ problems regarding working towards SCEF (Safer, Cheaper, Easier, Faster) operations?	*8*
	Manufacturin g Capacity Technological and Human Resources	Is there sufficient manufacturing capacity, technological or human resources to carry out the change currently undertaken?	*8*
	Organisation Structure	Does the company structure allow sufficient inter-functional communication? Does it fit to the modern principle of flat organisation? Does it have a horizontal team based structure to deal with short term change implementation?	*6*
	Data Collection	Is the data collection system capable of generating data for the major operational performance measures (quality, cost, time, productivity)?	*8*
		Sub-Score	***7.3***
		Total Score	***5***

Table 5.6: Change Indicator Score Sheet Level 1 – Heritage

Indicator's Score Sheet

Description: **Level 2 – Project Environment** Company / Plant: **Pilkington** Date : **Jan 2001**

Change Activity	Identify Areas of Improvements/ Company Success Factors	Prioritise Actions	Select Appropriate Tools	Set WCM Targets
Description	➢ Company success factors identified after assessing the elements in Level 1 -- Input Environment: ▪ C.I. in products and processes ▪ Training programmes ▪ Team building ▪ New jobs ▪ New organisations ▪ Benchmarking ▪ New procedures ▪ New databases	➢ Decisions on prioritising actions are made in a WCM project team meeting, taking into considerations not only financial, technological and human resources, but also the inputs from Level 1: ▪ Improve uptime ▪ Increase flow rate ▪ Increase yield ➢ Pareto analysis used for prioritisation	➢ Tools chosen to support specific areas of improvements manufacturing objectives ▪ SMED ▪ TPM ▪ Automation ▪ System Process Control (Tools/ Methods and Statistical Process Control ➢ Tools are aligned with performance measures ▪ SMED / TPM → Uptime ▪ Automation → Flow rate ▪ System Process Control → Yield	➢ Target is set to achieve an improvement in the following performance measures: ▪ PPM ▪ Yield ▪ Lost time accident rate/ Lost worked day rate ▪ Productivity ▪ Work Cost ➢ The general way forward for operations: ▪ Simpler ▪ More Focused ▪ More Efficient ▪ Lower Cost ➢ No International Standards / no specific set figure for the above targets, but a standard is set across the organisation with MTW programme

Indicator's Score Sheet

Description: **Level 2 – Project Environment** Company / Plant: **Pilkington** Date : **Jan 2001**

Summary	➢ Areas of improvements are identified as a direct result of assessing the external and internal inputs from Level 1. ➢ All of the input factors are being considered in detail ➢ Becoming a SCEF operational environment is nominated as an area of improvement	➢ Decisions on prioritising actions are made in a WCM project team meeting ➢ Taking into considerations not only financial, technological and human resources, but also the inputs from Level 1 ➢ Plus using analytic methodologies to decide, eg. pareto analysis,	➢ Tools are chosen to support specific areas of improvements and to achieve specific manufacturing objectives ➢ Tools are selected to fit WCM principles and to create a lean / SCEF operational environment ➢ Tools are aligned with performance measures	➢ Realistic operational targets are set consistent with the performance measures, efforts are made to assure target achievements ➢ Targets are reassessed during WCM project team meetings, to ensure they are achieved, maintained, and regularly re-established. ➢ New targets are continually set for a SCEF operational environment
Score	*9*	*8*	*7*	*8*
			Ave. Score	***8***

Table 5.7: Change Indicator Score Sheet Level 2 – Pilkington

Indicator's Score Sheet

Description: **Level 3 – Process Environment** Company / Plant: **Rexel** Date : **Jan 2001**

Change Activity	Identify Corrective Actions	Prioritisation of Actions	WCM Implementations Progress Monitoring
Description	i. Reduce number of centres in cutter shafts ii. Review material of 3 tie rods which can only be made on super sprint iii. Use bright bar instead of black bar for cutter shaft production iv. Stop using Doubled reeled material for sized cutter shafts v. Identify 1st 5s project vi. Training of SORT vii. Red tags creation viii. Identify & purchase tooling cabinets & workbenches ix. Remove all stock from stores agreed with production control	Prioritise the laid out corrective actions by comparing and weighting the following potential improvements that can be brought upon: i. Process time mat's handling reduction ii. Reduction in cycle time as parts could manufactured on tie rod machine iii. Reduction in process time and material handling iv. Cost reduction v. Area to become model for 5Ss vi. Workers to have 5S knowledge & skills vii. For next red tag act. viii. To SEGREGATE tools ix. Stock write off	Improvements observed and recorded at the time: ➢ General tidy and cleaning of entire section ➢ Reduction in WIP stored ➢ Several cupboards identified no use -- removed ➢ Items not used in regular moved ➢ Red tag items to areas prior to disposal ➢ Two Britain capstans removed -- Taken off assets ➢ 1 Surplus Bridgeport Miller disposed ➢ Reduce no, of centres in cutter shafts (25%) ➢ Use bright bar instead of black bar for cutter shaft production (50%) ➢ Identify & purchase tooling cabinets & workbenches (50%)
Summary	➢ The prioritised areas of improvements (Level 2) are translated into an identifiable set of specific actions	➢ Decisions on prioritising actions are made in a WCM project team meeting, taking into considerations not only financial, technological	➢ Meetings are regular and involve not just management but shop floor people (eg. team or cell leaders)

Indicator's Score Sheet

Description: **Level 3 – Process Environment** Company / Plant: **Rexel** Date : **Jan 2001**

	➢ The set of corrective actions/ countermeasures are generated using: ▪ "forward mechanism" after carefully analysing the concerns and causes ▪ "backward mechanism" where the set of corrective actions prompt the establishment of a corresponding set of potential improvements ➢ The corrective actions are in the simplest possible operational form ➢ The generation of corrective actions ▪ Employs the theory and practices of the tools which are put to use ▪ Takes into consideration the available resources and expertise to perform them	and human resources, but also the main success factors of the company ➢ Actions are prioritised taking into account the constraints (eg. Time, capital, labour and other available resources) ➢ No specific analytical tool / methodology is used to prioritise the actions (Pareto, Analytical Hierarchical Process, Priority Map or other Operational Research approach)	➢ A regular progress report generated which includes: ▪ Breakdown of each corrective actions, target and actual completion dates and individuals in responsibility ▪ Improved outcomes of the corrective actions ▪ Why certain corrective actions did not work out as it should be ▪ Key Performance Indicator to show overall result of the implementations as a feedback to business strategies ➢ Reports are circulated among the entire workforce, progresses are well-communicated and are fed back to Level 2 "identifying areas of improvements"
Score	**9**	**7**	**10**
		Average Score	**8.7**

Table 5.8: Change Indicator Score Sheet Level 3 – Rexel

Indicator's Score Sheet

Description: **KAIZEN Bird 'Wings'** Company / Plant: **Corus** Date : **Jan 2001**

Change Activities	Performance Measures / Benchmarking	WCM objectives / Principles of Simplicity
Description	➢ Financial measures – gross margin, net profit, ROI / ROE, ratio analyses ➢ Machine uptime / downtime + machine productivity + operators utilisation + quality acceptance → Overall Equipment Efficiency (associated with Total Productive Maintenance carried out together with tools such as the 5Ss) ➢ Intangible measure – Non-conformance reports, customer satisfaction, service complaints ➢ Matrix analysis – ranking of benefits and impact on P&L account ➢ Benchmarking within CORUS – identifying performance and process gaps	➢ TPM and OEE measures tackle quality and productivity issues directly, and indirectly improve cost reduction, flexibility and delivery performance ➢ 5Ss (translated into 5Cs) aims to attack waste and improve workplace condition ➢ ISO 14001 – environmental policy ➢ Company employs 4As system (Awareness, Advancement, Ability and Achievement) as a continuous improvement steps towards target ➢ Barry's WC organisation model as a vehicle
Summary	➢ Not just basic financial measures, non-financial measures include tangible and intangible WC performance measures ➢ Performance measures link with cost, quality, productivity, workplace improvements & customer	➢ Company working towards all the 6 major WCM objectives at all times ➢ Company using at least one tool to support each of the 6 major WCM objectives

Indicator's Score Sheet

Description: **KAIZEN Bird 'Wings'** Company / Plant: **Corus** Date : **Jan 2001**

	satisfaction (80% of WCM objectives) ➢ Performance measures completes the balanced scorecard ➢ Performance measures are regularly generated and are in conjunction with tools / operations within the company ➢ PM serves as an indicator to WCM implementation progress, and a feedback to identifying the new set of company success factors (KAIZEN Bird Level 2) or corrective actions (KAIZEN Bird Level 3) ➢ Internal benchmarking activities carried out. But benchmarking with competitors is not marked; neither it is with customers and suppliers. ➢ Occasional factory visits but no benchmarking record to feedback to business model	➢ The tools are utilised help achieve targets successfully ➢ Continuous improvement working culture, small steps at a time but regularly making progress ➢ Elimination of waste and lean working principles ➢ Business strategies align with operations, and performance measures with processes
Score	**PM = 18, Benchmarking = 11, Ave = 14.5**	**WCM Obj = 18, Principles = 15, Ave = 16.5**
	Total Ave. Score	**15.5**

Table 5.9: Change Indicator Score Sheet Wings – Corus

5.4 Summary

Rexel, Pilkington, and Corus collaborated in this research via case studies. This is also known as reactive participation. Heritage Silverware was proactively participating in this research, as it involved projects that allowed the BoC model to be used within the company. This research investigated a spectrum of companies with different sizes, products, management approaches and levels of engagement in WCM, which has a significant contribution to creating a generic change model as stated in the research objective.

Each of the four participating manufacturing companies had adopted a set of different methodologies and tools to change towards WCM. Pilkington Automotive underwent a successful re-engineering process in the early phase of change programme, and is now joining its other Pilkington plants across the globe engaging in a group-wide improvement programme -- 'manufacturing to win'. Its processes achieve high MoPs and a culture of CI fuses across the flat-structured organisation. Their King's Norton plant exhibits excellence in most areas of a WCM change effort. Rexel has an extensive commitment in the CI programme led by a team of enthusiasts including managers, team leaders and engineers. The use of JIT and CI principles and tools constantly improves shop floor operations, and promotes awareness among the workforce. At CORUS, it was proven that the business and financial end of an organisation have a huge impact on its WCM implementations. The merging of businesses and the pressure of creating bottom line results were the factors that stalled the change effort at times. At the other end of the spectrum, Heritage struggled to take on board WCM initiatives due to its lack of time, cash and human resources. A number of projects were carried out to improve data collection, MoPs, WCM awareness etc. Transforming a traditionally run factory to a WCM conscious organisation needs top-down support. Nevertheless it was evident that WCM in a small company is not only possible, but is as important as that in a global enterprise.

The BoC model was developed to provide the capability of simulating any type of change implementation. This has been proven successful so far in the research, where the model simulated change programmes of all the four actively participating companies and within the context of Caribbean industry. The simulations were carried out by transferring elements of change programmes, such as a company's up-front success factors, the tools chosen, MoPs utilised and the progress monitoring system, into suitable areas in the model. All the organisational changes studied have seemed to follow the generic pattern suggested by the BoC model. The research has produced case studies and industrial applications that fulfilled the requirements to strongly indicate that BoC, achieving the primary aim of the research, is a generic model.

Outcome of the use of the BoC model is demonstrated in three different ways: general outcome, MoPs and 'change indicator' scores. Awareness, uplift of culture, workplace improvements are some of many general outcomes observed. MoPs provide more specific results with figures but has no real value in comparison of the four participating companies. The most direct feedback for using the model is through the scores of the change indicator, which now represents the true measure of a change programme having achieved a strong indication that BoC is generic to different manufacturing companies. The four participating companies were scored by categories that have been preset. This will allow comparisons to be made between companies' performances, over different periods of time, and various areas of change within one company.

CHAPTER 6

Discussions and Conclusions

Outline of Chapter

Chapter 6 begins by making comparisons between existing world class manufacturing (WCM) models / frameworks to the one produced in this research – the 'birds of change' (BoC) model. The comparisons aim to raise justification for creating this model. Then analyses of the results – mainly the change indicator scores of each participating company – are made. The chapter then concludes whether (i) the objectives of the change model, and more importantly, (ii) the primary aim and secondary objectives of the research, have been achieved. Objectives that are not yet achieved will be highlighted in the next (final) chapter as recommendations for future work. This chapter also holds discussions such as the justifications and weaknesses of the change indicator, and raises issues on how WCM is distinguished from other management approaches such as JIT, TPM and TQM; whether WCM is for small enterprises and team structure is a tool or a culture. These have been popular discussions carried out among practitioners and academics.

6.1 Introduction

Four existing models / frameworks relating to WCM were presented in Chapter 4, before the final model of this research 'birds of change' (BoC) was introduced. These models / frameworks represent studies of the past five years that led to the development of the BoC model. As well as examining the theories, objectives and practical implications of each of these models / frameworks, it is important that this research presents shortcomings of these models in order to support the ground to establish a new model. Furthermore, the new model needs to possess originality in theories, objectives and applications in comparison to existing ones.

The BoC model was tested in four manufacturing plants. The application of this management model is supported by a scoring system named change indicator (see Chapter 4) to assess the companies' performances in their efforts to change towards being a WCM organisation. Chapter 5 exhibits scores of all four manufacturing plants taken at the same time. How exactly do these scores portray the change ability, reflect the strengths and weaknesses, and predict the change future of the company? The results require analysis in detail.

Early in the research the aim and objectives were laid. When the main product of the research – the change model – was introduced, a set of objectives was also established for the model in particular. It is fundamental in any research to revisit the objectives to discover how much of these were finally achieved.

Alongside researching the change endeavour of the industry towards WCM, many issues had arisen in relation to the topic. Some of these issues needed to be further investigated to substantiate the main arguments of the research.

6.2 Comparing 'Birds of Change' (BoC) and Existing Models

The 'Birds of Change' (BoC) model is compared to the four existing WCM-related models / frameworks to justify its novelty. The four models / frameworks, as detailed in Chapter 4, are:

- Barry's model of a WC organisation (1998)
- Gilgeous's manufacturing excellence framework (1997)
- Barsky's WC customer satisfaction (1995)
- Obolensky's approach to business re-engineering (1994)

These four models / frameworks were taken for comparison purpose because they each present various management approaches. They each embody a large similarity, and yet an abundance of differences to BoC. In the effort of comparing BoC with the other existing models / frameworks, boxes are shaded with different colours to indicate the similar activities / elements.

6.2.1 Barry vs. BoC

Barry's model of a world class (WC) organisation presented 17 core activities in its global overview. As explained in Chapter 4, a company begins its WC journey from the top of the model, travels downwards in the model and picks up the next activity if the company feels the need to improve in that area. A lower level of the model provides more detailed activities and tools in that specific area.

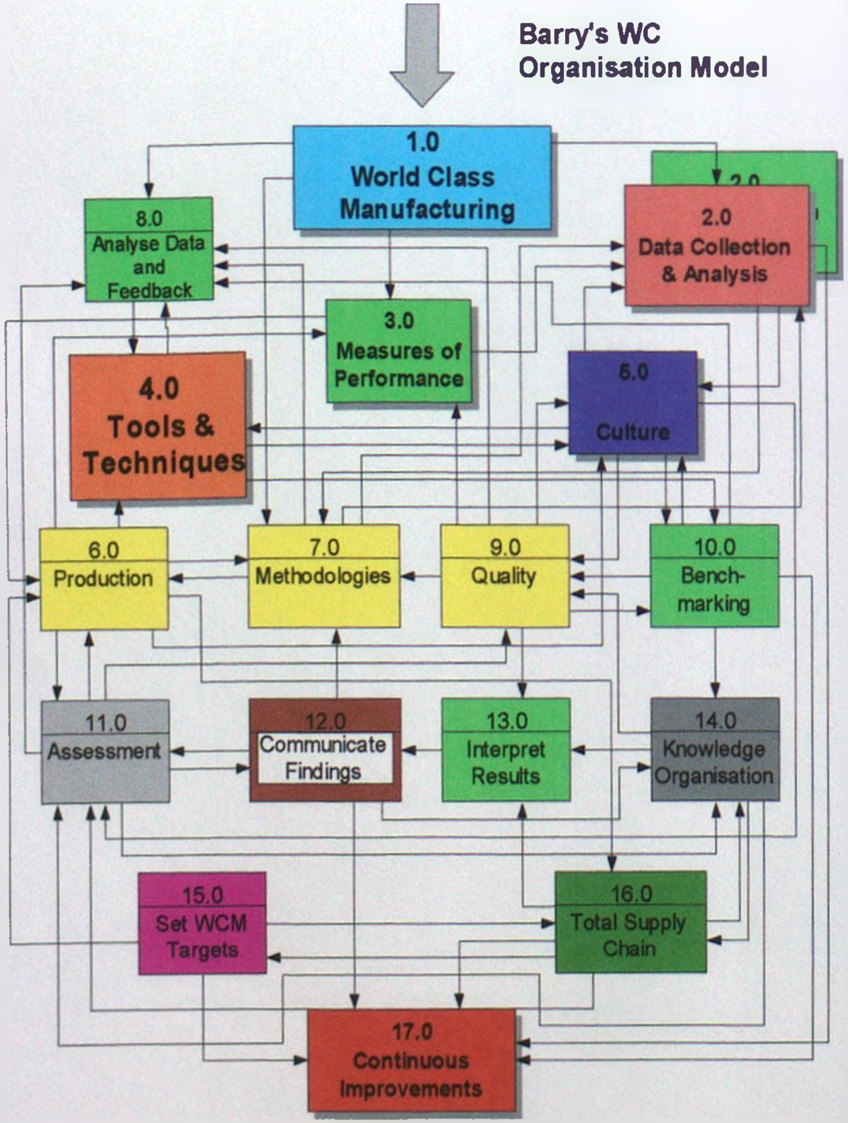
It is apparent that both models share a majority of common elements, despite having them placed in different areas (see figure 6.1). An easy way to see it is when one takes elements in Barry's model, regroups them and puts them in sequence, then it becomes the BoC. Relocation of elements provides evident advantage for the following reasons:

- It becomes clear where the element fits into the organisation (business strategy / team planning / shop floor improvement actions / implementations)
- It helps allocation of resources (top management decision / team problem solving / process improvement)

Barry has taken the model to a great length of detail. Hundreds of elements are mentioned in the lower level of the 17 core activities (exhibited in figure 4.1 [b]). This research focused on developing a generic route of change. A company's success factors are very diverse, and new tools never cease to be re-invented. By creating a basic framework allowing its inner elements to change over time, rather than fixing the detail according to current knowledge, is the only way to sustain the eligibility of the model in the future.

All 17 activities carry equal weight, and there is no specific sequence to follow. However, the BoC (KAIZEN Bird in particular) inhibits a rigid sequential approach -- from left to right following the bird's forward motion. Restriction on freedom at this level is desirable as process improvers need to follow some basic paths.

When one looks beyond a core activity and explores its lower levels, often that one activity branches out to many 'elements', each can be an activity of a smaller scale, a tool or technique. With no way of prioritising these 'elements', one is risking spending too much time and resources in choosing and implementing an inappropriate one. This has been eliminated in the BoC model. Every 'element' in the BoC is defined according to its confined area (e.g. Element = Input in 'input environment' / Activity in 'project' and 'process environment').



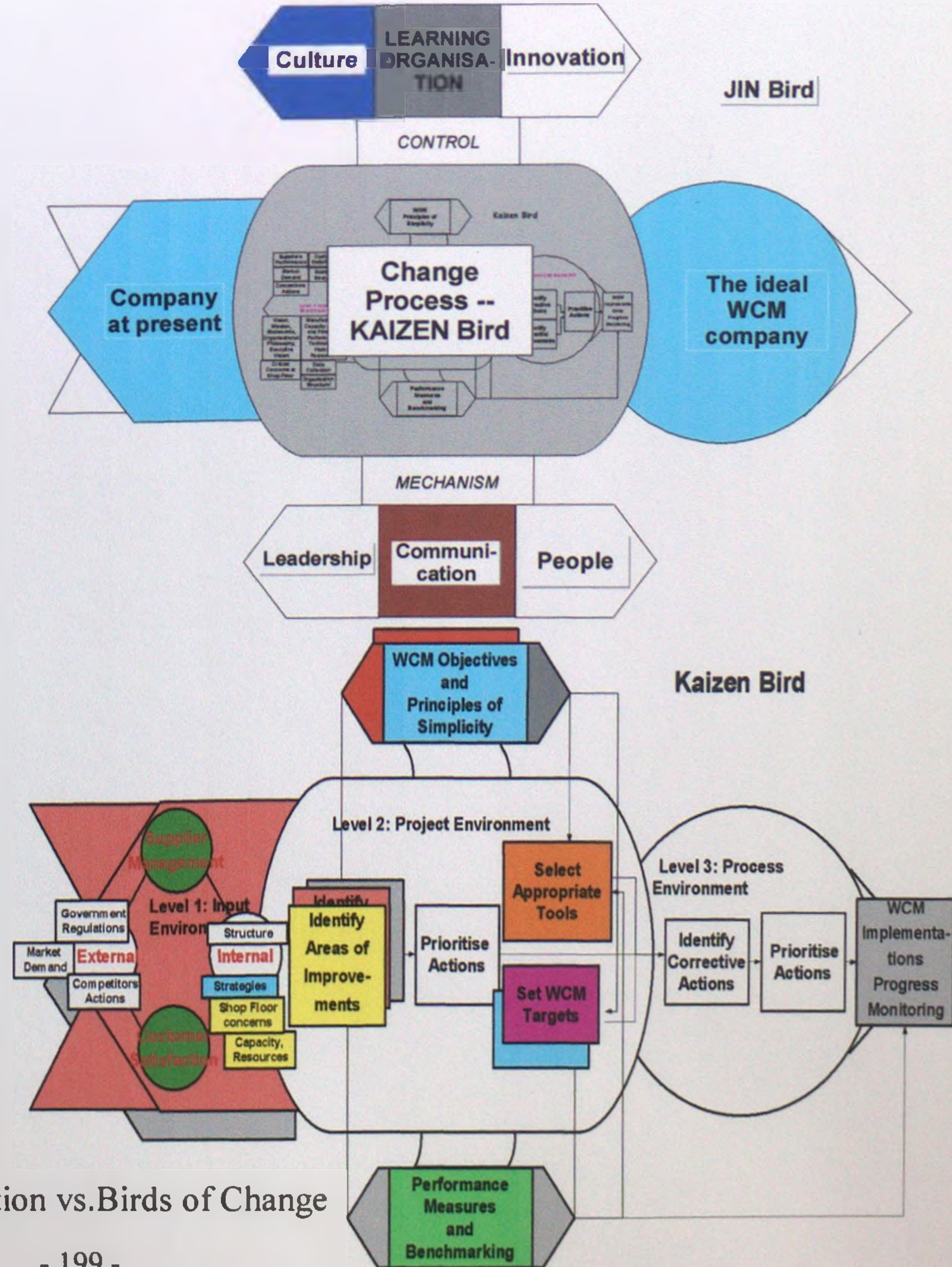


Figure 6.1: Barry's Model of a World Class Organisation vs.Birds of Change

Questions also arise when a detailed study was performed on the arrows appearing in the model:

- On the first level it appeared that arrows represent the paths from one activity to another. However, on the lower level many can be interpreted as 'inputs'. The arrows do not specify relationships between elements and this therefore has to rely on an individual's interpretation.
- Direction of the arrow is elaborated as 'input into', 'next activity', or 'tool useful for'. Again, these can also be interpretations of individuals.
- Presumably elements are only inter-connected when linked with an arrow. However, there are a few instances where core activities are not directly linked with an arrow, although they obviously share common elements. For example, measures of performance [3.0] should be part of a company's internal assessment [13.0], and WCM targets [15.0] must be set by judging its MoPs or assessment outcome. Nevertheless these activities are not directly connected in any way.

In the BoC model, every arrow exists for a specific purpose. Each arrow indicates a direct link between two activities. Hence any two activities joined by an arrow have a relationship, which in some cases is described in a sub-model (see section 4.7). An arrowhead represents "next activity" following the forward motion of the bird; otherwise it represents an "input into" an activity from the 'wings' of the KAIZEN Bird.

6.2.2 Gilgeous vs. BoC

Figure 6.2 illustrates a comparison of Gilgeous framework to the BoC model. Gilgeous's framework is structured as a hierarchy, as opposed to the BoC model of sequential nature.

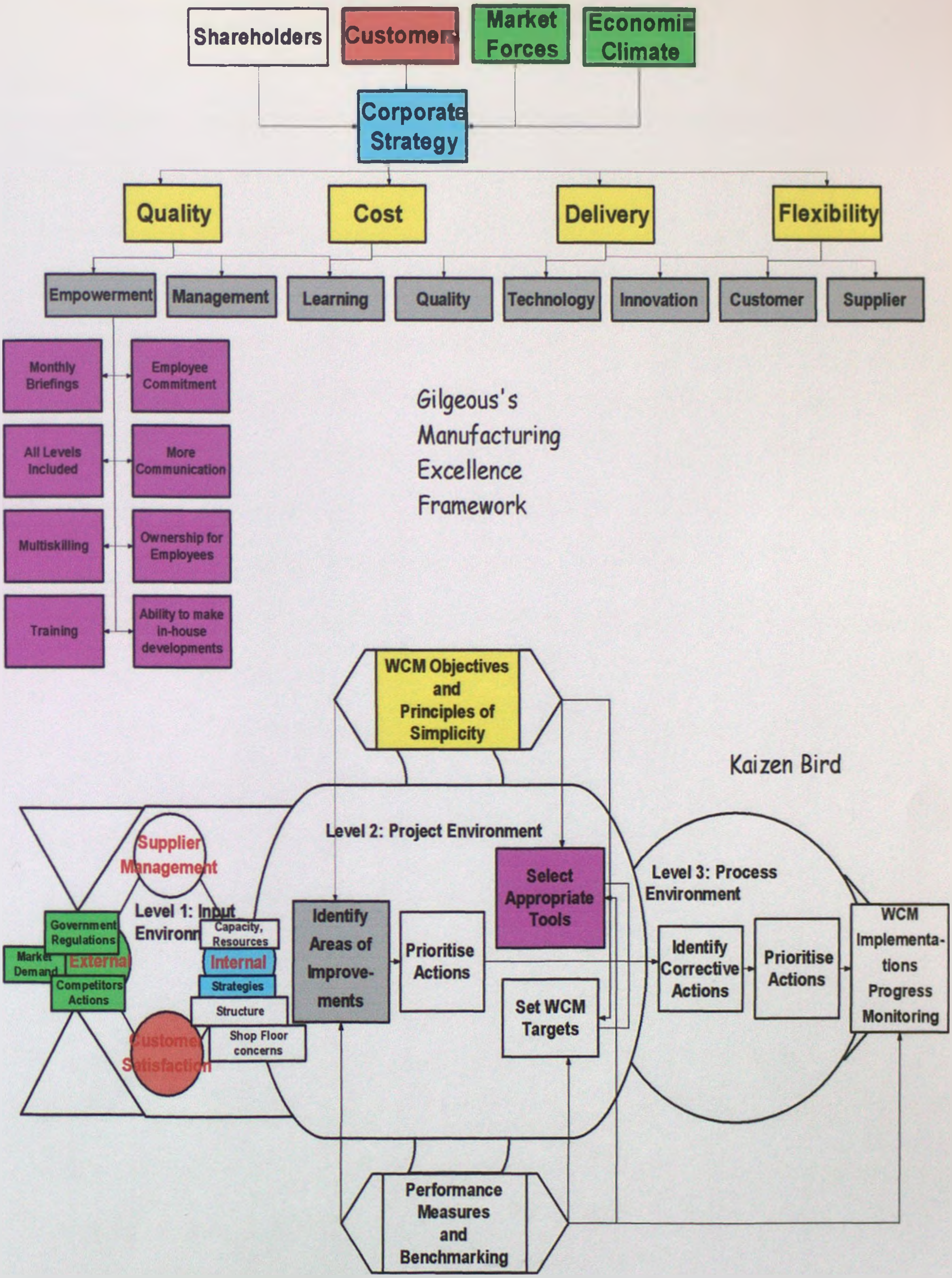


Figure 6.2: Gilgeous Manufacturing Excellence Framework vs. Birds of Change

In a way a hierarchical model can be sequential, if one works its way from top to bottom. However, a model of such hierarchical nature provides a sense of superiority in the activities. The activities appearing at the bottom of the hierarchy (the enablers) only seem to support the middle level (the initiatives). Likewise, the middle level is there to assist the achievement of the final objectives on the top level in the hierarchy. A sequential model, one such as BoC, gives equal weight to all activities across the model. For example, setting up company success factors is just as important as carrying out small corrective actions.

The top level of Gilgeous's framework can be related directly to Level 1 of KAIZEN Bird – 'input environment'. Gilgeous listed the factors that formulate corporate strategy, namely customer, economic climate, shareholers and market forces, but the model only focuses on corporate strategy that satisfies customers. This fits into one of the many possible patterns that can be possibly formed in BoC, given that customer satisfaction is a top priority of the organisation at the time.

Figure 6.3 shows the complete loop of factors forming corporate strategy (KAIZEN Bird). The shaded areas contain factors suggested by Gilgeous. This research suggested that corporate strategies cannot be formed without assessing internal manufacturing capabilities and performances of immediate participant in the supply chain (ie. supplier).

Gilgeous's point was agreed that the basic manufacturing objectives (cost, quality, delivery, flexibility) are the leading elements of achieving manufacturing excellence, although this research suggested workplace improvements, customer satisfaction and health and safety on top of those mentioned. The agreement traces back to the definition of WCM where both conformed in "fulfilling the main WCM objectives". Further concurrence of the two models falls into the two lower levels. The eight initiatives in Gilgeous's model comply with 'identifying areas of improvement' (KAIZEN Bird level 2 'project environment'); and all the enablers in the manufacturing excellence framework are in conjunction with the selection of tools in KAIZEN Bird.

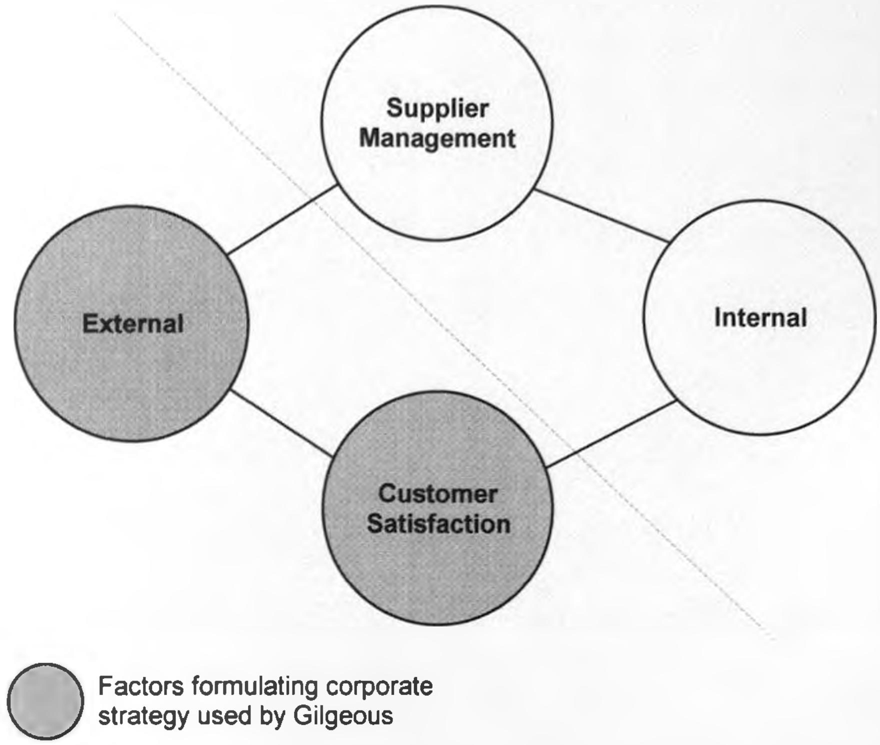


Figure 6.3: Factors formulating corporate strategy suggested by Gilgeous (1997) in comparison with 'input environment' loop in KAIZEN Bird Level 1

The core essence of WCM is continuous improvement (CI), which is not accommodated in Gilgeous's framework. If a feedback loop is introduced in the manufacturing excellence framework with a target setting and progress monitoring system, the entire framework can be turned into more of a process. KAIZEN Bird did exactly that. CIs are driven by a system of monitoring implementation progress supported by MoPs and target setting.

6.2.3 Barsky vs. BoC

To compare the KAIZEN Bird to Barsky's customer satisfaction (CS) model, it is practicable to translate elements of KAIZEN Bird into a CS orientation. To do this, one has to approach the KAIZEN Bird having assumed that CS is the primary company success factor. Figure 6.4[a] simplifies KAIZEN Bird into its five main areas (level 1, 2, 3 and the two 'wings'). The simplified version of KAIZEN Bird is then examined and represented with the assumption that CS is made a primary concern throughout the change process.

The CS-oriented KAIZEN Bird is now comparable to Barsky's model. When compared, Barsky's CS model fits comfortably into KAIZEN Bird. Both models are based on the concept of CI and share many similar elements. Figure 6.4 [b] illustrates the matching elements of the two models. Every activity mentioned in Barsky's model is covered in the process of KAIZEN Bird, and vice-versa. The activities are broken down in different details but the outer structures resemble each other.

The concerns above would all be under the assumption that CS is the focus point. KAIZEN Bird allows change management from all other points of view. A company may approach WCM when it sees the need to tackle internal shop floor problems; others would probably place the emphasis on quality or flexibility. For this reason, Barsky's model is only one out of the many possible combinations one can create from KAIZEN Bird. So one should bear in mind that Barsky's model is comparable only when CS is made the primary concern or the approach to tackle all problems.

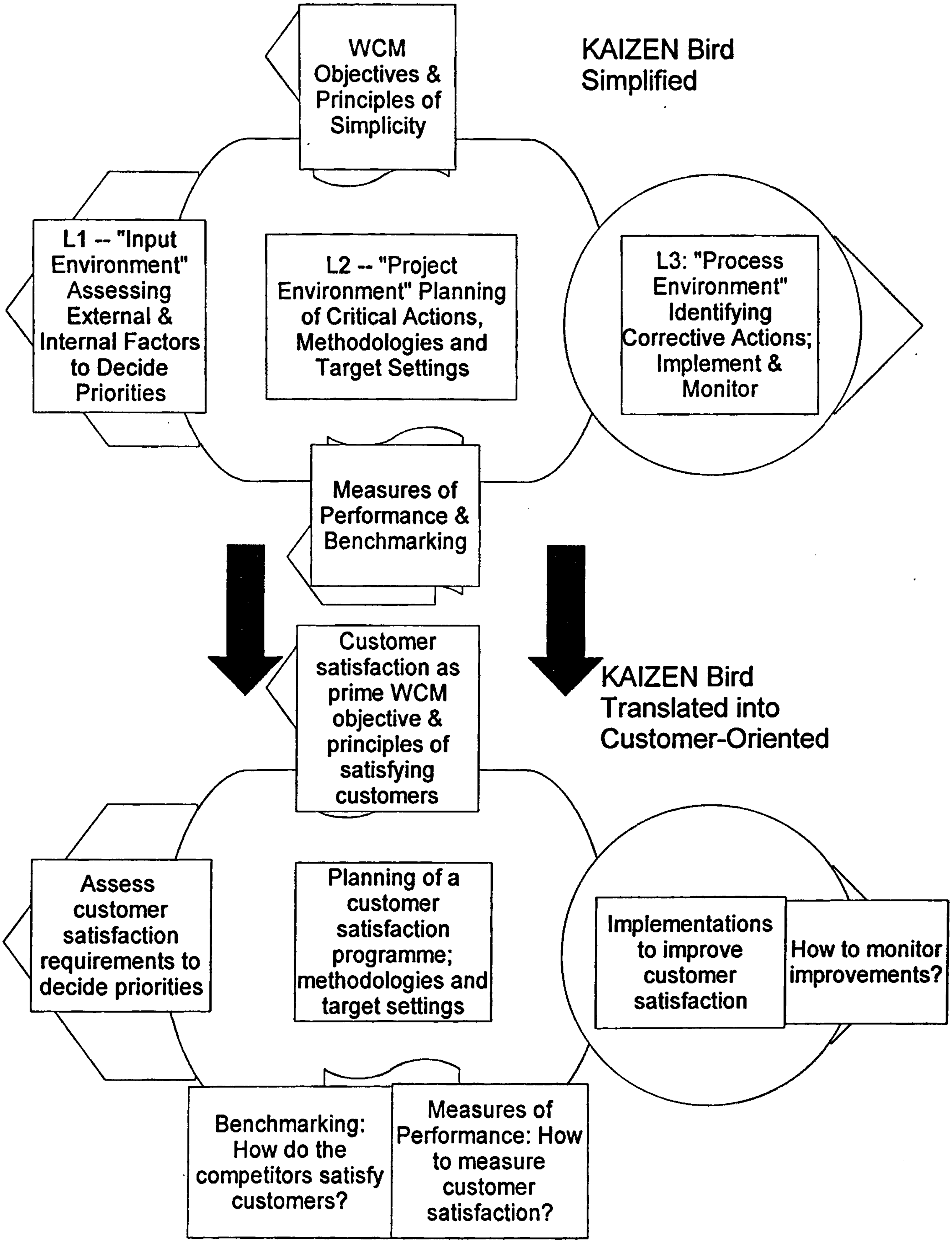


Figure 6.4 [a]: KAIZEN Bird simplified and translated to be customer satisfaction oriented

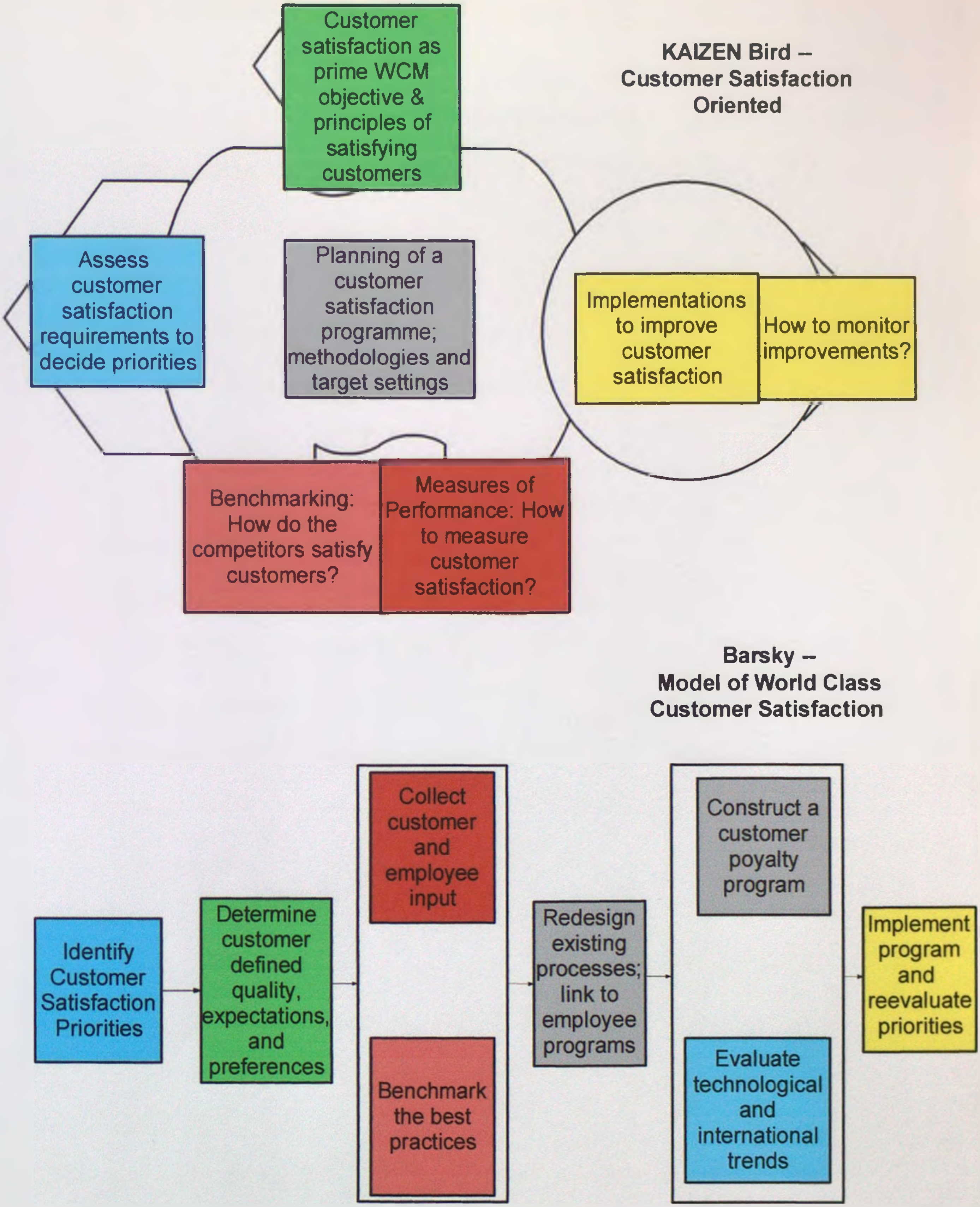


Figure 6.4 [b]: Barsky's Customer Satisfaction Model vs. Birds of Change

6.2.4 Obolensky vs. BoC

Obolensky's model of business re-engineering resembles any typical change or KAIZEN approach. They share a similar pattern of implementation steps, which is translated by Obolensky in these simplest terms:

Know what you want → Make a plan → Do it → Monitor

KAIZEN Bird employs the exact same approach:

Input Environment → Project Environment → Process Environment

→ Monitor Progress of Implementation

The comparison of the two models is straightforward (see figure 6.5). In the 'input environment' the company assesses itself by asking questions involving customer satisfaction, supplier requirement, internal and external factors. The aim is to establish a set of success factors / areas of improvements. In other words, "know what you want". Once the success factors are identified, the project team needs to select the appropriate tools to help achieve certain targets in 'project environment', which is very much a "make a plan" stage. To "do it", these improvement areas need to be translated into specific corrective actions. That is being done in the 'process environment'. Finally, a monitoring system is required to ensure progress of the implementation.

The guiding elements that feed into the whole KAIZEN Bird process include:

- MoPs and benchmarking that tell whether or not the corrective actions are proving effective in achieving the targets, hence indicating whether or not there is a need to "change how you do it"
- a set of pre-defined WCM principles which guides the improvements
- WCM objectives and continuous input from the 'input environment' to help "change what you want".

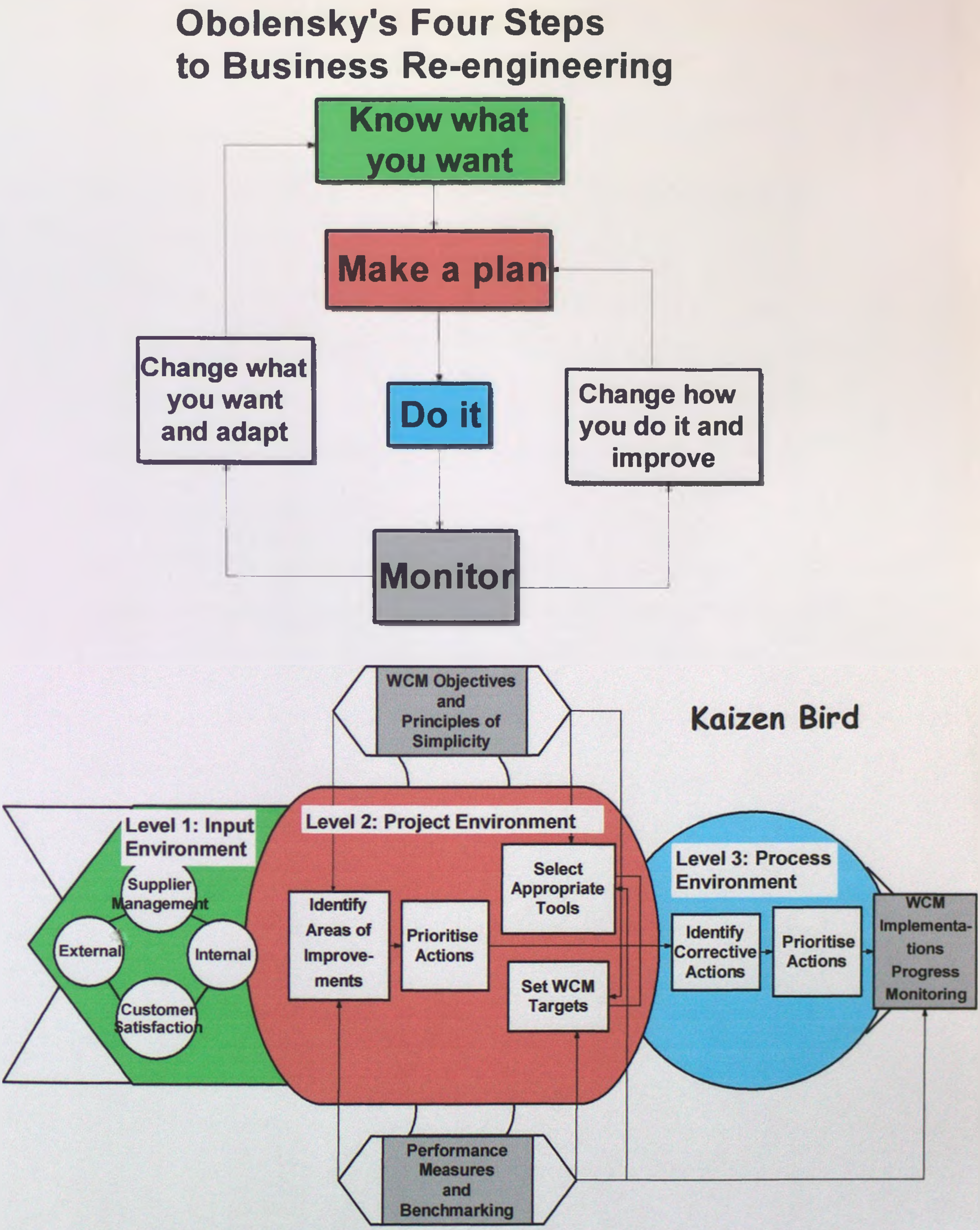


Figure 6.5: Obolensky's Business Re-engineering Model vs. Birds of Change

6.2.5 Conclusions of the Model Comparisons

Having compared the BoC model to the four other existing models / framework, it is important to reiterate the two purposes of carrying out these comparisons:

- To justify the need to create a new model, and
- To emphasise the originality of the model, hence the research

Figure 6.6 is a summary of these comparisons. Components that are in common of all the models / frameworks are listed to achieve fairness. First it is essential to understand what the author's points of view on WCM are. This is not just to justify that the models are all WCM-related, it is also to recognise the set-out point of each model. Then a description of physical structure and nature of the model is given to each model to re-create a quick graphical representation of the models, and more importantly how they work. Finally, strengths and weaknesses of all the five models / frameworks are highlighted.

What the research has achieved is having gathered all the strengths and uniqueness of the other models and re-produced them in the BoC model. Shortcomings of the other models have also been identified and modified in the BoC model. There are shortcomings embedded in the BoC model itself, but these are of a different nature. They are mainly related to the need to enhance its practical use and expanding its capability by inputting more industrial data and theoretical backings. In conclusion, the BoC model is a product of many improvements made on existing models / frameworks, plus elements that are added through industrial applications and literature survey.

	**Barry's Model of a WC Organisation**	**Gilgeous's Manufacturing Excellent Framework**	**Obolensky's Business Re-engineering process**	**Barsky's WC Customer satisfaction model**	**Tey's BoC Model**
WCM Definition	CI not only applies to manufacturing, but the whole spectrum of the organisation, WCM should be changed to just WC	Using Greene's "Continuously outperform best practices, know competitors' and own strengths and weaknesses"	An evolution or practical strategic application of various management approaches via radical change / re-engineering the working structure of an organisation	World class means increased profitability, and this is achieved by innovative and effective approaches to ultimately improve customer satisfaction	Competitive advantage through manufacturing strength. Strategic vision, creating, effective organisational structure, employees-management integration, appropriate tools, continuous improvement culture in cost, quality, productivity, customer satisfaction and health & safety.
Model Structure + Nature	Global overview → 17 core activities → Supporting elements	Strategy → 4 objectives → 8 initiatives → enablers	4 generic continuous improvement steps with feedback elements	8 continuous improvement steps focusing on customer satisfaction	JIN Bird (input, output, control and mechanisms) → KAIZEN Bird (3 levels; 13 elements) → 2 sub-models
	Circular	Hierarchical	Sequential	Sequential	Sequential, hierarchical, circular
Unique-ness + Strength	Strong practicality; dynamic, highlights culture, learning and communication	Principle orientated, consists of many best practices; complete framework	Creates a dramatic culture shift; tackle the core structure of the organisation	High practicality; Clear implementation steps; extensive industrial examples	Clear implementation steps, dynamic; high practicality; sense of prioritisation; complete framework inc. soft structure; assessment capability
Short-comings	Undefined elements; lack sense of prioritisation; model mechanisms unclear; complexity of model needs clarification	Determination of success factors does not include internal inputs; lack sequential steps and sense of prioritisation of actions	Concentrated on only the organisational change aspect of WCM implementation	Constrained to only Customer Satisfaction orientation in the whole WCM domain	Insufficient industrial input; Insufficient supporting tools; Lack of operational research capability; assessment capability needs enforcement

Figure 6.6: A Summary of comparison between the BoC model and four existing models / frameworks

6.3 Analyses of Results

Table 6.1 exhibits the 'change indicator' scores of the four main participating companies. Scores of each company are presented as a total as well as for each segment of the KAIZEN Bird. Given that all these scores were taken at the same time, a comparison between the companies' change implementations can now be carried out. The total score of the company reflects the overall strength of its change towards WCM at that time. However, it is the scores in each individual area that tell what area the company is efficient in, in which area the plant needs to improve, and where effort has to be focused on.

Scoring Matrices	*Max. possible score*	Rexel	Pilkington	Corus	Heritage
L1 – Input Environment	10	6.6	6.7	5.6	5.0
L2 – Project Environment	10	7.3	8.0	6.0	5.0
L3 – Process Environment	10	8.7	7.7	4.3	6.7
KAIZEN Wing –	20	17.3	17.5	15.5	6.3
Total Score	50	39.9	39.9	31.4	23.0

Table 6.1: Change indicator scores of the participating companies in comparison (scores taken on Jan 2001)

Rexel and Pilkington shared the highest score among the participants (total score = 39.9), followed by Corus (total score = 31.4) and then Heritage (total score = 23.0). The scores give a general idea on the standard of involvement in the company's change towards a

WCM working environment. Correlating the scores to the initial observations made on the companies' characteristics (see table 5.1), the following conclusions can be drawn:

- High scoring companies have a management team to specifically deal with WCM issues. The team has clear objectives and action plans to achieve targets
- High scorers tend to be flat organisations with cross functional teams; low scorers tend to have a hierarchical organisational structure with functional specialisation
- Direct and open communication between personnel is the key to high scoring; as opposed to top-down vertical communication
- High scoring plants have clean and tidy workplaces in the office and shop floor
- The workforce in high scoring organisations is generally made up of more process thinkers / improvers rather than labours with repetitive jobs
- Lack of resources (human resource, cash flow, space and information) is a major cause of low scores; companies with rich data resources in MoPs score higher

Following are some other minor observations, which need further evidence to support their accuracy:

- Change in business (e.g. merging, expansion etc) can hinder change progress and produce negative influences on workers' morale
- Business re-engineering creates an opportunity for a breakthrough in WCM
- High scorers tend to be sensitive to health and safety issues
- The smallest company with the lowest turnover scored the lowest in the research
- Low scorers have suppliers / customers who are also less WCM conscious
- High scorers have embarked in WCM for longer duration compared to low scorers

The scores have no direct relation to:

- Product types / ranges
- The type of change vehicle / framework / tools used

The total score is the sum of the individual scores in four main areas of the KAIZEN Bird. Hence to analyse a company's overall change capability it is imperative to examine each and every one of the four areas. The overall score does not reflect the change capability proportionally. For example, scoring half of the other company does not mean having half the capability. However, evidence shows (figure 6.7) that if a company scores high overall, it tends to achieve high scores in every area; a low scorer on the other hand scores low in every area.

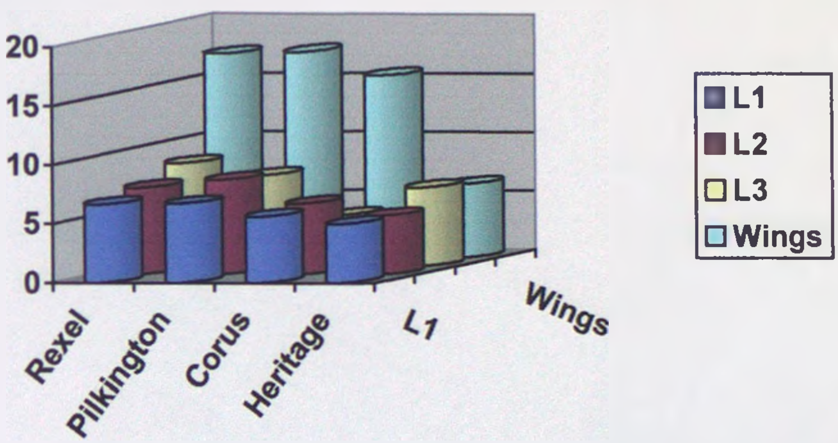


Figure 6.7: Change Indicator scores of each company in each area of KAIZEN Bird

Two exceptions to the above conclusions are worth a close look at:

- Corus's score (n = 4.3 /10) for Level 3 'process environment' is the lowest of all areas, and of all companies. Its high score in the "wings" keeps its overall score above 30 (advancing zone). However, having such low score in 'process environment' indicates that (i) the primary concerns are not being transformed into corrective actions, and / or (ii) the corrective actions are not being carried out efficiently. The specifically low score needs attention.

- Heritage scored far lower than the average in KAIZEN Wings. The company's score in the other areas (L1, 2 and 3) can be brought to par with the others with extra inputs. It is even doing better in 'process environment' than Corus, which means things get going and are done on the shop floor. However, an extreme low score in the 'wings' have put Heritage in the low end of the scoreboard (total = 23). The company needs (i) immediate and radical attention to its MoPs data, and (ii) an enhancement in the awareness of WCM principles and a good understanding of WCM objectives.

Comparing the two highest scorers -- Rexel and Pilkington, both achieved above average in level 1 and excellent in the 'wings'. Pilkington acquired a higher score in level 2 'project environment' whereas Rexel came stronger in level 3 'process environment'. This indicates that Pilkington accomplished more in the planning phase of the change programme, however Rexel had a more established system in the actual implementation of shop floor improvements.

Corus, on the other hand, performed moderately in all departments except level 3. This poor performance is a warning sign to make fundamental adjustments in carrying out shop floor corrective actions in conjunction with the company's business strategies or mission statement.

Heritage scored lowest across the band except level 3. Low scores in level 1 and 2 are caused by a general lack of awareness towards WCM. As a conventional small business, profit making and keeping production flowing is more of a concern than process improvements at the time. This traditional management attitude was magnified in the KAIZEN 'wing' score (= 6.3/20) taken six months into the launch of WCM change project. The score is much lower than average due to the fact that the company has no prior WCM implementation and utilisation of any sort of WCM tools. Adapting to WCM principles, generating MoPs and benchmarking, and building towards all WCM objectives have been proven to be most time consuming. Heritage's score in Level 3 (= 6.7/10) was one that can be celebrated. The score is higher than Corus and is close to the other highly ranked companies. Compared to the other scores, Heritage has reaped achievement in this particular area. The launch of the change project has made a vast impact here. Hence it proved that it is relatively less time consuming implementing activities in level 3 'process environment' as it is here where small-step CI are taken. One significant conclusion is also that simple changes can be made faster in small firms than large ones. The small firm CEO has much more independence of action.

The companies' scores in each area are averaged and shown in figure 6.8. The score of 'KAIZEN wings' carries more weight, hence the average only produces significance in comparison when presented in percentage. Theoretically the comparison should provide a hint as to how easy or difficult it is for a company to score highly in each area. The figure demonstrates that companies' scores increase progressively as the KAIZEN process progresses. This suggests that companies struggle to identify important success factors at the early stage of the change programme (level 1), but find it a lot easier to carry out and monitor small corrective actions (level 3). The highest average score lies in 'KAIZEN wings', which suggests that most companies perform well in WCM principles, objectives and MoPs. However, if the average scores in percentage are to be broken down again, the above hypotheses become random conclusions (figure 6.9). Heritage's score in KAIZEN wings was lowest of all areas, and two of the four companies score higher in level 2 than level 3. The only indication of trend is that all companies seem to score equal or higher in level 2 than level 1. What can be drawn from here is that identifying company success factors out of external, internal, customer and supplier factors is a complex matter and things are likely to be overlooked. However if a company gets a grasp of what constitute to its success and competitive advantage, the planning stage (level 2) proves to be easier.

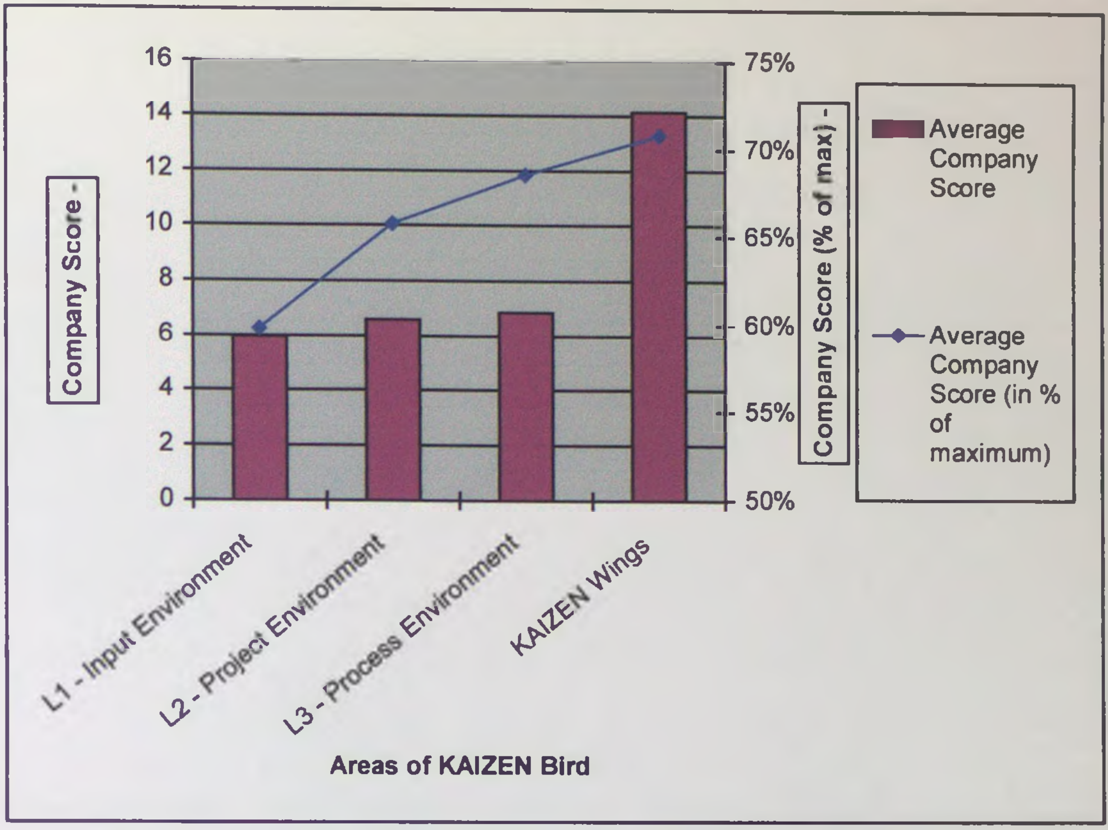


Figure 6.8: Average company actual scores and scores in the form of % of maximum in each area of KAIZEN Bird

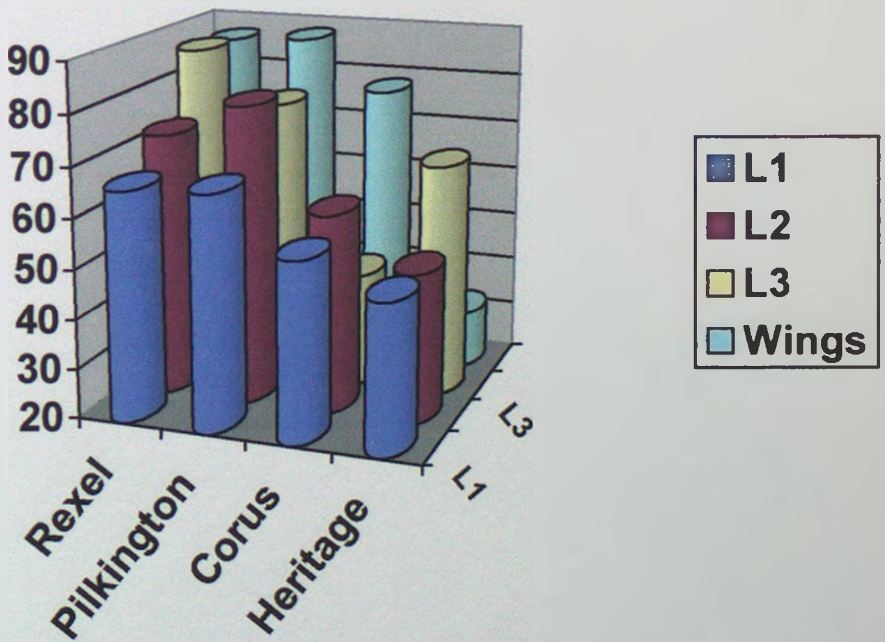


Figure 6.9: A breakdown of company %scores in each area

Figure 6.10 presents each company's score of one area (KAIZEN bird L2) over the same time span. The arrow-head score shows how well a company is changing in WCM, whereas the length of the span indicates how much the company has improved from the start to end of the time period. A few interesting observations can be concluded as follows:

- Pilkington represents a company with very high score to start with but has the least improvement over time. This can be an indication that when performance reaches a high point, improvement becomes harder and more stagnant.
- Heritage had the lowest score as a start but experienced the highest rate of change. One could say that improvements are easy to achieve when there is plenty of room for it, but this is not the case for Corus as it remained scoring at the lower end over the given time span. However, it shows that simple changes can be made faster in small firms as a small firm CEO has much more independence in action.
- Rexel seems to be progressing with a steady rate at the higher end. Hence the only conclusion that can be drawn so far is that change performance at one time has no indication of the rate of change. Although not observed in this example, the rate of change could easily have been negative.

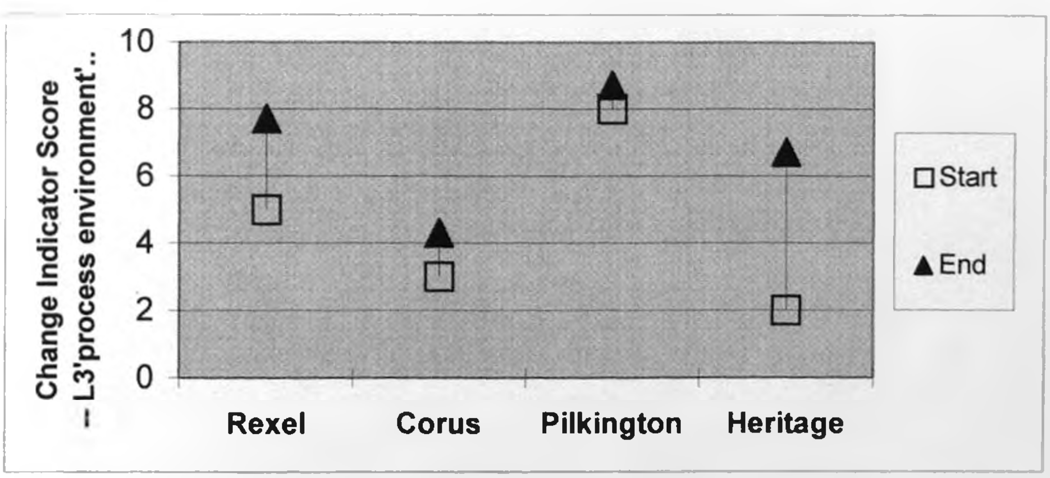


Figure 6.10: Comparison of companies' scores of change in 'project environment'

6.4 Conclusions

To draw main conclusions of the research, the author has adapted the approach of revisiting first the objectives of the model, and second, the overall objectives of the research. Each objective, primary or secondary, is reviewed to state if it has been achieved, and if not how far the research has come to achieve it.

6.4.1 Model Objectives Revisited

To recap the objectives that the BoC model set out to achieve:

- Translating business strategies into operations
- Facilitating modern WCM principles, philosophies and tools
- Aligning WCM objectives with modern tools and appropriate MoPs
- Setting up MoPs and benchmarking as feedback of change progress
- Incorporating soft structure of OC

Business strategies are formed by gathering information laid out in KAIZEN Bird level 1 – 'input environment'. These are external factors such as market demand, competitors' actions, economic situation and regional aspirations; internal factors such as shop floor critical concerns, employee feedback; and input along the supply chain – customer satisfaction factors and supplier performance. By assessing these factors, it allows the company to identify areas of improvement, which brings the process into level 2 in the KAIZEN Bird. This would then follow by selecting appropriate tools and setting reasonable targets, with the help of WCM principles suggested by the studies, and carefully selected MoPs that are able to provide feedback to the process. The next and final level in the model is identifying operational / corrective actions in the simplest form. The implementation of actions is guided by a system of progress monitoring established through case studies done in this research.

The BoC model is a process of translating business strategies into operations. This has been proven by substantial examples, given in Chapter 5, related to the four industrial collaborations of this research. This translation process is complex, and may require data or materials such as methodologies of tools, and best practices continuously produced in the industry, but as a conclusion, a generic framework and guideline of the process has been provided by the BoC model.

The research has investigated, to various levels of detail, all significant management approaches of the manufacturing industry. JIT, TPM, TQM, BSC, CI, LM etc. are WCM-related approaches that have been studied and analysed in terms of their differences as well as their similarities. The overlapping principles, as well as philosophies and practices that are unique to certain approaches, have been gathered to produce a comprehensive list to follow. The tools that come with them have also been researched and utilised during the industrial collaborations. These tools have proven useful in industry for the past two decades, especially the past five years. Obviously, the research had only involved four industrial collaborations, and new management approaches and tools appear constantly. As a result, the BoC model is not able to provide all the answers. What it is able to do, is to facilitate modern WCM principles, philosophies and tools.

In terms of aligning WCM objectives with modern tools and appropriate MoPs, the research has coordinated a final year project to produce two sub-models to supplement the BoC model. One of the two sub-models describes the correlation between WCM objectives and the tools. The other presents these tools and their corresponding MoPs. Hence this objective of the model also, has been achieved.

KAIZEN Bird, as the name suggests, is a process of CI. The sequence of steps that the model advocates to carry out change towards WCM does not stop after one journey. It repeats itself as frequently as the company situation requires. In this type of process a feedback loop is imperative. MoPs, if used appropriately, give a good picture of the success or failure of the current process. Due to this reason, MoPs have been set up as the feedback element of the model. MoPs indicate if an implementation has been successful, suggest if new targets need to be set, and denote whether an identified area of improvement has been achieved. Two of the four companies have an established system of MoP in place for this feedback. The other two do not, due to a lack of awareness of WCM initiatives or an inappropriate use of MoPs. Hence the question of whether MoPs are best in providing feedback to change success has not been answered.

However, this research has created a supplementary scoring system of the BoC model, named the 'change indicator'. This scoring system, consisting of four matrices, audits a company's change programme according to the process laid out by KAIZEN Bird. The criteria were set up by studies of WCM change programmes in various literature reports, and in the four participating firms. Although the scoring system is believed to be generic, more industrial input is required to make such a claim.

On top of the KAIZEN Bird, the model comprises another layer labeled as JIN Bird. JIN Bird, KAIZEN Bird and the sub-models form the BoC model. JIN Bird is the top layer of the model, and has the overview of the OC towards WCM. KAIZEN Bird is the core of JIN Bird that brings company at present towards the direction of achieving the ideal WCM status, which of course, is an indefinite goal. JIN Bird illustrates that soft structure – made of culture, innovation, learning organisation, people, leadership and communication, is the governing element of the entire change process. This research agrees that when it comes to soft structure, there is no best way of managing. The attempt to create a "how to" model of soft structure remains in vain. However, what this research has done is identify traditional and modern views of culture, and take a stand on this issue. It has also outlined principles related to other soft issues that has produced success in the past. This has set a rigid framework and basis for future studies of soft structure in the OC towards WCM.

In addition to the five objectives mentioned, the BoC model has achieved other objectives not set forth in the research. The industrial applications of the BoC model has come to conclude that the model works on a company's change programme as a visual management tool. It provides a dynamic guide to show the organisation's WCM status, and drives CI. On a piece of paper, it enables quick understanding of what is going on, the strengths and weaknesses of the change programme, and areas that need immediate attention. This creates a sense of prioritisation in actions. The updated model speeds up meetings, promote awareness of WCM not only to executives but everyone across the organisation.

6.4.2 Research Objectives Revisited

The primary aim of the research is to build a model of organisational change towards WCM. The model has been tested in four UK-based companies and applied to the manufacturing sector in the Caribbean. There is evidence to show that the 'birds of change' model is generic to different manufacturing environments, that it is applicable to companies of different sizes, product ranges, organisational structures and physical locations – from a multinational giant corporate with a long history of success in WCM to a small plant hiring 20 people who have no previous knowledge of WCM.

The following objectives were set to achieve the primary aim of the research:

- To establish a standard definition of the term WCM for reference throughout the research
- To investigate the role of MoPs and benchmarking in WCM

- To develop a decision-making tool in prioritising actions
- To evaluate the importance of soft issues in change
- To study the dynamics of a change programme

The research now has a comprehensive and appropriate definition to be used throughout the research. A vast amount of literature had been consulted in the quest of putting the final definition together. This final definition encompasses elements of many aspects of WCM. It also generated a solid basis for building the model of change later on in the research.

The role of MoPs in WCM is clearly vital. MoPs provide feedback of any implementation to enable new targets to be set and new areas of improvement to be identified. Without MoPs a company would not know where it stands, and hence where to go from there. The appropriate use of MoPs drives CI and this is the essence of WCM. Moreover, MoPs force communication across the organisation and between management and shop floor. This role is especially crucial as WCM aims to create a flatter structure with more communication between its workforce. Benchmarking, on the other hand, gives positive results only when appropriately conducted. However, as competition becomes fiercer and strategic alliance along the supply chain becomes more significant, it is increasingly clear that benchmarking will play a far-reaching role in WCM.

In many ways, the BoC model assists decision making in prioritising actions. These actions include establishing company success factors, the selection of appropriate tools, and the utilisation of MoPs. The research believes that this assistance can be enhanced by using management tools. This has been included in one of the future works identified in the final chapter.

The research concludes that soft issues such as culture and people are of great important in change. In fact, the model of change has appointed a framework of soft structure that governs the success of failure of a change process. A company can invest in the highest technologies or best tools, but without the suitable culture of getting people involved, all implementations can and will fall apart eventually. Substantial leadership and management support is the key to creating this cultural shift to drive continuous change. A company needs to endorse open communication, promote innovation and learning organisation to sustain this cultural evolution.

The research has not achieved a complete understanding of the dynamics of a change programme. It had seen how change initiative dies from the lack of resources. It had witnessed few greater forces than the WCM implementations, such as a change of management personnel and a business shift of some sort. It had also learnt that re-engineering can transform an organisation but cannot maintain the success. The model, however, is not yet able to accommodate the complications of a change programme such as these.

6.5 Further Discussions

Several discussion topics were raised while researching the area of WCM. These discussions concern argumentative statements that are often brought up by academics and practitioners in the quest of WCM. The different sides of the argument are presented, and a stand is taken by the author to unify concepts of the current research.

6.5.1 Justifications and Weaknesses of the Change Indicator

This is to create a degree of freedom for the scorer. However, there are potential weaknesses of this scoring method. This degree of freedom makes the scores potentially subjective. The 'in-between' scores have not been given specific criteria. To score in between the categories of 'aware' (score = 3) and 'adapt' (score = 6), one will choose to score a '4' or '5' depending highly on their individual judgements, and this can be influenced by a few factors:

- Individuals' understanding of the statement
- Individuals' opinions on the performance
- Urge to perform well / to critical remarks

The scoring in this research have been carried out by various individuals, but analysis has been done only on the scores given by the researcher (author), who plays the role of an 'outsider' in most of the case studies. This is to prevent biased judgement on the companies' performances, and to maintain a consistent and fair evaluation process. However, scoring by one individual inhibits a less accurate result due to personal experience and a possible lack of certain knowledge. Hence there are suggestions that more than one 'outsider' should be involved in the scorings. On the other hand, if personnel in the company are to participate in the scoring, the analysis must also take into account the biased judgements mentioned earlier. A shop floor operator will tend to score highly in his / her related area as he / she wants to be perceived as 'doing a good job'.

The change indicator may also benefit if the scoring method is to be more objective. It will give a more accurate result if scorers were to be given a list of 'yes / no' type questions, rather than to score by comparing against a set of criteria. However, this would restrict the freedom of the scorers and the opportunities to gain creative feedback. The questionnaire would also need to be created in much more detail.

6.5.2 WCM -- Another 3-letter acronym?

Manufacturing industry from the 70s through to the 90s has seen the blossoming of various methodologies that were meant to induce effective ways of achieving competitive advantage. These methodologies usually contain a set of principles, advanced tools and new ways of thinking and forming strategies. The research collected at least 30 of these, and new ones appearing constantly. A few well-known examples being:

- Just-in-time (JIT)
- Total productive maintenance (TPM)
- Total quality management (TQM)
- Computer aided design / computer aided manufacture (CAD / CAM)
- Computer integrated manufacturing (CIM)
- Flexible manufacturing system (FMS)
- Manufacturing resource planning (MRP I / MRP II)

Coincidently most of these can be abbreviated into 3 letters, and hence labeled as the "3-letter acronyms". Based on the literature survey presented in Chapter 2, these are the distinguish features of a 3-letter acronym:

- Contains set of principles, tools and MoPs that work towards a specific goal or vision
- Can be adopted as an individual tool
- Appears quickly like a new "trend" which any competitor would feel the need to take on board or otherwise get left behind
- Provides a massive market for consultancy
- Many became commercial packages for strategic management

WCM appeared in the mid 80s. It was when the world's effort to adapt the other 3-letter acronyms peaked. Naturally, WCM was regarded as "just another 3-letter acronym".

As far as to how a 3-letter acronym is defined here, there are a few important points to get across to place WCM away from the 3-letter acronym category:

- WCM is not just a set of principles and tools. It is a generic way to strengthen manufacturing ability to achieve competitive advantage
- WCM should not be adopted as an individual tool. It is not a "trend" or a "fashion" to be followed. It should be taken as a way to work towards a competitive position in the industry, as long as competition exists
- Any 3-letter acronym can only be used as part of the WCM model, or as a specific path towards being WC
- Any industry or company can and should take on WCM, but not necessarily any other 3-letter acronyms

Due to the reasons mentioned above, it is useful and necessary to separate WCM from the other 3-letter acronyms. Therefore it was made an important objective for the thesis. If WCM is at any point regarded on par with the other 3-letter acronyms, the understanding of the change model will fall apart.

So what is the inter-relationship between any of the 3-letter acronyms and WCM? Figure 6.11 illustrates how the other 3-letter acronyms can be fitted as a specific path in a WCM endeavour. As far as the arguments are presented in this thesis, WCM is and should be the ultimate goal of any manufacturing company striving to survive and to gain competitive advantage. The generic model of change towards WCM (i.e. BoC model) guides a company / a plant towards that goal. All the 3-letter acronyms mentioned in this thesis (e.g. JIT, TPM and TQM) belong to a designated route / path that fits into the model in their own way.

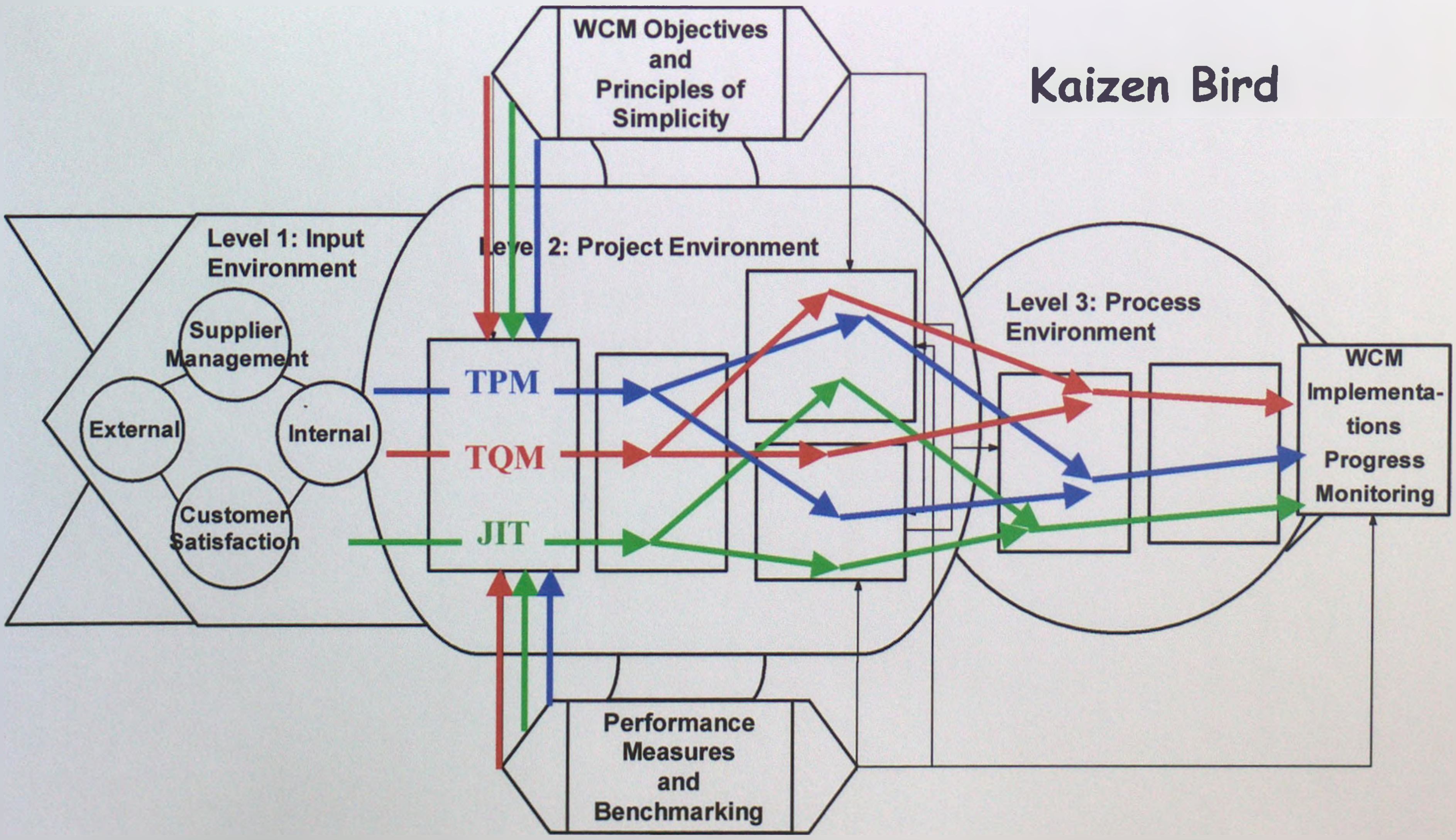


Figure 6.11: An illustration of management approaches as designated paths in WCM

As much as they move in the same direction, each of these routes approaches WCM from a different aspect. The decision to use these approaches depends on the up-front concern or areas that need improvement in the company. What distinguish these approaches are not just their different principles, but also the tools and the MoPs that come with them. Consequently, a company that randomly employs one of these routes may be brought to success by chance, or as we have seen happening more often, it can lead to nowhere if the company's situation at the time does not fit the particular route.

6.5.3 Is WCM for Small Enterprises?

WCM is often seen as a massive undertaking only for big companies. Executives of smaller size manufacturing companies often get intimidated by the sound of being "world class". Take a simplified version of definition for WCM -- the ability to outperform the competitors internationally in terms of manufacturing performances, ie. quality, costs, productivity and delivery performance. Being small does not mean not being able to produce better quality products. It also does not mean not being able to provide good delivery services at low costs. By having realistic expectations and by maximising the potential of the techniques that are feasible, WCM can be successfully implemented in small and medium enterprises (SMEs) (Farsijani, 1996). Embracing CI, utilising appropriate principles and having understanding between management and workforce are also crucial. WCM is not about size. Nowhere in any WCM definition does it state that it is only for big enterprises. WCM is just as important to a local manufacturing plant employing 20 people as to a global enterprise with 50,000 employees.

6.5.4 Team Structure – Tool or Culture?

Team structure has always existed in all organisation, in one form or another. Traditionally it has been vertical, or hierarchical. Vertical teams are made up of members within the same department or business function, eg. Engineering team. It is often led by the member on top of the hierarchy, eg. Engineering manager.

However, the team structure that creates new age organisation is that of a horizontal nature. A horizontal team, or sometimes known as a cross-functional team, is one formed by members 'horizontally across' the organisation. Members are from different departments/ functions of the company, and there is no obvious form of hierarchy within the members to begin with. Normally the team leader needs to be appointed. The idea of horizontal team structure goes hand-in-hand with that of a flat organisation with close inter-functional linkages. Creating a flat organisation and reducing the sense of hierarchy in an organisation have a healthy effect in empowering the workforce and lifting an innovative spirit.

Building teams to carry out tasks is a WCM practice. Organisations with a flat structure consist of cross-functional teams. There is no hierarchy within each team, but there is a top-level team formed by executives that makes the up-front decisions of the company. It is important to relate bottom teams (eg. manufacturing teams) to the top-level team (strategic team). Communication and understanding of company objectives and manufacturing objectives are vital.

A tool is something we use to carry out a specific task. In that way a team can be seen as a tool because it is used to carry out a project. Horizontal team structure has proven to be an effective tool to carry out projects, especially short-term projects.

Culture is “the way we are used to do things around here”. In a company, the team structure is a cultural aspect. If the company has always been operating in vertical team structure, then that is the way people are used to, ie. the culture.

So to conclude a team is used as a problem solving tool, but the concept of different team structures can be developed into a company culture. The ultimate aim for a WC organisation is to establish a flat structure consisting of many cross functional teams. The teams exist only for a short term, and are dismissed when its appointed task is terminated. New teams are formed all the time to carry out specific projects.

6.6 Summary of Conclusions

Four existing frameworks / models related to WCM were chosen to measure up to KAIZEN Bird. Each has a different approach to WCM, and shortcomings that have been identified to justify the creation of KAIZEN Bird. Gilgeous's and Barry's frameworks are examples of existing frameworks that focus on WCM but lack sequential steps of implementation. The elements of these frameworks were nevertheless important in WCM change programmes. Hence they were incorporated in the BoC model and translated into sequential steps for industrial application. Barry's model has been used to audit 73 companies in the Caribbean. The BoC model is built based on modifications to Barry's model. Hence the two models work in parallel to test manufacturing companies in different regions. The fact that Barry's model has worked in the Caribbean manufacturing sector is a support to indicating the generic nature of the BoC model.

Obolensky and Barsky, on the other hand, built sequential models on business re-engineering and customer satisfaction but the focus is steered away from WCM. The BoC model follows principles and tools of WCM and its implementation steps are found to conform with these models. As a conclusion, the research not only has achieved its main aim of producing a generic model of an OC towards WCM, but a model that possesses original implications that have not been reached by other already existing models / frameworks.

Analysing the results of scoring change programmes using the change indicator, it is found that high scorers, i.e. companies that perform well in their change efforts towards WCM, tend to have these characteristics:

- Clear objectives and committed management team in their change programmes
- Flat organisational structures, cross-functional project teams and open communication
- Tidy workplace and systematic workplace improvements
- Workforce are made up of more thinkers and process improvers

The results show that high-score organisations tend to score highly in every area, and likewise for low-score organisations. However, companies should pay attention to the score of the individual areas. This is what gives indication of the strengths and weaknesses of the company's change programme and helps to generate action plans and strategies.

To generate whether companies perform better in certain area of the change process than the others, a bigger sample of firms would be needed. However, earlier indication suggested that companies achieve better results in the planning stage as compared to the input stage of change in the beginning. Research also shows that change performance at one time has no indication of the rate of change. Companies should avoid complacency, as performing well in the change programme does not guarantee progress if no continuous effort is put into it. Utilisation of the BoC model is a continuous process.

The BoC model presents all the elements needed (both hard and soft structures) to establish OC towards WCM. The model has proved itself to be a guide towards implementing a WCM programme by showing in detail each step to be followed, from making strategic decisions to conducting shop floor corrective actions. Throughout this process, the model facilitates state-of-the-art WCM principles, philosophies and tools and at the same time linking these tools to the appropriate MoPs and manufacturing objectives such as costs and quality. In addition to the five objectives mentioned, the BoC model has achieved other objectives not set forth in the research:

- Visual monitoring tool
- Dynamic guide to company's WCM status
- Drive for CI
- Provides a sense of prioritisation in actions
- Consists of academically and industrial proven principles
- Comprehensive, covering the entire organisation

Although WCM was introduced during a period when the world was busy adapting the Japanese JIT manufacturing techniques and TQM, it has been concluded that WCM should be distinguished from all the other '3-letter acronyms', and that these '3-letter acronyms' should be taken as designated paths that fit into the WCM model depending on the need of the company.

WCM should not be regarded as an approach unique to large enterprises. Small and medium size companies face global competition and WCM should be adopted by all manufacturers to gain competitive advantage.

Team working is a tool to carry out specific tasks or projects. Organisations that embark on WCM initiatives and desire to effectively carry out WCM implementations should promote cross-functional teams and create a flat organisational structure.

If the various management tools can be better understood, decision makers in manufacturing industry will have an easier life investing in the appropriate measures. If a specific route towards WCM can be identified, together with a set of principles to be followed, management will save a great deal of time and resources trying to solve the puzzles of why change efforts fail. Having a generic route towards WCM does not mean that every company will be utilising the same tools and implementing the same change programme. Due to the diversity in manufacturing capacities, workforce culture, competition in the industry, financial ability and other constraints, each change programme will vary.

If the journey towards WCM can be seen as a road trip, there will be many stations along the way. The entire workforce will travel the journey together, going past all the stations. However the journey does not stop there. The travellers go back to the starting point again, and again, passing all the stations, but picking up different items each time, and performing different tasks each time. The route is 'generic', but every trip is a different experience. The model gives guidance on what area to focus in each step, and provides clues on the sort of information needed, more than it specifies the exact answers.

What is to be kept in mind, is that the model is not a model of a WC organisation, but it is rather a model of change. When it comes to change management, there is no absolute solution to every situation. As Urwick once said (1958), "No serious student of management has ever suggested that there was one best way of organising a business, but the use of 'flexible rules' provides a useful generalisation for everyday requirements".

CHAPTER 7

Future Work

Outline of Chapter

Chapter 7 suggests ways of taking the research a step further. The author's recommendations of future work will be outlined, in particular the further use of the model 'birds of change' (BoC) within industry, and the possible enhancement or modifications on the model.

7.1 Further Model Refinement

As the model is already designed in a flexible manner, i.e. one can take the mainframe of the model and apply it to a particular company / plant, hence the usage of the model is expected to sustain for many years to come. This is to say that model refinement will not be the principal concept of the model, but rather enrichment.

- One of the secondary objectives of the research, which came short of achieving the desired goal, was to establish operational research into the model. One can suggest to develop a decision making tool, like an Analytical Hierarchical Process (AHP) system in prioritising actions.
- Identify other existing management philosophies (eg. JIT, TPM, TQM) as a designated path through BoC. This can be done by highlighting activities / elements in the BoC model that make up the particular management philosophy, and link them together. This will be a means to prove that these philosophies lie within the big picture of the BoC model.
- Up to this point 2 sub-models were built:
  - WCM tools vs. MoPs
  - WCM tools vs. objectives

  Although there is no immediate necessity, further sub-models can be established to describe relationship between other activities / elements of the model.
- Update contents of the model: contents that are most likely to change are within level 1 'input environment', as external / internal factors affecting WCM are more dynamic and uncertain than any others.

7.2 Use of 'Birds of Change' Model in Manufacturing Industry

The model has been tested and verified in four manufacturing plants / companies. In three out of the four cases, companies' inputs had been acquired to modify the model at the same time as the model had been tested.

- More empirical research will be needed to justify the use of the model. This will be carried out by means of industrial collaboration. The model to be tested will be the complete model as presented in this thesis
- Industrial participation can be of different nature, such as:
  - fully funded projects of WCM change programme
  - seminars, workshops
  - mailing surveys / questionnaires to acquire data
- The objective of research remains to seek diversity. Participating companies will be of different sizes, locations and different levels of WCM undertakings

7.3 Use of Change Indicator Scoring System

A change indicator has been designed as a supplement of the change model to score companies' effort to change. Hence, it has to be used alongside all empirical research in industry to fulfill its potential.

- So far the change indicator has been used at irregular intervals, and over a short period of time (less than a year). When researching companies in the future, an appropriate interval should be allocated to score the change programme. It should also be taken over a longer period of time rather than just scoring at one instance
- The process of evaluation involves objective judgements by managers or employees. Even if done by an independent consultant, the entire evaluation is largely subjective. What can be done to ensure that the evaluation reflects the true picture of a company's performance?
- How to measure culture, innovation, people and leadership? The scoring of soft issues remains an interesting topic to research in for many years to come

7.4 Software Development

The model can be made more user-friendly by creating an interface that can be linked to a company's IT system. The system will have the following capabilities:

- Data transfer from shop floor, customers and suppliers
- Data storage and analysis (eg. MoPs)
- Scoring based on the change indicator
- Knowledge storage for effective learning in WCM principles and tools
- Extensive modeling to enhance management skills
- Report generation and presentation
- Operational research applications

7.5 Further Investigations

Possible improvements to a WCM change process are endless. There is so much to investigate about the dynamics of an OC towards WCM. Below are a few suggestions to future studies:

- What is the optimum number of WCM projects at hand?
- What is the optimum duration of a project (relative to project scale)?
- What is the optimum number of members in a WCM project team?
- Should there be a maximum number of MoPs for a shop floor manager to handle? How quickly should these figures of performance be available for effective action to be taken to remedy the situation?
- Is there a saturation for change?

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Appendix A

WCM Tools vs. Measures of Performance

Results from

MEng Final Year Project (Thorburn, 2001)

School of Mechanical and Manufacturing Engineering

University of Birmingham

Industrial input from

Rexel Business Machines

Supervised by

Joo Tey

In conjunction with the research in "World Class Manufacturing"

Aspect to be Monitored	JIT	TQM	TPM	5Ss	SPC	DFMA	SMED	QFD
Availability rate	*					*		
Average idle time	*		*			*		
Average issues	*					*		
Average job lead (or flow) time	*					*		
Average stock levels	*							
Average wait time	*							
Change over time						*	*	
Cycle time analysis							*	
Equipment utilisation ratio		*				*	*	
Good Production		*			*			
Job earliness over job tardiness		*						
Job wait time variance								
Lead time for first batch to exit	*					*		*
Lead time for whole of batch	*							
Line Efficiency	*			*	*	*		
Line inefficiency	*			*	*	*		
Maintenance index			*	*				
Manufacturing lead time (MLT)						*		
Mean number of assemblies in progress	*							
Number of breakdowns per month			*					
Number of breakdowns per week			*					
Output per unit input						*		
Overall Equipment Effectiveness		*	*				*	
Percentage of capacity in use	*	*		*				
Performance rate	*							
Probability of system being empty								
Probability of system being full								
Production capacity								
Production rate								
Production speed								
Quality Rate		*			*	*		*
Queue length variance								
Queuing to manufacturing time ratio								
Service level		*						
Schedule performance	*	*						
Scrap parts per million		*			*			
Scrap rate		*			*			
Space utilisation ratio				*				
Stock as a percentage of sales								*
Throughput efficiency								
TIP (time in process) ratio	*					*		
Total Production								
Utilisation of Machinery		*						
WIP	*							
WIP as a fraction of average queue length	*							

WCM Tools vs. Measures of Performance (Thorburn, 2001)

Aspect to be Monitored	RCM	FMEA	MRP	MRPII	KANBAN	CIM	FMS
Availability rate				*	*	*	*
Average idle time	*			*	*	*	*
Average issues				*	*	*	*
Average job lead (or flow) time					*	*	*
Average stock levels				*	*	*	*
Average wait time			*	*	*	*	*
Change over time				*		*	*
Cycle time analysis						*	*
Equipment utilisation ratio				*		*	*
Good Production				*		*	*
Job earliness over job tardiness			*	*		*	
Job wait time variance			*	*		*	
Lead time for first batch to exit		*		*	*	*	
Lead time for whole of batch				*	*	*	*
Line Efficiency					*	*	*
Line inefficiency				*	*	*	*
Maintenance index	*			*		*	
Manufacturing lead time (MLT)			*	*		*	*
Mean number of assemblies in progress					*	*	*
Number of breakdowns per month	*					*	*
Number of breakdowns per week	*			*		*	
Output per unit input				*		*	
Overall Equipment Effectiveness	*			*		*	*
Percentage of capacity in use				*	*	*	*
Performance rate				*	*	*	*
Probability of system being empty			*	*		*	
Probability of system being full			*	*		*	
Production capacity				*		*	*
Production rate				*		*	*
Production speed				*		*	
Quality Rate		*				*	*
Queue length variance						*	*
Queuing to manufacturing time ratio				*		*	
Service level			*	*		*	*
Schedule performance			*	*	*	*	*
Scrap parts per million		*				*	*
Scrap rate		*				*	*
Space utilisation ratio						*	*
Stock as a percentage of sales				*		*	
Throughput efficiency			*	*		*	
TIP (time in process) ratio				*	*	*	*
Total Production				*		*	*
Utilisation of Machinery				*		*	*
WIP			*	*	*	*	*
WIP as a fraction of average queue length			*	*	*	*	*

WCM Tools vs. Measures of Performance (Thorburn, 2001)

Aspect to be Monitored	QWL	CBM	CAPP	CAPM	FMC	WCM
Availability rate			*	*	*	*
Average idle time		*	*	*	*	*
Average issues			*	*	*	*
Average job lead (or flow) time			*	*	*	*
Average stock levels			*	*	*	*
Average wait time			*	*	*	*
Change over time					*	*
Cycle time analysis					*	*
Equipment utilisation ratio					*	*
Good Production					*	*
Job earliness over job tardiness						*
Job wait time variance						*
Lead time for first batch to exit			*	*		*
Lead time for whole of batch			*	*	*	*
Line Efficiency			*	*	*	*
Line inefficiency			*	*	*	*
Maintenance index		*				*
Manufacturing lead time (MLT)					*	*
Mean number of assemblies in progress			*	*	*	*
Number of breakdowns per month		*			*	*
Number of breakdowns per week		*				*
Output per unit input			*	*		*
Overall Equipment Effectiveness		*			*	*
Percentage of capacity in use			*	*	*	*
Performance rate			*	*	*	*
Probability of system being empty						*
Probability of system being full						*
Production capacity					*	*
Production rate					*	*
Production speed						*
Quality Rate					*	*
Queue length variance					*	*
Queuing to manufacturing time ratio						*
Service level					*	*
Schedule performance			*	*	*	*
Scrap parts per million					*	*
Scrap rate					*	*
Space utilisation ratio					*	*
Stock as a percentage of sales						*
Throughput efficiency						*
TIP (time in process) ratio			*	*	*	*
Total Production					*	*
Utilisation of Machinery					*	*
WIP			*	*	*	*
WIP as a fraction of average queue length			*	*	*	*

WCM Tools vs. Measures of Performance (Thorburn, 2001)

Aspect to be Monitored	JIT	TQM	TPM	5Ss	SPC	DFMA	SMED	QFD
WIP ratio	*							
Working capital productivity								
Absenteeism rate as a percentage								
Average daily sales								*
Delivery Performance	*	*				*		
Mean no. of items in system over no. of customers in system								*
Number of accidents per month			*					
Number of customer complaints					*			*
Number of suppliers (primary and general)		*						
Personnel costs as a percentage of total sales								
Productivity (as a function of workers hours)								
Ratio of maintenance to production labour			*	*				
Sales per person								*
Turnover ratio (inventory)								
Training index				*				

WCM Tools vs. Measures of Performance (Thorburn, 2001)

Aspect to be Monitored	RCM	FMEA	MRP	MRPII	KANBAN	CIM	FMS
WIP ratio			*	*	*	*	*
Working capital productivity						*	*
Absentecism rate as a percentage						*	
Average daily sales						*	
Delivery Performance		*	*	*	*	*	*
Mean no. of items in system over no. of customers in system				*		*	
Number of accidents per month	*	*				*	
Number of customer complaints		*				*	
Number of suppliers (primary and general)		*				*	
Personnel costs as a percentage of total sales				*		*	
Productivity (as a function of workers hours)				*		*	
Ratio of maintenance to production labour	*					*	
Sales per person				*		*	
Turnover ratio (inventory)				*		*	*
Training index						*	

WCM Tools vs. Measures of Performance (Thorburn, 2001)

Aspect to be Monitored	QWL	CBM	CAPP	CAPM	FMC	WCM
WIP ratio			*	*	*	*
Working capital productivity					*	*
Absenteeism rate as a percentage	*					*
Average daily sales						*
Delivery Performance			*	*	*	*
Mean no. of items in system over no. of customers in system						*
Number of accidents per month	*	*				*
Number of customer complaints	*					*
Number of suppliers (primary and general)	*					*
Personnel costs as a percentage of total sales						*
Productivity (as a function of workers hours)						*
Ratio of maintenance to production labour	*	*				*
Sales per person	*					*
Turnover ratio (inventory)					*	*
Training index	*					*

Meaning of Abreviations

JIT	Just In Time
TQM	Total Quality Management
TPM	Total Preventative Maintenance
5S's	A Factory management method
SPC	Statistical Process Control
DFMA	Design For Manufacture and Assembly
SMED	Single Minuite Exchange of Dies
QFD	Quality Functions Deployment
CAE	Computer Aided Engineering
RCM	Reliability Centered Maintenance
FMEA	Failure Mode And Effect Analysis
MRP	Material Resource Planning
MRP II	Manufacturing Resource Planning
ERP	Enterprise Resource Planning
APS	Advanced Planning and Scheduling
QRM	Quick Response Manufacturing
CMM	Co-ordinate Measuring Machine
6 Sigma	More precise SPC
SOP	Standard Operations Procedure
PDCA	Plan-Do-Check-Act
CIM	Computer Intergrated Manufacture
FMS	Flexible Manufacturig Systems
QWL	Quality of Working Life
CBM	Computer Based Maintenance
CAPP	Computer-Aided Process Planning
CAPM	Computer-Aided Production Management
FMC	Flexible Manufacturig Cells
WCM	World Class Manufacture

WCM Tools vs. Measures of Performance (Thorburn, 2001)

Appendix B

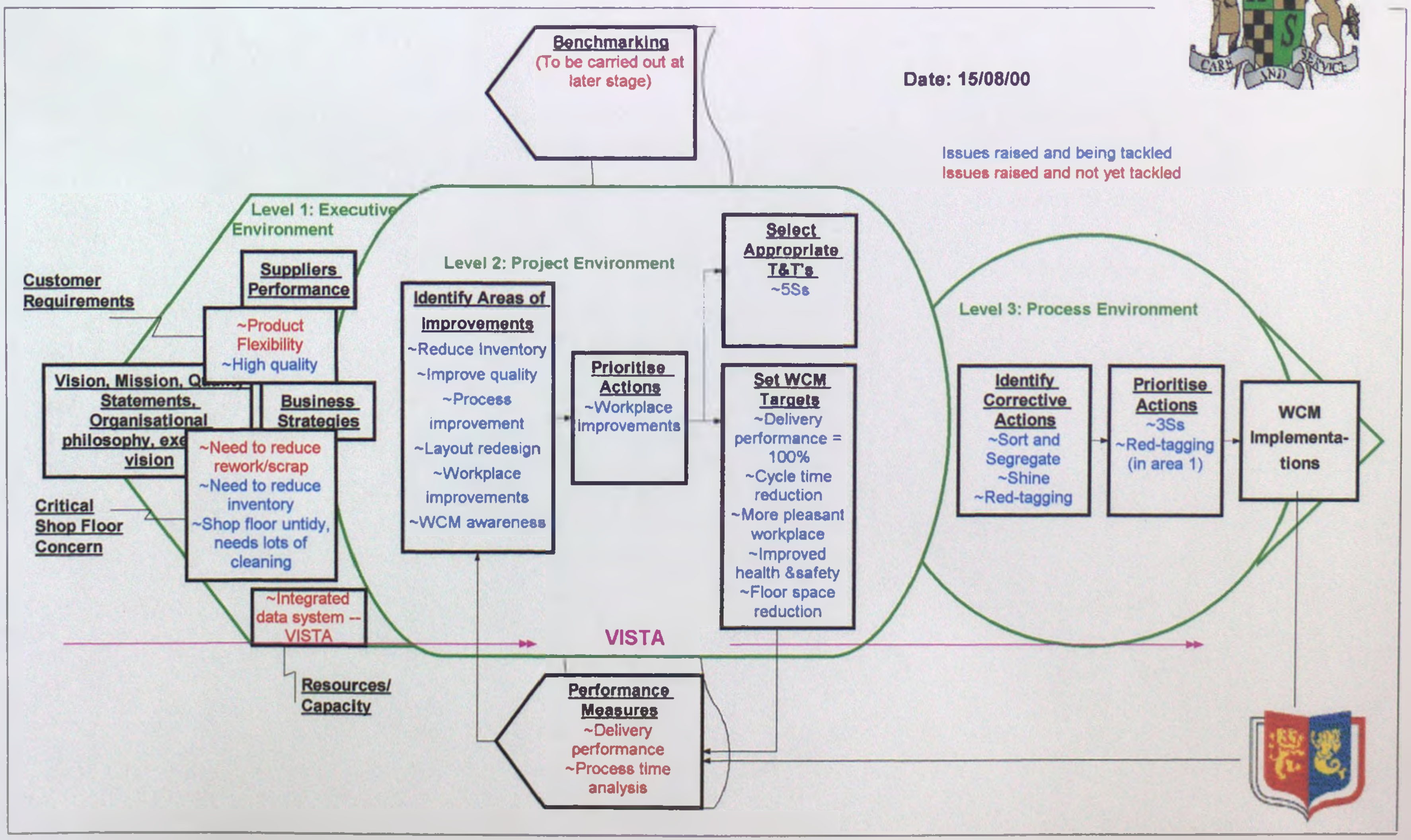
WCM Change Implementations @ Heritage Silverware

[1] Application of BoC Model
[August – November 2000]

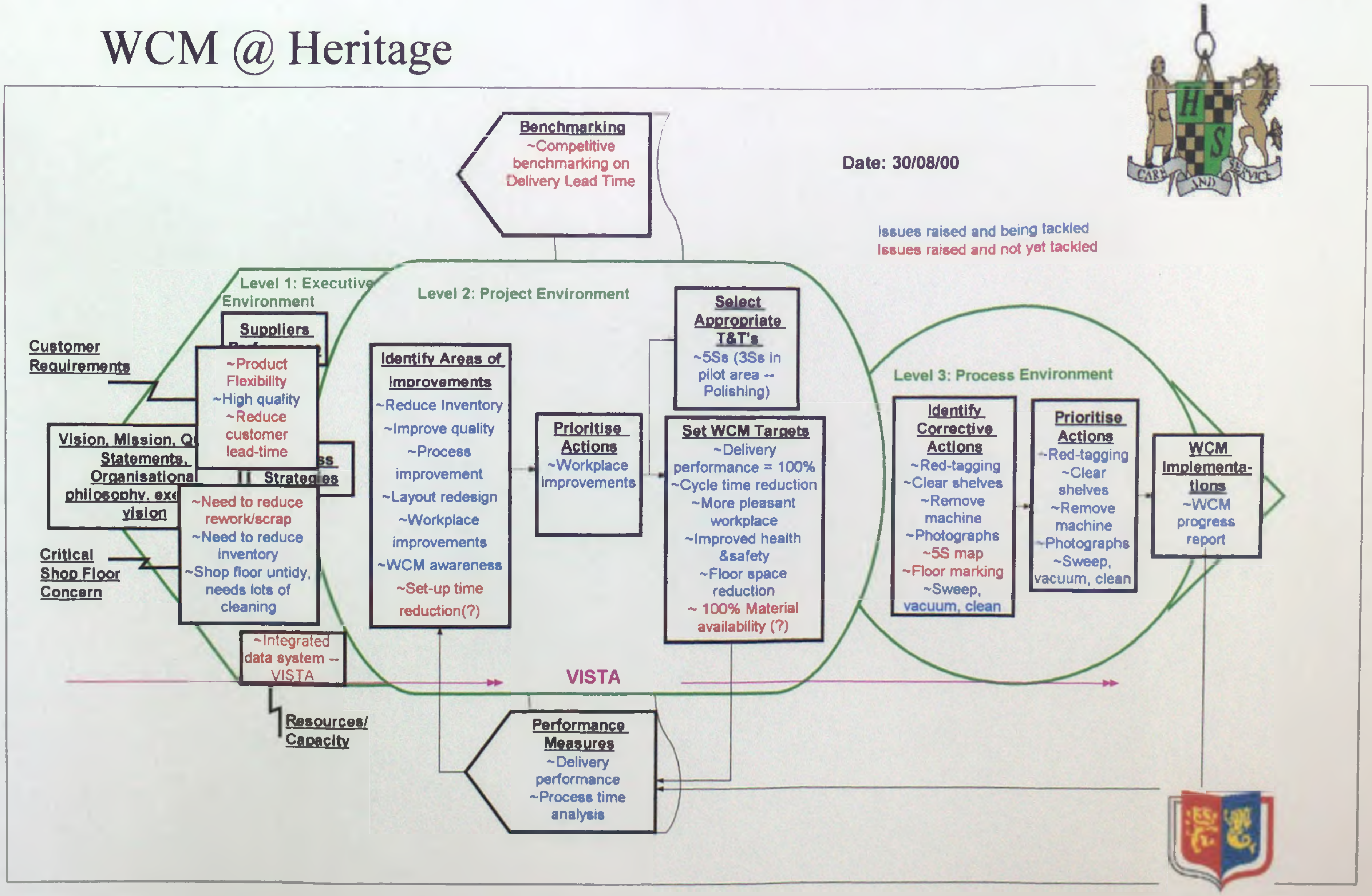
[2] Continuous Improvements Progress Reports
[August – November 2000]

Prepared by
Joo Tey

WCM @ Heritage



WCM @ Heritage



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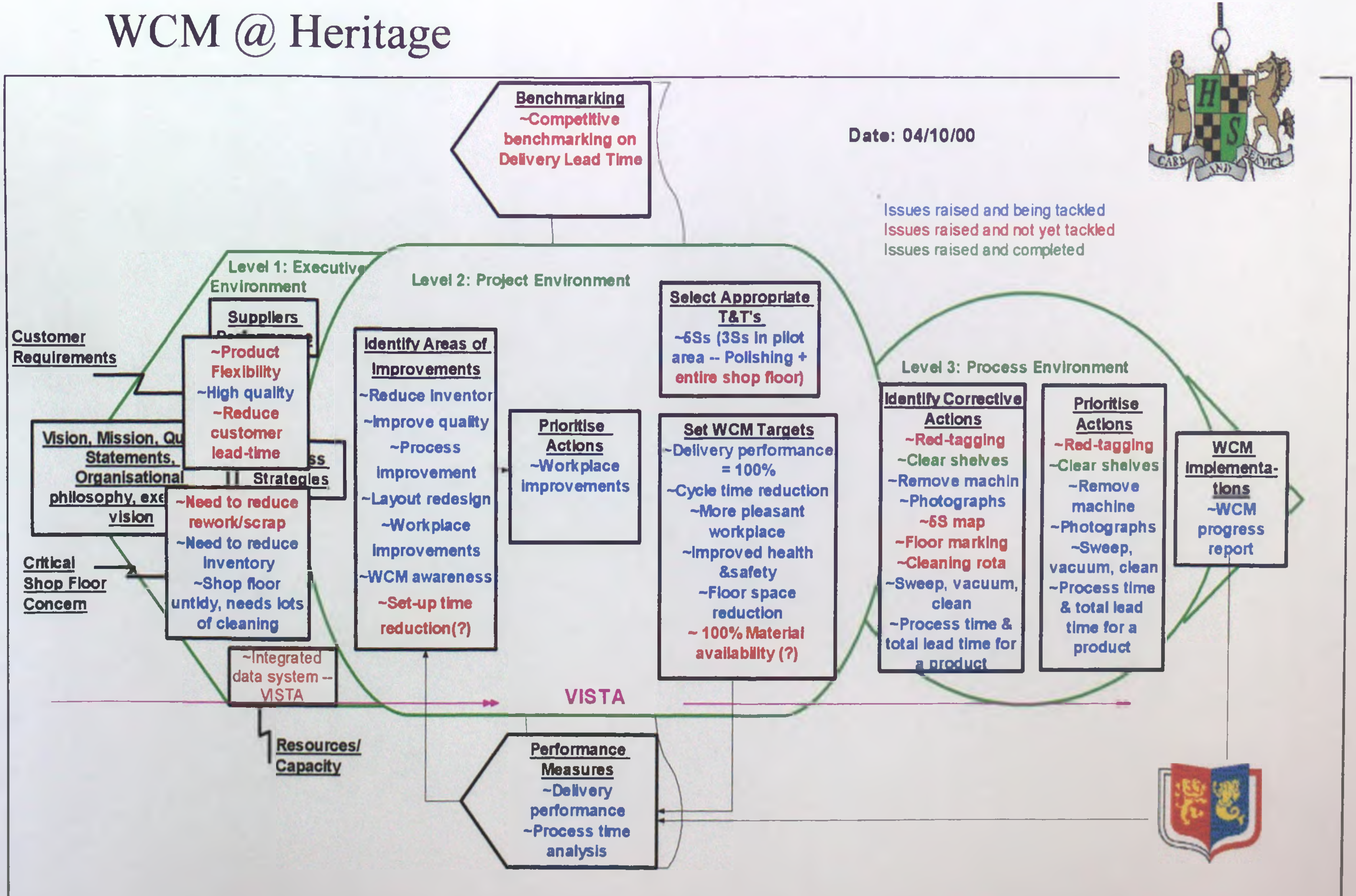

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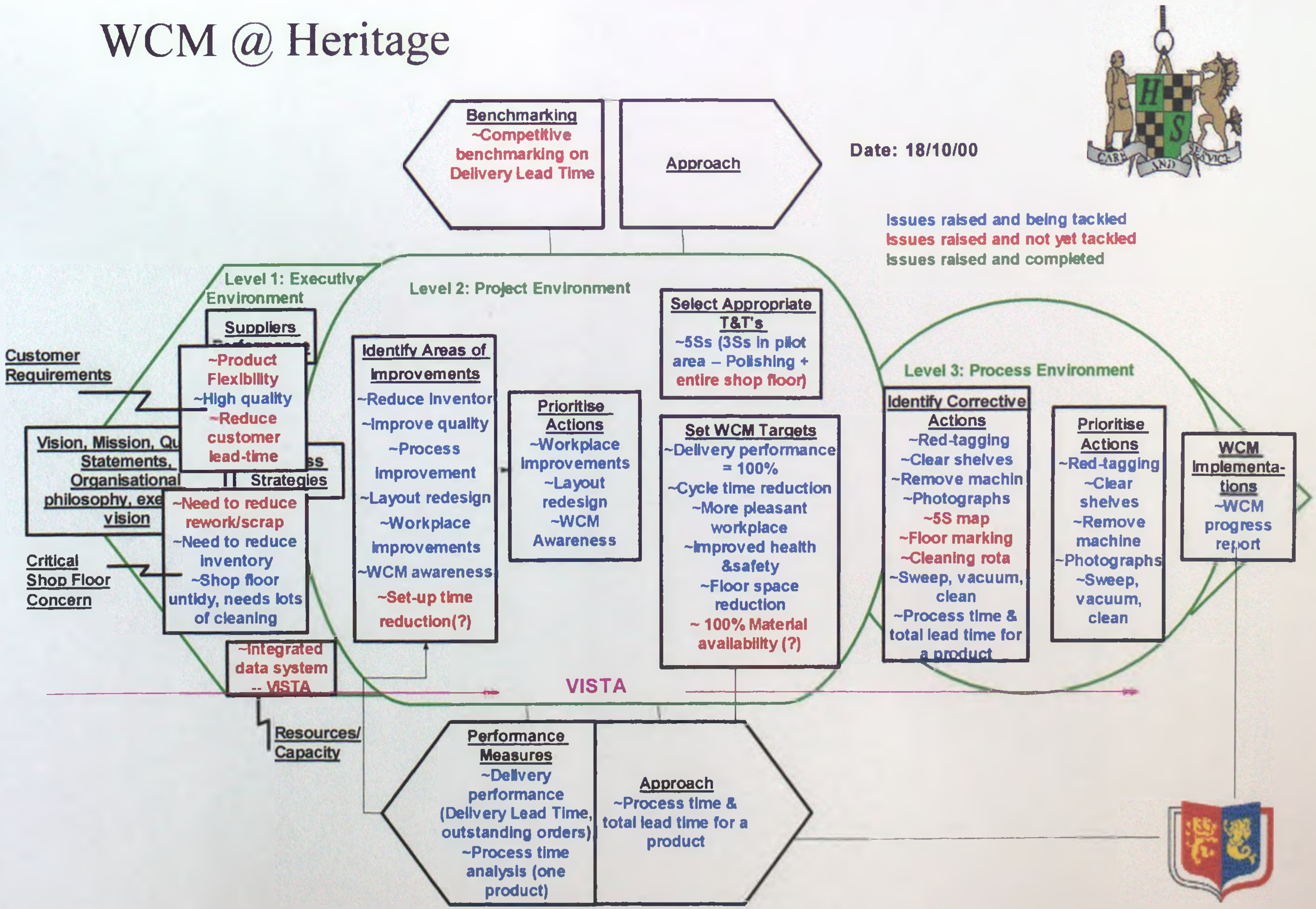
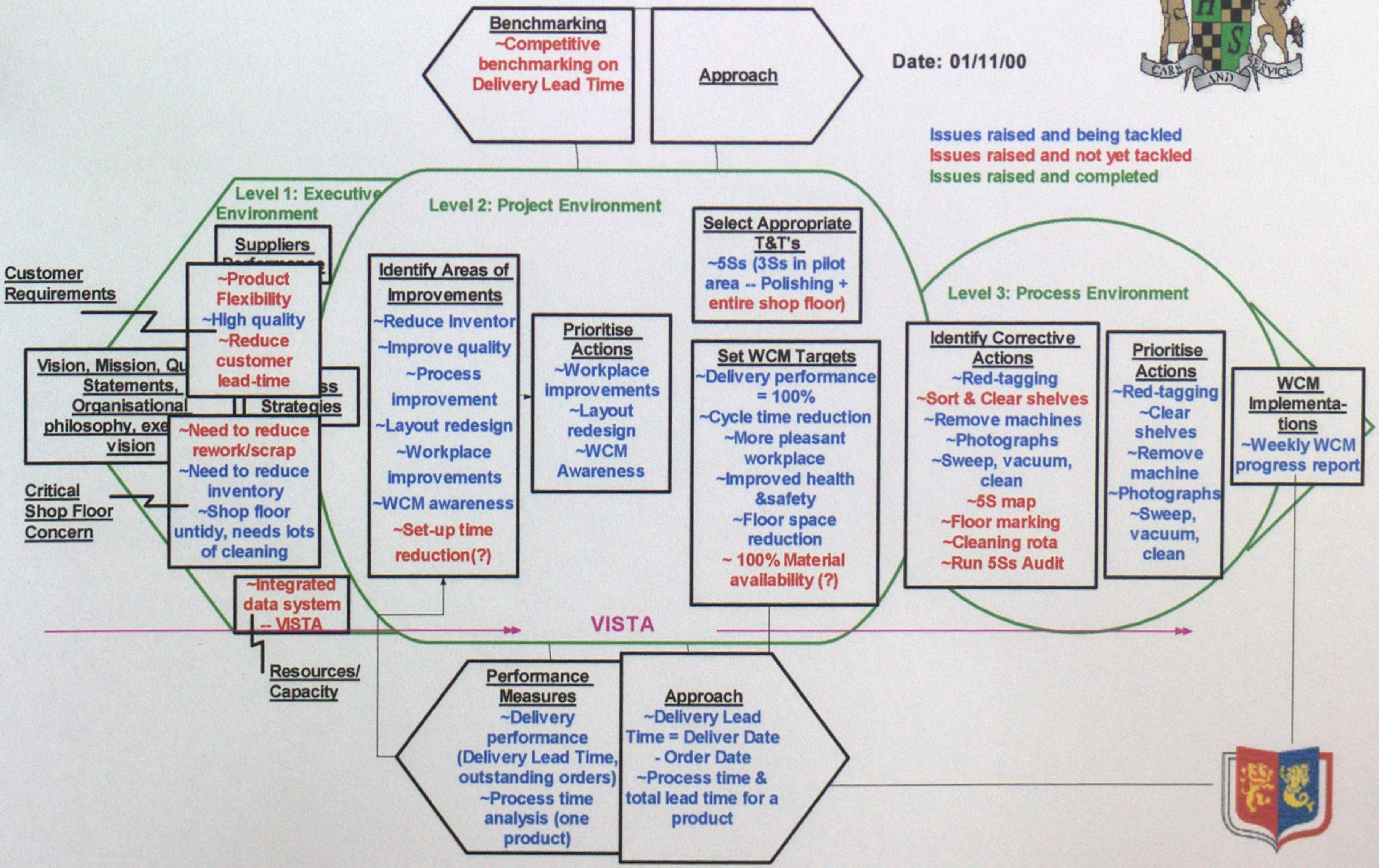


WCM @ Heritage

Date: 01/11/00



WCM @ Heritage

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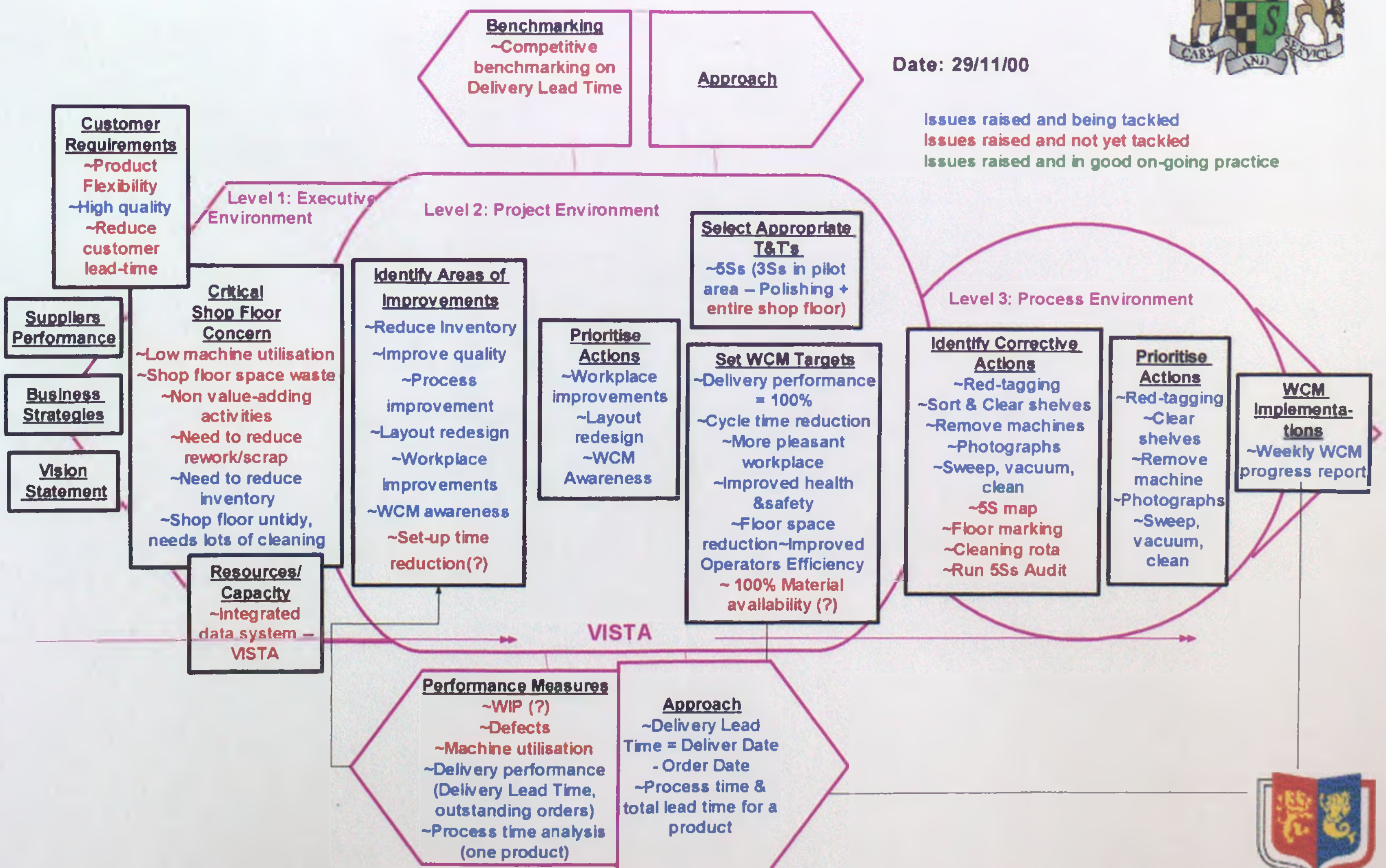

WCM @ Heritage: KAIZEN Progress Report

Week 1: 23, August, 00

No	Corrective Actions	Responsibility	Target completion date	Progress (%)										Actual completion date	Comments
				10	20	30	40	50	60	70	80	90	100		
1.	Prepare red-tags [SORT]	Ben	Wed 30/8												Make 200 red tags and train operators on its usage
2.	Photography (polishing shop)	Ben, Tey	Wed 30/8												Take pictures at each stage using digital camera
3.	Clear shelve no.1 [SORT, SEGREGATE]	Harry												23/8	Well done!
4.	Set-up machine - automatic [SORT]	McD	20/10 (2 months)												
5.	Remove machine – two-ended manual polishing (blue)	McD, Harry	Fri 1/9												
6.	1 sort, 1 segregate, 1 shine	Ben	Wed 30/8												Gather sheets answered by operators, summarise
7.	Delivery performance data [PM]	Mireille, Tey	On-going												Retrieve previous and current delivery details, produce delivery lead-time for the past 2 months
8.	Process cycle time analysis [PM]	McD, Tey, Mireille	Wed 30/8												Discuss methods of performance measure

Next meeting:- 30/08/00 @ 1100	Previous meetings	Date Time								

WCM Innovator:- **Martin Tey**	**WCM Team:-** **Martin Tey, Martin McDonaugh, Mireille, Ben, Harry**

WCM @ Heritage: KAIZEN Progress Report

Week 2: 30, August, 00

No	Corrective Actions	Responsibility	Target completion date	Progress (%) 10	20	30	40	50	60	70	80	90	100	Actual completion date	Comments
1.	Prepare red-tags [SORT]	Ben	Wed 30/8 overdue												Make 200 red tags and train operators on its usage
2.	Photography (polishing shop)	Ben, Tey, Pippa	On-going												Take pictures at each stage using digital camera – First set of pictures already taken
3.	Clear shelve no.1 [SORT, SEGREGATE]	Harry												23/8	Well done!
4.	Set-up machine - automatic [SORT]	McD	20/10 (2 months)												
5.	Remove machine – two-ended manual polishing (blue)	McD, Harry	Fri 1/9												
6.	1 sort, 1 segregate, 1 shine	Ben	Wed 06/09												Gather sheets answered by operators, summarise, and get them done
7.	Delivery performance data [PM]	Mireille, Tey	On-going												Retrieve previous and current delivery details, produce delivery lead-time for the past 2 months
8.	Process cycle time analysis [PM]	McD, Tey, Mireille	Wed 06/09												Discuss methods of performance measure Idea proposed: choose a product and analyse the BOM

Next meeting:- 06/09/00 @ 1100	Previous meetings	Date	23/08	30/08							
		Time	1400	1300							

WCM Innovator:-	**WCM Team:-**
Martin Tey	**Martin Tey, Martin McDonaugh, Mireille, Ben, Harry, Mick, Terry, Moss, Pippa**

5Ss improvements to be made during September

5S map (operators propose better ways of changing shop floor layout, in this case polishing shop, then move the machines around for better efficiency)

Floor markings (After cleaning and re-layout, place tape on floor and mark areas for machines, tools, scrap, WIP, and walking paths)

- Read handouts for further reference

P/S: Ben, please list down the things that are done and send it back to me through email. Much appreciated!

1. First set of photographs taken (30/08) and saved in PC.
2. Walls have been painted in polishing shop (updated 30/08)

WCM @ Heritage: KAIZEN Progress Report **Week 8: 11/10/00**

No	Corrective Actions	Responsibility	Target completion date	Progress (%)										Actual completion date	Comments
				10	20	30	40	50	60	70	80	90	100		
1.	Prepare red-tags [SORT]	Ben	Wed 30/8 overdue												Make 200 red tags and train operators on its usage. Ben has done template
2.	Photography (polishing shop)	Ben, Tey, Pippa	On-going												Take pictures at each stage using digital camera – First set of pictures already taken
3.	Clear shelve no.1 [SORT, SEGREGATE]	Harry												23/8	Well done!
4.	Set-up machine - automatic [SORT]	McD	20/10 (2 months)												It is taking up space and it is not working!
5.	Remove machine – two-ended manual polishing (blue)	McD, Harry	Fri 1/9											06/09	Didn't record when it was done
6.	1 sort, 1 segregate, 1 shine	Ben	Wed 06/09 overdue												Nothing is happening now?
7.	Remove semi-auto machine, green boxes	Ben, McD	11/10/00												
8.	Sweep floor in other areas of shop floor	Pat (?)													Good innitiative!
9.	Sweep, clean and tidy "China shop"	Ben	On-going												China shop is now looking tidy, and much space available
10.	Delivery performance data [PM]	Mireille, Tey, Ben	On-going												Excel format. Tey generating lead time regularly.

11.	Process cycle time analysis [PM]	McD, Tey, Mireille, Ben, Chin	Wed 06/09											Decided to choose a product (product name?) and analyse process time manually. Need actual lead time plus waiting, moving, to stock time as well.

Next meeting:- 18/10/00 @ 1100	Previous meetings	Date	23/08	30/08	04/10						
		Time	1400	1300	1245						

WCM Innovator:-	**WCM Team:-**
Martin Tey	**Martin Tey, Martin McDonaugh, Mireille, Ben, Harry, Mick, Terry, Moss, Pippa, Chin**

<u>5Ss improvements to be made during October</u>

5S map (operators propose better ways of changing shop floor layout, in this case polishing shop, then move the machines around for better efficiency)
p/s: McD suggested a change of layout in polishing shop.

Floor markings (After cleaning and re-layout, place tape on floor and mark areas for machines, tools, scrap, WIP, and walking paths)

- Read handouts (given by Tey) for further reference

Cleaning Rota (suggested by McD, part of 5S – standardise phase)

"A walk down the shop floor" (Each week, Tey + Ben + McD take a walk down the shop floor, point out what needs to be done, record it on paper and discuss during the meeting on the same day)

WCM @ Heritage: KAIZEN Progress Report

Week 9: 18/10/00

[CA]Corrective Actions/ [PM]Performance Measures/ [EL] Inputs @ Executive Level	Responsibility	Target completion date	Progress (%)										Actual completion date	Comments
			10	20	30	40	50	60	70	80	90	100		
[CA] Prepare red-tags "SORT"	Ben, Tey	Wed 30/8 overdue												Red tags are ready to be used. Operators need to be trained.
[CA] Photography (polishing shop)	Ben, Tey, Pippa	On-going												Take pictures at each stage using digital camera – First set of pictures already taken
[CA] Set-up machine – automatic "SORT"	McD	20/10 (2mths) Overdue												It is taking up space and it is not working!
[CA] Remove machine – two-ended manual polishing (blue)	McD, Harry	Fri 1/9											06/09	Didn't record when it was done
[CA] 1 sort, 1 segregate, 1 shine	Ben	Wed 06/09 overdue												Nothing is happening now?
[CA] Remove semi-auto machine, green boxes	Ben, McD	11/10/00 overdue												Polishing shop gets cluttered up again!
[CA] Sweep floor in other areas of shop floor	Pat (?)													Good innitiative!
[CA] Sweep, clean and tidy "China shop"	Ben	On-going												China shop is now looking tidy, and much space available
[CA] Polishing shop re-layout (5S map)	McD, Ben, Tey													Need to take a "walk down the shop floor", and Sort.
[CA] Floor cleaning (scrubbing) and marking	McD, Ben, Tey, Mireille													After 5S map is done
[PM] Delivery performance data	Mireille, Tey, Ben	On-going												Excel format. Tey generating lead time, no. of outstanding orders regularly.

[PM] Process cycle time analysis	McD, Tey, Mireille, Ben, Chin	Wed 06/09 overdue											Decided to choose a product (product name?) and analyse process time manually. Need actual lead time plus waiting, moving, to stock time as well.
[EL] Business strategies	McD	Wed 25/10/00											McD to come up with business strategies and put them down on paper.

Next meeting:- 25/10/00 @ 1100	Previous meetings	Date	23/08	30/08	04/10	18/10					
		Time	1400	1300	1245	1200					
WCM Innovator:-	**WCM Team:-**										
Martin Tey	**Martin Tey, Martin McDonaugh, Mireille, Ben, Harry, Mick, Terry, Moss, Pippa, Chin**										

5Ss improvements to be made during October

5S map (operators propose better ways of changing shop floor layout, in this case polishing shop, then move the machines around for better efficiency)
p/s: McD suggested a change of layout in polishing shop.

Floor markings (After cleaning and re-layout, place tape on floor and mark areas for machines, tools, scrap, WIP, and walking paths)

- Read handouts (given by Tey) for further reference

Cleaning Rota (suggested by McD, part of 5S – standardise phase)

"A walk down the shop floor" (Each week, Tey + Ben + McD take a walk down the shop floor, point out what needs to be done, record it on paper and discuss during the meeting on the same day)

WCM @ Heritage: KAIZEN Progress Report

Week 11 : 01/11/00

[CA]Corrective Actions/ [PM]Performance Measures/ [EL] Inputs @ Executive Level	Responsibility	Target completion date	Progress (%)										Actual completion date	Comments
			10	20	30	40	50	60	70	80	90	100		
[CA] Polishing shop re-layout (5S map) "SORT+SEGREGATE"	McD, Ben, Tey													Need to take a "walk down the shop floor", and Sort.
[CA] Floor cleaning (scrubbing) and marking "SHINE"	McD, Ben, Tey, Mireille													After 5S map is done
[CA] Clear tool shelves "SORT"														Get rid of the unneeded mops on the shelves
[CA] Move tool cupboard to shop floor "SEGREGATE"														
[CA] Prepare red-tags "SORT"	Ben, Tey	Wed 30/8 overdue												Have not been used. Ben's away.
[CA] Remove semi-auto machine, green boxes "SORT"	Ben, McD	11/10/00 overdue												Polishing shop gets cluttered up again!
[CA] Set-up machine – automatic "SORT"	McD	20/10 (2mths) Overdue												It is taking up space and it is not working!
[CA] 1 sort, 1 segregate, 1 shine (raised by operators)	Ben	Wed 06/09 overdue												Nothing is happening now?
[CA] Sweep floor in other areas of shop floor "SHINE"	?													No one's doing it at the moment
[CA] Sweep, clean and tidy "China shop" "SHINE"	Ben	On-going												China shop is now looking tidy, and much space available
[CA] Photography (polishing shop)	Ben, Tey, Pippa	On-going												No point taking more pictures, no progress on 5Ss

[PM] Delivery performance data	Mireille, Tey, Ben	On-going												Excel format. Tey generating lead time, no. of outstanding orders regularly.
[PM] Process cycle time analysis	McD, Tey, Mireille, Ben, Chin	Wed 06/09 overdue												Decided to choose a product (product name?) and analyse process time manually. Need actual lead time plus waiting, moving, to stock time
[EL] Business strategies	McD	Wed 25/10/00 overdue												McD to come up with business strategies and put them down on paper.

Next meeting:- 25/10/00 @ 1100	Previous meetings	Date	23/08	30/08	04/10	18/10					
		Time	1400	1300	1245	1200					

WCM Innovator:- **Martin Tey**	**WCM Team:-** **Martin Tey, Martin McDonaugh, Mireille, Ben, Harry, Mick, Terry, Moss, Pippa, Chin**

WCM @ Heritage: KAIZEN Progress Report

Week 16 : 29/11/00

[CA]Corrective Actions/ [PM]Performance Measures/ [EL] Inputs @ Executive Level	Responsibility	Target completion date	Progress (%)										Actual completion date	Comments
			10	20	30	40	50	60	70	80	90	100		
** [CA] Red tagging activity on machines, tools, shelves etc. (entire shop floor starting from polishing)	Ben, McD, Mirreile	22/01/01 (2 mnths)												6 machines in making shop have been red-tagged. Decision has to be made: sell, use or bin them.
[CA] Polishing shop re-layout (5S map) "SORT+SEGREGATE"	McD, Ben, Tey													Need to take a "walk down the shop floor", and Sort. Need to be done after removal of all unutilised machines and shelves
[CA] Floor cleaning (scrubbing) and marking "SHINE"	McD, Ben, Tey, Mireille													After 5S map is done
** [CA] Clear tool shelves "SORT" & "SEGREGATE"	Ben, Mirreile, Harry	24/11 overdue												❖ Get rid of the unused mops on the shelves ❖ Place mops in trays according to their different uses
[CA] Move tool cupboard to shop floor "SEGREGATE"														
[CA] Prepare red-tags "SORT"	Ben, Tey	Wed 30/8 overdue											22/11	Red tagging activity started
[CA] Sweep floor in other areas of shop floor "SHINE"	?													No one's doing it at the moment Get operators to clean their own workplace.
[CA] Sweep, clean and tidy "China shop" "SHINE"	Ben	On-going												China shop cleaning has not been followed up
[CA] Photography (polishing shop)	Ben, Tey, Pippa	On-going												Take photographs of clean workplace as "STANDARDISE" activity
[PM] Delivery performance data	Mireille, Tey, Ben	On-going												Excel format. Tey generating lead time, no. of outstanding orders regularly.

[PM] Process cycle time analysis	McD, Tey, Mireille, Ben, Chin	Wed 06/09 overdue												Decided to choose a product (product name?) and analyse process time manually. Need actual lead time plus waiting, moving, to stock time
** [EL] Business strategies	McD	Wed 25/10/00 overdue												McD to come up with business strategies and put them down on paper.

Next meeting:- 25/10/00 @ 1100	Previous meetings	Date	23/08	30/08	04/10	18/10						
		Time	1400	1300	1245	1200						
WCM Innovator:- **Martin Tey**	**WCM Team:-** **Martin Tey, Martin McDonaugh, Mireille, Ben, Harry, Mick, Terry, Moss, Pippa, Chin**											

** Up front issues discussed last week. Actions should be taken to tackle these first!

1 Sort 1 Segregate and 1 Shine

The idea is to get each operator to suggest the following at the beginning of 5S activity

- One thing to get rid of
- One thing to be moved to a more appropriate location
- One thing to be cleaned

One out of 3 operators responded to the idea. The rest couldn't be bothered.
Suggestions given by the operator were not attended either.
Progress stopped @ 20% completion

[CA] 1 sort, 1 segregate, 1 shine (raised by operators)	Ben	Wed 06/09 overdue												Nothing is happening now?

Red-tagging and 5Ss activities

The following activities are not happening due to several reasons

- "SORT" is not done properly – unused materials have been moved from place to place within the shop floor, and not really deciding what to do with it.
- Red-tagging should be carried out in the entire shop floor (and starting from polishing). It will help solving the problems
- Changes have not been done at the pace they should have been. Therefore things get forgotten and people's enthusiasm fades
- 5Ss activities should involve standardisation. Cleaning rotas, manual operation procedure, photographs should be done and used

[CA] Remove semi-auto machine, green boxes "SORT"	Ben, McD	11/10/00 overdue												Polishing shop gets cluttered up again!
[CA] Set-up machine – automatic "SORT"	McD	20/10 (2mths) Overdue												It is taking up space and it is not working!

Appendix C

Activity Sampling @ Hoogovens Aluminium UK (CORUS)

Conducted by

Joo Tey

In conjunction with the research in "World Class Manufacturing"

ACTIVITY SAMPLING @ HAUK: PILOT STUDY

Date: 6/7/99 – 16/7/99
Observer: Martin Tey

Sampling was taken approximately every half hour (1045, 1115, 1145, 1215, 1345, 1415, 1445, 1500, 1545) on three occasions. Different days of the week were chosen to avoid repetition of production pattern due to the same day of week. No sample was taken during lunch (1300 to 1330) and 2 tea breaks (note observation time 1500 instead of 1515 to avoid tea break).
Observations were mainly on machine running/not running. For the machines that are running, it was observed whether or not it has an operator working on it.
Further observations were taken on the reasons of machine not running. This includes:
- Set-up/Changeover time
- Maintenance
- Operator absent
- Operator resting
- Operator working on other machine
- Operator fetching material
- Operator packing/delivering material

Machine Utilisation for each cell:-

Sawing Cell	38.09%
Cut-To-Length Cell	43.33%
Guillotine Cell	15.72%
Slitting Cell	10.00%

Breakdown utilisation for each machine:-

<u>**Sawing Cell**</u> (No. of machine = 7, No. of operator = 3)

Kaltenbach 1	46.67%	Band Saw 1	70%
Kaltenbach 2	60%	Band Saw 2	80%
Kaltenbach 3	10%	Wall Saw	0%
Kaltenbach 4	0%		

*Note:
- Kaltenbach 3, 4 and Wall Saw were nearly constantly not in use, sometimes due to operator absent from work.
- Two Band Saws run automatically at low speed. Therefore there was not much of operator involvement. At most times operator was resting or loading finished material into boxes.

<u>**CTL Cell**</u> (No. of machine = 4, No. of operator = 3)

Bell Decoiler	43.33%
Schnutz Leveller	43.33%
CTL	43.33%
Bell Stacker	43.33%

*Note:

- This is a continuous process. The 4 machines are either all running at the same time or stagnant. This explains why their utilisations equal.
- It takes a long time to set up each batch of job, eg. loading coil, positioning wood or stacking, measuring initial thickness and length, fetching material, and clearing scrap.
- When the machines are running, it usually only involves operators watching the machines
- Operators often need to deal with rejected coil, or cutting remaining coils as scrap

Guillotine Cell (No. of machine = 7, No. of operator = 4)

Guillotine 1	26.67%	Guillotine 5	0%
Guillotine 2	36.67%	Film Applicator 1	36.67%
Guillotine 3	0%	Film Applicator 2	10%
Guillotine 4	0%		

*Note:

- Guillotine 1 sometimes needs 2 operators. Therefore it sometimes needs operator from Guillotine 2.
- Guillotine 3,4 and 5 were not at all in use.

Slitting Cell (No. of machine = 2, No. of operator = 1)

Coil Slitter 1	16.67%
Coil Slitter 2	3.33%

*Note:

- Least number of machines and operators, lowest production
- For two consequent observations, it could be that the operator is packing the same batch of finished job.
- Very low utilisation of machine, operator spends most of the time loading, unloading, fetching, delivering and measuring
- Due to the change in customer need, Coil Slitter 2 was not at all in use for the time being.

Shop floor machine utilisation is very low overall **(26.79%)**. Five machines had 0% utilisation. Set up and changeover took up most of the production time in the CTL and slitting cell. Through the observation, operators were occupied most of the time but were not working at a fast pace.

With the sampling intervals being approximately half hour, it was very likely to catch the machines between run-time, either before or after, making the result not as accurate as it can be. Therefore, it was felt that sampling intervals should be shortened, which will result in larger number of observations.

It can be concluded that the shop floor is still a long way from Just-In-Time manufacturing. On the other hand, there was hardly any maintenance activities observed during the activity sampling (only occurred during 1% of the observation).

ACTIVITY SAMPLING @ HAUK

CELL #1: SAWING CELL **Operator(s): Matthew, Julian, Paul (absent)**

Date: 06/07/99 (Tues)					**Observer: Tey**						**Study # 1**
Machines	Time										% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
KALTENBACH 1	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%
KALTENBACH 2	✓	X_{OA}	✓	✓	X	✓	✓	X_{OA}	©	✓	60%
KALTENBACH 3	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	✓	X_{OA}	10%
KALTENBACH 4	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%
BAND SAW 1	✓$_{o}$	✓$_{o}$	✓$_{o}$	✓$_{o}$	✓$_{o}$	✓$_{o}$	✓$_{o}$	✓$_{o}$	✓$_{o}$	X	90%
BAND SAW 2	✓$_{o}$	✓$_{o}$	✓$_{o}$	✓$_{o}$	✓$_{o}$	X	X	✓$_{o}$	✓$_{o}$	✓$_{o}$	80%
WALL SAW	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%

M/C running (with operator monitoring)	✓	M/C not running	X
		M/C breakdown	Ø
M/C running (without operator monitoring)	✓$_{o}$	Operator absent	OA
		Operator resting	OR
Set-up/Changeover time	©	Operator working on other m/c	OW
Maintenance	M	Operator fetching material	OF
		Operator packing finished material	OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

*** Kaltenbach 3,4 and Wall Saw nearly constantly not in use. Kaltenbach 1 not in use because operator absent from work**

ACTIVITY SAMPLING @ HAUK

CELL #1: SAWING CELL **Operator(s): Matthew, Julian, Paul**

Date: 12/07/99 (Mon)				**Observer: Tey**						**Study # 2**
Machines	Time									% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
KALTENBACH 1	✓	✓	✓	X_{OA}	✓	✓	✓	X_{OA}	✓	✓	80%
KALTENBACH 2	©	✓	✓	✓	X	✓	✓	X_{OA}	X	✓	60%
KALTENBACH 3	X	X	X	X	X	X	X	©	✓	✓	20%
KALTENBACH 4	X	X	X	X	X	X	X	X	X	X	0%
BAND SAW 1	$✓_o$	$✓_o$	©	$✓_o$	$✓_o$	X_{OP}	X_{OP}	X	X	X	40%
BAND SAW 2	$✓_o$	$✓_o$	$✓_o$	$✓_o$	$✓_o$	X	X	©	$✓_o$	$✓_o$	70%
WALL SAW	X	X	X	X	X	X	X	X	X	X	0%

M/C running (with operator monitoring)	✓	M/C not running	X
M/C running (without operator monitoring)	$✓_o$	M/C breakdown	Ø
Set-up/Changeover time	©	Operator absent	OA
Maintenance	M	Operator resting	OR
		Operator working on other m/c	OW
		Operator fetching material	OF
		Operator packing finished material	OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

- **Band Saw runs slowly, hence not much of operator involvement. Most of the time operators are loading materials into boxes**

ACTIVITY SAMPLING @ HAUK

CELL #1: SAWING CELL **Operator(s): Matthew, Julian, Paul**

Date: 16/07/99 (Fri)				**Observer: Tey**						**Study # 3**
Machines	Time									% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
KALTENBACH 1	✓	✓	✓	X_{OA}	✓	✓	✓	X_{OA}	X	X	60%
KALTENBACH 2	✓	X_{OA}	✓	✓	X	✓	✓	X_{OA}	©	✓	60%
KALTENBACH 3	X	X	X	X	X	X	X	X	X	X	0%
KALTENBACH 4	X	X	X	X	X	X	X	X	X	X	0%
BAND SAW 1	$✓_o$	$✓_o$	$✓_o$	$✓_o$	$✓_o$	$✓_o$	$✓_o$	$✓_o$	M	M	80%
BAND SAW 2	$✓_o$	$✓_o$	$✓_o$	$✓_o$	$✓_o$	X	X	$✓_o$	M	M	60%
WALL SAW	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X	X	0%

M/C running (with operator monitoring) ✓
M/C running (without operator monitoring) $✓_o$
Set-up/Changeover time ©
Maintenance M

M/C not running X
M/C breakdown Ø
Operator absent OA
Operator resting OR
Operator working on other m/c OW
Operator fetching material OF
Operator packing finished material OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

- **Band Saw runs slowly, hence not much of operator involvement. Most of the time operators are loading materials into boxes**
- **Time for maintenance is allocated on Fridays after 3pm**

ACTIVITY SAMPLING @ HAUK

CELL # 2: CTL CELL **Operator(s): Vic, Steve, Geof (absent)**

Date: 06/07/99 (Tues)				**Observer: Tey**						**Study # 1**
Machines	Time									% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
BELL DECOILER	$X_{OF,OP}$	$X_{©,OP}$	$X_{©}$	X_{OF}	$\checkmark_{o}$	$\checkmark_{o}$	$X_{©}$	$X_{©}$	$\checkmark$	$\checkmark$	40%
SHNUTZ LEVELLER	$X_{OF,OP}$	$X_{©,OP}$	$X_{©}$	X_{OF}	$\checkmark_{o}$	$\checkmark_{o}$	$X_{©}$	$X_{©}$	$\checkmark$	$\checkmark$	40%
BELL STACKER	$X_{OF,OP}$	$X_{©,OP}$	$X_{©}$	X_{OF}	$\checkmark_{o}$	$\checkmark_{o}$	$X_{©}$	$X_{©}$	$\checkmark$	$\checkmark$	40%
CTL	$X_{OF,OP}$	$X_{©,OP}$	$X_{©}$	X_{OF}	$\checkmark_{o}$	$\checkmark_{o}$	$X_{©}$	$X_{©}$	$\checkmark$	$\checkmark$	40%

M/C running (with operator monitoring)	$\checkmark$
M/C running (without operator monitoring)	$\checkmark_{o}$
Set-up/Changeover time	©
Maintenance	M

M/C not running	X
M/C breakdown	Ø
Operator absent	OA
Operator resting	OR
Operator working on other m/c	OW
Operator fetching material	OF
Operator packing finished material	OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

* **All machines run together (either all running or all in stagnant)**
* **Long time to set up, loading coil, measuring, fetching and clearing scrap**

<u>**ACTIVITY SAMPLING @ HAUK**</u>

CELL # 2: CTL CELL **Operator(s): Vic, Steve, Geof**

Date: 12/07/99 (Mon)				**Observer: Tey**						**Study # 2**
Machines	Time									% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
BELL DECOILER	X©	X_{OF}	✓$_o$	✓	✓	✓$_o$	X©	X©	X©.OP	✓	50%
SHNUTZ LEVELLER	X©	X_{OF}	✓$_o$	✓	✓	✓$_o$	X©	X©	X©.OP	✓	50%
BELL STACKER	X©	X_{OF}	✓$_o$	✓	✓	✓$_o$	X©	X©	X©.OP	✓	50%
CTL	X©	X_{OF}	✓$_o$	✓	✓	✓$_o$	X©	X©	X©.OP	✓	50%

M/C running (with operator monitoring)	✓
M/C running (without operator monitoring)	✓$_o$
Set-up/Changeover time	©
Maintenance	M

M/C not running	X
M/C breakdown	Ø
Operator absent	OA
Operator resting	OR
Operator working on other m/c	OW
Operator fetching material	OF
Operator packing finished material	OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

* **Once the machines are set up, operators usually only need to watch the machine running**
* **Operator often has to deal with rejected coil**

ACTIVITY SAMPLING @ HAUK

CELL # 2: CTL CELL **Operator(s): Vic, Steve, Geof**

Date: 16/07/99 (Fri)				**Observer: Tey**						**Study # 3**
Machines	Time									% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
BELL DECOILER	✓o	✓o	X©	XOF	XOP	XOF	XOR	✓	✓	M	40%
SHNUTZ LEVELLER	✓o	✓o	X©	XOF	XOP	XOF	XOR	✓	✓	M	40%
BELL STACKER	✓o	✓o	X©	XOF	XOP	XOF	XOR	✓	✓	M	40%
CTL	✓o	✓o	X©	XOF	XOP	XOF	XOR	✓	✓	M	40%

M/C running (with operator monitoring)	✓	M/C not running	X
M/C running (without operator monitoring)	✓o	M/C breakdown	Ø
Set-up/Changeover time	©	Operator absent	OA
Maintenance	M	Operator resting	OR
		Operator working on other m/c	OW
		Operator fetching material	OF
		Operator packing finished material	OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

* **Once the machines are set up, operators usually only need to watch the machine running**
* **Maintenance time allocated on Fri after 3pm**

ACTIVITY SAMPLING @ HAUK

CELL # 3: GUILLOTINE CELL **Operator(s): Allan, Dave, Paul, Ray**

Date: 06/07/99 (Tues)					**Observer: Tey**					**Study # 1**
Machines	Time									% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
GUILLOTINE 1 (12ft)	X_{OP}	X_{OP}	X_{OA}	X_{OR}	✓	✓	X_{OR}	X_{OR}	X	X	20%
GUILLOTINE 2 (10ft)	X	✓	✓	✓	X_{OW}	X_{OW}	X_{OA}	X_{OR}	X	✓	40%
GUILLOTINE 3 (8ft)	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%
GUILLOTINE 4 (6ft)	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%
GUILLOTINE 5 (small)	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%
Auto Film APPLICATOR 1	X_{OF}	X_{OP}	X	✓	✓	X_{OA}	✓	X	X©	X_{OA}	30%
Auto. Film APPLICATOR 2	X©	✓	X	X_{OA}	X	X_{OR}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	10%

M/C running (with operator monitoring)	✓	M/C not running	X
M/C running (without operator monitoring)	✓$_{o}$	M/C breakdown	Ø
Set-up/Changeover time	©	Operator absent	OA
Maintenance	M	Operator resting	OR
		Operator working on other m/c	OW
		Operator fetching material	OF
		Operator packing finished material	OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

*** 12ft Guillotine needs 2 operators at times**

ACTIVITY SAMPLING @ HAUK

CELL # 3: GUILLOTINE CELL **Operator(s): Allan, Dave, Paul, Ray**

Date: 12/07/99 (Mon)				**Observer: Tey**						**Study # 2**
Machines	Time									% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
GUILLOTINE 1 (12ft)	X_{OP}	X_{OP}	✓	✓	X_{OR}	X_{OA}	X_{OP}	X_{OR}	X_{OA}	X_{OW}	20%
GUILLOTINE 2 (10ft)	X_{OF}	X_{OA}	X_{OW}	X_{OW}	✓	✓	X_{OA}	✓	X_{OP}	X_{OP}	30%
GUILLOTINE 3 (8ft)	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%
GUILLOTINE 4 (6ft)	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%
GUILLOTINE 5 (small)	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%
Auto Film APPLICATOR 1	✓	✓	X_{OR}	X_{OF}	X©	X_{OA}	X©	✓	✓	X_{OP}	40%
Auto. Film APPLICATOR 2	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	0%

M/C running (with operator monitoring)	✓	M/C not running	X
M/C running (without operator monitoring)	$✓_o$	M/C breakdown	Ø
Set-up/Changeover time	©	Operator absent	OA
Maintenance	M	Operator resting	OR
		Operator working on other m/c	OW
		Operator fetching material	OF
		Operator packing finished material	OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

* **Operators often not within sight – away to fetch materials or order forms; somtimes writing on paper, or looking at computers**
* **Coater 2 broke down and not functioning all day**

ACTIVITY SAMPLING @ HAUK

CELL # 3: GUILLOTINE CELL **Operator(s): Allan, Dave, Paul, Ray**

Date: 16/07/99 (Fri)					**Observer: Tey**					**Study # 3**
Machines	Time									% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
GUILLOTINE 1 (12ft)	✓	✓	✓	X_{OR}	✓	X_{OP}	X_{OP}	X_{OA}	X	X	40%
GUILLOTINE 2 (10ft)	X	X_{OW}	X_{OW}	✓	X_{OW}	X_{OW}	X_{OA}	✓	✓	✓	40%
GUILLOTINE 3 (8ft)	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%
GUILLOTINE 4 (6ft)	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%
GUILLOTINE 5 (small)	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	X_{OA}	0%
Auto Film APPLICATOR 1	X_{OF}	✓	✓	X_{OA}	✓	X_{OP}	✓	X©	X©	X_{OA}	40%
Auto. Film APPLICATOR 2	X©	X_{OF}	X_{OF}	✓	✓	X_{OR}	$X_{OP.OF}$	X_{OP}	X_{OA}	X_{OA}	20%

M/C running (with operator monitoring)	✓	M/C not running	X
M/C running (without operator monitoring)	$✓_o$	M/C breakdown	Ø
Set-up/Changeover time	©	Operator absent	OA
Maintenance	M	Operator resting	OR
		Operator working on other m/c	OW
		Operator fetching material	OF
		Operator packing finished material	OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

* **Guillotine 3,4 and 5 are not in use at all**
* **No maintenance activity in this cell on Friday afternoon**

ACTIVITY SAMPLING @ HAUK

CELL # 4: SLITTING CELL **Operator(s): Dennis**

Date: 06/07/99 (Tues)	**Observer: Tey**									**Study # 1**
Machines	Time									% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
COIL SLITTER 1	$X_{OP} \rightarrow X_{OP}$		$X_{OP} \rightarrow X_{OP}$		X_{OA}	X_{OP}	X©	X©	X_M	✓	10%
COIL SLITTER 2	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	0%

M/C running (with operator monitoring)	✓
M/C running (without operator monitoring)	✓$_o$
Set-up/Changeover time	©
Maintenance	M

M/C not running	X
M/C breakdown	Ø
Operator absent	OA
Operator resting	OR
Operator working on other m/c	OW
Operator fetching material	OF
Operator packing finished material	OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

* **$X_{OP} \rightarrow X_{OP}$ Operator possible packing the same batch of job**
* **Very low utilisation of machines. Operators spend most time on loading, unloading, fetching, delivering and measuring**

ACTIVITY SAMPLING @ HAUK

CELL # 4: SLITTING CELL **Operator(s): Dennis**

Date: 12/07/99 (Mon)	**Observer: Tey**									**Study # 2**
Machines	Time									% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
COIL SLITTER 1	X©	✓	$X_{OP} \rightarrow X_{OP}$				X_{OA}	X©	✓	X_{OP}	20%
COIL SLITTER 2	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	0%

M/C running (with operator monitoring)	✓
M/C running (without operator monitoring)	✓o
Set-up/Changeover time	©
Maintenance	M
M/C not running	X
M/C breakdown	Ø
Operator absent	OA
Operator resting	OR
Operator working on other m/c	OW
Operator fetching / delivering material	OF
Operator packing finished material	OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

* **$X_{OP} \rightarrow X_{OP}$ Operator packing the same batch of job**
* **Due to the change in customer need, Coil Slitter 2 was not at all in use for the time being**

ACTIVITY SAMPLING @ HAUK

CELL # 4: SLITTING CELL **Operator(s): Dennis**

Date: 16/07/99 (Fri)					Observer: Tey						Study # 3
Machines	Time										% Utilisation
	1045	1115	1145	1215	1245	1345	1415	1445	1500	1545	
COIL SLITTER 1	X_{OP}	X©	✓	✓	X_{OP}	X_{OW}	X_{OW}	X_{OW}	M	X_{OF}	20%
COIL SLITTER 2	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X_{OW}	X©	✓	X_{OP}	X	X	10%

M/C running (with operator monitoring)	✓	M/C not running	X
M/C running (without operator monitoring)	$✓_{o}$	M/C breakdown	Ø
Set-up/Changeover time	©	Operator absent	OA
Maintenance	M	Operator resting	OR
		Operator working on other m/c	OW
		Operator fetching / delivering material	OF
		Operator packing finished material	OP

Everyday working shift: 0800 - 1600
Tea breaks: 1000 - 1030 (morning), 1515 - 1530 (afternoon)
Lunch break: 1300-1330
Observations start after morning tea break

* **Operator maintain slitter machine by tightening screws and lubricating**

CELL Guillotine, Plastic Coating	**MACHINE** Automatic Film Applicator X2
OPERATOR(S) Allan (L), Dave, Paul, Ray	
DESCRIPTION OF PROCESS Guillotining to precise dimensions Plastic Coating (1 side or 2 sides)	
DETAIL OF MAINTENANCE Only frequent lubrication	
OTHER NOTES Not filling in 5Cs checksheet, machine problems which affects quality, not knowing SPC and computer	

CELL Sawing	**MACHINE** Kaltenbach Saw X4
OPERATOR(S) Paul (L), Matthew, Julian	
DESCRIPTION OF PROCESS Extrusion	
DETAIL OF MAINTENANCE Maintenance records, red-tagging, 5Cs	
OTHER NOTES KANBAN, palettes	

CELL CTL	**MACHINE** BELL Decoiler, Stacker
OPERATOR(S) Vic, Steve, Geoff	
DESCRIPTION OF PROCESS Coiling → Plastic coating → CTL → Stacking	
DETAIL OF MAINTENANCE 5Cs, Red-tagging	
OTHER NOTES Circuit, software problems	

CELL Slitting	**MACHINE** Coil Slitter X2
OPERATOR(S) Dennis	
DESCRIPTION OF PROCESS	
DETAIL OF MAINTENANCE Not much, never filled in 5Cs check sheet	
OTHER NOTES Use tolerance check techniques, one machine very infrequently used due to change of customer need	

Appendix D

Change Indicator Score Sheets

Results from

"The Assessment of Organisational Change towards WCM

using the BoC model"

@

Heritage Silverware

Rexel Business Machines

Pilkington Automotive

Hoogovens Aluminium UK (Corus)

by

Joo Tey

In collaboration with the research in "World Class Manufacturing"

Indicator's Score Sheet

Description: **Level 1 – Input Environment**

Company / Plant: **Pilkington**
Date: **Jan 2001**

Stage	Score	Description
Avoid	0	This issue has never been brought to question
Aware	3	This issue has been dealt with in the past but without much success
Adapt	6	This issue has been / is now being brought to attention and is being acted upon
Achieved	10	The company has a successful history / has established an efficient solution of dealing with this issue

Categories of Input Environment	Issues leading to company's success factors		*Score*
Supplier Management	Are suppliers' performances being measured (quality, delivery etc.)?		*6*
	Are standards set for suppliers' performance?		*5*
	Are supplier relationships managed and documented?		*5*
		Sub-score	*5.3*
Customer Satisfaction	Is there a good effort of communication with the customers to understand their needs?		*6*
	Is customer satisfaction being monitored by means of survey, interview or etc.?		*6*
	Is there an allocated time and resources towards customer satisfaction and improvements?		*6*
		Sub-score	*6*
External Factors	*Market Demands*	Is the company aware of current market needs and market competitive factors?	*7*
	Government Regulations	What are the government regulations or regional political factors that have significant impacts on the business?	*7*
	Competitors Actions	Is the company aware of its competitors' strength, and their actions in attracting customers?	*6*

		Sub-score	*6.7*
Internal Factors	*Vision/ Mission Statements Management's Vision/ Business Strategy/ Organisation Philosophies*	Is there a vision / mission statement known to the entire workforce and the customers? Is there an underlying set of organization philosophies/ principles known and followed by the entire organization?	*10*
		What is the management's vision / strategies of change towards world class manufacturing?	*10*
		What is the company's business plan (5-year plan for example) taking into account all the above factors?	*7*
	Critical Shop Floor Concerns	What are the factors hindering shop floor processes from becoming an efficient and productive working environment? What are the main concerns/ problems regarding working towards SCEF (Safer, Cheaper, Easier, Faster) operations?	*8*
	Manufacturing Capacity Technological and Human Resources	Is there sufficient manufacturing capacity, technological or human resources to carry out the change currently undertaken?	*7*
	Organisation Structure	Does the company structure allow sufficient inter-functional communication? Does it fit to the modern principle of flat organization? Does it have a horizontal team based structure to deal with short term change implementation?	*10*
	Data Collection	Is the data collection system capable of generating data for the major operational performance measures (quality, cost, time, productivity)?	*9*
		Sub-Score	*8.7*
		Total Score	*6.7*

Indicator's Score Sheet

Description: **Level 3 – Process Environment** Company / Plant: **Pilkington** Date : **Jan 2001**

<table>
<tr><th>Change Activity</th><th>Identify Corrective Actions</th><th>Prioritisation of Actions</th><th>WCM Implementations Progress Monitoring</th></tr>
<tr>
<td>Description</td>
<td>

Project teams each identify their own corrective actions
The corrective actions are specific to certain improvements, one example given below

Roller Breaks Reduction BOSS
<table>
<tr><th>No.</th><th>Action Description</th></tr>
<tr><td>26</td><td>Pre nip 2 first roller smile changed from 18mm to 21mm in 1.25x200 deeper</td></tr>
<tr><td>27</td><td>Outbreak of roller breaks, traced to poor edge work</td></tr>
<tr><td>3</td><td>Spare set rollers: Prenip 1 and weekly check of rollers</td></tr>
<tr><td>5</td><td>X200: Two distinct types of breakage</td></tr>
<tr><td></td><td>Tip breaks: Chalking of moulds on A5 and replacement of carbon inserts</td></tr>
<tr><td></td><td>High energy breaks: investigating altering P/N1 smile from 21 to 23mm</td></tr>
<tr><td>9</td><td>Mondeo reprogrammed cnc programme</td></tr>
<tr><td>16</td><td>Nissan hs, install bit pattern tracking similar to x200</td></tr>
</table>
</td>
<td>

Pick an initial project that yields success quickly
Prioritisation is done by singling out value-added and non value-added activities
Non value-added tasks are ranked to identify the largest time offender
Time is the common denominator

</td>
<td>

Start dates and completion dates (both forecasted and real) are recorded for every corrective actions
Progress is monitored by percentage
Team members are allocated to each task
An implementation sheet is produced to show all the above details plus

The trend of roller breaks in % by month (actual, target and budget)
A chart showing roller breaks and line breaks final as the main causes of scrap last month
Actual cost, budget cost and the target cost

</td>
</tr>
</table>

Indicator's Score Sheet

Description: **Level 3 – Process Environment** Company / Plant: **Pilkington** Date : **Jan 2001**

	22	Mould marks on eq and Toyota PI to refurbish moulds greater frequency		
	23	Lehr to improve edgework on x200 & hs		
Summary	➢ Corrective actions are results of a diffusion from company success factors → areas of improvements (Level 2) ➢ The corrective actions are in the simplest possible operational form ➢ The set of corrective actions/ countermeasures are generated using "forward mechanism" after carefully analyzing the concerns and causes; and backward mechanism to present corresponding set of potential improvements ➢ The generation of corrective actions Employs the theory and practices of the tools and techniques which are put to use and takes into consideration the available resources (eg. Budgets)		➢ Actions are prioritized only due to constraints (eg. Time) ➢ Prioritisation of actions carried out by WCM project team ➢ No specific analytical tool / methodology is used to prioritise the actions (Pareto, Analytical Hierarchical Process, Priority Map or other Operational Research approach)	➢ Meetings are regular and involve not just management but shop floor people (eg. team or cell leaders) ➢ A progress report generated regularly includes ▪ Corrective actions, target and actual completion dates and individuals in responsibility ▪ Performance measures charts as a result of the corrective actions ➢ Reports are circulated among the entire workforce, progesses are well-communicated and are fed back to Level 2 "identifying areas of improvements"
Score	10		5	8
			Average Score	*7.7*

Indicator's Score Sheet

Description: **KAIZEN Bird 'Wings'** Company / Plant: **Pilkington**

Date : **Jan 2001**

Change Activities	Performance Measures / Benchmarking	WCM objectives / Principles of Simplicity
Description	➢ Standard performance measures used across the organisation such as: ▪ Yield ▪ Productivity ▪ Uptime ▪ Changeover time ▪ Flow rate ▪ PPM ▪ Wok cost ▪ Lost time accident rate ▪ Lost worked day rate ➢ These performance measures are to support the tools and techniques such as ▪ Uptime → SMED – TPM ▪ Flow rate → automation ▪ Yield → System Process Control ➢ Standard benchmarking exercise of manufacturing improvement includes the assessment of the following: ▪ Training for process improvers, and operators ▪ On-goings for process improvement teams ▪ Completed tasks for improvement teams ▪ Tools used ▪ Monitoring of the improvement teams ▪ Parts per million ▪ Green book	➢ The improvement programme includes the following objectives: ▪ Environment, Health and Safety ▪ Quality ▪ KAIZEN / TPM / 6 Sigma agenda in the Manufacturing improvement wall ▪ Lean organisation ▪ Manufacturing Standards ▪ New Model Introduction ▪ Learning and Communication ➢ The tools currently utilised and making impacts are ▪ SMED ▪ FMEA ▪ 5Ss ▪ SPC ➢ The building of ONE Pilkington is based on the engagement of making the group ▪ Simpler ▪ More focused ▪ More efficient ▪ Lower cost Which can all be translated into KAIZEN bird language as SCEF (Safer, Cheaper, Easier and Faster) ➢ Pilkington as one organisation is communicated through a fully structured in-house programme

Indicator's Score Sheet

Description: **KAIZEN Bird 'Wings'**

Company / Plant: **Pilkington**

Date : **Jan 2001**

	▪ Standardisation ▪ Corrective actions ➢ This benchmarking is a one-day audit programme containing presentations, plant tour, evaluation and discussion sessions	"Manufacturing To Win" ➢ Plant manufacturing strategic manager has a vision towards the plant's own WCM implementations: 5Ss → TPM → Problem Solving Teams → 6 Sigma
Summary	➢ World class performance measures, including tangibles and intangibles, are regularly generated and show all WCM objectives ➢ Performance measures are in conjunction with tools and techniques / operations within the company ➢ PM acts as an indicator to WCM implementation progress, and a feedback to identifying the new set of company success factors (KAIZEN Bird Level 2) or corrective actions (KAIZEN Bird Level 3) ➢ Regular external and internal benchmarking activities carried out in all WCM areas of interest; regular benchmarking visits to fellow pilkington companies in the same group ➢ Standard benchmarking procedures set, benchmarked data being analysed and feedback to identify company success factors (KAIZEN Bird Level 2) and corrective actions (KAIZEN Bird Level 3)	➢ Company working towards all the 6 major WCM objectives at all times using tools / techniques to support each of them ➢ The tools / techniques are utilised to full potential, and they help achieve targets successfully ➢ Company works towards a lean and SCEF working environment ➢ The entire organisation has a clear vision of what they want to achieve as a WC company and how to achieve these objectives ➢ Strategies / vision /mission statements are translated into shop floor corrective actions; all operations are aligned with company's up-front success factors
Score	PM = 18 , Benchmarking = 12 , Ave = 15	WCM Obj = 20 , Principles = 20, Ave = 20
	Total Ave. Score	***17.5***

Indicator's Score Sheet

Description: **Level 1 – Input Environment** Company / Plant: **Rexel**

Date: **Jan 2001**

Stage	Score	Description
Avoid	0	This issue has never been brought to question
Aware	3	This issue has been dealt with in the past but without much success
Adapt	6	This issue has been / is now being brought to attention and is being acted upon
Achieved	10	The company has a successful history / has established an efficient solution of dealing with this issue

Categories of Input Environment	Issues leading to company's success factors		*Score*
Supplier Management	Are suppliers' performances being measured (quality, delivery etc.)?		*6*
	Are standards set for suppliers' performance?		*7*
	Are supplier relationships managed and documented?		*8*
		Sub-score	*7*
Customer Satisfaction	Is there a good effort of communication with the customers to understand their needs?		*8*
	Is customer satisfaction being monitored by means of survey, interview or etc.?		*5*
	Is there an allocated time and resources towards customer satisfaction and improvements?		*6*
		Sub-score	*6.3*
External Factors	*Market Demands*	Is the company aware of current market needs and market competitive factors?	*7*
	Government Regulations	What are the government regulations or regional political factors that have significant impacts on the business?	*2*
	Competitors Actions	Is the company aware of its competitors' strength, and their actions in attracting customers?	*6*

		Sub-score	*5*
Internal Factors	*Vision/ Mission Statements Management's Vision/ Business Strategy/ Organisation Philosophies*	Is there a vision / mission statement known to the entire workforce and the customers? Is there an underlying set of organization philosophies/ principles known and followed by the entire organization?	*7*
		What is the management's vision / strategies of change towards world class manufacturing?	*10*
		What is the company's business plan (5-year plan for example) taking into account all the above factors?	*6*
	Critical Shop Floor Concerns	What are the factors hindering shop floor processes from becoming an efficient and productive working environment? What are the main concerns/ problems regarding working towards SCEF (Safer, Cheaper, Easier, Faster) operations?	*9*
	Manufacturing Capacity Technological and Human Resources	Is there sufficient manufacturing capacity, technological or human resources to carry out the change currently undertaken?	*7*
	Organisation Structure	Does the company structure allow sufficient inter-functional communication? Does it fit to the modern principle of flat organization? Does it have a horizontal team based structure to deal with short term change implementation?	*8*
	Data Collection	Is the data collection system capable of generating data for the major operational performance measures (quality, cost, time, productivity)?	*8*
		Sub-Score	*7.9*
		Total Score	*6.6*

Indicator's Score Sheet

Description: **Level 2 – Project Environment** Company / Plant: **Rexel** Date : **Jan 2001**

Change Activity	Identify Areas of Improvements/ Company Success Factors	Prioritise Actions	Select Appropriate Tools	Set WCM Targets
Description	➢ Regular and detailed assessment of internal factors, esp. critical shop floor concerns to produce significant areas of improvements ➢ Company success factors are under constant consideration with lean and SCEF thinking ➢ Areas of improvements identified are: ▪ Reduce Inventory ▪ Improve quality ▪ Set-up time reduction ▪ Process improvement ▪ Layout redesign ▪ Workplace improvements ▪ WCM awareness ▪ Supplier management ▪ Team building ▪ Training of 5Ss principles ▪ Training for Team Leaders ▪ Morale improvements ▪ Employees working benefits	➢ Actions prioritised considering financial, technological and human resources: ▪ Workplace arrangement ▪ Layout and logistics ▪ Process improvements (Engineering) ▪ Training/ presentation of 5S principles ▪ Team building exercises ▪ Supplier management ▪ Team building	➢ Tools selected: ▪ 5Ss ▪ JIT/ lean manufacturing ▪ Faxban ➢ Management has good knowledge of tools ➢ Tools are well documented and communicated	➢ Realistic operational targets are set persistent with the performance measures, efforts are made to assure target achievements ▪ Delivery performance > 95% ▪ Cycle time reduction ▪ Bronze audit 80% ▪ OEE 85% ➢ Targets are set to achieve international standards (ISO, Baldridge, Deming etc.) ▪ H&S to meet ISO 9001 standard ➢ New targets are continually set for a SCEF operational environment ▪ More pleasant ▪ workplace ▪ Improved health & safety ▪ Floor space reduction ▪ Reduce variation

Indicator's Score Sheet

Description: **Level 2 – Project Environment** Company / Plant: **Rexel** Date : **Jan 2001**

Summary	➢ Areas of improvements are identified as a direct result of assessing the external and internal inputs from Level 1. More than half of the input factors are being considered ➢ Becoming a SCEF operational environment is nominated as an area of improvement	➢ Decisions on prioritising actions are made taking into considerations financial, technological and human resources	➢ Tools are chosen and modified to support specific areas of improvements and to achieve specific manufacturing objectives ➢ Tools are selected to fit WCM principles and to create a lean / SCEF operational environment	➢ Realistic operational targets are set persistent with the performance measures, efforts are made to assure target achievements ➢ Targets are reassessed to ensure they are achieved, maintained, and regularly re-established ➢ Targets are set to achieve international standards (ISO, Baldridge, Deming etc.) ➢ New targets are continually set for a SCEF operational environment
Score	*8*	*5*	*7*	*9*
			Ave. Score	*7.3*

Indicator's Score Sheet

Description: **KAIZEN Bird 'Wings'**

Company / Plant: **Rexel**

Date : **Jan 2001**

Change Activities	Performance Measures / Benchmarking	WCM objectives / Principles of Simplicity
Description	➢ Financial performance was easy – cost breakeven was the target (plant produce for warehouse, not directly to consumers) ➢ OEE to show machine and operator utilisation, used in conjunction with TPM and 5Ss activities ➢ Scrap costs, right first time analysis and PPM (Parts Per Million) to show quality performance ➢ Customer satisfaction measured in terms of delivery performance and warranty performance ➢ KPI (Key Performance Indicator) to link performance measures to business measures and the corrective actions ➢ Intangible performances include labour productivity, accident rate (safety triangle) and absenteeism ➢ Benchmarking in product feasibility (compare similar product in every aspect)	➢ TPM and OEE implemented to increase quality, productivity; 5Ss tools utilised to improve workplace condition and aid cost reduction ➢ ISO 9001 is employed to tackle environmental, health and safety issue ➢ Customer satisfaction is closely monitored (next customer in the chain is the warehouse) ➢ JIT / faxban / layout redesign to attack waste, non value-adding activities and achieve lean / SCEF working environment ➢ Management has a strategic vision towards WCM implementations: Health and Safety → Productivity → Quality → Environment ➢ On-going WCM acitivities using continuous improvement principles

Indicator's Score Sheet

Description: **KAIZEN Bird 'Wings'** Company / Plant: **Rexel**

Date : **Jan 2001**

	➢ Bronze audit allows internal benchmarking on process improvements	
Summary	➢ World class performance measures, including tangibles and intangibles, are regularly generated and show all WCM objectives ➢ Performance measures are in conjunction with tools and techniques / operations within the company ➢ PM acts as an indicator to WCM implementation progress, and a feedback to identifying the new set of company success factors (KAIZEN Bird Level 2) or corrective actions (KAIZEN Bird Level 3) ➢ Competitive benchmarking activities carried out on products and processes, internally between departments and externally with competitors	➢ Company working towards all the 6 major WCM objectives at all times ➢ Company using at least one tool / technique to support each of the 6 major WCM objectives ➢ Find new / innovative ways of achieving objectives, including utilising modern tools / techniques ➢ Constantly achieving continuous improvements, elimination of waste / non value-adding activities and a lean working environment (safer, cleaner, easier and faster) ➢ Strategies / vision /mission statements are translated into shop floor corrective actions; all operations are aligned with company's up-front success factors
Score	PM = 19, Benchmarking = 13, Ave = 16	WCM Obj = 19, Principles = 18, Ave = 18.5
	Total Ave. Score	*17.3*

Indicator's Score Sheet

Description: **Level 1 – Input Environment** Company / Plant: **Corus**

Date: **Jan 2001**

Stage	Score	Description
Avoid	0	This issue has never been brought to question
Aware	3	This issue has been dealt with in the past but without much success
Adapt	6	This issue has been / is now being brought to attention and is being acted upon
Achieved	10	The company has a successful history / has established an efficient solution of dealing with this issue

Categories of Input Environment	**Issues leading to company's success factors**		***Score***
Supplier Management	Are suppliers' performances being measured (quality, delivery etc.)?		*6*
	Are standards set for suppliers' performance?		*6*
	Are supplier relationships managed and documented?		*6*
		Sub-score	*6*
Customer Satisfaction	Is there a good effort of communication with the customers to understand their needs?		*3*
	Is customer satisfaction being monitored by means of survey, interview or etc.?		*3*
	Is there an allocated time and resources towards customer satisfaction and improvements?		*6*
		Sub-score	*4*
External Factors	*Market Demands*	Is the company aware of current market needs and market competitive factors?	*6*
	Government Regulations	What are the government regulations or regional political factors that have significant impacts on the business?	*5*
	Competitors Actions	Is the company aware of its competitors' strength, and their actions in attracting customers?	*7*

		Sub-score	*6*
Internal Factors	*Vision/ Mission Statements Management's Vision/ Business Strategy/ Organisation Philosophies*	Is there a vision / mission statement known to the entire workforce and the customers? Is there an underlying set of organization philosophies/ principles known and followed by the entire organization?	*5*
		What is the management's vision / strategies of change towards world class manufacturing?	*8*
		What is the company's business plan (5-year plan for example) taking into account all the above factors?	*6*
	Critical Shop Floor Concerns	What are the factors hindering shop floor processes from becoming an efficient and productive working environment? What are the main concerns/ problems regarding working towards SCEF (Safer, Cheaper, Easier, Faster) operations?	*10*
	Manufacturing Capacity Technological and Human Resources	Is there sufficient manufacturing capacity, technological or human resources to carry out the change currently undertaken?	*6*
	Organisation Structure	Does the company structure allow sufficient inter-functional communication? Does it fit to the modern principle of flat organization? Does it have a horizontal team based structure to deal with short term change implementation?	*2*
	Data Collection	Is the data collection system capable of generating data for the major operational performance measures (quality, cost, time, productivity)?	*5*
		Sub-Score	*6*
		Total Score	*5.6*

Indicator's Score Sheet

Description: **Level 2 – Project Environment**

Company / Plant: **Corus**

Date : **Jan 2001**

Change Activity	Identify Areas of Improvements/ Company Success Factors	Prioritise Actions	Select Appropriate Tools	Set WCM Targets
Description	➢ Company success factors identified after assessing the elements in Level 1 -- Input Environment: ▪ Improve financial situation (make profit) ▪ Upraise workers morale ▪ Improve delivery performance ▪ Increase manufacturing capacity ▪ Sustain WCM implementations with now less resources ➢ Detailed assessment of internal factors (critical shop floor concerns and available resources), external factors (market demand), customer and supplier concerns to produce significant areas of improvements ➢ Merging of business made an impact on the decision of company success factors ➢ Areas of improvements are also identified through Barry's model of WC organisation	➢ Matrix analysis is used to rank benefits and impact on P&L account ➢ Actions are prioritised based on financial justification ➢ Comparison is made between the identified areas of improvement and those raised in the model of WC organisation (Barry) before action is prioritised	➢ Tools are chosen to achieve specific manufacturing objectives ▪ Process Capability and Tool Setting ▪ SPC ▪ TPM ▪ 5Ss ▪ JIT, cellular, KANBAN ▪ FMEA ▪ Layout design ▪ Product models and simulations	➢ International standards are set to be achieved ▪ ISO 9002 ▪ ISO 14001 Environment ▪ UK/European Quality Award and Shingo Prize ➢ Basic target set for OEE, SPC ➢ General target of lean and SCEF; and an improvement of financial performance

Indicator's Score Sheet

Description: **Level 2 – Project Environment** Company / Plant: **Corus**

Date : **Jan 2001**

Summary	➢ Areas of improvements are identified after assessing the external and internal inputs from Level 1 ➢ More than half of the input factors are being considered ➢ Becoming a SCEF operational environment is nominated as an area of improvement ➢ Success factors should be identified to company's specific needs, and a management model should be used as an aid, not as it is	➢ Actions are prioritized due to constraints (mainly financial resources) ➢ Very basic analytical method is used	➢ Tools are largely at use and help create a SCEF and lean environment ➢ Tools make impact on certain performances but many are not aligned with the company's specified success factors	➢ Some realistic operational targets are set persistent with the performance measures, efforts are made to assure target achievements ➢ Targets are set to achieve international standards (ISO, Baldridge, Deming etc.) ➢ Targets are continually set for a SCEF operational environment
Score	8	5	5	6
			Ave. Score	6

Indicator's Score Sheet

Description: **Level 3 – Process Environment** Company / Plant: **Corus** Date : **Jan 2001**

Change Activity	Identify Corrective Actions	Prioritisation of Actions	WCM Implementations Progress Monitoring
Description	➢ Corrective actions identified at this point are: i. Activity Sampling ii. 'Outsourced' Customer Care Programme iii. Non-Conformance Reports iv. Red-tagging v. Service complaints vi. Critical concerns audit vii. Joint initiatives with customers – vertical collaboration viii. Investment in cut-to-length line ix. Interest in more value-added activities	➢ Prioritise actions according to the limited resources available after merging ➢ Prioritisation mainly based on its impact on bottom line results	➢ Progress is based on bottom line results, and driven by Barry's WC model ➢ Reports only include OEE, SPC, and financial performance ➢ Meetings not regular, and not continuous in terms of WCM implementations
Summary	➢ The corrective actions are **not** in the simplest possible operational form ➢ Some (not all) prioritised areas of improvements (from Level 2) are translated into an identifiable set of specific actions ➢ There are partial use of the "forward mechanism" or the "backward mechanism", these are out of intuition and not recorded ➢ The generation of corrective actions employs the theory and practices of the tools and techniques which are put to use	➢ No obvious activity of prioritisation ➢ Actions are prioritized taking into account only the constraints (eg. Time, capital, labour and other available resources)	➢ Meetings are carried out occasionally involving management and team leaders ➢ Reports are rarely done and only include financial performances, or the overall progress of big projects, without breaking down progress of smaller actions
Score	6	3	4
		Average Score	4.3

Indicator's Score Sheet

Description: **Level 2 – Project Environment**

Company / Plant: **Heritage**

Date : **Jan 2001**

Change Activity	Identify Areas of Improvements/ Company Success Factors	Prioritise Actions	Select Appropriate Tools	Set WCM Targets
Description	➢ Company success factors identified after assessing the elements in Level 1 -- Input Environment: ▪ Reduce Inventory ▪ Improve quality ▪ Process improvement ▪ Layout redesign ▪ Workplace improvements ▪ WCM awareness ▪ Set-up time reduction	➢ Decisions on prioritising actions are made in a WCM project team meeting, taking into considerations not only financial, technological and human resources, but also the inputs from Level 1: ▪ Workplace improvements ▪ Layout redesign ▪ WCM Awareness	➢ One tool was chosen to achieve manufacturing objective and to tackle areas of improvement ▪ 5Ss (3Ss in pilot area – Polishing + entire shop floor)	➢ Target is set to achieve an improvement in the following performance measures: ▪ Delivery performance = 100% ▪ Cycle time reduction The general way forward for operations: ▪ More pleasant workplace ▪ Improved health &safety ▪ Floor space reduction ▪ Improved Operators Efficiency ▪ 100% Material availability ➢ No International Standards / no specific set figure for the above targets

Indicator's Score Sheet

Description: **Level 2 – Project Environment**

Company / Plant: **Heritage**

Date : **Jan 2001**

Summary	➢ Areas of improvements are identified as a direct result of assessing the external and internal inputs from Level 1. ➢ Less than half of all the input factors are being considered ➢ Becoming a SCEF operational environment is nominated as an area of improvement	➢ Decisions on prioritising actions are made in a WCM project team meeting ➢ Actions are prioritized only due to constraints (eg. time, capital, available resources)	➢ Not enough resources (time and labour) to utilise more tools ➢ Tools are chosen to support specific areas of improvements and to achieve specific manufacturing objectives ➢ Tools are selected to fit WCM principles and to create a lean / SCEF operational environment	➢ Few operational targets are set, but not persistent with performance measures ➢ Efforts are made to assure target achievements, but target set were proven Unrealistic
Score	*6*	*6*	*5*	*3*
			Ave. Score	***5.0***

Indicator's Score Sheet

Description: **Level 3 – Process Environment** Company / Plant: **Heritage**

Date : **Jan 2001**

Change Activity	Identify Corrective Actions	Prioritisation of Actions	WCM Implementations Progress Monitoring
Description	➢ Corrective actions identified at this point are: (tools related) i. Red-tagging ii. Sort & Clear shelves iii. Remove machines iv. Photographs v. Sweep, vacuum, clean vi. 5S map vii. Floor marking viii. Cleaning rota ix. Run 5Ss Audit (performance measures related) i. Generate regular delivery performance data ii. Generate cycle time (executive level related) i. Generate business strategies	➢ Corrective actions outlined after prioritisation: i. Red-tagging ii. Clear shelves iii. Remove machine iv. Photographs v. Sweep, vacuum, clean ➢ Prioritising in this instance is simple, due to the very few corrective actions / areas of improvements identified ➢ Prioritisation only based on restrictions in human, time and capital resources	➢ Implementations at the time: [CA] for corrections, [PM] for performance measures, and [EL] for executive Level [CA] Red tagging activity on machines, tools, shelves etc. (entire shop floor starting from polishing) [CA] Polishing shop re-layout (5S map) "SORT+SEGREGATE" [CA] Floor cleaning (scrubbing) and marking "SHINE" [CA] Clear tool shelves "SORT" & "SEGREGATE" [CA] Move tool cupboard to shop floor "SEGREGATE" [CA] Prepare red-tags "SORT" [CA] Sweep floor in other areas of shop floor "SHINE" [CA] Sweep, clean and tidy "China shop" "SHINE" [CA] Photography (polishing shop) [PM] Delivery performance data [PM] Process cycle time analysis [EL] Business strategies

Indicator's Score Sheet

Description: **Level 3 – Process Environment**

Company / Plant: **Heritage**

Date : **Jan 2001**

Summary	➢ Some prioritised areas of improvements (from Level 2) are translated into an identifiable set of specific actions ➢ The set of corrective actions/ countermeasures are generated using: • "forward mechanism" after carefully analyzing the concerns and causes • "backward mechanism" where the set of corrective actions prompt the establishment of a corresponding set of potential improvements ➢ The corrective actions are in the simplest possible operational form ➢ The generation of corrective actions employs the theory and practices of the tools and techniques which are put to use ➢ Takes into consideration the available resources and expertise to perform them	➢ Prioritisation of actions carried out by WCM project team ➢ Actions are prioritized taking into account only the constraints (eg. Time, capital, labour and other available resources)	➢ Meetings are carried out regularly, but only involve management and no one of the shop floor ➢ The reports keep a record of the corrective actions, the progresses and the people responsible for the actions ➢ A progress report generated regularly includes ▪ Corrective actions, target and actual completion dates and individuals in responsibility ▪ Improved outcomes of the corrective actions, ▪ Performance measures charts as a result of the corrective actions ▪ Why certain corrective actions did not work out ➢ Reports are circulated among the WCM team, not the shop floor people ➢ Reports are fed back to level 2
Score	7	6	7
		Average Score	6.7

Indicator's Score Sheet

Description: KAIZEN Bird 'Wings' Company / Plant: Heritage Date : Jan 2001

Change Activities	Performance Measures / Benchmarking	WCM objectives / Principles of Simplicity
Description	➢ WCM related measures: ▪ WIP ▪ Defects ▪ Machine utilisation ▪ Delivery performance (Delivery Lead Time, outstanding orders) ▪ Process time analysis (one product) ➢ No intangible measures ➢ No obvious benchmarking activities	➢ Company took on WCM for less than 6 months, data collection and IT system are only starting to fall in place ➢ Plan to tackle workplace improvement, waste elimination through 5Ss ➢ Employs 'Birds of change' as a change vehicle
Summary	➢ Only basic performance measures, and mostly done manually ➢ Performance measures link with quality, productivity, & customer satisfaction (60% of WCM objectives) ➢ Only delivery performance is regularly generated, other measures are beginning to be generated ➢ No benchmarking activity, aware of competitor's strength but no significant effort is made to find out more	➢ Aware of the basic objectives (cost, quality, productivity), working towards workplace improvement as a preliminary objective for cost and quality ➢ Company using one tool to support this objective, the tool proved to help achieve this objective ➢ Continuous improvement working culture, small steps at a time but regularly making progress ➢ Elimination of waste and lean working principles ➢ Strategies / vision /mission statements are translated into shop floor corrective actions
Score	*PM = 7, Benchmarking = 0, Ave = 3.5*	*WCM Obj = 5, Principles = 13, Ave = 9*
	Total Ave. Score	*6.3*

Appendix E – Publications

[1] **"Tools and Techniques of World Class Manufacturing"**

J G M Tey, S Barry and A W Duffill, 1999

Published in Advances in Manufacturing Technology XIII, Proceedings of the 15th National Conference of Manufacturing Research, University of Bath, UK. 6-8 Sept.

[2] **"A Continuous Improvement Programme towards World Class Manufacturing"**

J G M Tey and A W Duffill, 2000

Published in Proceedings of the 6th Annual Research Symposium of Postgraduate Research, School of Manufacturing and Mechanical Engineering, University of Birmingham, May

[3] **"Model of a Change Programme – The First Step towards World Class Manufacturing"**

J G M Tey and A W Duffill, 2000

Published in Advances in Manufacturing Technology XIV, Proceedings of the 16th National Conference of Manufacturing Research, University of East London, 5-7 Sept.

[4] **"A World Class Manufacturing Change Indicator"**

J G M Tey, A W Duffill and G B Williams, 2001

Published in Proceedings of the 7th Annual Research Symposium of Postgraduate Research, School of Manufacturing and Mechanical Engineering, University of Birmingham, May.

[Won best presentation]

[5] **"Birds of Change:
A Process of Building a World Class Manufacturing Organisation"**

J G M Tey, A W Duffill and G B Williams, 2001

Published in Proceedings of the 16th International Conference on Production Research, 29th July- 3rd August, 2001, Prague, Czech Republic

[Submitted to International Journal of Production and Operation Management]

Published in Advances in Manufacturing Technology XIII, 1999

Tools and Techniques for World Class Manufacturing

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Summary

An organisation needs to undergo changes to attain world class status. Even a leading world class company must ensure continuous improvements to stay ahead of the competitors. Other organisations, who wish to become world class, need 'revolutionary' change programmes and then to follow this with continual improvements. It is advocated, in this paper, that to implement an effective change programme, an organisation would be assisted by using an embracing model. The model would guide the company through its change programme and then the following continual improvements. The model would be comprehensive to satisfy the many industrial companies but also adaptable to a single company's specific needs. The model is outlined and then one of the sub-models, namely tools and techniques (T&Ts), will be discussed.

This paper also documents the way two industrial organisations implemented the change programmes in relation to the T&Ts sub-model. The T&Ts sub-model provided a useful guide as these companies strove to become world class and enabled them to select the most appropriate T&Ts from a wide range. They implemented the chosen T&Ts and followed up by measuring their success with suitable measures of performance (MOP).

1 Introduction

For any organisation to employ a world class manufacturing (WCM) initiative, often the following steps are needed: obtain buy-in by the company executive, set WCM targets, establish taskforces, develop a change plan, carry out MOP etc., but eventually it is the utilisation of T&Ts that makes the improvements happen. The concept of WCM was introduced in the 1980s, since then many T&Ts have been suggested, developed and utilised. It has also been urged that no organisation should utilise the T&Ts without considering the organisation's current situation and evaluating the appropriateness of the T&Ts within their own shop floor.

This research developed a WCM model which was both comprehensive and could be specifically applied [1]. The model, shown in Fig.1, commences with a global overview, which outlines a number of core components or sub-models which, the research suggested, were essential for an organisation wishing to attain world class status. Each sub-model was then broken down into relevant ancillary activities, which

could then be selected as appropriate. This paper concentrates on one of the many sub-models, namely T&Ts, and presents the relevant ancillary activities.
Six organisations have been used to develop the WCM model, five of which have seen significant improvements in manufacturing efficiency, customer satisfaction, as well as business performance. This paper will focus on two of those organisations, scrutinising the T&Ts that have been put to use, and outlining some of the successes achieved.

2 The WCM Model

2.1 The Global Model

The WCM model [1] is shown in Fig.1. It was circular in that an organisation could commence at any of the 17 'boxes', termed sub-models. Ideally the organisation should start at the WCM sub-model (i.e. were the executive buy-in is centred) and then move on to any of the other sub-models, deciding if they are relevant or not. Fig.1 exhibits a simplified version of the model, only displaying names of the sub-models which were relevant to this paper. Therefore it should be noted that each of the boxes represents a particular sub-model (e.g. data collection, measures of performance, culture [2] etc.).

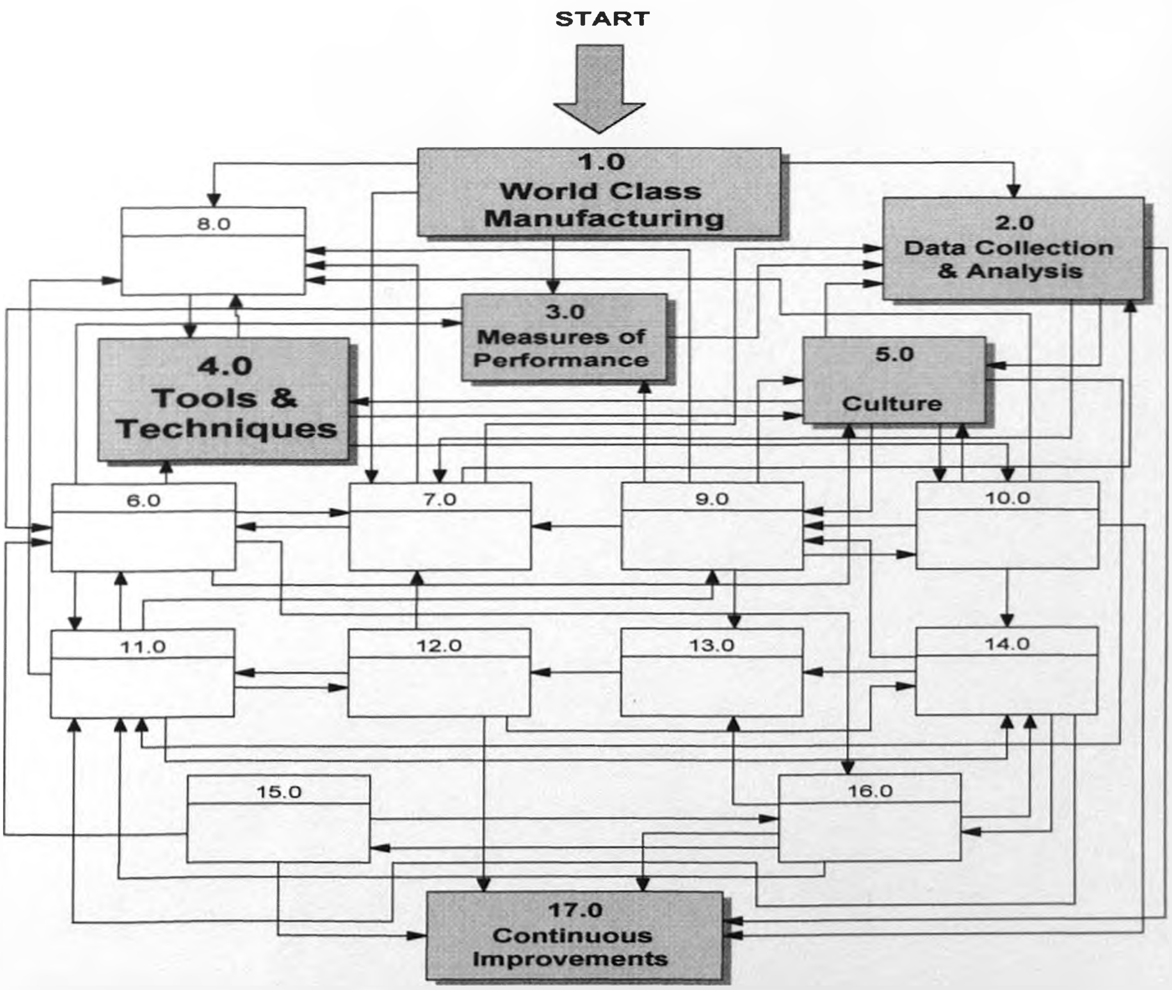

***Figure 1**: WCM – Global Overview Model*

2.2 The T&Ts Sub-Model

In this paper the authors will describe how two companies used the T&Ts sub-model (numbered 4.0). The individual T&Ts, again selected because they were relevant to this paper, are given in Figs.2 and 3., and were termed ancillary activities (e.g. just in time, total productive maintenance, cellular manufacture etc.).

3 Two Case Studies

These are two of the six case studies carried out when applying the WCM model in practical industrial environments [1]. Both organisations have successfully applied the model during their initial change programme. They are now undertaking continuous improvement, re-applying the model to guide them as they continually improve upon their original WCM targets.

Both companies used the global WCM model (Fig.1) and arrived at the T&Ts sub-model. Figs.2 and 3 show the T&Ts which each company then used. As can be seen there was some commonalities but also each company felt some T&Ts were not for them. The relevant ancillary activities used by each organisation are highlighted in the figures.

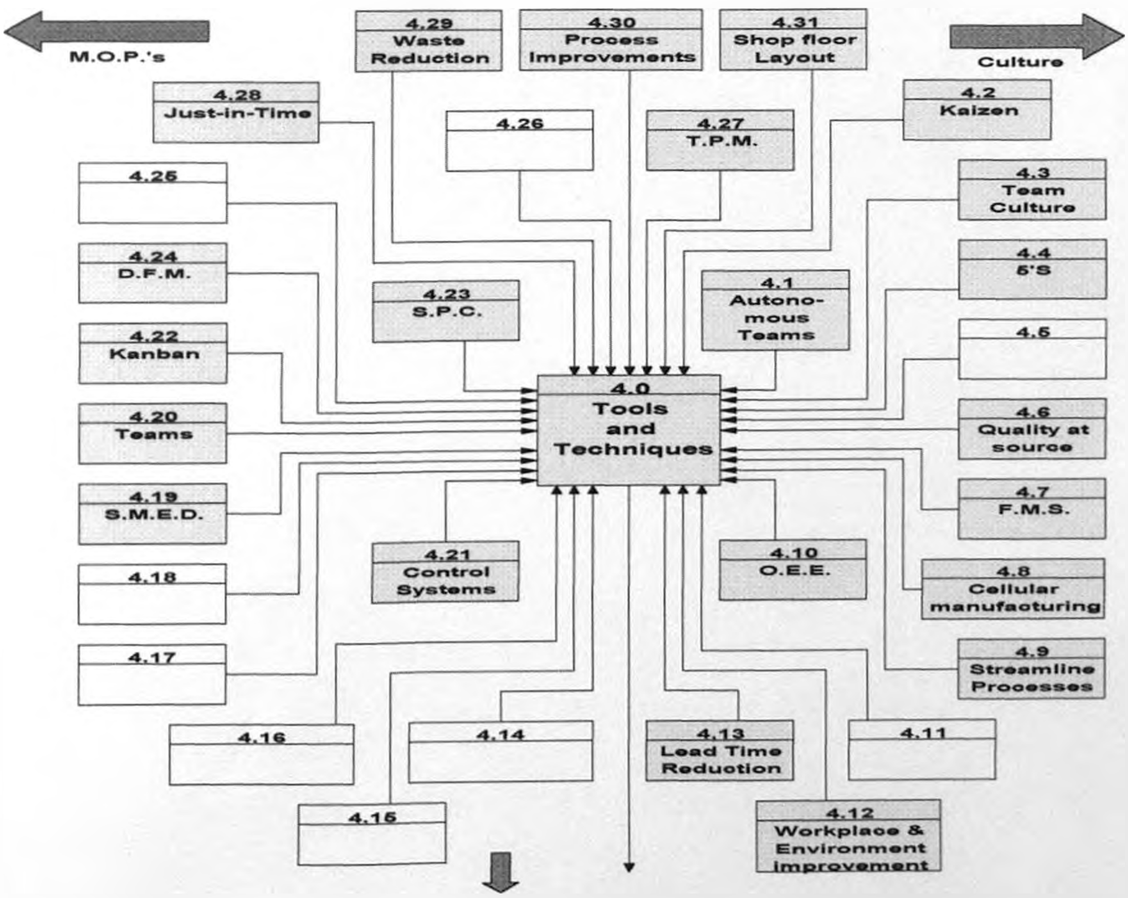

Figure 2: T&Ts Sub-model utilised by 1st Company

Key to Figs 2 and 3:

- FMS Flexible Manufacturing System
- OEE Overall Equipment Effectiveness
- SMED Single Minute Change of Dies
- DFM Design For Manufacture
- SPC Statistical Process Control
- TPM Total Productive Maintenance

3.1 1st Company

The 1st company produced rubber engineering components. The company was founded in the early part of the 20th century and currently has a turnover approaching £0.5bn. The change programme started in 1995 and is continuing. The T&Ts sub-model, Fig.2, shows that the company had a large and succesful change programme. It is worth noting that following the effectiveness of their change programme the company took a further step by setting up WCM training for their suppliers.

Improvements observed can be outlined as following [1]:

- reduction in tool change-over time from 7.5 hours to 1.2 hours (this is achieved through single-minute-exchange-of-dies (SMED).
- vastly reduced work-in-progress (WIP) levels and waste (through just-in-time).
- items such as 5Ss ('5Ss' being the Japanese terminology for work place improvements), cellular manufacturing layouts and overall equipment effectiveness (OEE) also showed major improvements.

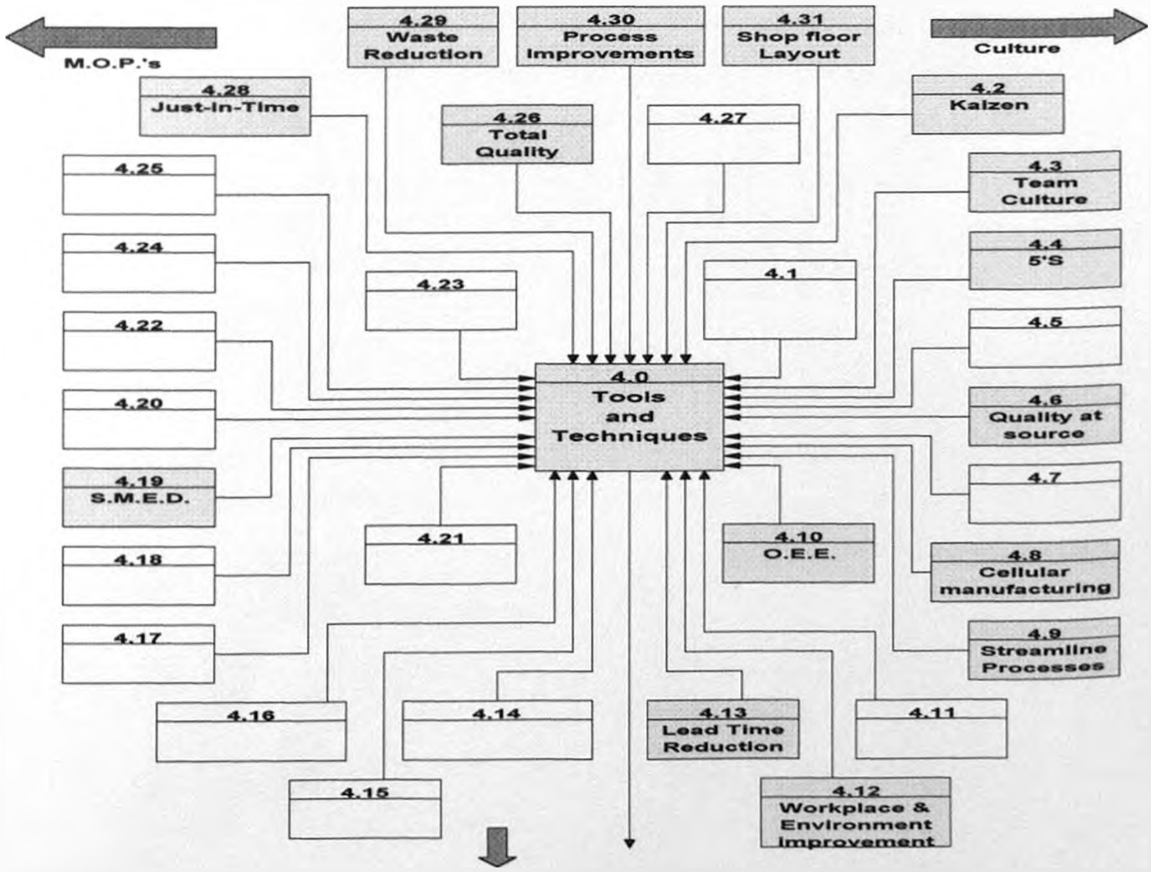

Figure3: T&Ts Sub-model utilised by 2nd Company: HAUK

3.2 2nd Company; Hoogovens Aluminium UK Ltd. (HAUK)

The 2nd company was Hoogovens Aluminium UK Ltd. (HAUK), which was part of an international group with 21K employees, operated as aluminium and steel stockholders. The UK part of the group, which employs a little over 100 staff, was founded in the mid 1970s. Its turnover was £70m at the time of the implementation of the change programme, which is also continuing. The T&Ts sub-model is shown in Fig.3, it can again be seen that a comprehensive change programme ensued. HAUK had conducted an intensive critical concerns audit in the process of developing a set of satisfying T&Ts [3].

Improvements observed within HAUK can also be outlined [1]:

- cellullar manufacturing methods are functioning well.
- attention to shop floor layouts has improved material flow.
- supplier/customer partnerships are beginning to develop with quality at source.
- costs are beginning to come down due to general use of T&Ts.
- immediate improvements are made by continuous changes, which is the essence of Kaizen.

Conclusions

The objective of the WCM global model is to guide any company wishing to achieve world class status. Considering a company's standpoint, a suitable route plan is chosen and implemented. Then the process can start over again for the continuous improvements.

T&Ts is one of the most critical sub-models within a WCM global model. There are, perhaps, too many T&Ts available, thus it is essential for a company to utilise those that it really needs. Eventually, these will aim to improve productivity, quality, delivery performance, as well as to keep costs down.

Many companies have been successful in implementing the WCM model. In order to do so, everyone in the company needs to be involved in the change programme. Without a culture change from executive buy-in to the cascading down to the shop floor, WCM targets can never be achieved.

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A Continuous Improvement Programme towards World Class Manufacturing

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This paper sets out by investigating the various literal definitions of world class manufacturing (WCM), and narrowing it down to fit the current research. It then examines a few existing WCM models / frameworks and presents a model of a general change programme. These are supported by research done in Hoogovens Aluminium UK and followed by a case study looking at the on-going change programme in Rexel Business Machines – ACCO Europe. It is a 3-stage continuous improvement (CI) programme namely bronze, silver and gold. This change programme is then tested against the model. It is believed that this change programme model will lead to the development of a generic model of WCM using empirical evidence. Companies are recommended to use the model as a start in their world class (WC) journey.

Introduction

An organisation needs to undergo changes to attain WC status. Even a leading WC company must ensure CI to stay ahead of the competitors. People have a general reluctance to change. Often the biggest problems of WCM implementation are to get the executive to buy in, to create a total culture change, and to find the resources to make improvements in the middle of the busy daily routines.

Many manufacturers start off with an enthusiastic target of WC. However sometime into it, the progress becomes stationary. Others introduce many new techniques but have made little impact in productivity, cost, quality and delivery performance. Or the employees simply regard the changes as "a waste of time" or "just some charts on the wall to impress visitors". There are plenty of techniques such as JIT, TPM, TQC etc. that have led to manufacturing excellence. When seeking best practice, one should ask, "Is this appropriate for us?" or "Would it support our needs?" To blindly adopt what the competitors do will only result in lagging behind them (Skinner, 1995). These are due to poor management of change. Thus, WC implementations need to be built on a well-constructed, systematic change programme that involves the entire workforce. This research aims to tackle the above problems by developing a generic model for a change programme towards WCM.

Defining World Class Manufacturing

WCM is a broad topic. Managers, academics, practitioners and writers have come up with various definitions for WCM.

- In his profound book "World Class Manufacturing", Schonberger defined WC as "One that fulfils the customer's demands for high quality, low costs, short lead times and flexibility". He also brought up the idea of rapid and CI (Schonberger, 1986).
- Another significant writer, Jim Todd supported this but added "being the best in the world" (Todd, 1995) which has been challenged that no one can be best in the world in all aspects, and no one can constantly be the best in any of these aspects.

- The above arguments was rounded up by Peter Urban, President of Camex Corporate Consultants, Ontario, saying "WC manufacturers differ from an average manufacturer in their continuous striving for improvements in quality, costs, lead-times, customer service, and general responsiveness".
- And it has been given a more thorough definition by Greene "[WCM companies are] those companies which continuously outperform the industry's global best practices and which know intimately their customers and suppliers, know their competitors' performance capabilities and know their own strengths and weaknesses. All of which form a basis of continually changing – competitive strategies and performance objectives" (Greene, 1992).
- Womack, Jones and Roos brought the idea of lean production, "uses less of everything – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires far less than half the inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products." (Womack *et al*, 1990)
- Oliver *et al* defined WC using empirical evidence, "To qualify as WC, a plant had to demonstrate outstanding performance on measures of both productivity and quality... units per labour hour=95/100, % failures at final inspection = 0.03 (1994) ...identify WC plants using a consistent set of performance measures (1996)".

A company can be WC if it achieves WC in manufacturing, marketing, supply chain management etc. However, the focus here is making a company WC through manufacturing. Manufacturing can be a competitive weapon. It can make a company WC (Hayes and Wheelwright, 1984). This is done by continually striving to outperform the best competitors internationally in all the following manufacturing related factors: quality, cost, productivity and delivery performance. Many are in agreement with WCM being a dynamic and an on-going process. As Brower (1992) said "WCM is a continuous pilgrimage toward an ideal, not a static goal. In summary: The search for perfection never ends." These will form the domain for the concept of WCM in the following sections.

Existing Model or Framework of World Class Manufacturing

WCM is not just a concept, a set of principles, a sequence of actions, nor a vision to achieve. It is rather a combination of all. Therefore, a framework or a model is normally the best way to present the whole idea of WCM. Many attempts have been made by various authors to produce a complete model / framework which is general for all manufacturing organisations.

- Thomas Gunn was one of the first who came up with a comprehensive model for WCM (Gunn, 1987). His framework clearly explains the links between WCM and other factors such as strategy, people, capability, resources and customers / suppliers.
- Davenport's framework (1993) covered 4 criteria for change process selection. It outlined the steps to change, i.e. selection of process, process modelling, model analysis, model improvement and implementations. He also pointed out that the measures of a change programme are usually timetables, milestones, preliminary goals and budgets.
- In 1998 Barry produced a model of a WC organisation which includes a global overview and 17 sub-models, e.g. measures of performance, tools and techniques, culture etc, each consisting of activities that need to be carried out in the corresponding sub-model. The model is claimed to be circular, hierarchical and dynamic. (Barry, 1998)
- A similar model (also hierarchical) called the "framework for manufacturing excellence", was created by Gilgeous (1999) from the University of Nottingham. The lowest level of the framework shows the "enablers" supporting each of the 8 initiatives that underpin the 4 manufacturing performance objectives namely quality, costs, delivery and flexibility.
- Womack *et al* (1990) believes that WCM can be achieved through lean manufacturing. Apart from his lean model, Williams (1999) proposed 4 autonomous steps towards WCM

and Oliver *et al* (1994) established the characteristics that WC plants should exhibit in comparison with non-WC plants, backing them up with empirical evidence.

These frameworks / models are excellent guidelines to WCM. They provide nearly all the principles and improvement activities that a company requires to achieve WC. However, the basic queries are "So, what do we do next?" or "Where do we start?" A vehicle is needed tell people exactly what they have to do, and it all needs to be translated into simple operational terms, which is the objective of the following section. Similar attempts were made by Harrington who suggested the 5 phases of business process improvement (Harrington, 1991) and Kotter with his 8 phases for transformation projects (Kotter, 1995).

The Model of a Change Programme

Change is something that should be unique to each organisation, and co-ordinated by a change manager and a comprehensive implementation (Barry, 1998). However, this research aimed to create a general model for companies to achieve WC (Figure. 1).

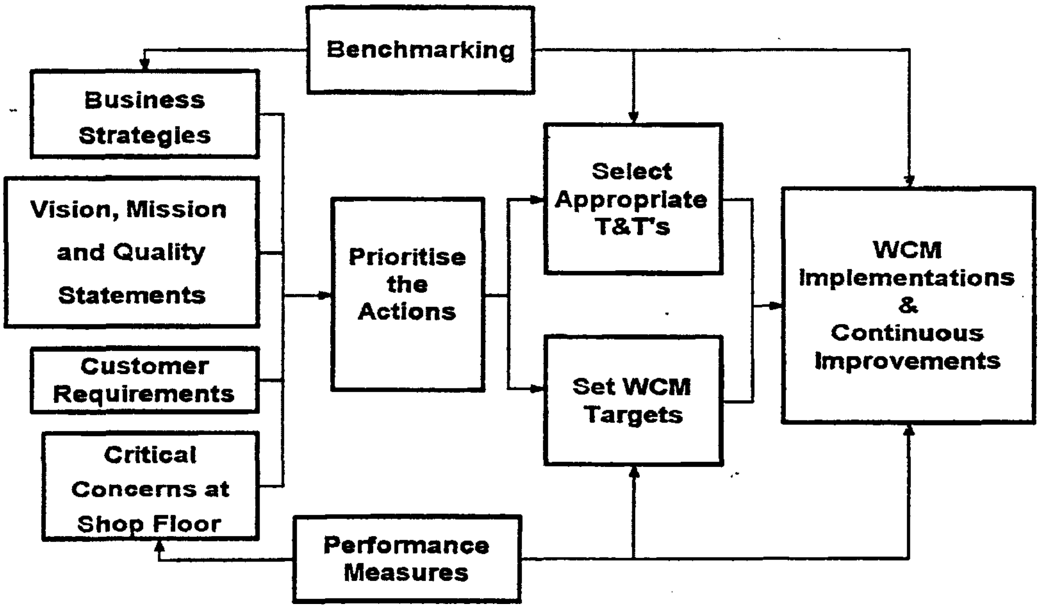

Figure 1 – Model of a General Change Programme

First of all, the change programme has to be driven by the company's mission statement and it's business strategies, accompanied by customer requirements. Organisational philosophies or a set of common values in the company tie people together, give meaning to their daily working lives and establish the context within which day-to-day operating decisions are made (Hayes and Wheelwright, 1984). However, the business and customer factors are not enough to establish effective changes. A study at Hoogovens Aluminium UK suggested that it is essential to develop critical concerns within the shop floor (Williams, 1999). The company then ought to be able to prioritise actions at different stages of the implementation (Todd, 1995). It is commonly agreed that all the development activities in a company should be prioritised and based on a carefully crafted business strategy (Kaplan and Norton, 1996). Once the company has decided which actions come up front, whether to improve delivery performance, reduce lead- time, or cut down all costs by half, it can then select the tools and techniques as the "enablers" to achieve these targets (Gilgeous, 1997). Eventually tools and techniques are what make the improvements (Tey, 1999). At this stage, realistic WCM targets should also be set within a time frame. Finally, changes are implemented. Then the whole process starts all over again, as the journey of world class never ends. With the constant change of market requirements and customer expectations, manufacturers have to continuously improve their product design, quality and delivery performance as well as to drive costs down.

Measures of performance allow the organisation to intimately know its own capabilities and through benchmarking, one can make comparisons internally between departments or externally between organisations. Both should be carried out at all stages of the change programme to maintain competitive advantage.

Rexel Case Study

Research has been carried out in Rexel Business Machines – ACCO Europe investigating a change programme aiming to achieve CI and WCM. ACCO faces international competition and it sees the need to be WC to stay at the leading edge. Twelve months ago, the Rexel plant in Droitwich started a CI plan. The plant manufactures laminating, binding and shredding machines. It has 250 employees and a turnover of £36 million.

The programme was initiated by a CI manager and carried out in the form of an employee award scheme, which comprises 3 phases of WC implementations, namely the bronze, silver and gold. The award scheme aimed to bring the company to WC status on a CI basis. All employees from all departments (although the emphasis is on the shop floor) are involved, creating a competition between departments to achieve the award. The organisation is currently striving towards bronze award, and planning to move on to silver in 6 months time.

The change programme utilises visual management rather than the conventional "post mortem" type of progress control. Visual control enables problems to be visible as they occur and makes immediate corrective actions possible. Among the many tools used are the 5Ss (the 5 Japanese terminology on housekeeping and controlled organisation, the meaning outlined as sort, segregate, shine, standardise and sustain), red-tagging, total productive maintenance, overall equipment efficiency (OEE) etc.

A standard audit is run by a facilitator each week to assess the departments for the bronze award. The audit assesses on the achievement of the first two components of the 5Ss:

- Sort: Identify necessary items, parts, equipment and documents. Only the required amount of parts to meet the daily production schedule should be in the manufacturing area.
- Segregate: Arrange items close to where they are needed, identify what goes where and improve asset management (red tag and remove).

Rexel Case Study vs. Change Programme Model

The CI programme was tested against the change programme model (Figure.2). Objectives, tools, targets and measurements of the programme fit accurately in the model. An overview of the CI programme at present stage is simply presented in the model shown.

Conclusions

The model was created on the hypothesis of theories and existing frameworks, and within the domain of the designated definition. The case study then fits in properly, which indicates that the objective has been reached. The model can be used as a guideline to change programmes. It provides a simple step approach to translate WCM goals into comprehensive operational terms. The model should be used as a never-ending loop, like the essence of kaizen (CI). It should be reviewed on a regular basis, not only by management, but team leaders and workers. Data and information should be updated at all times. Future work includes modification of the model, as it is believed that there are inter-relations between the elements. More empirical research is needed to further test and develop a more generic model.

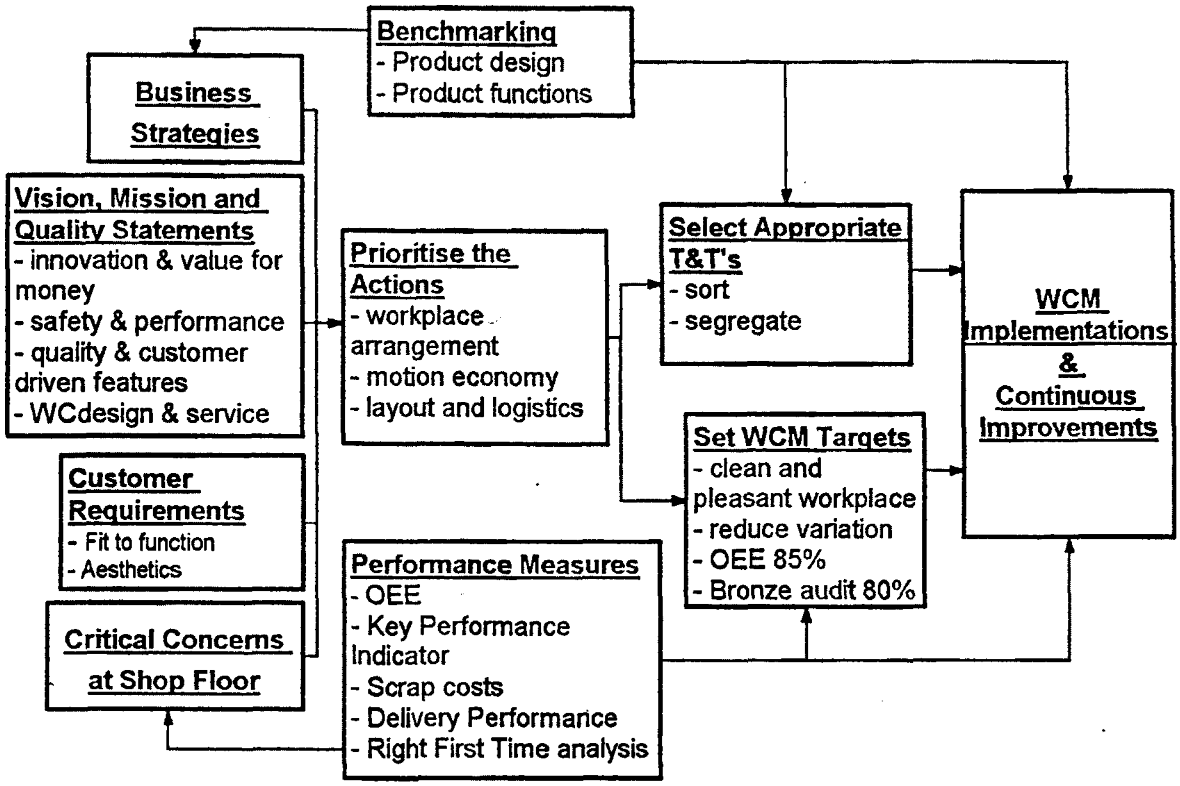

Figure 2: Change Programme in Rexel at present stage

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Model of a change programme – the first step towards world class manufacturing

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Summary

This paper sets out by investigating the various definitions of world class manufacturing (WCM) in literature, and narrowing it down to fit the context. It then examines a few existing WCM models/frameworks and presents a model of a general change programme. These are followed by a case study looking at the on-going change programme in Rexel Business Machines –ACCO Europe. It is a 3-stage continuous improvement (CI) programme namely bronze, silver and gold. The principal tools and techniques used are mentioned. This change programme is then tested against the model. It is believed that this change programme model will lead to the development of a complete generic model of WCM based on empirical evidence. Companies are recommended to use the model as a starting point in their world class (WC) journey.

1. Introduction

An organisation needs to undergo changes to attain WC status. Even a leading WC company must ensure CI to stay ahead of the competitors. People have a general reluctance to change. Often the biggest problems of WCM implementation are to get the executive to buy in, to create a total culture change, and to find the resources to make improvements in the middle of the busy daily routines.

Many manufacturers start off with an enthusiastic target of WC. However sometime into it, the progress becomes stationary. Then it is often wondered if WC is just an unrealistic concept. Others introduce many new techniques but have made little impact in productivity, cost, quality and delivery performance. Or the employees simply regard the changes as "a waste of time" or "just some charts on the wall to impress visitors". There are plenty of techniques such as JIT, TPM, TQC etc. that have led to manufacturing excellence. When seeking best practice, one should ask, "Is this appropriate for us?" or "Would it support our needs?" Blindly adopt what the competitors do will only result in lagging behind them [1]. These are due to poor management of change. Thus, WC implementations need to be built on a well-constructed, systematic change programme that involves total workforce commitment. This research aims to tackle the above problems by developing a generic model for a change programme towards WCM.

2. Defining World Class Manufacturing

WCM is a broad topic. Managers, academics, practitioners and writers have come up with various definitions for WCM.

- In his profound book "World Class Manufacturing", Schonberger defined world class as "One that fulfils the customer's demands for high quality, low costs, short lead times and flexibility". He also brought up the idea of rapid and CI [2].
- Another significant writer, Jim Todd supported this but added "being the best in the world" [3] which has been challenged that no one can be best in the world in all aspects, and no one can be constantly the best in any of these aspects.
- The above arguments was rounded up by Peter Urban, President of Camex Corporate Consultants, Ontario, saying "WC manufacturers differ from an average manufacturer in their continuous striving for improvements in quality, costs, lead-times, customer service, and general responsiveness".
- And it has been given a more thorough definition by Greene "[WCM companies are] those companies which continuously outperform the industry's global best practices and which know intimately their customers and suppliers, know their competitors' performance capabilities and know their own strengths and weaknesses. All of which form a basis of continually changing – competitive strategies and performance objectives" [4].
- Womack et al [5] brought the idea of lean production "uses less of everything – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires far less than half the inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products."
- Oliver et al [6][7] believed in using empirical evidence to define world class "To qualify as world class, a plant had to demonstrate outstanding performance on measures of both productivity and quality... units per labour hour=95/100, % failures at final inspection and test=0.03... identify world class plants using a consistent set of performance measures"
- Hanson and Voss [8][9] tried to categorise world class companies based on survey data where firms are asked to rate their manufacturing practice and performance against a range of fronts... quality, lean production, logistics, organisation and culture, manufacturing systems and concurrent engineering. However the results were claimed to be biased towards certain industries [10].

A company can be WC if it achieves WC in manufacturing, marketing, supply chain management etc. However, the focus here is making a company WC through manufacturing. Manufacturing can be a competitive weapon. It can make a company WC [11]. This is done by continually striving to outperform the best competitors internationally in all the following manufacturing related factors: quality, cost, productivity and delivery performance. Many are in agreement with WCM being a dynamic and an on-going process. As Brower said "WCM is a continuous pilgrimage toward an ideal, not a static goal. In summary: The search for perfection never ends." [12]. These will form the domain for the concept of WCM in the following sections.

3. The Model of a Change Programme

Change is something that should be unique to each organisation, and co-ordinated by a change manager and a comprehensive implementation [13]. However, this research aimed to create a general model for companies to achieve WC (Fig. 1).

First of all, the change programme has to be driven by the company's mission statement and it's business strategies, accompanied by customer requirements. Organisational philosophies or a set of common values in the company tie people together, give meaning to their daily working lives and establish the context within which day-to-day operating decisions are made [11]. However, the business and customer factors are not enough to establish effective changes. A study at Hoogovens Aluminium UK suggested that it is essential to develop critical concerns within the shop floor [14]. The company then ought to be able to prioritise actions at different stages of the implementation [3]. It is commonly agreed that all the development activities in a company should be prioritised and based on a carefully crafted business strategy [15]. Once the company has decided which actions come up front, whether to improve delivery performance, reduce lead- time, or cut down all costs by half, it can then select the tools and techniques as the "enablers" to achieve these targets [16]. Eventually tools and techniques are what make the improvements [17]. At this stage, realistic WCM targets should also be set within a time frame. Finally, changes are implemented. The whole process starts all over again, as the journey of world class never ends. With the constant change of market requirements and customer expectations, manufacturers have to continuously improve their product design, quality and delivery performance as well as to keep costs low.

Measures of performance allow the organisation to intimately know its own capabilities and through benchmarking, one can make comparisons internally between departments or externally between organisations. Both should be carried out at all stages of the change programme to maintain competitive advantage.

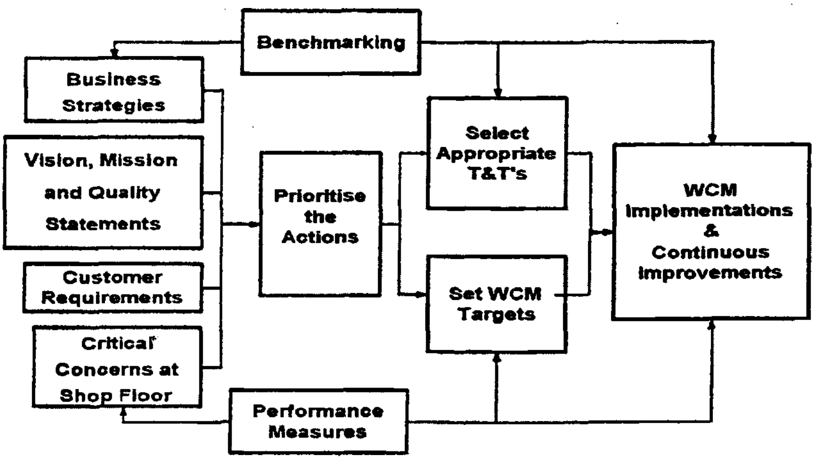

Figure 1 – Model of a General Change Programme

4. Rexel Case Study

Research has been carried out in Rexel Business Machines –ACCO Europe investigating a change programme aiming to achieve continuous improvement and WCM. ACCO faces international competition and it sees the need to be world class to stay at the leading edge. Twelve months ago, the Rexel plant in Droitwich started a continuous improvement plan. The company manufactures laminating, binding and shredding machines. It has 250 employees and a turnover of £36 million.

The award scheme aimed to bring the company to world class status on a continuous improvement basis. The programme was initiated by a continuous improvement manager and carried out in the form of an employee award scheme, which comprises 3 phases of world class implementations, namely the bronze, silver and gold. All employees from all departments (although the emphasis is on the shop floor) are involved, creating a competition between departments to achieve the award. The organisation is currently striving to achieve bronze award, and planning to move on to silver in 6 months time.

The change programme utilises visual management rather than the conventional "post mortem" type of progress control. Visual control enables problems to be visible as they occur and makes immediate corrective actions possible. Among the many tools used are the 5Ss (the 5 Japanese terminology on housekeeping and controlled organisation, the meaning outlined as sort, segregate, shine, standardise and sustain), red-tagging, total productive maintenance, overall equipment efficiency etc.

4.1 The Standard Bronze Audit

A standard audit is run by a facilitator each week to assess the departments for the bronze award. The following shows the guidelines for the audit:

1. Achieve the first two components of the 5Ss technique:
   a. Sort: Identify necessary items, parts, equipment and documents. Only the required amount of parts to meet the daily production schedule should be in the manufacturing area.
   b. Segregate: Arrange items close to where they are needed, identify what goes where and improve asset management (red tag and remove)
2. Introduce an agreed number of standard operating procedures (SOP):
   These SOPs shall be completed by the team members taking into account:
   - The design of tools and equipment
   - Arrangement of workplace and assembly lines
   - Use of human body
3. Layout and logistics examined for the most efficient and effective product manufacture. This shall allow for:
   - Increase in available floor capacity
   - Reduction in material flow – number of touches
   - Elimination of unofficial storage areas/work-in-progress areas

- Reduction in material movement -distance travelled from raw material to finished product
- A decrease in non-value adding activities

During the routine audit process the team will have to demonstrate what they have achieved in all of the above topics.

4. Implementation of ILU boards (charts showing the progress of training programme) in the cell. This shall include the development of skills assessment forms and a training plan for all cell team members including photographs of each team member
5. Business related team boards.
This shall design and display all relevant business performance documentation and each team needs to be able to understand and explain the content

4.2 Rexel Case Study vs Change Programme Model

The C.I. programme was tested against the change programme model (Figure.2). Objectives, tools, targets and measurements of the programme fit accurately in the model. An overview of the C.I. programme at present stage is simply presented in the model shown.

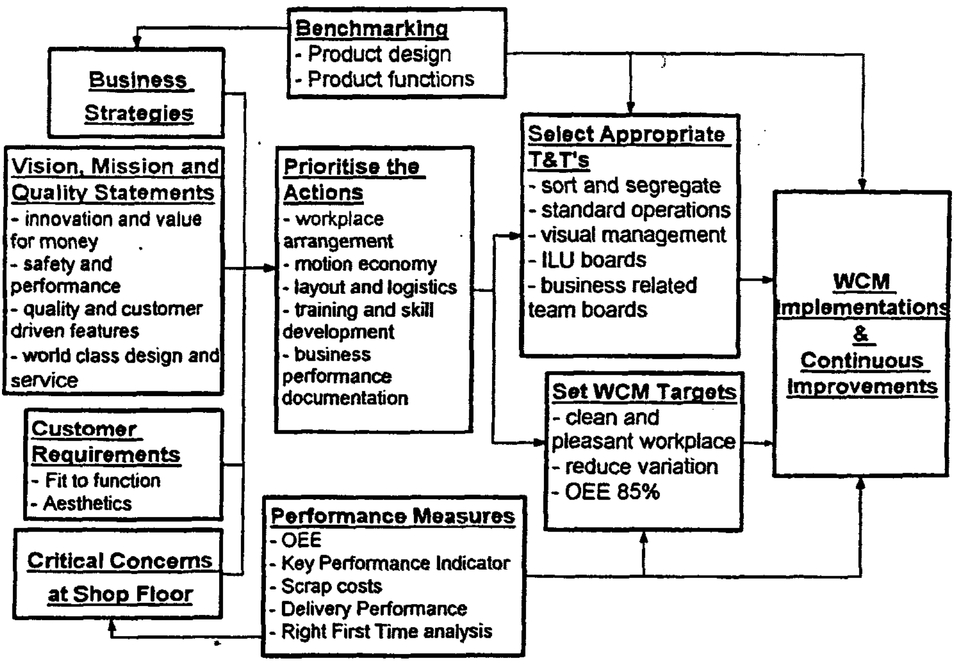

Figure 2: Change Programme in Rexel at present stage

5. Conclusions

The model was created on the hypothesis of theories and existing frameworks .The case study then fits in properly, which indicates that the objective has been reached. The model can be used as a guideline to change programmes. The model should be used as a never-ending loop, like the essence of kaizen (CI). Data and information should be updated at all times. The model should be reviewed on a regular basis, not only by management, but team leaders and workers. More empirical research is needed to further test and develop a more generic model.

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A WORLD CLASS MANUFACTURING CHANGE INDICATOR

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World class manufacturing (WCM) studies have been carried out on the trend of operations strategy over the years, investigating how conventional manufacturing management have been diversified to become principle-based, lean thinking, customer-focused, and total quality oriented. Manufacturers who are not aware of this trend or are not adapting quickly enough to this change find themselves losing competitive edge in no time. This paper outlines a generic model of change towards WCM, developed with the case studies of five manufacturing companies based in the United Kingdom. Then built on the model, a scoring system is developed to evaluate a company's change. The scoring matrix system, named a "change indicator", also serves as a guideline to industry's best practise in a WCM change journey.

Introduction

The past two decades have witnessed the world market competition stretching from domestic to global. Product life cycles have become much shorter and yet shrinking (Kaplan and Norton, 1996). Competitive philosophy has evolved from superior product design, financial and marketing ingenuity to pure manufacturing strength – "the ability to make it better" (Hayes and Wheelwright, 1984).

This has aroused the concept of world class manufacturing (WCM). Having existed in the world of literature for nearly two decades, the term WCM is still very much ill defined. (Tey and Duffill, 2000). Throughout this research, WCM has been defined as gaining competitive advantage through manufacturing strength, which refers to the following areas: cost, quality, productivity, customer satisfaction and health & safety. This is done by continuously making small and rapid improvements. Pilkington Automotive pretty much said it all by naming it "manufacturing to win". WCM is not about being the best, but continuously improving shop floor process to make operations safer, cheaper, easier and faster (SCEF).

Knowing that not changing fast enough will not only end up losing competitive advantage but will threaten survival, companies take on board various change programmes to adapt to WCM. There is no specific set of tools and techniques to achieve WCM. Some manufacturers tend to follow the successful examples in industry but find it makes no impacts on their own organisations. Many change programmes start off making dramatic improvements but do not last. These failed attempts have led to doubting the worthiness of WCM.

A two-years research has been carried out looking at the organizational change towards WCM, involving four UK manufacturing companies of different sizes (ranges from 20 to 500 employees) and products. They are Pilkington Automotive, Rexel Business Machines, Heritage Silverware and Corus. The objective of this research is to construct a generic model of change towards WCM (Tey and Duffill, 2000) and establish a supplement document capable of evaluating a company's change, named the "change indicator".

Model of Change towards WCM

The model is presented in figures 1&2, both in the visual illustration of a bird, representing the sequential nature of the model (forward direction from tail to head). Figure 1 represents the global view of change, with the company at present as the input and an ideal world class company as the output. As WCM is a never-ending journey, the output can be seen as a forever-moving target. This global view of change functions as an IDEFO model (Mayer et al., 1994), where the core activity lies in the centre. The "control" elements are

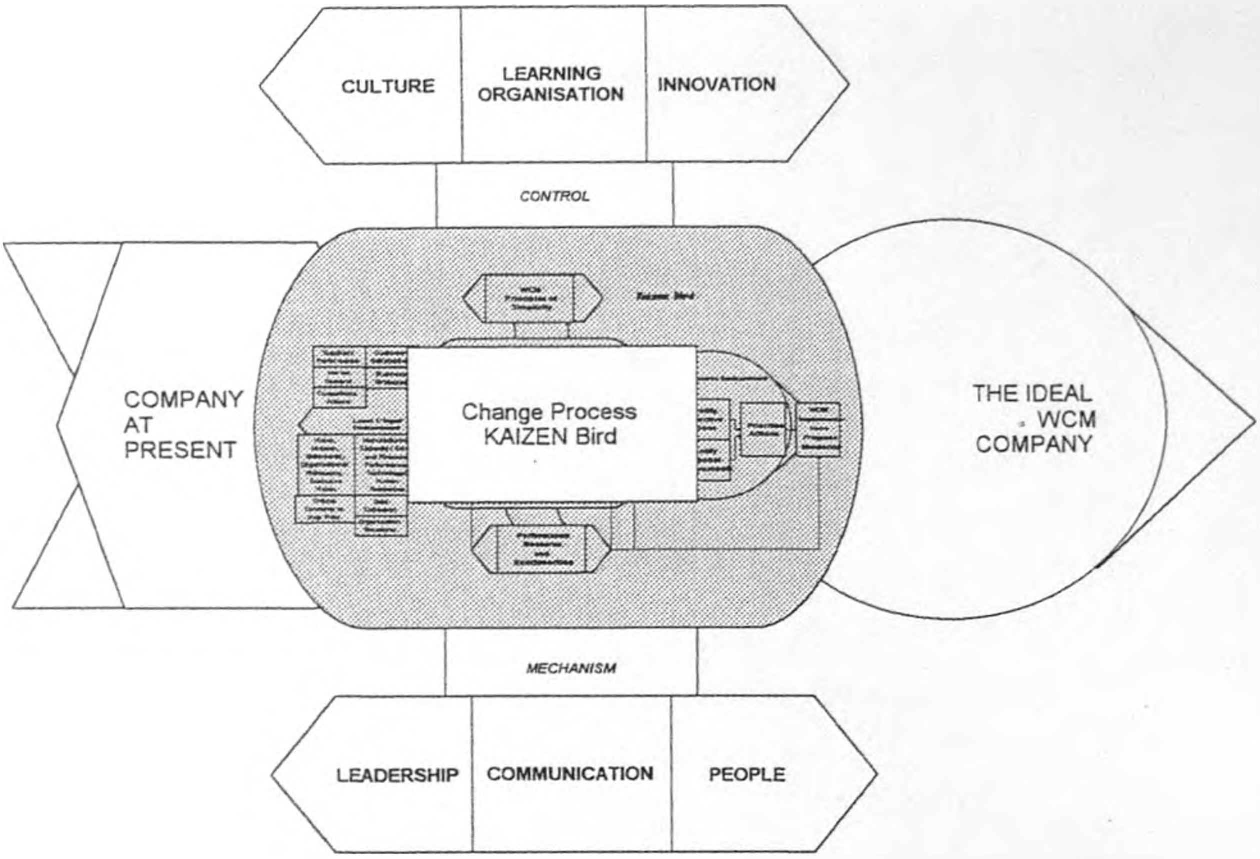

Figure 1: Big Bird of Change – An Overview of An Organisational Change towards WCM

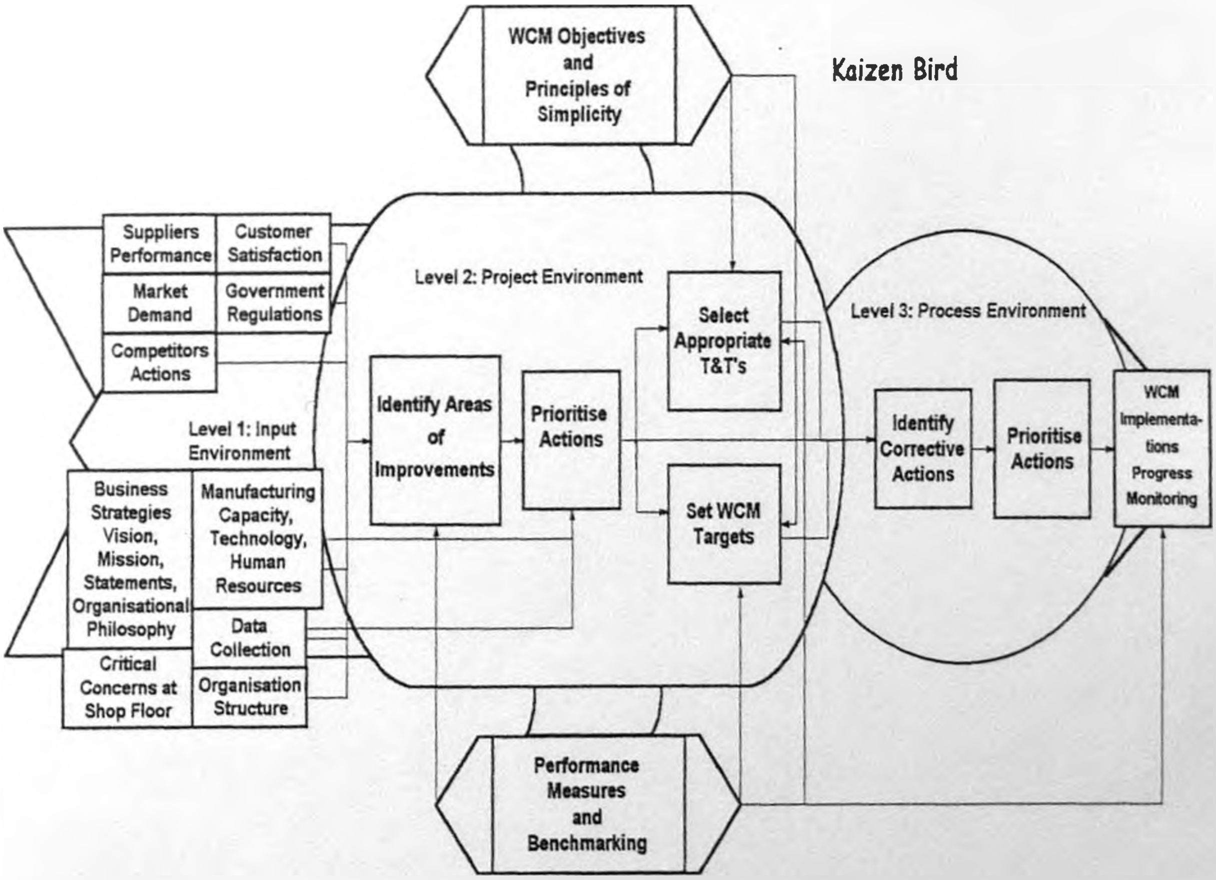

Figure 2: KAIZEN Bird – Actual Change Process towards WCM

culture, innovation, and learning organization (Peters, 1983; Kanter, 1984) whereas the "mechanisms" are people, leadership and communication. (Peters, 1983). These are the essential elements of any change programme, without which change will not happen at all.

The core activity is the actual change process, also known as 'KAIZEN Bird'. A blown up model is shown in fig. 2. The change follows from 'tail' to 'head' through 3 levels: level 1 -- 'input environment', level 2 -- 'project environment', and level 3 -- 'process environment'. Level 1 is where strategies are formed and combined with internal and external factors to generate critical areas of improvements in Level 2. Strategies are developed both inside-out, ie. considering operation capabilities, shop floor concerns; and outside-in, ie. considering customers, market demands and competitors (Brown, 2000). In level 2, management teams carry out action planning, selection of tools and techniques and target setting. Level 3 is where the actual actions take place and the progresses monitored.

'KAIZEN wings' carry the components of invaluable importance. They play the role of supporting and guiding elements throughout the change programme. One side of the wing denotes primary WCM principles and manufacturing objectives ie. quality, cost, productivity and customer satisfaction (Schonberger, 1986; Gilgeous, 1997). The other wing represents performance measures and benchmarking, which not only show the effectiveness of change and the performance gap, but also provide feedback to review areas of improvements and set more appropriate targets. The model embodies four fundamental objectives:

- To translate business strategies into operations (Todd, 1995; Kaplan and Norton, 1996)
- To set up performance measures and benchmarking as feedback of change success
- To facilitate modern WCM principles, philosophies, tools and techniques
- To highlight soft structure of change: leadership, people, culture and innovation

The model has been tested on 4 manufacturing plants. The plants range from one that has been through successful business re-engineering, whose employees continuously challenge the quality of their jobs in a dynamic and exciting environment; to one that finds itself struggling between making changes and meeting production schedules, whose management is constantly under pressure. The author studied the different characteristics of those companies and established a scoring system capable of evaluating a company's change towards WCM. This system is known as the "change indicator".

The Change Indicator

The change indicator is a tool built on the generic model of change. The entire change indicator is made up of 5 scoring matrices, each like the one illustrated in figure 3. The scoring matrices are constructed for the five areas followed (refer to figures 1 and 2):

- The big bird's wings – the soft issues of change
- KAIZEN bird level 1 – input environment
- KAIZEN bird level 2 – project environment
- KAIZEN bird level 3 – process environment
- KAIZEN bird's wings – guiding elements across actual change process

In a scoring matrix, scorings are carried out for each activity (a box represents an activity) in the specified area. For example, the area specified in fig. 3 is KAIZEN bird level 2 (project environment), therefore the activities being audited are: (i) identifying areas of improvements, (ii) prioritizing actions, (iii) selecting tools and techniques and (iv) setting WCM targets. Each activity is scored between zero and 10, ranked in 4 stages. The 4 stages are perceived as 4A's, namely "avoid", "aware", "adapt" and "achieve" which is a blend of the 4A's autonomous steps to WCM by Williams (1999) and the 4A's learning process introduced by Joynson (2000). Table 1 shows the general criteria of the 4A's stages.

The change indicator outlines the change characteristics of different companies, from where nothing literally exists ("avoid") to the stage of industry's best practice ("achieved"). Therefore, despite its raison-d'etre of evaluating a company's change towards WCM, the change indicator provides a guideline for the company to benchmark themselves against best practices and make progress. The indicator is also able to highlight the problem areas and activities that hinder change, allowing the companies to know its strengths and weaknesses.

What stage?	Score	Description
Avoid	0	Nothing currently exists
Aware	3	Aware of the technique and implementing part(s) of it
Adapt	6	Actively involved in the implementations but problems are encountered and improvements are required
Achieved	10	Understanding and implementing best practices and good principles

Table 1: General criteria of the 4A's stages in the Change Indicator

Score	Identify Areas of Improvements/ Company Success Factors	Prioritise Actions	Select Appropriate Tools & Techniques (T&Ts)	Set WCM Targets
0	No specific improvement areas identified. Only the matter of running production and making money	Nothing done to prioritise any actions	Do not recognize any T&Ts in the document, operate in traditional way	No targets are set. No performance measures are generated. Only financial targets (sales, profit)
3	Areas of improvements identified after assessing the external and internal inputs from Level 1. Less than half of all the input factors are being considered	Actions are prioritized only due to constraints (eg. time, capital, available resources) or the executive's knowledge and preference	Utilising some T&Ts but without specific reasons. "Do it because everyone else does!" or "seems necessary to keep up with the modern techniques"	Few operational targets (quality, cost, time, health and safety, personnel) are set, but not persistent with performance measures
6	Areas of improvements are identified after assessing the external and internal inputs from Level 1. More than half of the input factors are being considered An improvement area should always be becoming a SCEF operational environment	Decisions on prioritising actions are made in a WCM project team meeting, taking into considerations not only financial, technological and human resources, but also the inputs from Level 1	T&Ts are chosen to support specific areas of improvements and to achieve specific manufacturing objectives	Realistic operational targets are set persistent with the performance measures, efforts are made to assure target achievements Targets are set to achieve international standards (ISO, Baldridge, Deming etc.) New targets are continually set for a SCEF operational environment
10	Areas of improvements are identified after assessing the external and internal inputs from Level 1. All of the input factors are being considered in detail An improvement area should always be becoming a SCEF operational environment	Prioritisation of actions carried out by WCM project team as mentioned above, plus using one or more analytic methodologies to decide, eg. pareto analysis, Analytical Hierarchical Process, Priority Map or other OR approaches	T&Ts are chosen and modified to support specific areas of improvements and to achieve specific manufacturing objectives, esp. towards SCEF operational environment	Targets are reassessed during WCM project team meetings, to ensure they are achieved, maintained, and regularly re-established. Targets are set to achieve international standards (ISO, Baldridge, Deming etc.) New targets are continually set for a SCEF operational environment

Figure 3: Change Indicator – Scoring Matrix for KAIZEN Bird Level 2 'Project Environment'

The scoring system is designed for each area but it is not aimed at a certain group of personnel. The ultimate structure of work is flat, team-based and cross-functional. Therefore each area of change should involve members from different departments. The scoring is thus effective in the way that it targets an activity of the change and not the people involved.

Figure 4 presents an example of using the change indicator. All companies in participation are assessed in their project environment using the scoring matrix in fig. 3. All activities in the area are scored and averaged. The averaged score is then compared from the start of the project to present time. The arrow-head score shows how well a company is changing, whereas the length of the span indicates how much the company has improved.

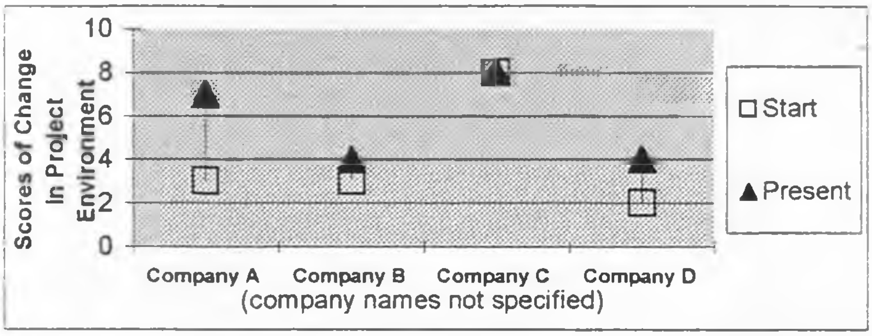

Figure 4: Comparison of companies' scores of change in project environment

Conclusions

The change indicator was established with the sound basis of the generic model of change developed earlier and several good industrial case studies. It has practical implications for companies implementing changes. It needs to be used alongside the change model. While organizational change is usually the crux of the pilgrimage towards WCM, and its complications so often lead to the lack of understanding and therefore the failure of change programmes, the change indicator proves to be a precious tool in analyzing and tackling this problem. Like the essence of KAIZEN, the goal is not only to achieve the optimum score but also to sustain excellence and to continuously create innovation. More in-depth research needs to be conducted to complete all the five scoring matrices of the change indicator. Ideally, more case studies are required to contribute to a more universal change indicator.

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Birds of Change --
A Process of Building a WCM Organisation

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Introduction

Advanced technology and communication have brought the world close together, making global competition fiercer than ever. To stay in the league of top class manufacturers, innovative product design, high speed and low cost operations, excellent quality and customer satisfaction are, to name a few, the basic survival elements. The past two and half decades witnessed a massive transformation of manufacturing industry. Market competitiveness, customer expectations, management philosophies and organizational structure had gone through an evolution. This evolutionary era marked the end of what is called the "industrial age" and continues today as the "information age". To excel, one needs to analyse the characteristics of the industrial and information ages. Those who cannot keep up with the pace of change will quickly lose their competitive edge. More importantly, companies must evolve a culture of continuous improvements (CI), innovation and growth (Joynson, 2000; James, 1997). Achieving excellence is not enough. One must be equipped with the ability to continuously challenge the position of excellence in order to outperform global competitors.

World class manufacturing (WCM) was introduced with the intention of providing this survival kit. Coincidently, this happened during a period when the world was busy adapting the Japanese just in time (JIT) manufacturing techniques and total quality management (TQM). WCM was naturally seen as "just another 3-letter acronym". However, WCM is different in a way that it doesn't comprise a certain set of tools and techniques (T&Ts); neither does it embrace a widely recognized set of principles. Is WCM just a jargon to impress customers? Are JIT and TQM subsets of the whole WCM concept? Definitions of WCM need to be reviewed to provide answers to these questions.

Research has been carried out investigating organizational change programmes towards WCM, involving companies of different sizes, product ranges and change magnitudes. Studies of common practices and activities of these companies' change programmes led to the development of a generic model of change in various WCM undertakings. The objective of the paper is to present the change model, which aims to produce a generic approach to take the organizations through an effective transformation process, with accompanying WCM principles, tools and techniques to achieve a culture of CI and excellent performances in all manufacturing objectives.

Industrial Age vs. Information Age

Over the years the accent in manufacturing organizations has changed. Table.1 illustrates the effects of this change from the industrial age to the information age.

	Industrial Age	Information Age
Business	Battlefield	Ecosystem
Corporation	Machine	Community
Management Philosophy	Planning & control (edicts, procedures, policies)	Principle-based
	Control	Service
Competitiveness	Domestic	Global
Product Life Cycles	Long	Short and shrinking
Change	Pain	Growth
Motivation	Fear	Vision
Organisation Structure	Top down	Flat organization
	Functional specialisation	Cross-functional teams
	Segmentalist	Integrative
Information Flow	Constricted	Free
Communication	Vertical	Horizontal
Product Design	R&D	Product champions
Production	Low cost, standardized products	Highly customized products
Manufacturing Flow	"Push" from production	"Pull" from customer orders
Manufacturing Objective	Cost	Quality
Workforce, People	Direct Labour	Knowledge workers
	Hierarchy	First name basis
	Employee, Worker	People, crew members, hosts, associates
Employee	Children	Peers, Adults
Learning Organization	Text books	People contribution
Performance Measures	Financial (sales, profit)	Non-financial (Inventory turnover, customer satisfaction)
Competitive Philosophy	Superior product design, financial strength, marketing ingenuity	Manufacturing strength (the "ability to make it better")

* Sources taken from Schonberger (1986), Womack et. al. (1990), Kaplan and Norton (1996), James (1997), Kanter (1983), Peters (1982), Hayes and Wheelwright (1984)

Table 1: Comparing characteristics of the industrial age and the information age

The industrial age traced back roughly from 1850 to 1975. Then a new era of industrial revolution started, which is named the information age. One of the earliest literatures during this transformation era was that of Townsend (1970). "If you are not in business for fun or profit what the hell are you doing here?" is one of the thousands of humorous and philosophical statements made in his profound and sagacious book. One can also relate this change to the good example of Fordism and post-Fordism.

Henry Ford pioneered mass production in the early 20th century with the inherent concept of cost reduction and increase in product quality. This mass production system dominated global industry for more than 50 years with huge success (Womack et. al., 1990). Emerging into the information age, manufacturers now need to tailor their production system to one that is agile, flexible and able to customize products to individual requirements. In other words, whether global, regional or local, manufacturers have to be world class.

WCM Definition

Hayes and Wheelwright (1984) initiated the concept of building manufacturing strength -- "the ability to make it better", as a competitive weapon; but it was Schonberger (1986) who formalized the term WCM in his profound book. Since then, academics and practitioners have come up with various definitions. World class manufacturing literally carries the implication of global competition. Manufacturers now face vicious threats to survival from competitors all around the globe. Based on this argument, a world class manufacturer has been regarded as "being the best in the world" (Todd, 1995), having "the ability to compete anywhere in the world" (Wireman, 1990), "possessing best practices, equaling or surpassing best international companies" (Voss, 1995) or surviving the "enhanced capabilities of existing firms, as well as the emergence of new entrants from all over the globe" (Brown, 2000).

Some emphasize the essence of CI in WCM (Schonberger, 1986; Urban, 1989) by describing it "a continuous pilgrimage towards an ideal, not a static goal" (Brower, 1991) and a "never ending journey" (Barry, 1998).

The most mentioned element in defining WCM is the set of WCM objectives to be achieved (Schonberger, 1986; Urban, 1989; Wireman, 1990; Brower, 1991; Harmon and Peterson, 1992; Todd, 1995). They can be categorized into:

- Quality
- Costs
- Productivity (includes flexibility, agility and lead times)
- Customer satisfaction (includes delivery performance, service and responsiveness)

"Ostensibly in every value-creating activity at every step in the value chain that a firm engages in" (Harrigan, 1993).

It is important to state that WCM status is pursued without neglecting the infrastructure of organizations: culture, innovation, management and employee involvements, resources and environment (Feigenbaum, 1991; Kinni, 1996) and combining them with corporate strategies, vision statements and competitive factors (Greene, 1992; Chan, 1992).

WCM has also been related to several state-of-the-art philosophies, T&Ts such as TQM, concurrent engineering and lean manufacturing (Voss, 1995; Womack et. al., 1990; Hanson and Voss, 1993, 1995). Oliver et al (1994, 1996) argued that there should be a standard set of performance criteria in industry to identify world class plants.

The author would like to quote two particular definitions that seem to capture the more complete picture of WCM:

> "The continuous improvement of manufacturing performance to a position of excellence, which satisfies customers, shareholders and employees. Achieved by means of innovative measures and the use of integrated

proven tools and techniques by trained and capable employees, within a strategically planned and visionary framework" (Williams, 2000).

A "manufacturing management philosophy, which focuses on: (1) Continuous improvement in manufacturing processes from the employee and the management's perspective, (2) Clearly defined manufacturing goals and objectives, (3) The satisfaction of customer requirements, (4) Developing better ways to do the job right the first time, (5) Educating and training for new challenges, (6) Simplifying work processes, and (7) Eliminating bottlenecks which hinder productivity" (Edosomwan, 1996).

In the quest of a genuine definition used throughout this research, the author has adapted the core concepts from the various literatures and focused on what are seen in the industry as the important factors.

WCM is defined as gaining competitive advantage through manufacturing strength. This is done by establishing strategic vision, creating an innovative environment and an effective organizational structure, integrating employees and management, utilizing appropriate tools and techniques, and sustaining a culture of continuous improvement in the following areas: cost, quality, productivity, customer satisfaction and health and safety.

Pilkington Automotive pretty much said it all by naming it "manufacturing to win" (MTW). WCM is not about being the best. It is evaluating the company's strength at present, and constantly seeking the best way to change towards being better. The key is to continuously improve shop floor process methodologies to enable things to be done easier, faster, cheaper and safer (SCEF). Details of the definition will mostly be elaborated and modeled in the following section.

Model of Change towards WCM

This conceptual model is developed on the basis of several practical case studies, using Professional Diagrams Quickly (PDQ) modeling software (Barry, 1998) designed by Patton & Patton Software Corporation. It demonstrates a generic change programme of a company wishing to attain WCM status. The model embodies 4 fundamental objectives (Tey et. al., 2001):

- To translate business strategies into operations (Todd, 1994)
- To produce a soft structure of organizational change
- To set up performance measures and benchmarking as feedback of change success
- To facilitate modern WCM principles, philosophies, tools and techniques

Bird of change: Overview of an organizational change

The overview model of change is laid on a visual illustration of a bird in its forward flying mode (fig.1). This carries a metaphorical purpose to represent the main principles of WCM -- continuous improvements and moving forward. This model functions like an IDEF0 model (Mayer et. al., 1994). Table.2 shows the matching elements of an IDEF0 model and the bird of change model. A note here is that since WCM is defined as a never-ending journey, the output of the change programme as the ideal WCM company has to be seen as a forever moving target.

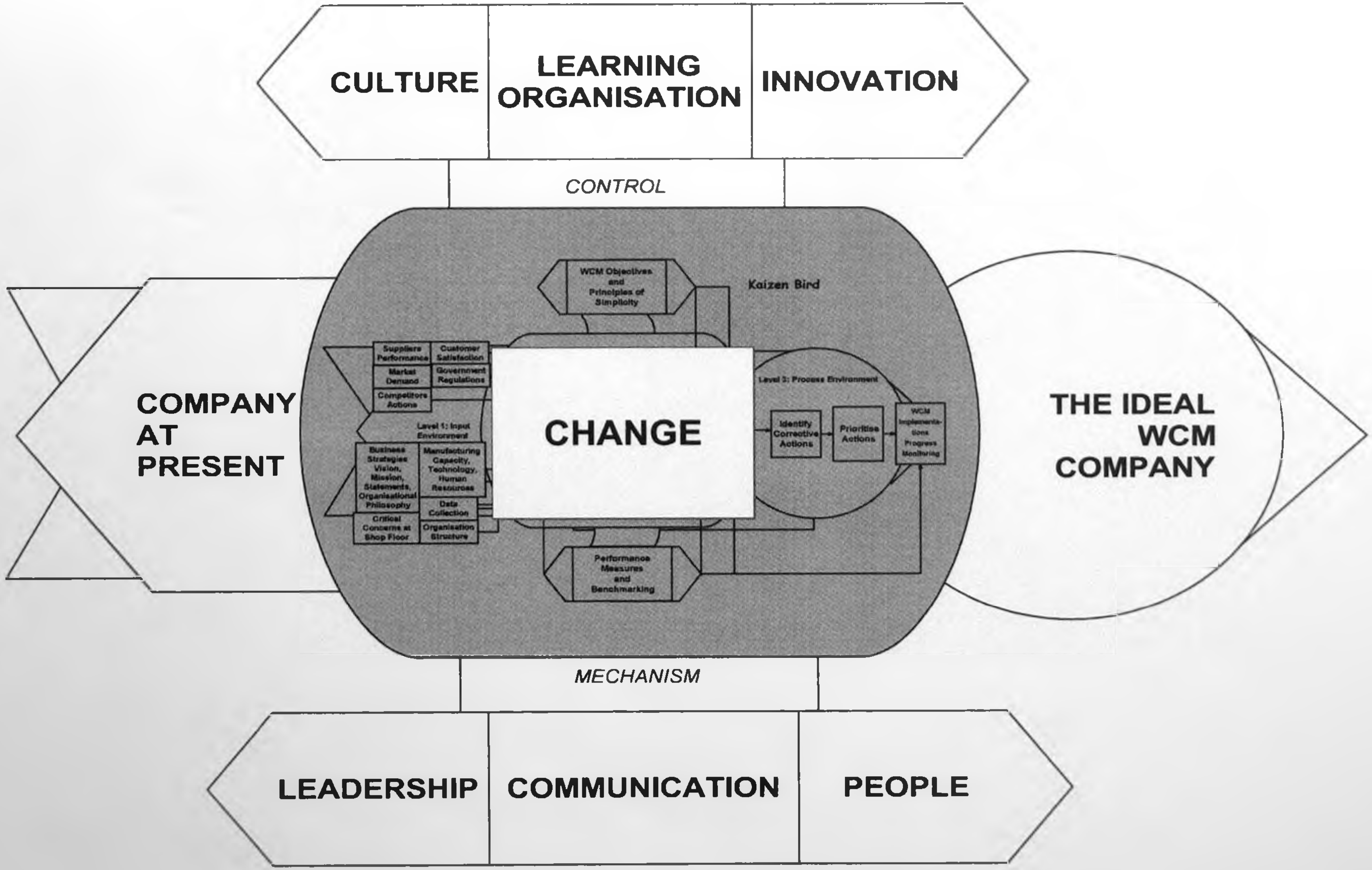

Figure 1: Bird of Change -- Overview of Organisational Change Towards WCM

IDEF0 Model	Bird of Change
Input	Company at present
Output	Ideal WCM company
Core Activity	Change process
Controls	Culture ←→ Learning Organization ←→ Innovation
Mechanisms	Leadership ←→ Communication ←→ People
Purpose	To produce a generic model of an organizational change towards WCM
Viewpoint	WCM change initiator

Table 2: Matching elements of the overview model "bird of change" to an IDEF0 model

Culture ←→ Learning Organisation ←→ Innovation

Dealing with soft issues is never easy. Transforming attitudes, practices and policies (infra-structure) is never as straight forward as making structural changes such as facilities, locations and technologies. "Our fascination with the tools of management obscures our apparent ignorance of the art" (Peters, 1982). Tools and techniques do not always solve all the problems. There is no formula to create a workplace with the right culture, ideal workforce attitude and a constant flow of innovative ideas.

A comprehensive review of organizational culture can be traced back to Handy (1976), who set the concept of culture in such detail that most preceding literatures can relate to it. Corporate culture was generally defined as 'a strong system of informal rules that spells out how people are to behave most of the time' (Deal and Kennedy, 1982). It predetermines its employees' behaviours, but over time these behaviours reinforce the culture so that it continues to reproduce the behaviour that led to success in the past (James, 1997). Simply, most would describe culture as "the way we do things around here" or "the way we think about things around here" (Williams et al, 1994). Maull et. al. (2001) presented an agreeable statement to the author's point of view of treating culture as a distinguishable element in organizational change due to its "soft" nature:

> Organisational culture provides a people-centred, theoretical perspective on the management of change that is seen to offer some insight into the "intangible" nature of organizations and their behaviours: a contrasting approach to the traditional management view of organization (formal structures, rules and procedures and rational arguments)

Culture has significant impact on organizational change. It affects the day-to-day operations of the workforce as individuals and as a whole. It is the basis of how an organization organizes itself, treats its staff and handles its relationship with customers and suppliers. As it is also believed to have worked well enough to be considered valid, culture is taught to new members as the way to behave, thus perpetuating organizational survival and growth (Schein, 1984).

Corresponding to the context of organizational change towards WCM, innovation refers to new ideas or methodologies generated in the following areas (referred to as the 4Ps):

- Product
- Policies
- People
- Process improvements (technological or engineering) and work practices

A "learning organization" is one in which people at all levels, individually and collectively, are continually increasing their capacity to produce results they really care about (Karash, 1994-98). Together with culture and innovation, these form the 3 control elements of a change programme.

Leadership ←→ Communication ←→ People (i.e. employees)

Similar to culture, the people problem is hard to tackle but can never be ignored. Modern companies are aware of that, and most companies implement some kind of people programmes. Mainly in the UK, and now expanded internationally, "Investors In People" is the standard achieved by organisations of all sizes and sectors who are committed to improving business performance through the development of their staff (Investors in People UK website, 2000). It is no longer sufficient to have only a training officer to provide necessary skills to the workforce. It is time to master the art of communication between leadership and people.

History has seen that many successful change programmes resulted from gaining extraordinary outcomes through ordinary people (Peters, 1982). People have the hidden spirit of "champion" in them. If anything can stir up that evolutionary change in culture and innovation, it is the ability of leadership to bring the "champion" out of the people. Leadership plays the following role in an organizational change (Kanter, 1983):

- Prime mover
- Strategic decision maker
- Making participation work
- Providing rewards and feedback

By communication it means "telling people what we're up to". In a traditional workplace, management keeps the workforce constantly guessing. They only have to do what they are told hence conflicts often occur due to misunderstandings and suspicions. Nowadays, management should keep an open policy. In return, every little achievement in change processes should be communicated by means of performance charts and progress reports. IBM claims 'respect for the people' as their main organizational philosophy. Gaining trust is the recipe for reaping people's maximum ability (Peters, 1982).

Besides giving trust, respect and dignity, trust can also be gained by empowerment (Gilgeous, 1997). Willing to train the workforce is the pre-requisite to setting expectations on their performance. Being granted the practical autonomy, people are more likely to take pride in their jobs, increasing innovation and productivity.

KAIZEN Bird

Focusing on the core activity in the overview model, the change process holds an underlying model of its own (fig.2). This model, also called the KAIZEN bird (where KAIZEN is the widely used Japanese terminology meaning continuous improvement), presents itself as a bird embraced in the body of the 'mother bird' (fig.1). It illustrates the complicated matter of change in a general manner. This model is designated to be followed in a sequence which simulates the natural forward movement of the bird, i.e. left to right. The actual change process normally travels through 3 levels, which will be explained in detail in the following sections.

Level 1: Input Environment

A structured change programme should begin at what is recognised in the model as the "input environment". It consists of all areas of consideration in which a company forms its critical concern factors. These can be internal inputs from the executives (vision and mission statements), management (manufacturing capacity and resources), employees (critical shop floor concerns, which are also obtained from management) and external factors such as customer satisfaction requirements, suppliers' performance, market demand, government regulations and competitors' actions (table.3).

KAIZEN Bird Level 1: Input Environment			
External Factors		**Internal Factors**	
Customer satisfaction What can we do to team up with our customers, understand their needs and discuss means of achieving quick responses to fulfill them?	**Suppliers' performance** How can we help our suppliers to be more competitive, in return making us more competitive?	**Vision statements** What is the company's vision statement -- the ultimate set of goals which is communicated throughout the workforce, and which change activities are related to?	**Manufacturing capacity/ resources** Do we have enough capacity, both technological and human resources, to support changes and ensure continuous improvements in the implementations?
Market demands Is the industry experiencing any kind of extreme market condition where change wouldn't matter much?	**Government/ regional regulations** Have government/ regional regulations imposed any restriction or significant influence on manufacturing sector and therefore our business?	**Critical shop floor concerns** What are the bottlenecks in our factory and what can we do about it to achieve lean objectives (i.e. making operations safer, cheaper, easier and faster)?	**Organisational Structure** Are we currently flattening organizational hierarchies, creating close inter-functional linkages, and transforming segmented structure to an integrative one (i.e. team based)?

Table 3: External and internal factors in KAIZEN Bird Level 1 "input environment"

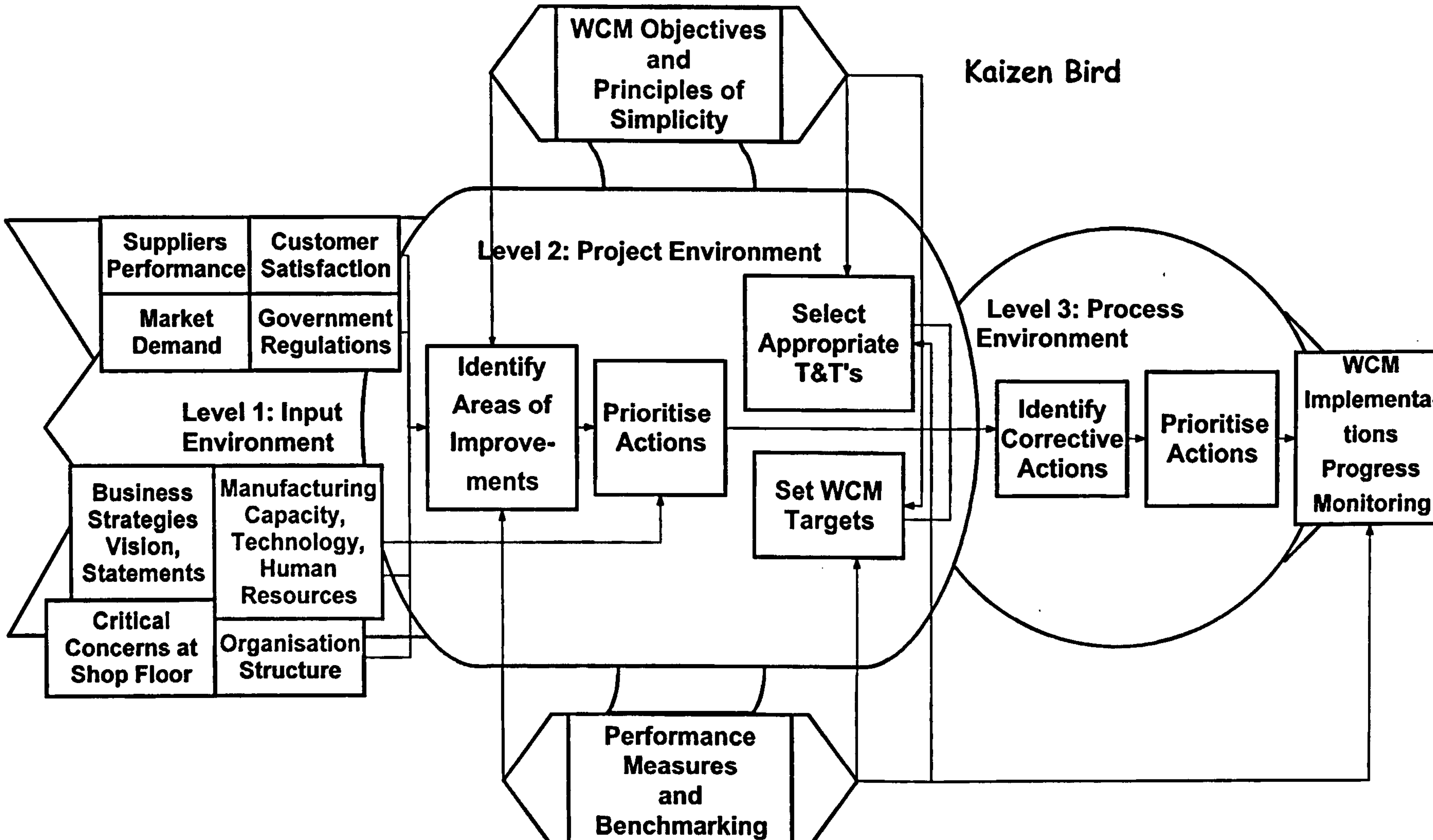

Figure 2: Change Process towards WCM

Level 2: Project Environment

With these inputs the management team builds a list of improvement areas, which happens in the "project environment". Due to practicality, not all the improvements can happen at the same time. Therefore, the list needs to be assessed and a process of prioritization carried out. When the selection process gets complicated, decision-making tools can used. Depending on the degree of complication and the number of factors considered, tools suggested are analytical hierarchical process (AHP) (Golden et al, 1989), priority mapping (Robinson, 1997), or just simple pareto analysis (Kondo, 1997) and a possibility decision. Often though, decisions are made out of executives' or management's intuition. After the areas of improvements are prioritized, it is then necessary to select appropriate T&Ts and set corresponding targets.

Selecting appropriate tools and techniques

This research investigates the tools and techniques used in industry, ranging from simple concepts like single-minute-exchange of dies (SMED) to complicated sets of philosophies such as total quality management (TQM) and total productive maintenance (TPM). Each tool or technique aims to make improvements in one or more of the following six WCM objectives: quality, cost, delivery performance, productivity/ flexibility, workplace improvement and health and safety. A sub model (fig.3) is created to present the inter-relationships between the T&Ts with the objectives. Therefore, based upon the supporting sub-model, T&Ts are selected depending of the current areas of improvements prioritized.

Set WCM targets

This does not refer to financial targets. All targets set here are related to the six WCM objectives, and must correspond to areas of improvements prioritised earlier on. Here there are two types of targets: one in the form of performance measures, another in the form of international standards or awards.

The first type of target is essential in a change programme. Targets are set to create the next level of improvement. They have to be achievable and realistic. There is no use for a company with an overall equipment efficiency (OEE) figure of 15% to set its next month's target to 80%. Although the target might beat its competitors, it is just not going to happen. Financial targets are not set here because there is no direct link between WCM implementations to a company's financial performance. Logically, successful WCM implementations will drive costs down, increase quality, reduce wastes and satisfy customers better, which will all increase the company's profit. However the relationship is complex and often not justified.

To name a few, international standards and awards are QS9000, ISO 9000 and 14000, Malcolm Baldrige Award, Deming Prize and Shingo Prize. These awards and prizes started at different times in different regions of the world. As they contain specific sets of criteria for excellence and carry international recognition, companies tend to adopt any one as a shortcut to world class status. However, as each of these awards and prizes focus on different elements of business and manufacturing functions (e.g. customer satisfaction, human resources, quality, process planning, leadership and people etc.), the benefit of blindly adopting and achieving an award is largely in doubt (Mayet, 2001).

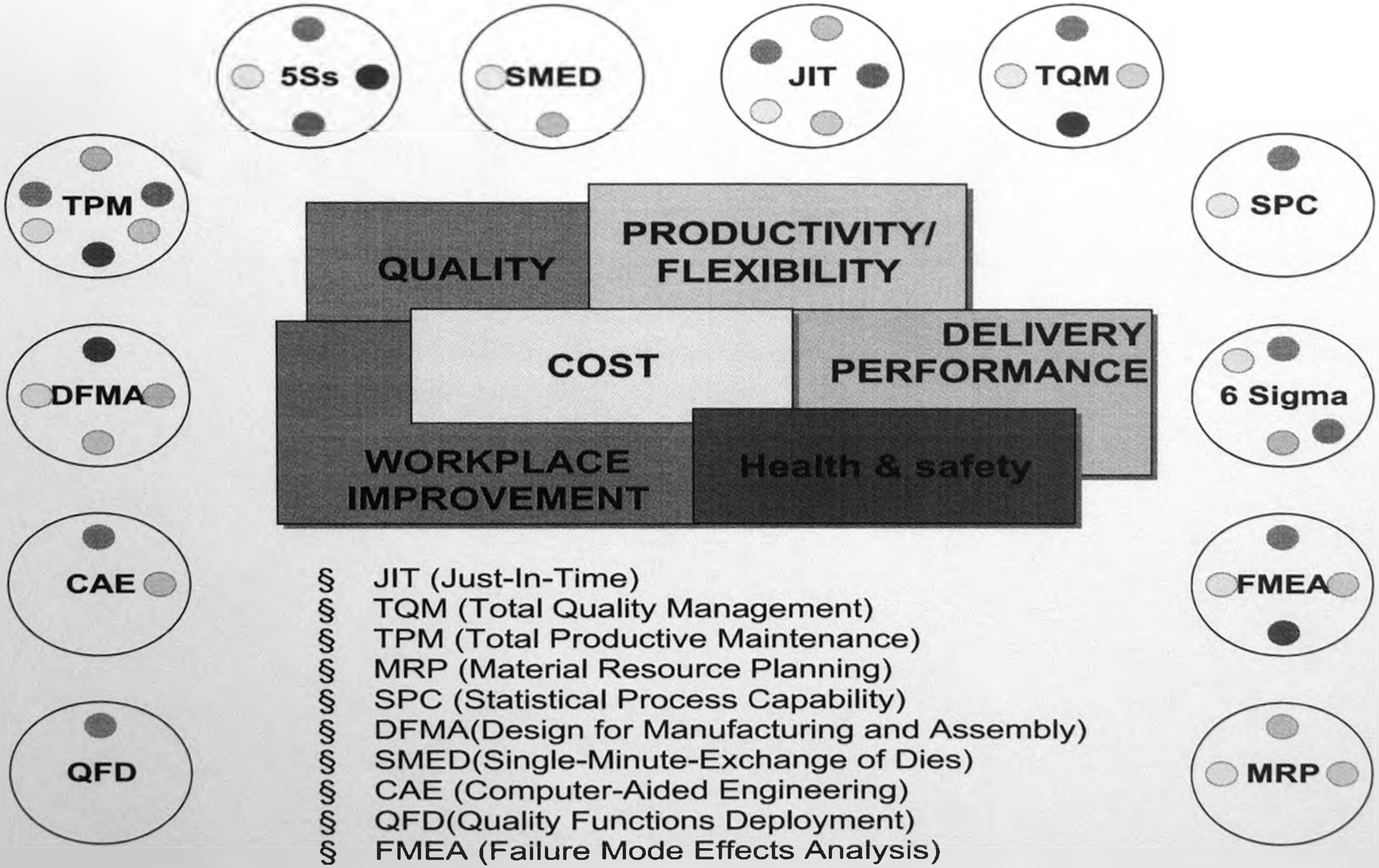

Figure 3: Relationships between Tools and Techniques with WCM Objectives

Level 3: Process Environment

The first fundamental of the change model is to translate business strategies into shop floor operations. Process environment is where these operations take place. The primary elements are identifying corrective actions, prioritizing actions and progress monitoring. One reason for which change programmes fail is that the change process comes to a standstill at the end of "project environment" (level 2 of the KAIZEN Bird). Executives take on big ideas, or management decides to implement some kind of WCM programme, but it has never been translated into specific actions. Big targets can never be accomplished if they are not broken into small and achievable actions. Milestones and deliverables are essential to any continuous improvement activity.

Identify Corrective Actions

Corrective actions are specific tasks that contribute to fulfilling the areas of improvements in level 2. For example, if workplace improvement is identified as a main area of concern, and 5Ss is selected as the enabling tool, the corrective actions can be sweeping the floor, clearing the tool shelves, removing machines or red-tagging activities. There are two ways of generating the corrective actions: the forward mechanism and the backward mechanism (fig.4). With the forward mechanism, concerns are raised and the causes are analysed before a set of counter measures are established. However, the backward mechanism works in a way which actions are generated before identifying their relevant potential improvements. (There is only a difference in reasoning logics, and both mechanisms work well in their own ways.)

Concerns ⇨ **Causes** ⇨ **Countermeasures (Corrective Actions)**

Forward mechanism

Corrective actions ⇨ **Reasons** ⇨ **Potential Improvements**

Backward mechanism

Figure 4: Forward and backward mechanisms in generating corrective actions in KAIZEN Bird Level 3 "process environment"

Prioritise Corrective Actions

Basically, the principle of this action is the same as prioritizing areas of improvement mentioned earlier in level 2 "project environment", and the tools recommended to carry out prioritization apply here. However, as the decisions to be made in level 3 "process environment" are much smaller, the prioritization becomes easier and less necessary. At most times decisions are made based on budget and the resources available.

WCM Implementations Progress Monitoring

Regular meetings are held for two reasons: to discuss problems and to communicate progress. KAIZEN meetings formed for a specific improvement project normally involve all members of the team. A typical progress report consists of the following elements:

- Corrective actions identified (including details of forward or backward mechanism)
- Individuals from the team responsible for each action
- Start date, expected and actual completion date
- Indication of progress
- Performance charts related to the actions
- Problems, rewards, or causes of failure

Wings of KAIZEN Bird

The wings of the KAIZEN bird carry the most vital components of the change process. They are neither controls nor mechanisms, but guiding and supporting elements that must be integrated into the entire change process. WCM objectives, located on one side of the wings together with WCM principles, refer to quality, cost, productivity and customer satisfaction (Gilgeous, 1997). All improvement initiatives are related to one or more of the objectives, and the objectives need to be achieved simultaneously. When selecting T&Ts, it is important to know which objectives can be achieved. Fig.3 shows the author's attempt to link T&Ts to WCM objectives.

There is a non-exhaustive list of WCM principles. In his latest book, Schonberger proposed 16 principles of WCM from the perspective of customer satisfaction (Schonberger, 1996). Constantly growing people is the key to success (Joynson, 2000). Peters sees managing-by-wandering-around (MBWA) as the way to go (Peters, 1983). Various principles can be followed depending on the individual's point of view. In this research, WCM principles can be summarized as follow:

- Small and rapid step changes
- Constant elimination of waste, including non value-adding activities
- Working towards a SCEF operational environment
- Strict alignment of performance measures with processes

The other wing denotes performance measures and benchmarking. No improvement programme will work without these two elements, as they play an important role in (Oakland, 1999):

- Measuring success against organization vision and objectives
- Tracking progress on each significant change activity
- Identifying strength and weaknesses in each area of entire change process
- Comparing performance against internal standards (previous results) or external standards (best practice)

Conventional management relied heavily on financial figures (e.g. sales, profit etc) to measure success; however this is now regarded as somewhat insufficient. In a WCM change environment, solely utilizing financial measures is not entirely accurate and can be discriminatory. Measures directly related to WCM objectives are needed. However, debates have been raised as to how WCM can be justified if it cannot be shown to directly affect a company's "bottom line results". In the pursuit of this matter, a recent research had established a correlation between financial measures with the scoring of a WCM framework (Mayet, 2001).

Meanwhile, current research shows that WCM performance measures can be categorized into:

- Productivity/ flexibility/ agility (eg. lead times, machine up-time, inventory)
- Quality (eg. scrap, rework)
- Customer satisfaction (eg. delivery performance, support, warranty returns)
- Employee involvement/ people measurement (eg. absenteeism, staff turnover, incentives and involvements)

Some performance measures have several elements combined in one figure, OEE being a good example. It measures the availability, performance of machines and quality (Nakajima, 1989). A basic rule of thumb is to measure only what is needed. The same applies to benchmarking exercises. The outcomes of the measures need to be justified against the cost of implementing them. As mentioned earlier, translating vision statements and business strategies into operations is one of the main objectives of the change model. Performance measures should therefore make sure the actions measured are aligned with the strategies. Research carried out in the participating companies suggested that key performance indicator (KPI) is a good representation of performance measures as it links results to strategies as well as the corrective actions.

Case Studies

Several UK based companies have participated in this research, but presented here are the four most actively involved: Rexel Business Machines, Pilkington Automotive, Corus and Heritage Silverware. Table.3 outlines the diverse characteristics of the four companies, each with distinct size, product range, management style and change features.

Using the Model

The case studies contributed to the development of the generic change model; and the model produced was then tested against the companies. The following figures (fig.5-8) show examples of applications of the change model in Heritage Silverware and Rexel in a certain short period of time during their WCM implementations. It is best to refer to KAIZEN Bird (fig.2) in conjunction with these figures.

Fig.5 demonstrates an example in which to identify areas of improvement, several input factors need to be assessed. These factors are both internal and external, as mentioned earlier in KAIZEN Bird level 1 (fig.2). Here the external factors taken into account are suppliers' performance and customer satisfaction; whereas shop floor critical concerns and manufacturing capacity and resources are the internal factors considered. Having examined each factor in the company, several areas of improvements are listed. These areas then become the upfront concern in the company's WCM programme.

Fig.6 is an extension to fig.5. It is difficult to execute all the identified areas of improvement at the same time. Therefore prioritization of action is necessary. In this instance, it has been decided that workplace continuous improvements, team building exercise and training of 5Ss are to be put off due to the lack of resources. Data collection on component stock is seen to be the bottleneck. By solving this, many other areas will be unraveled, including delivery performance and supplier's dependence. Using logical reasoning, data collection is then placed as the top priority.

	Rexel	Pilkington	Corus	Heritage
Size (no. of employees)	250	500	38	25
Products	Business Machines (Shredding, laminating, copying machines)	Glass (car windows, windshields)	Aluminium (to customer's required sizes and shapes)	Tableware (make-to-order)
Organisational Structure	Few hierarchies, mostly flat; partially integrative; cross functional teams formed occasionally	Flat, partially integrative, cross-functional teams formed for temporary projects	Top down; partially integrative; functional specialisation	Top down; segmentalist; functional specialisation
Change characteristics	Change is norm, plant experiencing extensive and rapid improvements in layouts, process time reductions and quality assurance, workforce subjected to a transformation of change culture led by continuous improvement (C.I.) manager	Change is driven by the world wide organization as a whole, the plant is practicing excellent continuous improvements after a dramatic re-engineering, entire workforce seeking ways to challenge quality and break through high performance measures	Change has happened but not justified, tools and techniques are adapted, implemented but positive results are rarely obtained, merging has negative impact in change, however the plant is set for a re-engineering	Change has been halted by production and business expansion, plant operated in the traditional way, change culture takes time to be introduced and adapted
Vehicle/ framework for change programme towards WCM	Continuous Improvement programme facilitated by the C.I. manager	Manufacturing To Win (MTW) programme, composed for the entire organization, communicated through intranet	Barry's Model of a world class organization; William's 4 autonomous steps to WCM	Tey's birds of change towards WCM
Bottleneck in change	Bringing the entire workforce into the culture of constant transformation and improvements	Integrate the plants implementations to MTW programme to excel as one PILKINGTON world wide	Lay-offs resulted from merging interrupted change projects and affect morale	Lack of resources, cash flow problems, lack of inventory information and performance measures
Main WCM activities	5Ss activities in shaft production; health and safety; environment; employee benefits; supplier management	Manufacturing improvements (team building and KAIZEN); environment, health and safety; standardization; new model introduction; learning & communication	Critical concerns audit, TPM, OEE, SPC, 5Ss, FMEAs, Production modelling and simulations	Set up data collection system, 5Ss on shop floor
Management's vision	Health and Safety → Productivity → Quality → Environment	5Ss → TPM → Team based structure → 6 Sigma	Improve financial performance → benchmarking → customer satisfaction → business excellence scheme	Data collection on component stock and system input → 5Ss → WCM implementations

Table 3: Four participating companies and their main characteristics in the research developing Birds of Change towards WCM

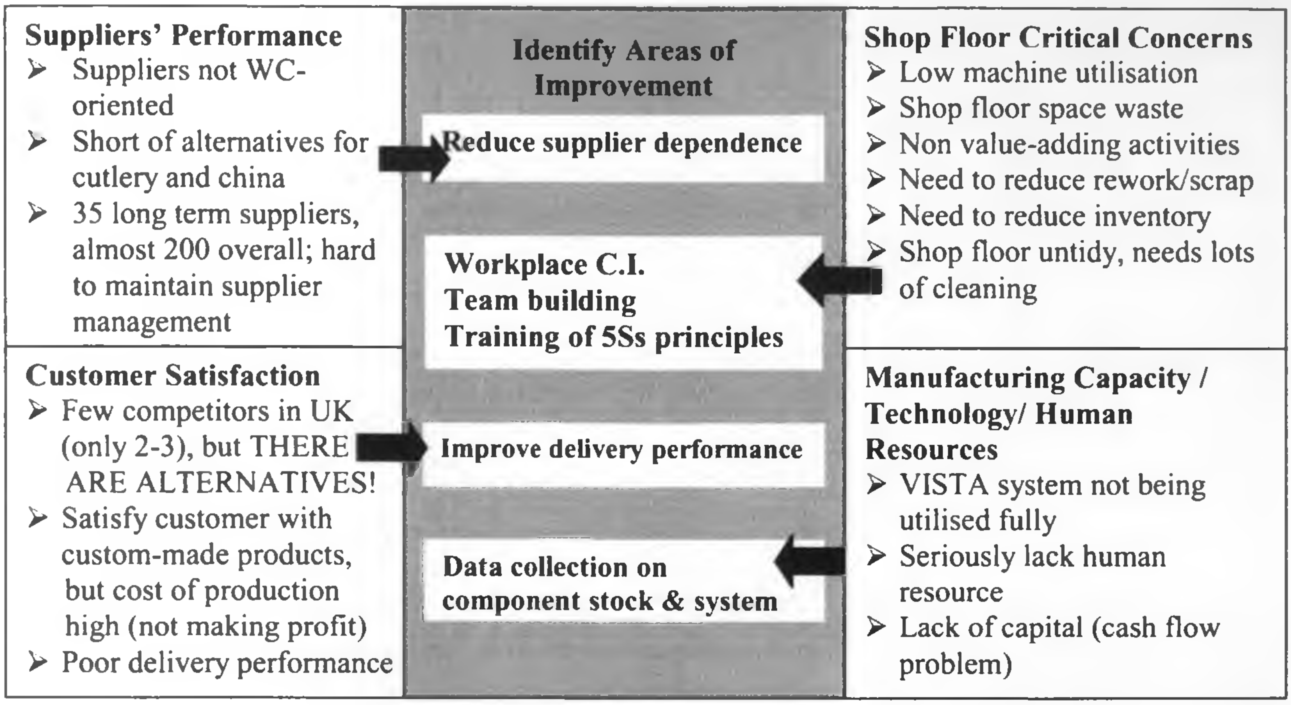

Figure 5: A case of Heritage Silverware – assessing inputs in KAIZEN Bird level 1 "input environment" to identify areas of improvement

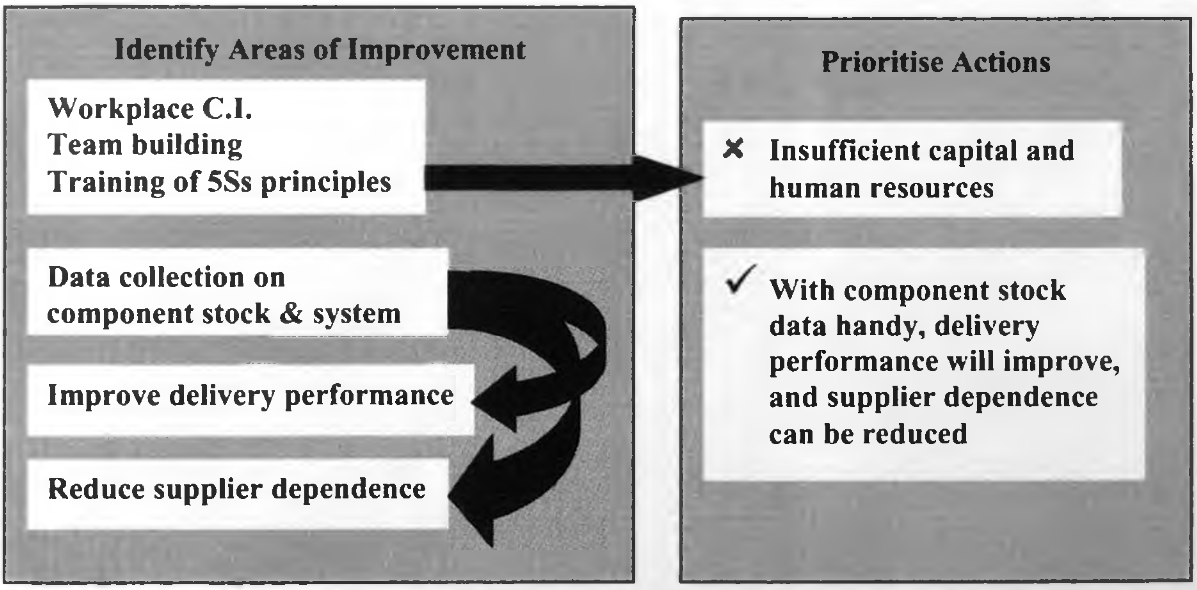

Figure 6: A case of Heritage Silverware – prioritizing actions within the areas of improvement identified

Figs.7 & 8 each presents an instance of change activities outlined in KAIZEN Bird level 3 'process environment'. As explained in the earlier section, corrective actions are identified after the selection of appropriate T&Ts. The case shown in fig.7 is one related to 5Ss. Potential improvements aim to justify corrective actions so that they can later be prioritised. This represents the backward mechanism indicated in fig.4.

Identify Corrective Actions	Potential Improvements
➤ Use bright bar instead of black bar for cutter shaft production	➤ Reduction in process time and material handling
➤ Stop using Doubled reeled material for sized cutter shafts	➤ Cost reduction
➤ Identify 1st 5s project	➤ Area to become model for 5Ss
➤ Training of SORT	➤ Workers to have 5S knowledge & skills
➤ Red tags creation	➤ For next red-tagging activity
➤ Identify & purchase tooling cabinets & workbenches	➤ To SEGREGATE tools
➤ Remove all stock from stores agreed with production control	➤ Stock write-off

Figure 7: A case of Rexel – Activities in KAIZEN Bird level 3 "process environment"

Finally, a system of monitoring WCM implementation progress is critical (fig.8). Displayed here is an example of a one-page report which clearly illustrates the purpose. This report was updated on a weekly basis in co-ordination with the WCM team meetings. It contains important information such as the on-going activities, the people responsible, target and actual completion dates, progresses, and relevant comments.

Conclusions

Substantial research has been carried out on existing WCM literatures, leading to the authors' version of a WCM definition, which incorporated most key aspects mentioned in the other literatures. This definition is used as a foundation to construct the 'birds of change' – a change model towards a WCM organization. It was also recognized that the manufacturing industry is going through an evolutionary era. The study of the industrial age and the information age has set a rigid background to the research of organisational change programmes towards WCM.

The model has proved to be a step guide for WCM implementation and has also emerged as a tool to drive continuous improvements and to monitor progress. The fundamental objectives of the model, laid out in the beginning of the research, have taken effect throughout the change programmes in each participating companies. The generic nature of the model has been validated by testing it against four UK based manufacturing companies of various sizes, products, management styles and change characteristics. The results show that any manufacturer can take on WCM initiatives. The KAIZEN Bird has to be followed by its sequence, but each activity can be adapted in different ways to suit a company's needs and its current situation.

To take the 'birds of change' to a further stage of practical application, a supplementary scoring system was established. This scoring system, described as the "change indicator" (Tey et. al., 2001), was designed to evaluate a company's change programme towards WCM by scoring every core activity of the change model.

Further research is required across a wider range of companies and in different regions to make the model more universal. The model itself needs to be refined, especially on the soft structure. Correlations between change activities are to be

[CA]Corrective Actions/ [PM]Performance Measures/ [IE] Input Environment	Respon-sibility	Target comple-tion date	Progress (%)										Actual comp-letion date	Comments
			10	20	30	40	50	60	70	80	90	100		
** [CA] Red tagging activity on machines, tools, shelves etc. (entire shop floor starting from polishing)	Ben, McD, Mir	22/01/01 (2 mnths)												6 machines in making shop have been red-tagged. Decision has to be made: sell, use or bin them.
[CA] Polishing shop re-layout (5S map) "SORT+SEGREGATE"	McD, Ben, Tey													Need to take a "walk down the shop floor", and Sort. Need to be done after removal of all unneeded machines and shelves
** [CA] Clear tool shelves "SORT" & "SEGREGATE"	Ben, Mir, Harry	24/11 overdue												❖ Get rid of the unneeded mops on the shelves ❖ Place mops in trays according to their different uses
[CA] Prepare red-tags "SORT"	Ben, Tey	Wed 30/8 overdue											22/11	Red tagging activity started
[CA] Photography (polishing shop)	Ben, Tey, Pip	On-going												Take photographs of clean workplace as "STANDARDISE" activity
[PM] Delivery performance data	Mir, Tey, Ben	On-going												Excel format. Tey generating lead time, no. of outstanding orders regularly.
[PM] Process cycle time analysis	McD, Tey, Mir, Ben, Chin	Wed 06/09 overdue												Decided to choose a product (product name?) and analyse process time manually. Need actual lead time plus waiting, moving, to stock time
** [IE] Business strategies	McD	Wed 25/10 overdue												McD to come up with business strategies and put them down on paper.

Meeting:- 29/11/00 @ 1100	Previous meetings	Date	23/08	30/08	04/10	18/10	25/10	01/11	15/11		Next meeting:- 05/12/00
		Time	1400	1300	1245	1200	1100	1300	1400		

Figure 8: A case of Heritage Silverware – WCM implementations progress monitoring in KAIZEN Bird level 3 "Process Environment"

developed. It is also suggested that the study of the distinct characteristics of the industrial age and the information age be put into use to assist companies in the understanding and preparation for the changes in global industry.

In conjunction with the change indicator, the 'birds of change' model is aimed to lead companies in their WCM pilgrimage, and to accommodate their ability not just to compete; but to win.

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