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A Multi-Case Investigation into the Effectiveness of Shop Floor Improvement Teams at South African Manufacturers

by

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Degree of Doctor of Philosophy

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Declaration

I hereby declare that this thesis is my own unaided work. It is being submitted for the degree of Doctor of Philosophy at the University of Cape Town. It has not been submitted before for any degree or examination at any other university.

Signed: Signed by candidate

Date: 4 June 2007

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Abbreviations

CD:	Competitive Dynamics (a consulting firm used by some WPC firms)
CI:	Continuous Improvement
CIM:	Computer Integrated Manufacturing
CMA:	Contemporary Manufacturing Approach
HPWS:	High-Performance Work System
HPWT:	High-performance Work Team
HR:	Human Resource
HRM:	Human Resource Management
JIT:	Just-in-Time
KZN:	Kwazulu-Natal
MD:	Managing Director
MDWT:	Multi-disciplinary Work Team
NCR:	Non-conformance Report
Nedlac:	National Economic Development and Labour Council
PDM:	Participative Decision Making
ppm:	parts per million
QA:	Quality Assurance
QC:	Quality Control
RM:	Rough Make-up
SDWT:	Self-directed Work Team
SPC:	Statistical Process Control
STS:	Socio-technical Systems
TBWO:	Team-based Work Organisation
TPS:	Toyota Production System
TQM:	Total Quality Management
WC:	World-class
WCP:	Western Cape
WCM:	World-class Manufacturing
WCP:	Workplace Challenge
WIP:	Work-in-progress

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Abstract

This research was prompted by the apparent contradiction between the popularity of contemporary approaches to manufacturing (CMAs), such as total quality management, just-in-time, and lean production, and the empirical research evidence which indicates that few of these programmes result in demonstrable operational performance improvement.

A review of the theory identifies bundles of practices associated with CMA programmes, established shop floor teams, and continuous process improvement as essential for such a programme to be effective. The process of implementation of CMA programmes is also identified as an important determinant of success, together with a number of moderating factors such as market conditions, organisational disruption, process type, and industry sector.

As research on this topic has been criticised for lack of rigour, a longitudinal, quasi-experimental, multi-case research design was used. Qualitative and quantitative data were collected over a 3-year period from 12 South African manufacturing firms that participated in a government-sponsored project to implement team-based work organisation. The data from each case were analysed separately to test the research hypotheses on a case-by-case basis before cross-case analysis by means of pattern-matching was conducted. The quantitative data were used to corroborate the findings of the qualitative data by means of correlation analysis.

The research hypotheses were not rejected, although the degree of confidence in the research results was limited by data availability and reliability considerations. It was found that thorough implementation of TBWO programmes was moderately associated with improved productivity performance and weakly associated with quality improvement. The hypothesis with respect to the association between teamwork and continuous improvement practices and operational performance outcomes was less strongly supported. Organisational disruption and poor market conditions were found to be inhibiters of effective implementation, whereas the longer experience of CMAs by firms in the automotive sector seemed to facilitate programme implementation, and firms with mature TBWO implementation

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programmes showed the greatest performance improvement. Confidence in the finding that only a minority of the firms that implement TBWO programmes derive demonstrable operational performance improvement from the programme is strengthened as these findings are consistent with previous research.

Recommendations for further research are that the following issues should be documented and their impact on performance outcomes should be investigated

- poor operational performance measurement;
- different patterns of programme implementation;
- the trade-off between allocation of resources to production output versus process improvement;
- the effectiveness of problem-solving and decision-making by shop floor employees when they undertake process improvement projects.

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Chapter 1: Introduction

1.1. Introduction

1.1.1. Summary of this Research

The effective implementation of team-based work organisation (TBWO) has long been a topic of research, and this study investigated the effect on operational performance outcomes of the implementation of TBWO programmes at manufacturing firms.

The research question arises out of the apparent contradiction between the popularity of TBWO amongst industry practitioners and the consequent adoption of these programmes by many manufacturing firms as research findings indicate that only a minority of firms derive demonstrable operational performance improvement from the implementation of TBWO programmes. This raises the question of whether TBWO is in fact an effective means of improving operational performance and, if it is, what are the firms where performance does improve after introduction of TBWO doing right?

Apart from the above substantive rationale for the research, it is also warranted from a methodological perspective. While it has been recognised that TBWO is a particularly complex topic, the rigour of research on TBWO has been called into question for being anecdotal, perceptual, and/or cross-sectional. In an attempt to improve on the quality of research in this field, this study makes use of a multi-case, longitudinal, quasi-experimental design, in which both qualitative and quantitative data is collected and analysed.

In the chapter in which the theoretical framework is developed, teamwork and continuous improvement are identified as essential practices of contemporary manufacturing approaches, such as lean, world-class, or just-in-time manufacturing. The theory on the types and evolution of teams are reviewed together with a number of explanatory theories of why continuous improvement is central to sustained performance improvement. Then, the impact of how programmes are implemented is reviewed, both for programme implementation in general and as specifically related to implementation of TBWO. The empirical evidence on the successful outcomes of

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TBWO as well as the fact that relatively few of the firms that adopt TBWO are demonstrably successful is then presented. The complex dynamics of TBWO implementation and possible moderating factors such as market conditions, organisational disruption, process type, and industry sector are also reviewed. The chapter closes with the formulation of the research questions and research hypotheses.

In the chapter on method, the validity and reliability requirements of the case method, longitudinal studies, and quasi-experimental designs are reviewed, and it is shown how this research was conducted to meet these requirements. Variable selection and operationalisation are documented, together with a description of how the data analysis was done.

The detailed case study reports are contained in appendixes which are summarised in cross-case analyses presented in chapter 4. The qualitative findings are corroborated by quantitative analysis of the results before contrary findings and moderating factors are discussed. The research findings are also tested against the consideration of an alternative explanatory theory, namely, that the performance improvement may have been due to improved capacity utilisation.

The research hypotheses were not rejected, although the degree of confidence in the research results was limited by data availability and reliability considerations. It was found that thorough implementation of TBWO programmes was moderately associated with improved productivity performance and weakly associated with quality improvement. The hypothesis with respect to the association between teamwork and continuous improvement practices and operational performance outcomes was less strongly supported. Organisational disruption and poor market conditions were found to be inhibiters of effective implementation, whereas being in the automotive sector seemed to facilitate programme implementation, and firms with mature TBWO implementation programmes showed the greatest performance improvement.

1.1.2. Note on Terminology

Research on this topic is bedevilled by a plethora of terms and interchangeable use of terminology, which leads to much confusion (Storey, 1994, p. 7; Goh et al., 1997, p.

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165). The main theoretical concept to be used in this research will be reviewed and defined in chapter 2. For now, the way in which terms are used will be briefly stated to avoid confusing the reader at the outset.

Contemporary manufacturing approaches (CMAs) is the term used to refer generally to programmes such as lean production (LP), world class manufacturing (WCM), just-in-time (JIT), total quality management (TQM), total productive maintenance (TPM) and others that are aimed at comprehensive changes in the organisation of work and in the production process to improve performance *without* the introduction of technology that is an innovation for the operation.

Team-based work organisation (TBWO) refers specifically to the organisation of shop floor employees to work in teams, quite often in organisational structures with fewer levels and less hierarchical reporting structures. When referred to as *TBWO programmes*, the term is also intended to include other practices associated with teamwork, such as cellular layouts, skills development, decentralised performance measurement and quality management, and employee participation in process improvement.

Three sets of TBWO practices will also be distinguished. Human resource (HR) practices include communication and consultation with the workforce, enhanced employee facilities, training, teamwork, incentive systems, and job security. World-class (WC) practices refers to quality management, shop floor layout to improve flow, batch size reduction and the use of best operating practice such as visual management, waste reduction, performance feedback, and so on. Finally, continuous improvement (CI) practices refers specifically to employees making use of problem-solving techniques during time dedicated to making process improvements and having the authority and resources to implement small changes.

The term *project* is used to refer to an initiative (usually by government) to support a number of firms which each introduce a comprehensive *programme* to implement a set of management practices to improve the performance of their operations.

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1.1.3. Research Context

1.1.3.1. The Workplace Challenge Project

A South African government project, the Workplace Challenge (WPC) was a R24m (about US$3.5m) South African government project to help small and medium-sized manufacturers to introduce "workplace change". Participating firms received a partial subsidy to engage consultants to design and implement the initiatives within certain project parameters. The project provided a unique opportunity to study implementation of TBWO at multiple firms at more or less the same stage and conditions of implementation (i.e. a quasi- or natural experiment).

The WPC grew out of the new South African government's industrial restructuring initiatives after the African National Congress government came to power in 1994. At a national policy level, the WPC was informed by the government's emphasis on building harmonious workplace relations between management (who were mostly historically advantaged white males) and employees (who were mostly historically disadvantaged black males) (Dickinson, 2000, p. 72). This divide coincided with traditional hierarchical work organisation, which was reported to "seriously impede communication, and make problem solving and flexibility difficult. Workers' tacit skills [we]re not recognised or tapped, and many workers [we]re locked into menial task-oriented jobs, rather than responsible jobs which encourage[d] conceptual work" (Bethlehem, 1994, pp. 107-8).

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The WPC was seen as an initiative to "enhance the competitive capability of local companies and sectors to compete in the global market and ensure high investment and employment security with economic growth" (National Productivity Institute, 2003, p. 3). The project was initiated during 1996 and 1997, with dialogue between government, business and labour representatives at national and regional levels in the National Economic Development and Labour Council (Nedlac), a statuary body established to facilitate the resolution of issues of national importance between the "social partners" in the country. The following issues were discussed until consensus was reached:

- Definition of Productivity
  The stakeholders contested the term "productivity", and the definition was extended to gain acceptance that productivity improvement was a key ingredient in South Africa's ability to survive in a global economy. The productivity process was then defined as the conversion of inputs, such as human resources (management and workers), technology, capital, and materials, into products and services consumed by markets. It was emphasised that if workers were expected to contribute to productivity, they also had to *benefit from sharing* gains from those improvements.

- Working Environment
  Two alternative routes to economic development were debated. The *'sweat-shop', low-skills, low wages route* would be achieved by paying workers the lowest possible wages and keeping the benefits to a bare minimum in order to keep costs down (e.g. China, Korea, Taiwan). The *'self-actualisation', high-skills, high-wages route* would be characterised by good employment conditions, such as wages, training and development, and competitive advantages based on innovative products and services (e.g. Singapore, Japan, USA). It was agreed that the only option left to South Africa was the 'self-actualisation', high-skills, high-wages route.

- Best Operating Practices
  Intelligent production and service delivery in the workplace could be achieved by identifying *best operating practices* specific to every industry and organisation (in the manufacturing and service industries).

- Workplace Change Agreement
  A *workplace change agreement* was proposed to commit management and labour to a change process and enable them to negotiate and agree on specific measures over a specified time and in terms of a broad framework...

- Employment Security
  Employment would actually increase or at least remain stable if there were an increasing demand for goods and services (in a growing economy)... It was advocated that the *Workplace Challenge should not improve productivity at the expense of jobs.*

- Training and Empowerment
  Both business and labour emphasised the need for *training and worker empowerment* as vital ingredients in attaining international competitiveness. *The training of both workers and management was emphasised.*

- Labour/Management Relationship
  Both business and labour acknowledged that a lack of *trust and cooperation between management and labour* would impact negatively on attempts to improve productivity and competitiveness on the shop floor. The causes of poor business/labour relations were identified as (1) a perceived lack of information disclosure (financial and production), communication and consultation on decisions between management and labour, (2) the lack of a common understanding of the definition and goals of productivity improvement, and (3) hierarchical and inflexible management styles in the workplace.

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- Working within the Public Policy Framework
  Workplace change of the scope and magnitude envisioned by the Workplace Challenge initiative should not take place in isolation from *public policy*. Labour laws have an enormous influence on the plans of individual companies. The participants emphasised the need for *institutional coordination* between plant-level initiatives and sectoral and national policy initiatives.

(National Productivity Institute, 2003, pp. 7-8, emphasis in the original)

After the dialogue phase of the project, consensus was reached on the objectives of the project and the implementation process to be followed. The objectives were:

- *Facilitating constructive dialogue between government, business and labour* on improving economic performance and productivity at industry and shop floor levels;
- *Enhancing the capacity of stakeholders* (capacity building) to empower the participating companies to engage in this process and make change happen;
- *Piloting improvement in shop floor activities* aimed at transforming the workplace by implementing better operating practices;
- *Sharing information and diffusing lessons* learnt to participating companies, other companies and sectors and other interested parties.

(National Productivity Institute, 2003, p. 5, emphasis in the original)

The bulk of the WPC project activities took place at firm level. These were the TBWO implementation programmes that were studied for this research.

1.1.3.2. The Workplace Challenge at Firm Level

At firm level, the WPC took place by organising participating firms into "sectors", mostly by virtue of the similarity of products and/or markets. About five to ten firms participated in each of 12 sectors over a 2-year period (which was extended in some cases). The sector initiatives were piloted in the plastics-converting and capital-equipment sectors in 1997/8. Other participating sectors included clothing, auto-components, stainless steel, footwear, furniture, fruit and fish processing, and so on. At sector level, the process involved several phases, as illustrated in Figure 1.1 below (National Productivity Institute, 2003, p. 11):

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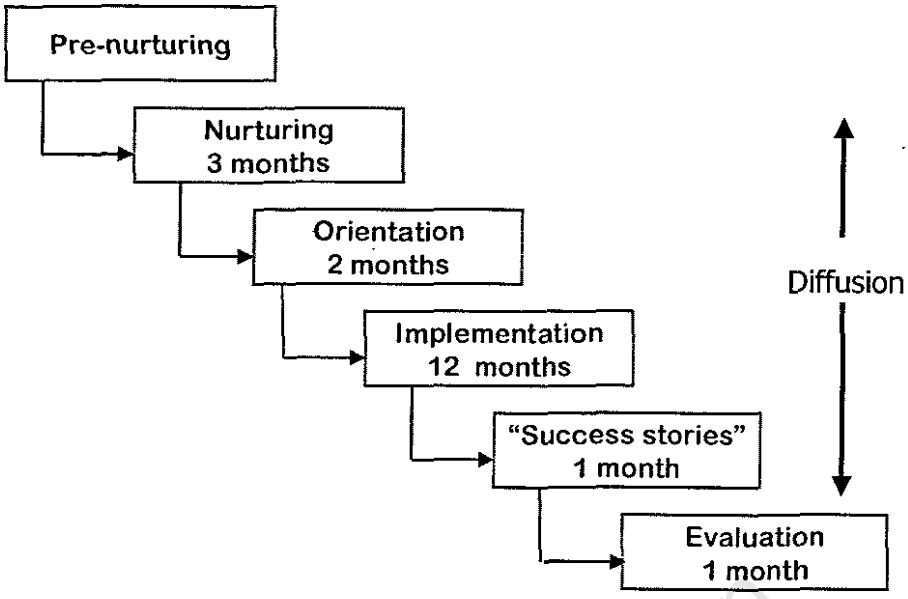

Figure 1.1: Phases of WPC implementation at Participating Firms

1. Pre-Nurturing

   Identification of potential sectors for inclusion in the project and preparatory work to initiate a sector steering committee.

2. Nurturing

   A sector manager helped to constitute a sector steering committee, which governed the project within the sector and made application to the national WPC steering committee for financial and other support to the firms.

3. Orientation

   Several capacity-building workshops were conducted for people from the participating firms in each sector. These included the following:

   - Labour Capacity Building Workshop: Labour representatives were informed about workplace restructuring and its possible consequences, and they explored how to respond as labour representatives.
   - Best Practice Workshops: Shop floor employees were introduced to continuous improvement techniques and given an opportunity to learn how they work by doing a practical project.
   - Supervisor/Line Management Workshop: Middle management were informed about their roles in workplace change and explored how to respond to these changes.

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4. Implementation

   In this phase, the firm-level steering committees selected a consultant from a pre-approved register to help their firms draw up a workplace change plan and implement it over a 2-year period. This often took the form of a programme to restructure the work organisation, re-negotiate industrial relations, implement training and ongoing support to the workforce, and introduce new performance measurement, incentive systems and other firm-specific initiatives.

5. "Success Stories"

   Compilation of resource material for diffusion of lessons learnt. (It should be noted that much of this was anecdotal and focused on "success stories".)

6. Evaluation

   Evaluation of the firm-level results and the WPC sector project management.

A document on the WPC marketing and diffusion strategy mentions the following examples of workplace change processes that lead to actual best operating practices that were publicised by means of publications, videos, television programmes, and other media:

> *Processes related to relationship building* (building trust, facilitating cooperation, identifying mutual objectives);
> *Processes leading to the establishment of legitimate structures* (ensuring stakeholder representation, capacity building, ensuring effective role playing at sector and plant level forums);
> *Processes leading to development of structured change and productivity improvement frameworks* (workplace change agreements, joint productivity strategies, identification of BOP methodologies, measuring success and identifying meaningful measures of change);
> *Implementation of change/productivity improvement programmes* (types of approaches used, what worked/didn't work, company growth);
> *How information was shared* (milestone workshops, research reports, WPC national committee meetings).

(Van der Hoff et al., 2001, p. 4, emphasis in the original)

1.1.3.3. Previous Research on Workplace Change in South Africa

A number of research papers have been published on the WPC and other efforts to introduce workplace change. Several reports were published by researchers attached to sectors of the WPC, but they are of varying quality as the researchers were not all professionally trained to conduct research. More reliable research on the WPC was

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published in a book edited by Webster and Von Holdt (2005). This book reviews the state of South African workplaces in the context of the social, political and economic transformation that has taken place in post-apartheid South Africa. It is primarily concerned with the extent to which the nature of the relationship between management and labour impacts on successful implementation of workplace change programmes (Webster & Von Holdt, 2005, p. 8). Two chapters in this book are particularly relevant to this research.

Maree and Godfrey (2005) report on the effect on performance from a two fish-processing firms that implemented different types of workplace change initiatives. At both firms data was collected by means of interviews, attitude surveys and performance outcome measures.

In the first case an employee participation scheme was implemented consisting of mostly a stakeholder representative council, work teams that met regularly to discuss their performance and take remedial action, and an employee share ownership scheme. Operational performance measures indicated that output and yield improved over a period of four years. This improvement was attributed to the workplace change initiatives, although the influence of the gradual introduction of new machines is also noted. Over this period the firm's profitability improved, but workers' wages and employment security declined, although their attitudes were generally positive (Maree & Godfrey, 2005, pp. 127-135).

At the second case a sophisticated electronic measurement system of individual worker productivity on traditional production lines was implemented in conjunction with a productivity incentive scheme and temporary cross-functional process improvement teams. Although productivity performance outcomes were mixed, the product mix also changed over an eight-year period to include more value-added products. This made the operation more profitable and worker wages also increased although their attitudes were less positive (Maree & Godfrey, 2005, pp. 136-144).

The other chapter by Dickinson (2005) reports on three firms in the plastics converting sector, the first sector to participate in the WPC. Ethnographic methods were used to investigate the extent to which "industrial relations and internal

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colonialism will continue to act as a braking force on productivity in South Africa" (Dickinson, 2005, p. 190). It was found that the different perspectives of management (primarily concerned with company profitability) and labour (primarily concerned with worker upliftment), the role of unions in facilitating or obstructing the implementation of TBWO programmes at the firms, and a long history of adversarial industrial relations caused the implementation of these initiatives to proceed unevenly. Ultimately implementation of the initiatives was not completed at two of the three firms, although the third firm was a "vindication of improved workplace relations as a vehicle for improved productivity" (Dickinson, 2005, p. 205).

Both these studies indicate that, in addition to factors mostly under the control of management, other influences, such as the industrial relations climate and new technology, influence the performance outcomes of an operation. While a practicing manager needs to keep these considerations in mind, this research focuses primarily on the practices related to TBWO that are normally within the remit of management.

1.2. Rationale for the Research

While the WPC provided the opportunity to undertake this research, there are several reasons, other than simply being opportunistic, as to why it was important to do it. Firstly, the popular perception that TBWO is linked to improved performance has led to increasing adoption of these types of programmes, despite evidence contradicting their efficacy. This research could shed light on the value of these programmes. Secondly, there have been calls for higher quality research on this topic from a methodological point of view, and this research attempts to address some of those concerns. And finally, it is anticipated that this research will be of value for replication of previous studies and extension of theory on the subject.

1.2.1. Popularity of TBWO

The following quotations give some sense of the popularity of teamwork:

> Everyone knows that teamwork is a good thing; in fact it is essential! (Maxwell, 2001, p. xi)

> Cover stories in Business Week and Fortune magazines, carrying the headlines, "Go team! The Payoff from Teamwork" and "Who needs a Boss?" respectively, give some indication of the extent to which autonomous group

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> working has captured the attention of American management. (Buchanan, 1994, p. 209).

> Team-based management or self-managed teams have been called the "second industrial revolution" because of their incredible impact on today's business practices. (Fisher, 1994, as cited in Elmuti, 1996, p. 4)

1.2.1.1. Increase in Prevalence of TBWO

There is a lot of research evidence to show that the prevalence of TBWO has increased:

> ...there has been an overall increase in the use of high-involvement work practices by these plants from Round 1 to Round 2. The most striking increases are in the use of on-line work teams and off-line problem-solving groups (e.g., employee involvement groups, quality circles). (Pil & Macduffie, 1999, p. 87)

> In fact more than 50 per cent of all Fortune 500 companies utilize them, and it is estimated that by the year 2000, 90 per cent of all North American organizations will have at least some type of self-managed work teams. (Elmuti, 1996, p. 4)

> Survey evidence shows that the pace of workplace change, in terms of both the diffusion and the penetration of practices, has been quite rapid in recent years. (Appelbaum et al., 2000, p. 9)

However, there are also signs that not all of these initiatives survive:

> Since the early 1980's the use of TQM approaches has been on an upward trajectory in US companies... The fact that 24 percent of the programs began after 1991 but that the overall percentage of companies using TQM rose only 3 percent during the period between 1990 and 1993... means that some the Fortune 1000 (companies) have dropped their TQM programs as well. Nevertheless usage continues in approximately three-quarters of the largest U.S. companies. (Lawler et al., 1995, pp. 46-7)

1.2.1.2. Reasons for Adopting TBWO Programmes

It has been suggested that TBWO programmes are adopted due to "market forces" driving the need for greater operational efficiency and effectiveness (Dunlop & Weil, 1996, p. 335). The findings from a survey of 76 companies listed in Table 1.1 ranks this as the second most commonly mentioned reason for the adoption of TBWO, although it is unclear what "change" is being referred to in the most common reason cited (Elmuti, 1996, p. 11).

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Table 1.1: Reasons for Implementing Team-based Management

Reasons for Implementing Team-based Management given by Managers	% of Respondents
The accelerated speed of change has caused the necessity of paying attention to quality	40
The pressures of the global marketplace have shown that business practices of the past are increasingly inadequate	33
Team-based management has been advocated by very articulate and entertaining spokespersons, who credited such a system with helping to improve organisational effectiveness	12
Team-based management was expected to improve revenue, service to customers and quality of products and services	6
Team-based management has been used in conjunction with TQM and re-engineering efforts	5
Team-based management was expected to downsize companies and reduce labour size and costs	4

(adapted from Elmuti, 1996, p. 11)

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The reasons given for adopting TBWO programmes are underpinned by writings that suggest there is a positive association between implementation of these practices and performance outcomes. Some of this literature is based on defensible research results (Bessant et al., 2001, p. 75; Beyerlein, 2001, p. 98, and see also section 2.6.4.1). However, in a normative article on how to implement autonomous teams, it has been claimed that "a satisfied and valued workforce produces effective results" without offering any empirical evidence (Baines, 1993, p. 6). Also, in other writings, popularly held explanations for the link between practice and performance are offered, such as "more egalitarian, participative processes that will enable the unlocking of new ideas from a wide range of people" (Prekel & Sobey, 2001, p. 53).

1.2.1.3. Negative Comments on TBWO Programmes

Despite the popularity of TBWO, a host of concerns has been raised about the extent of its success:

> ...for each successful implementation of TQM there are many which have not been able to translate their efforts into operational or business improvement and organisational performance. (Samson & Terziovski, 1999, p. 394)

> After using a continuous improvement strategy for ten years, Alcoa Corporation's CEO, Paul H O'Neill, scrapped it, calling it a major mistake. (Harrington, 1995, p. 32)

> ...the costs of JIT may outweigh the perceived realizable benefits. Even if management considers these advanced manufacturing practices to be cost beneficial, the organizational-change process to adapt to new environmental conditions is "slow, painful, and uncertain" (Fullerton et al., 2003, p. 386).

> ...enthusiasm for empowered operational teams is not matched by strong empirical evidence of their impact in generating significant performance benefits. (Dunphy & Bryant, 1996, pp. 689-90)

> The current popularity of the team concept may lead to the danger of teams being implemented too easily, as a catch-all solution to organizational problems. If the difficulties in implementing and developing teams are underestimated, the likelihood of failure increases and the team concept may gain a bad reputation. (Van Amelsvoort & Benders, 1996, p. 169)

The following comments summarise the paradox that some firms derive great benefit from TBWO but that many others do not and suggest that selective reporting may be influencing the adoption of TBWO on the basis of incorrect assumptions:

> How can one reconcile these disappointing findings with all the anecdotes about companies that become "lean and mean" through right-sizing, delayering, and reengineering; and "closer to customers" through attention to quality, response time, and faster product development? One explanation is that the business press tends to focus on the few shining (apparent) successes, and pays little heed to the much larger number of dissatisfied adopters. (Hayes et al., 2005, pp. 10-11)

> Thus, the use of teams in these initiatives is based on the premise that teams are useful—i.e. they accomplish what they theoretically should accomplish. However, this assumption has little empirical backing in the literature. Existing research on the effectiveness of teams in operational contexts consists mostly of anecdotes linking the use of teams with the success of an initiative of which teams are a part (e.g. McLachlin, 1997). Accordingly, the relationship between the use of teams and operational effectiveness is confounded by the other factors that are involved in the initiative. (Pagell & LePine, 2002, p. 620)

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The comments also point to the need for more rigorous research on why TBWO succeeds in some firms but not in others. Hopefully, this research will go some way in resolving the paradox.

1.2.2. Inadequacies in the Research on TBWO

From a methodological point of view, the inadequacies of research conducted have been well documented. These will now be briefly reviewed.

1.2.2.1. Confusion about the Definition of Teamwork

As with the variety of CMAs, there is also a bewildering variety of types of teams. Not only has TBWO evolved over time from quality circles to autonomous teams to high performance work systems, to name a few, but there are also a variety of practices that may or may not be implemented, whatever the name used for the type of teamwork. It has been pointed out that some research on this topic has been of lesser value because the definition of the teams studied did not make a clear distinction between teams consisting exclusively of shop floor employees as opposed to teams consisting of managers (Pagell & LePine, 2002, p. 621). Even where, apparently, the same teamwork practices have been researched, it has been found that there were differing conceptions of what these practices actually entailed because of different understandings of the concepts between Japanese and Western managers (Sey, 2000, p. 488).

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As called for by Trochim (2005), this research attempts "to be more careful about the conceptual underpinnings of our empirical work" (Trochim, 2005, para. 12). Consistency between theoretical constructs and the variables on which data were collected was maintained by focussing clearly on the activities of shop floor teams and collecting data about the implementation of specific practices and teamwork activities rather than on generic team types.

1.2.2.2. Poor Quality Research

The quality of research on this topic has been severely criticised for a number of reasons. A positive-findings bias has been noted due to anecdotal evidence (Mullarkey & Jackson, 1995, p. 64; Fullerton et al., 2003, p.385; Choi & Eboch, 1998, p. 61), single-company case studies and selective reporting (Buchanan, 1994, p. 212), under-reporting of failures and hidden costs (corporatelawprof, 2001, para. 2),

inadequate methodological rigour (Barrick & Alexander, 1987, p. 581) and inadequate accounts of alternative explanations (Hackman & Powell, 2004, p. 87).

Respondent bias has also been reported as a problem: "...people do not say what they really think ('faking good'), or are unable to say what they really mean ('impoverished or restricted linguistic code')... [and], there is, of course, a difference (some might say a gulf) between what people say in terms of intentions to act and what they actually do" (Rushmer, 1997, p. 102).

This research attempts to counteract these methodological problems by relying on objective quantitative data in addition to the qualitative data collected.

1.2.2.3. Little Longitudinal Research

There have been numerous calls for longitudinal research to strengthen claims of the positive causal relationship between the implementation of TBWO programmes and performance outcomes (Moses & Stahelski, 1999, p. 394; Huselid, 1995, p. 668; Barrick & Alexander, 1987, p. 587). Given the fact that implementation of individual TBWO practices are most likely to be staggered over a period of time and the long lag between practice implementation and performance outcomes, there has been more than one call for such studies to extend over a 3- to 5-year period (Samson & Terziovski, 1999, p. 405; Bateman, 2005, p. 274).

The data for this research were collected over a 3-year period on both the practices implemented and the performance outcomes.

1.2.2.4. Field versus Survey Data

It has been said that this topic has been researched mostly by subjective opinion surveys (Kuipers & De Witte, 2005, p. 187; York & Miree, 2004, p. 291). Although this may be an overstatement, the fact remains that many studies on this topic are based on subjective perceptual data, which has some inherent methodological drawbacks compared to objective operational data collected by means of field studies.

It has been established that managers can have factually incorrect perceptions about the operations under their control and may confuse concepts where the distinctions can be quite crucial for research purposes (Mezias & Starbuck, 2003; Winter, 2003)

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and that "managers' ratings of team performance were not significantly correlated with ratings of team performance obtained from the team members" (O'Connell et al., 2002, p. 50). Concern has been raised about using such data without "examination of systematic informant bias and the related method variance and method bias" (Ketokivi & Schroeder, 2004, p. 247).

Despite the emphasis on operational performance measurement in CMAs, "quantitative data on the effect of TQM are relatively scarce" (Wruck & Jensen, 1998, p. 303), and it has been said that "the use of objective performance data, if available, is clearly preferable" (Kuipers & De Witte, 2005, p. 187).

Quantitative measures of both independent and dependent variables were collected in monthly increments for this research.

1.2.2.5. The Need for Qualitative Research

In spite of the concerns mentioned above, there is also a case to be made for the use of qualitative data. The detail and depth of information that can be gathered by qualitative means is itself of great value when interpreting why and how organisational initiatives impact on performance (Samson & Terziovski, 1999, p. 405). It was well put by Bresnahan et al. (2002), who said, "when it comes to assessing causality, social scientists have one advantage over natural scientists: we can ask our subjects why they do what they do" (p. 367).

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However, qualitative research also has its own weaknesses. Interpretative studies are open to question regarding methodological rigour. Without controls and/or event histories the evidence regarding causality may be weak (Easton & Jarrell, 1998, p. 257), and given the focused nature of qualitative studies, the ability to generalise may be limited (Ichniowski et al., 1996, p. 303).

Qualitative data were collected for this research by means of interviews, observation, photographs and documents for 12 firms in a multi-case research design.

1.2.2.6. Developing More Robust Theory

It is generally recognised that the complex nature of organisational interventions makes it very difficult to develop theory which conclusively links these interventions

with particular outcomes (Guest, 1997, p. 274; Roos et al., 2004, p. 28). Much the same has been said of TQM interventions, and it was recommended that researchers pay attention to the "multidimensionality of the TQM construct", use a "broad set of performance variables" and bear in mind that the "positive effect of each TQM practice on various levels of performance is different" (Kaynak, 2003, p. 426).

Two further recommendations make for even more challenges to research designed to improve our knowledge on this topic:

> The ideal study of team or organizational innovation implementation, we believe, is one that examines the implementation of a single innovation, or a common set of innovations, across a sample of adopting organizations or teams over time. (Klein & Knight, 2005, p. 244)

> Empirically, a good deal of quality team research exists. However, research has yet to be conducted that longitudinally compares the team approach with the individual approach in a field setting using " natural" work teams, doing "real" work. (Rogelberg, as cited in Church, 1998, p. 45)

The call for doing this research in natural settings requires a trade-off with the requirements of pure experimental research. The quasi-experimental setting of this research tries to make that trade-off as best possible. And, while not strictly speaking comparing individuals versus teams at work, the fact that some of the firms in the sample continued to use traditional forms of work organisation enabled that call to be addressed to some extent.

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1.2.3. Aims of this Research

Given the background, as discussed above, the primary aims of this research were:

- To investigate the relationship between the implementation of TBWO programmes at small and medium-sized manufacturers in South Africa and operational performance outcomes and to identify whether teamwork and CI practices are key enablers of improved operational performance.
- To use a multi-case, quasi-experimental, longitudinal research design to collect qualitative and quantitative data to make reliable empirical findings and contribute to knowledge on the research topic.

The secondary aims of the research were:

- To make recommendations for more effective management of the implementation of TBWO programmes and for industrial policy to support firms undertaking such programmes.
- To replicate previous research and interpret the implications of the findings of this research for previous empirical findings and theory.
- To make recommendations for areas of further research.

1.3. Structure of the Thesis

This thesis follows the traditional structure for reports of this kind, where a review of the existing theory on the topic is used to formulate research hypotheses, as applied in chapter 2. The research method is described in chapter 3, and the findings are reported in chapter four. Chapter five concludes with a discussion of the implications of the research.

1.3.1. Outline of the Theory Reviewed in Chapter 2

Chapter two starts with a review of CMAs and the role of teamwork and CI as key elements in CMA programmes. Teamwork and CI are then reviewed to define the concepts and describe the way in which they are implemented and practiced in manufacturing organisations. Several explanatory theories of why teamwork and CI might be positively associated are then presented. Thereafter, the process of programme implementation is reviewed as it has an important influence on the efficacy of the practices.

What performance outcomes can be expected from the implementation of TBWO and the issues of complementarities between practices, the lags between implementation and outcome, and the dynamics of implementation are discussed. Factors that might moderate the relationship between programme implementation and performance outcome are briefly reviewed before the research hypotheses are formulated.

1.3.2. Outline of the Research Method described in Chapter 3

The chapter on the research method used for this study starts with a review of case method, why it was appropriate for this research and what the requirements are for

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using it correctly. Several methodological issues with respect to the use of natural experiments, longitudinal research and multiple cases are also addressed.

The research design is then described, including the issues of case selection, what was done to meet validity and reliability requirements, variable selection and operationalisation, and data analysis. The way in which this research was conducted to meet methodological requirements is documented throughout the chapter as well.

1.3.3. Outline of Research Findings in Chapter 4

The detailed case studies are documented in Appendixes 4.1-4.12. In chapter 4, the findings are presented, first, by means of a general qualitative assessment of Hypothesis 1, followed by quantitative validation of the assessment. Then a case-by-case qualitative assessment of both Hypotheses 1 and 2 is done, which is also validated by a quantitative assessment. Contrary findings are interpreted, and their implications for the main research findings as well as the moderating and other factors are assessed. Finally, the findings are tested against an alternative explanatory theory.

1.3.4. Outline of the Conclusions in Chapter 5

Chapter five deals with the implications of the research findings for previous research and theory on this topic, and suggestions for further research are made. The implications for management of TBWO programme implementation and industrial policy support are discussed, and the limitations of the research are stated.

1.4. The Role of the Researcher in this Study

The role of the researcher in this study needs to be made explicit as I had been involved as a consultant and trainer in the WPC before the research commenced, and all the data were collected by me. As such, my involvement in the WPC, the advantages and disadvantages of collecting the data on my own, and the mental model with which I approached the research need to be presented to enable the reader to make an informed interpretation of the research.

1.4.1. Researcher's Involvement in the Workplace Challenge

In 1995 I was involved at the outset of the WPC in research to document the value chains in the sectors initially chosen for participation in the project. Subsequent to

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that, I helped to design, present and train facilitators of the best-practice workshops. During this time, I realised that the WPC offered a research opportunity on the implementation of TBWO. When I was appointed as the "cross-sectoral researcher" in 1999, I withdrew from all other involvement in the WPC in order to avoid influencing the programme implementation at the firms I studied. My research expenses were paid by the WPC, together with a small honorarium in return for writing a research report (Grütter, 2004).

The WPC was, in effect, an organisational experiment on the effect of introducing TBWO at medium-sized manufacturing firms on a scale for which research funds would never be available in South Africa. However, it also had limitations from a research point of view. Initially, the intention was to collect the data by means of monthly questionnaires filled in by the firm's management. It quickly became apparent that this data collection method would not work because the response rate was very low and the quality of the responses was poor. So, I started doing regular field trips to each of the 12 firms researched to collect practice implementation and performance outcome data and interview people at the firms. While it enhanced the quality of the information collected a great deal, it made heavy demands on my time as the implementation schedule of the programmes at the firms studied were not under my control.

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1.4.2. Data Collection by Single Researcher

Collection of all the data by one researcher raises the issue of bias, which is counter-acted in this research by the collection of objective data and triangulation, but it also has some advantages. It was possible to respond flexibly to data collection contingencies that arose in the field because I could make judgement calls on the application of data collection protocols without needing to keep in mind continuity with other researchers (Menard, 2002, pp. 36-7). Also, my experience in operations management enabled quick understanding of, and access to, data relevant to the research (Voss et al., 2002, p. 207).

1.4.3. Researcher's Mental Model of the Topic

With regard to case method, the research method employed here, Meredith (1998) stated that "understanding can only be considered knowledge within the confines of

someone's, typically the researcher's, perceptual framework" (p. 443). The researcher's beliefs and perspectives should therefore be made explicit. In this regard, I would describe my point of departure for this research as:

- Managerial in that operational outcomes are prioritised over workplace relations.
- Systemic in that the complex dynamics of social systems are recognised.
- Socio-technical in that the perspectives of shop floor staff and others are respected.

The model presented in Figure 1.2 represents my understanding of the causal links associated with CI, based on my general exposure to the literature and particularly my working experience of shop floor teams in factories. It was developed *prior* to the collection of data in an attempt to make explicit my tacit understanding of TBWO and my "point of entry" into the research (Henning et al., 2004, p. 26). The version presented here is a simplified version of the complete influence diagram in Appendix 1.1. Note that all but one of the relationships (indicated by arrows) in this diagram are positive. The full model contains many, but less influential, negative relationships.

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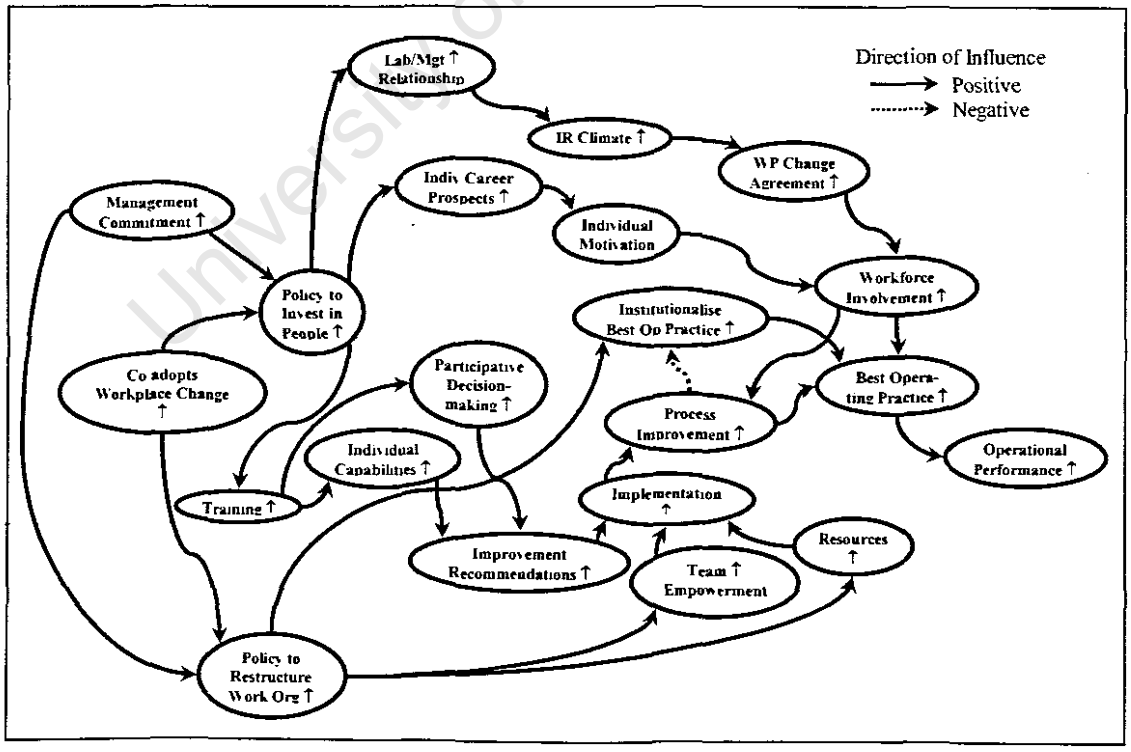

Figure 1.1: Researcher's Mental Model of Causal Influences on TBWO & CI

1.5. Scope of the Research

This research investigates the performance outcomes from the introduction of TBWO from a managerial perspective and does not attempt analysis of the social, political, and economical environment in which the firms operated. The scope of this research is also limited to small and medium-sized discrete product manufacturing plants in South Africa. However, to the extent that these firms are representative of many other similar formal Western manufacturing firms around the world, the research findings may be applicable more generally.

1.6. Ethics

The general approach to ethics in this research can be classified as utilitarian in that a pragmatic approach was taken to doing the research (Miles & Huberman, 1994, p. 289). In the interest of maximising knowledge creation on the topic, as much research information as possible was extracted from the participating firms and respondents without compromising their integrity.

The following ethical issues have been identified as relevant to qualitative research:

- Informed consent;
- Research impact on the subject matter;
- Confidentiality;
- Investigator manipulation of data or analysis findings.

(Schmitt & Klimoski, 1991, pp. 153-4)

The following ethical considerations have been identified as relevant in longitudinal research:

- Expectations and contracts between grant-awarding bodies and researchers, among researchers, and between researchers and respondents;
- Gathering and use of sensitive information;
- Free choice of participation, informed consent, respect for all persons' point of view;
- Open and reciprocal relationships between researchers and their host organisations.

(Pettigrew, 1995, pp. 116-8)

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Firms participating in the WPC were contractually obliged to participate in research associated with the WPC; however, this right was not enforced in this research. The primary concern of management in the firms researched was about confidentiality of firm-specific information. Undertakings were given to them that firm-specific information would not be shared with other firms and would not be made public in a way that could be traced back to the original firm. This was achieved, primarily, by making use of codes to identify the firms in the research, which are known only by the researcher, indexing of performance data and removal of measurement scales on graphs.

At the outset of interviews with individual respondents, they were informed that I was an independent researcher, what the research was about, that the information they provided would be treated confidentially and that their participation was voluntary. As respondents were interviewed repeatedly, I built up a working relationship with them, and almost no resistance by or discomfort of respondents was evident to me.

It was also important to maintain a clear position as an independent researcher because at times during the research, the firm's programmes were being evaluated by the WPC project manager, firms solicited additional programme support or funding, and the WPC project management was evaluated by outside agencies. When approached about these kinds of issues, I always made it clear that while I was in favour of government support for these kinds of initiatives in general, I could not become involved in efforts to secure firm-specific support, nor did I have any influence with the decision makers on these matters.

The data analysis was undertaken in such a way that a complete audit trail of the process is possible, to avoid selective or biased reporting. An undertaking was given to the firms participating in the research that the research results would be shared with them. Each of the firms was sent copies of the research report written for the WPC (Grütter, 2004), in which an earlier analysis of this research was reported. Furthermore, on completion of this more thorough analysis of the data, I intend to present these findings to the participating firms and other interested parties.

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Chapter 2: Theoretical Framework

2.1. Introduction

The core theoretical constructs used in this research will be developed in this chapter, together with some contextual theoretical issues. After a brief introduction of the contemporary approaches to manufacturing, the role of teamwork and continuous improvement practices in the improvement of operational performance will be presented. While this forms the central thesis of the research, theoretical aspects of programme implementation will be addressed as it deals with the process of making the workplace changes. The empirical research on performance outcomes from the introduction of TBWO will then be briefly reviewed as well as factors that could moderate these outcomes. Finally, the chapter closes with formulation of the hypotheses used for the research.

2.2. Contemporary Approaches to Manufacturing

As stated in the previous chapter, the different approaches to managing manufacturing operations such as TPS, JIT, TQM, WCM and LP have been subsumed under one heading as contemporary manufacturing approaches (CMA). Much has been written about what CMAs are, so only a brief overview of what has been covered extensively elsewhere will be provided here (Monden, 1983; Schonberger, 1986; Suzaki, 1993; Womack & Jones, 2003).

In a brief review of the history of lean production (Hines et al., 2004, p. 994) located the origin of CMAs in the Toyota Production System in Japan, when, in the 1950s, Taiichi Ohno developed the key concept of applying manufacturing resources to creating value for customers and regarding all other work effort as waste. This was in contrast to Fordist-type mass production, where the focus was more on capital productivity, with the consequence that other resources were used in a wasteful manner.

This approach to manufacturing evolved through several stages and with different emphases in the various industrial regions of the world. In the early years in Japan, there was a firm-level quality control and a just-in-time production scheduling approach, which broadened into total quality management that emphasised enterprise-

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wide employee involvement as these approaches spread to the West during the 1980s and early 1990s. In recent times, adaptation of the approach into supply-chain management and agile manufacturing are a reflection of the impact of information and communication technologies on co-ordination along the value chain and time-based competition.

The basic principles of CMAs are well summarised by the five principles of lean thinking:

1. Define value precisely from the perspective of the end customer in terms of a specific product with specific capabilities offered at a specific price and time.
2. Identify the entire value stream for each product or product family and eliminate waste.
3. Make the remaining value-creating steps flow.
4. Design and provide what the customer wants only when the customer wants it.
5. Pursue perfection.

   (Womack & Jones, 1996, pp. 15-28)

At what is arguably a higher level of abstraction, Spear and Bowen (1999) describe the essence of CMA as "the DNA of the Toyota Production System" (p. 98) and specify it as follows:

Rule 1: All work must be clearly specified as to content, sequence, timing and outcome.

Rule 2: Every customer-supplier connection must be direct, and there must be an unambiguous yes-or-no way to send requests and receive responses.

Rule 3: The pathway for every product or service must be simple and direct.

Rule 4: Any improvement must be made according to the scientific method, under the guidance of a teacher, at the lowest possible level in the organization.

The above conceptualisations of the essential attributes of CMAs raise philosophical issues about the nature of the environment in which production takes place and how knowledge about the production process is generated and captured. However, for the purpose of this research, the practices that are implemented when adopting a CMA are of greater interest. Accordingly, a review of what authors in the field regard as important practices was undertaken.

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The articles included in this review are part of a reference database including over 2000 journal articles on the topic of TBWO, compiled by the researcher over a period of about 8 years. The articles were identified by means of electronic searches using keywords such as "team", "teamwork", "continuous improvement", "quality management", "JIT", and "lean production" from Table of Contents' alerts and from following up citations in articles. Most of the important academic journals in the field such as the *Journal of Operations Management*, *Production and Operations Management*, *International Journal of Operations & Production Management*, *Team Performance Management*, *Academy of Management Journal*, *Decision Sciences*, *Administrative Science Quarterly*, *Group & Organization Management*, *Journal of Quality Management*, and *Total Quality Management* are included in the review.

Table 2.1 lists the CMA practices that were identified five or more times in journal articles that named the CMA as JIT, TQM, WCM or LP. Two sources, Shah and Ward (2003) and Cua et al. (2001), were similar compilations, and therefore care was taken not to double count the same source. It should also be noted that the practices reviewed were not necessarily related to performance outcomes but were merely practices associated with the CMA in the opinion of the respective authors. Further details are contained in Appendix 2.1.

This frequency count cannot be regarded as definitive as a degree of interpretation was necessary to classify these practices into the categories used here because they were often described in distinctive ways in the source material. Although referred to as a practice, what exactly qualifies as a practice (as opposed to an abstract principle or specific technique) has not been strictly defined. However, lists in which fewer than 10 practices were mentioned were excluded as these were considered to be more susceptible to a selection bias. Creation of more categories in which a practice could conceivably be classified together with other similar practices was avoided where possible. Despite all the above caveats, the list does serve the purpose of highlighting practices that are most commonly associated with CMAs.

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Table 2.1: Frequency of CMA Practices Mentioned in Literature Consulted

Practice	Count
Continuous process improvement	36
Pull flow control/JIT production/Kanban	31
Worker involvement (in CI)	31
Set-up reduction	29
Flow lines/process focus	28
Worker training	26
Multi-functional/skilled workers	25
Small lot sizing/reducing inventory	24
Expansion of autonomy and responsibility	23
Preventative maintenance/TPM	21
Visual management/information feedback	21
Team decision making	20
Quality at the source/self-inspection	20
Error-proof equipment/Jidoka	16
Cellular manufacturing	15
Order and cleanliness in the plant	15
Supplier involvement (in CI)	15
Customer orientation	13
JIT deliveries/purchasing	12
Focused factory production	10
Top-management/strategic support	10
Continuous reduction of cycle time	9
Quality control/performance measurement	9
Process capability improvement	8
Synchronised scheduling	8
Reduction of number of suppliers & distances	8
Statistical process control	8

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Strategic planning	8
Competence/performance pay systems	7
Multifunctional design teams	7
Levelled production	6
Parts standardisation	6
Zero defect principle/broad focus on quality	6
Cross-functional teams/planning	6
Work time flexibility/job rotation	5
Product modularisation/simplification	5
Design for manufacturability/product quality	5

While the high-ranking practices do not constitute a coherent programme to improve operational performance, it is apposite to note that the two key practices of interest in this research, continuous process improvement and team decision making, rank highly. In addition, a number of related practices, such as small-lot sizing/*Kanban* systems, worker involvement and training, multi-skilling, increased autonomy and visual management/information feedback, are also high on the list.

2.2.1. Teamwork & CI as Key Elements of Contemporary Manufacturing Approaches

As shown above, CMAs consist of a host of practices intended to improve the operational performance of firms. Some of the practices, such as set-up reduction, improved process capability, and reduced down-time are ends in themselves in that implementation of the practice leads directly to a reduction of operational waste. Other practices, such as training, statistical process control, housekeeping, and so on are means to the end of waste reduction. Of these different means, process improvement and teamwork are regarded as crucial practices, as illustrated by the following quotations:

> ...problem-solving teams are central to the kaizen, or continuous improvement, process and are a prominent feature of the work organization of large Japanese manufacturers. (Ichniowski & Shaw, 1999, p. 705)

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> The management literature has often credited 'kaizen' and the participation of the workforce in process improvement and refinement as being a key element in Japanese manufacturing success... SGAs' refers to small group activities which form the core of overt kaizen activity. (Brunet & New, 2003, pp. 1427-9)

> In practice, most quality programs focus on enhancing organizational performance through "continuous quality improvement", in which there is an effort to surface and systematically reduce or eliminate sources of customer dissatisfaction (including errors). (Sitkin et al., 1994, p. 542)

> Employee Involvement (Kaizen) is a fundamental means featured in common by TQC, TPM and JIT. (Enkawa, 1998)

> ISO 9000 delivered "consistency", which is necessary but not sufficient for quality... For this, kaizen was identified as appropriate... to lead the organization towards TQM... a process for company-wide continuous improvement. (Gondhalekar et al., 1995, p. 193)

> Employee suggestions are the most fundamental element in EI... Indeed, a formal employee suggestion system is often an integral part of such EI programs and HPWPs. (Kim, 2005, p. 633)

> ...team-based work in the guise of quality circles has been an integral part of most TQM programs. (Pagell & LePine, 2002, p. 620)

> Continuous quality improvement is fundamental to enhancing plant competitiveness. (Field, 1997, p. 1)

Many other authors refer to teamwork and CI as central to CMAs (Easton & Jarrell, 2000, p. 89; ILO, 2000; Hackman & Wageman, 1995, p. 5). The pre-occupation with these two practices, in short, is because CI is the mechanism by which changes are made to the production process to improve operational performance, and teams are the organisational unit regarded as most effective to make these changes. While there are other means by which these changes can come about, such as new technology, in CMA, the concern is with improving existing production processes through changing work practices rather than changing the production technology. The next two sections review the theoretical aspects of the teamwork and CI constructs.

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2.3. *Theory on Teamwork*

This review of theories related to teamwork starts with a section describing teams and then goes on to review models of teamwork in relation to performance. A vast amount of literature on teamwork exists, and therefore this review will focus on the aspects of the literature that is most relevant to shop floor teams. It should also be kept in mind that the complexity of TBWO is reflected in the terminology about it. Sometimes, different real-world manifestations of team work are referred to by the same term; at other times, different terminology is used for similar teamwork attributes (Field & Sinha, 2000, p. 105; Lazes & Falkenberg, 1991, p. 58; Sey, 2000, p. 488).

It should be re-iterated that this research focuses on shop floor teams. Therefore, teams at other levels in organisations, such as strategic management and organisational project teams, are not specifically addressed in this review.

2.3.1. Definition of Shop Floor Teams

Numerous definitions of teams exist (Cohen & Bailey, 1997, p. 241). Based on five definitions of teams by Mueller and Purcell (cited in Buchanan, 1994, p. 204), Wellins et al. (1991, pp. 3-5), Yeatts and Hyten (1998, p. xiii/iv), Cohen et al. (1996, p. 653) and Katzenbach and Smith (1993), the following general definition of teams was developed (See Appendix 2.2 for details):

A shop floor team is likely to be a permanent group of 5 to 15 employees who work in an inter-dependent way to produce a product or service as a whole for internal or external customers, with a high degree of autonomous team based decision making. They collectively take responsibility for managing their daily work, including work allocation, co-ordination of supplies and other resources required, monitoring and improvement of performance, and interaction with other teams and/or organisational functions. In addition, they are likely to have a participative leader, set their own team goals, encourage training towards being multi-skilled to facilitate job rotation, be involved in staff recruitment and discipline, and possibly set their own budgets.

The kind of teamwork described above is usually characterised as a fundamentally different kind of work organisation from traditional hierarchically structured and individual-based work organisation, which is also associated with Taylorist job design

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(Ashton & Sung, 2002, p. 73) and Fordist organisation of production (Hampson, 1999, p. 372).

2.3.2. Types of Shop Floor Teams

A number of different dimensions have been used to classify shop floor teams, depending on the interest of the researcher. For instance, teams have been looked at from the point of view of organisational innovation (Bailey & Sandy, 1999, p. 45), industrial democracy (ILO, 2000), regional/cultural differences (Goldman, 1993; Sey, 2000), team member interdependence (Belbin, 1993; Benne & Sheats, 1948) and socio-technical perspectives (Van Amelsvoort & Benders, 1996; Kuipers et al., 2004).

Several authors typed teams according to organisational structure and/or function (Cohen & Bailey, 1997, p. 241; Ratliff et al., 1999, p. 32). Variation among different types of teams has been classified into five groupings:

- Degree of permanence of the structure;
- Emphasis on competence creation, i.e. training;
- Genuine dispersal of influence;
- Degree of interchangeability of tasks; and
- Level of task assignment (from routine via tactical to strategic).

(Heller et al., 1998, p. 165)

In this research, the dimensions of greatest interest were team autonomy and the extent to which teams engaged in CI activities. To a lesser extent, organisational structure and whether the teams were permanent or not, were also of interest.

Lindberg and Berger (1997, p. 93) used a two-dimensional matrix to classify teams into types, according to the extent of engagement in CI activities and whether this was integrated into the team's normal work or was a stand-alone activity, as illustrated in Table 2.2. Quality circles meet off-line to do improvement projects; wide CI involves employees in process improvement across natural work groups, whereas organic CI applies to where CI has been institutionalised. Expert task-force CI refers to temporary cross-functional teams made up of technical experts, while the last type is individuals making suggestions implemented by other staff.

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Table 2.2: Team Types in a CI organisation

		IMPROVEMENT TASK		
		Parallel: Separated from ordinary tasks		Integrated: One of ordinary tasks
BASIC TASK DESIGN	Group	Quality circles	Wide-focus CI	Organic CI
	Individual	Expert task-force CI		Individual CI

However, the issue which underpins most of the abovementioned typologies is that of team autonomy. It is central to the role of teams inasmuch as much of the rationale for TBWO derives from the presumed efficiency of decentralised decision making. In the typologies of Harman et al. (2002, p. 363), Moses and Stahelski (1999, p. 393) and Field and Sinha (2000, p. 104), the position of the team in the organisational structure changes with team autonomy. So, for instance, Field and Sinha (2000) listed the following types of shop floor teams in order of increasing team autonomy:

- Traditional work groups have little autonomy and perform direct production tasks under supervision with indirect support provided by specialist staff.
- Quality circles have regular meetings of employees to formulate suggestions for process improvement in their work areas, although membership is usually voluntary. Little, if any, changes are made to the work organisation or to the authority hierarchy.
- Semi-autonomous work groups have greater control over direct production activities but not over technical support such as quality control or maintenance.
- Self-managing teams self-regulate entire interdependent sets of tasks, from purchasing raw materials to shipping the final product, including functions such as on-line quality control and autonomous maintenance, but the scope is limited to production-related tasks.
- Self-designing teams have full autonomy over not only production and related support activities but also over management of the team, which may include discipline, incentives, recruitment, and skills development.

Generally speaking, the teams studied in this research were encouraged to become self-managing, with an emphasis on day-to-day co-ordination of direct production

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activities, performance measurement and process improvement by the team. Few teams got as far as self-designing activities, although in one firm, the teams controlled budgets to make process improvements.

2.3.3. Models of Team Development

While team development is not a focus of this thesis, it is briefly reviewed as the implementation of TBWO over time is inherently dynamic and therefore patterns of team development have implications for performance outcomes.

One of the earliest models of team development proposes that teams go through several consecutive stages of development:

1. Forming: initial orientation between group members relative to required task behaviour;
2. Storming: interpersonal conflict dominates group behaviour;
3. Norming: the group coalesces around common norms of behaviour;
4. Performing: tasks are accomplished to the extent that appropriate group roles and behaviour have emerged;
5. Adjourning: disbanding of group.

(Tuckman & Jensen, 1977)

This consecutive phase model of group development has had significant influence and several other models have been developed from it. Katzenbach and Smith (1993) described a so-called team performance curve, where teams go from being a working group, where performance is the "sum of individual bests", through pseudo-teams with no team focus, real teams with a common purpose to high-performing teams who are also "committed to one another's personal growth and success" (pp. 91-92). Wellins et al. (1991) have a similar phase model based on a continuum of team empowerment (p. 26).

Socio-technical approaches take account of both technical task requirements and social relations to build open systems models of team development, in which employee development, group maintenance, boundary management and reflective learning shape the phased development of the teams from "bundles of individuals" to "open teams" (Van Amelsvoort & Benders, 1996, pp. 164-5).

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However, little empirical support has been found for strict sequential, or even for the more dynamic phase models of team development, and they have been criticised for being normative rather than descriptive (Kuipers, 2005, p. 23). Alternatives to sequential phase models have been proposed. Gersick, (1988) proposed a punctuated equilibrium model, and Marks et al. (2001) proposed a recurring phase model in which overlapping of phases occurs. A test of team development in a truck assembly plant found that teams did not develop according to a typical generalisable pattern, and therefore team development could not be linked to team performance. However, particular team development dimensions were found to be associated with particular performance outcomes, for example, "...increasing delegation of control tasks and an increasing capacity for improving initiative within the teams enabled the teams to reduce the number of defects" (Kuipers & De Witte, 2005, p. 197).

2.3.4. Models of Team Process

Whereas team development models attempt to explain team performance in terms of the maturation of teams, team process models focus more on how and under what circumstances teams process task-related activities. It has been suggested that the key issues of participative work systems can be subsumed under the headings of decision-making power, access to information, employee knowledge and skills, and reward systems (Lawler, 1991, p. 22).

Sagie and Koslowsky (2000, p. 18) proposed a three-path model of participatory decision making that suggests that motivational factors mediate decision acceptance, cognitive factors mediate decision quality, and inhibiting factors have a negative effect on decisions in the workplace, which in turn impacts on work outcomes. While the model is useful in delineating the role that human-related factors play, it does not address the influence of the organisational context in which teams work.

Appelbaum et al. (2000) used a model based on the "central role that work organisation plays in providing nonmanagerial employees with the opportunity to contribute discretionary effort through participation in shop floor problem solving and decision making" (p. 26). In addition to opportunity for substantive participation, skills and incentives are presumed to determine the effort employees exert to improve

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plant performance. This model allows for consideration of organisational and contextual determinants of performance, and in a wide-ranging review of several American industrial sectors, it was concluded that "more participatory work systems improve efficiency and enhance operational performance across a wide range of manufacturing industries" as well as "raise the level of trust within workplaces, increase workers' intrinsic rewards from work, and thereby enhance organizational commitment" (Appelbaum et al., 2000, p. 234).

Gladstein (1984, p. 502) proposed the model in Figure 2.1 below, which encompasses not only intra-group and organisational factors but also allows for group dynamics and the nature of the task to explain group effectiveness. It is one of the few models that has been empirically validated with a large sample, albeit with sales teams. She found that subjective group member ratings of group process and organisational support were positively correlated with employee satisfaction and perceived performance but negatively correlated on actual sales revenue, whereas boundary management and a marketing orientation were positively related to actual sales revenue.

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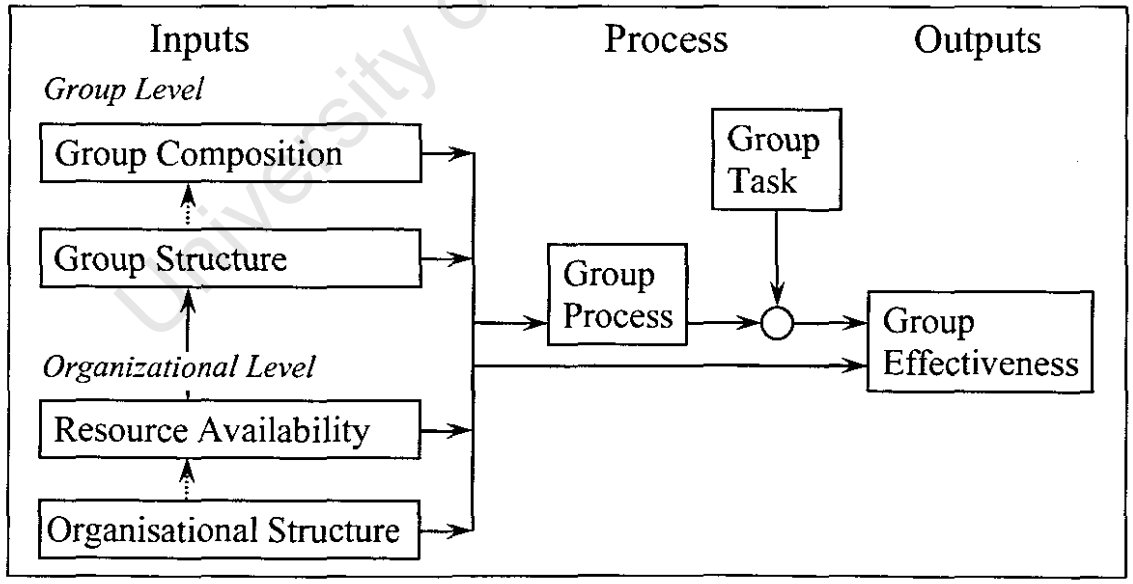

Figure 2.1: Gladstein's Model of Task Group Effectiveness

Mohrman and Novelli (1985, pp. 96-7) argued that two different sets of causal links are implied by the literature on quality circle effectiveness and therefore proposed two models. The first, as illustrated in Figure 2.2, relies on the implementation of suggestions to improve performance and employee satisfaction. The second,

illustrated in Figure 2.3, uses essentially the reverse causality, whereby improved employee satisfaction and motivation leads to improved performance.

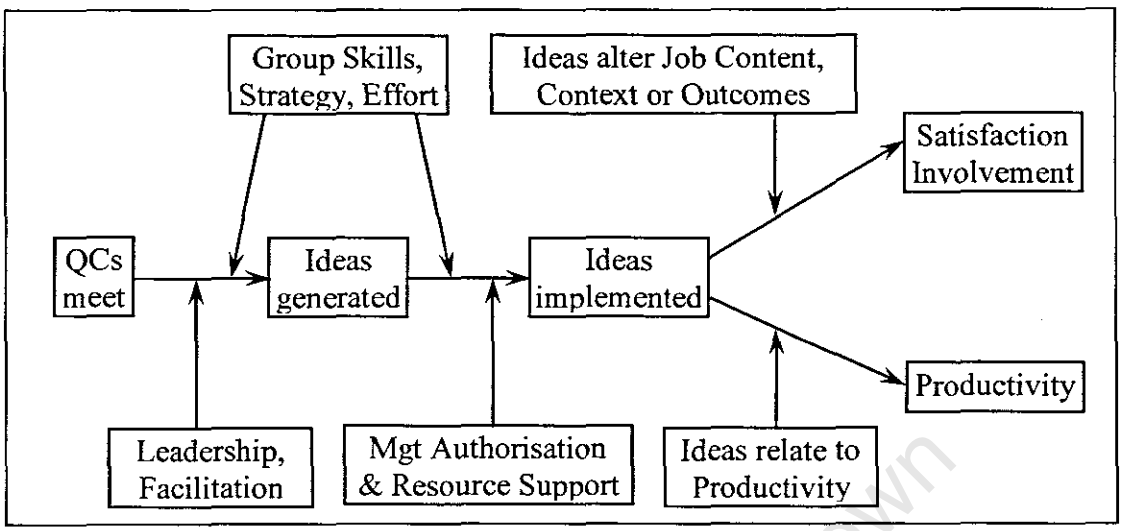

Figure 2.2: Mohrman and Novelli (1985) Model 1

The study based on these models found that "attitudinal improvements as a result of direct QC participation may not be accompanied by improvement in productivity and attitudes of the workforce as a whole" (Mohrman & Novelli, 1985, p. 109). This finding was partially explained by management's unsystematic use of problem-solving techniques and discouragement of fundamental change to work organisation.

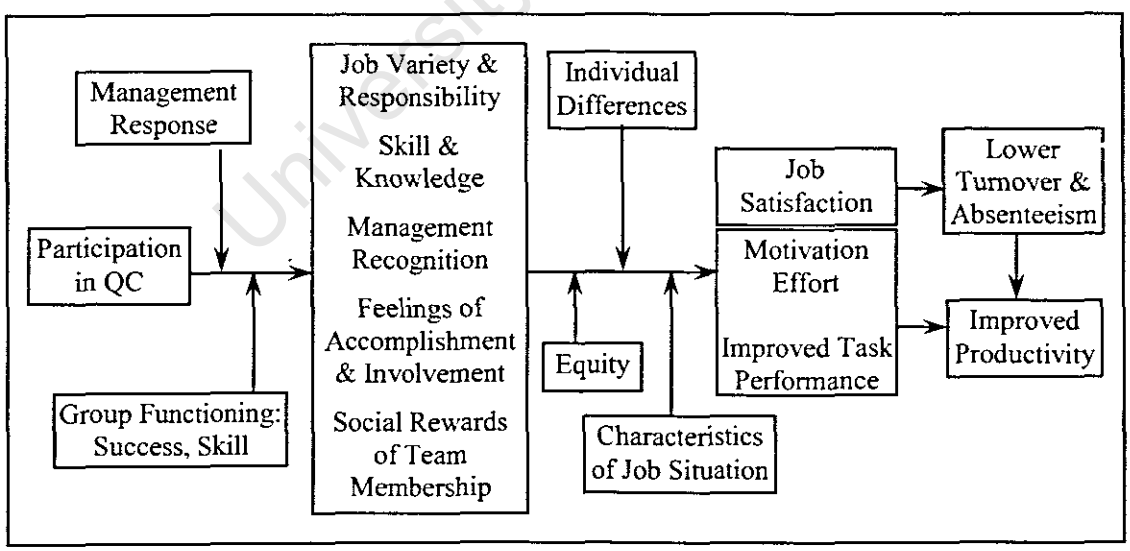

Figure 2.3: Mohrman and Novelli (1985) Model 2

Cohen et al. (1996, p. 643) developed a predictive model of team effectiveness based on several theoretical perspectives, including work design, self-leadership, socio-technical systems, and participative management. Four categories of variables that

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were presumed to predict self-managing work-team effectiveness were identified: group task design, encouraging supervisor behaviours, group characteristics, and employee involvement context. The model was tested with customer service teams in a telephone company and support was found for a positive relationship between the independent variables "group task design", "group characteristics", and "employee involvement context" and the dependent variables "employee rating of performance", "management rating of performance", "quality of work life" and "absenteeism", but not for the dependent variable "encouraging supervisor behaviour".

Yeatts and Hyten (1998) conducted multi-case research into self-managed work-team performance with the purpose of clarifying "the specific factors most important to an SMWT's success" (p. xv). To this end, they developed a theoretical model based on a review of eight models of TBWO, which they tested against the findings of ten cases of SMWTs from manufacturing, government and health organisations. Their initial input-process-output model contained ten input, two process and three output constructs (although these were at a high level of abstraction) chosen on the basis of frequency of use in previous models, empirical support and theoretical justifications.

After conducting the first six case studies, they made substantial revisions to the model, which was validated against a further four cases, which required only minor revisions to the model. The revised model (see Figure 2.4 below) contained 16 input constructs, six process constructs and a rationalisation of the output constructs to two performance constructs, with the exclusion of employee satisfaction and group maintenance as dependent constructs that were originally part of the model. They also introduced task-contingent factors as a moderating construct, feedback loops from outcomes to inputs, and process constructs, and a recognition that causality between the constructs are more complex than linear uni-directional relationships suggest. The final model must be one of the most comprehensive models of TBWO developed to date which illustrate the complexity of TBWO.

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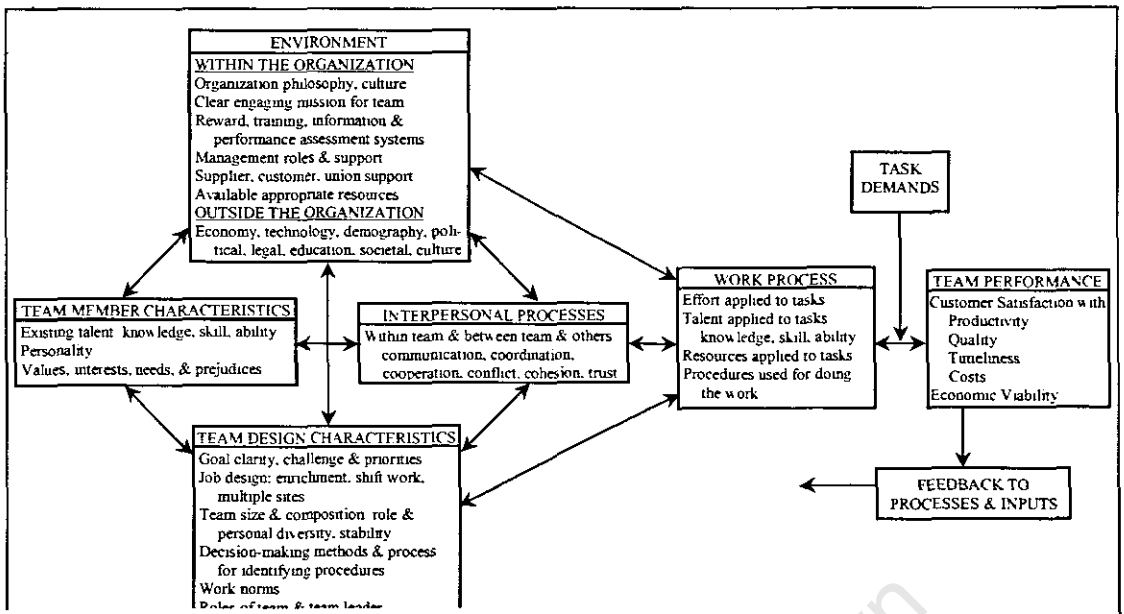

Figure 2.4: Yeatts and Hyten (1998). Revised Model of SMWT Process

2.4. *Theory on Continuous Improvement*

The second construct regarded as key to CMA is continuous process improvement, or *continuous improvement* for short. After defining the construct, describing the steps of doing it and identifying some obstacles to effective CI, several explanatory theories of CI will be reviewed.

2.4.1. Definitions of Continuous Improvement

Sometimes CI is defined as a broad change program, as distinct from project-based change (Lindberg & Berger, 1997, p. 86), but that is not the sense in which CI is used in this research. While CI is part of organisational programmes to implement CMAs, the focus here is on a narrow interpretation of CI, defined as "an organisation-wide process of focused and sustained incremental innovation" (Bessant & Francis, 1999, p. 1106). It is "a planned, organized and systematic process put into place (and ideally continuously improved) by management. The objective of this process is to create and sustain a behaviour that results in a multitude of adaptive improvements, which taken together, have a substantial impact on manufacturing performance" (Lindberg & Berger, 1997, p.88), and it is "driven by participative management so that all levels of the workforce are involved in this effort..." (Banker & Khosla, 1995, p. 432). While changes in operational systems (hard and soft) may come about through CI, the real focus of CI is on changing work practices on the production process at shop floor level (Spear & Bowen, 1999, p. 98).

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What the abovementioned definitions of CI do not state explicitly is that CI changes the way in which direct production is executed after a particular change to the process. Making CI work effectively therefore requires more than a mechanism to implement process improvements. It also requires a mechanism to capture the process change into a new work practice which is used consistently by all employees who work on the process (Lapré et al., 2000, p. 606; MacDuffie, 2000, p. 191). Also, it requires a mechanism to sustain the consistent use of the new work practice over time. Thus, process improvement needs to be complemented by process standardisation between interventions to effect process changes (Adler & Cole, 1993, p. 89; Spear, 2002, p. 764).

Lindberg and Berger (1997, p. 94) said that management controls three aspects of CI:

Process: Management defines *how* (by whom) and *when* improvement activities take place by means of time allocation and access to resources.

Content: Specification of themes (what to improve), problem-solving techniques, or end-results of improvement activities.

Goals: Indirect control of CI by defining business-related goals for teams (e.g., delivery, lead-time, or cost).

2.4.2. The Process of Doing Continuous Improvement

At the heart of the CI are the process steps to do it. Numerous "problem-solving" and "decision-making" techniques have been developed since the Plan-Do-Check-Act cycle was introduced by Walter Shewart and W. Edwards Deming (Deming, 1986, p.88; Linderman et al., 2004, p. 598). The following steps for doing a CI project have been compiled from seven sources on how to do it. A comparative table of all the sources is provided in Appendix 2.3.

1. Identify problem/improvement area in which to do project.
2. Learn to understand the process in that area by documenting the process.
3. Clarify what creates value for the customer.
4. Identify appropriate measures and collect data.
5. Analyse data to identify wastes most susceptible to improvement.
6. Identify possible countermeasures and decide which to implement.

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7. Plan and implement the countermeasures.
8. Evaluate the results and repeat if necessary.
9. Update process documentation with improved operating practices.

Obviously, there are many variations on the abovementioned steps of doing CI. However, CI, in essence, simply amounts to affording shop floor employees the opportunity to undertake systematic process improvement in addition to their direct production work. Despite this, actually getting CI done is not easy.

2.4.3. Obstacles to Doing Continuous Improvement

The first issue that presents an obstacle to doing CI is to release shop floor employees from direct production work to do CI because it changes the associated cost from an expense with a return in the short term to an investment with an uncertain future return. Several ways of dealing with this issue occur. In some firms, CI is integrated into the daily routine of permanent teams. They may address problems and process improvement during their regular team meetings when these are brought to light by performance monitoring. Alternatively, CI project teams may be temporarily constituted to address specific objectives. The former approach is less disruptive but may lead to inadequate attention to and/or effort in achieving CI. The latter allows for more focused CI but is more disruptive.

The second issue relates to the effectiveness of CI when it is being undertaken. Much has been written about the problem-solving and decision-making techniques that should be used when doing CI (Suzaki, 1993; Bunney & Dale, 1997, p. 184; Antony & Banuelas, 2002, p. 24). However, the techniques for collecting and analysing data are often used incorrectly or not at all due to insufficient training (Easton & Jarrell, 2000, p. 107; Mohrman & Novelli, 1985, p. 107). Even after adequate training, the techniques are regarded as too onerous and therefore neglected (Zbaracki, 1998, p. 608). The consequence is that identification of special causes and root-cause elimination is based on intuition and improvement suggestions are haphazardly selected (MacDuffie, 2000, p. 185).

Lack of resources and time to effect improvements after recommendations for improvement have been made can also be an obstacle. Apart from the direct effect of

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delaying improved performance, difficulty with implementation of suggestions also affects the motivation of employees and the credibility of the CI programme (Mohrman & Novelli, 1985, p. 102; Womack & Jones, 1996, p. 200).

The abovementioned obstacles relate to process improvement specifically. There are also wider organisational issues relating to programme implementation and sustenance and support system alignment that will be addressed later in section 2.5.

2.4.4. Explanatory Theories of Continuous Improvement

Having reviewed what CI is and some key issues regarding its execution, I now address explanations as to why it works. Once again, the focus is not on broad explanations such as organisational (Cole & Scott (Eds), 2000) or economic (Banker & Khosla, 1995; Lederer & Rhee, 1995) theories but on explanations of the firm-level dynamics of CI.

2.4.4.1. Quality Management Literature

Classical quality management theory, as originally proposed by Walter Shewhart (Shewhart, 1939) and developed by Edwards Deming (Deming, 1986) and others, relies on statistical analysis of performance to identify common and special causes of variation in performance. Common causes of performance variation are due to the inherent variation of the inputs to the production process, including the raw materials, equipment, and practices used as they were designed to be used. Special-cause variation is due to non-standard operation of the production system due to an identifiable deviation from operating the system as it was designed to run. A process from which special cause variation has been eliminated (i.e. runs within the specified statistical control limits) is said to be capable of producing according to specification. Further reduction of variation, or improving the mean performance, would require design changes to the production process and is therefore more difficult to effect (Deming, 1986, p. 310; Gitlow et al., 1989, p. 10).

The explanation for why reduction of process variation is beneficial lies with the negative consequences of high process variation. These include poor delivery performance, difficulty with production planning due to uncertain output, (Field & Sinha, 2005, p. 159), the direct cost of reworking defective output, and similar issues. In an attempt to reduce the negative impact on customers, firms often increase buffer

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inventory, but of course this leads to higher working capital requirements (Womack & Jones, 2003, p. 138) and contributes to obscuring the causes of production problems (Suzaki, 1993, p. 163).

The link between process variation and CI is that very often the purpose of CI is to reduce process variation. To this end, statistical process control (SPC) is one of the techniques most often used by shop floor teams doing CI projects as it enables the identification of sources of variation or poor performance (Womack & Jones, 2003, p.137). This does not imply that CI is limited to reduction of process variation; however, improving mean performance may require technical expertise and external authority to change the production system unless the change is in work practices that are within the prerogative of the shop floor employees.

2.4.4.2. Learning Curve Theory

The proposition that performance improves at a constant rate with every cumulative doubling of volume produced is well established in the literature (Yelle, 1979). However, it has been noted that the relationship is more complex than suggested by the basic formulation as learning rates differ across and within different industries, products and processes (McCreery et al., 2004, p. 394). The following inadequacies to the simple power form of the formula were identified by Lapré et al. (2000, p. 598):

- the observation of two patterns: initial downward concavity and a plateau effect;
- learning rates vary widely even within the same plant;
- learning rates are affected by external factors such as change of technology or the increase in scale of production;
- the remaining possible room for improvement affects the learning rate.

In addition, the rate of decay of performance is not always accounted for. This could be due to labour turnover, individuals forgetting how to produce optimally, poor documentation of operational practices, technological obsolescence, or relocation of production (Argote et al., 1990, p. 151; Repenning & Sterman, 2001, p. 66).

Nevertheless, the fact that the learning curve is not a simple relationship does not invalidate the basic principle that experience of a particular production process is often translated into improved performance. Descriptive mathematical formulations of

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the learning curve have been derived from observed performance data (Epple et al., 1991, p. 64), and Zangwill and Kantor (1998, p. 910) theoretically linked learning curve theory to CI by developing an equation based on an explanation of minimisation of waste (non-value-adding activities such as rework, delays, preparation time, transportation, etc.) in a process.

2.4.4.3. Agency Theory of Decision Making

Agency theory explains the dynamics of teamwork and CI in terms of the rights and responsibilities as contracted between principals (shareholders) and agents (management and employees). The basic principle of agency theory is that the optimal operation of the production process has been delegated by the shareholders via management to shop floor teams in exchange for rewards and incentives. According to Melnyk et al. (2004), these transactions have been studied from perspectives such co-ordination, control, and management of the relationship, and factors such as information availability, outcome uncertainty, risk propensity, programmability and length of the relationship have been considered as factors influencing the relationship. In operations management, the role of performance measurement as the mechanism by which the relationship is monitored and managed has received particular attention, as popularised by the adage "You cannot manage what you cannot measure" (Melnyk et al., 2004, p. 214).

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The utility of shop floor teams undertaking CI has been explained by Wruck and Jensen (1998, pp. 312-3) in terms of the transaction costs of transferring "specific knowledge" (valuable knowledge which is expensive to transfer). This knowledge exists at all levels of the organisation, and if decision rights to use the knowledge are not appropriately located, then inefficiencies ensue. Therefore, it is most appropriate for decision making about process improvements to be decentralised to shop floor teams as they are collectively most likely to have best access to the relevant information and are most likely to be in a position to make best use of the knowledge (Wruck & Jensen, 1998, p. 314; Tucker et al., 2002, p. 124). Management are said to be predisposed to overcentralise decision making because they systematically overestimate the agency costs of decentralised decision making and underestimate the value of specific knowledge at lower levels of the organisation. However, decentralisation is not appropriate if shop floor employees are incapable or unwilling

to utilise specific knowledge of the production process (Wruck & Jensen, 1998, p. 317).

2.4.4.4. Goal Theory

Goal theory is premised on the notion that well-specified goals lead to better performance than less well-specified goals or goals left to the discretion of the people undertaking process improvement. Six Sigma, which is regarded by some as a more sophisticated form of CI, sets the general goal for process improvement at no more than 3.4 defective parts per million. In a review of how goal theory is related to Six Sigma, Linderman et al. (2003) proposed the following relationships between goal-related conditions and performance:

- Specific and challenging, but attainable, goals are positively related to performance;
- Task complexity increases the level of challenge of goals, sometimes beyond a level thought to be attainable, which can lead to reduced commitment to attaining the goals;
- Training in process improvement techniques reduces the perceived difficulty of attaining challenging goals and increases commitment to attaining the goals;
- Reduced goal specificity leads to greater variation in performance outcomes;
- Training in techniques appropriate to the task complexity and the use of structured process improvement tools lead to increased performance on complex tasks;
- Top management support, access to improvement expertise, and improvement incentives increase goal commitment;
- Specific goals increase employee effort, focus activities on goal-relevant activities, and lead to more sustained effort to achieve the goals.

Thus, the primary value of goal theory for CI lies in its explanation of CI effectiveness in terms of the match between task complexity and the capability of employees to effect CI, as moderated by organisational support.

Setting appropriately challenging goals requires taking account of a variety of factors, not the least of which is that team members should believe that the team objectives are "possible and plausible" (Edmondson, 1995, p. 14). The goal estimate should preferably be based on baseline data of performance prior to the process improvement

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(Linderman et al., 2003, p. 194) and a realistic assessment of the means to achieve the goals (Schneiderman, 1988, p.53).

2.4.4.5. Institutional Theory

Institutional theory proposes that organisations are dependent on external constituencies for resources, and because resource transfer is not always proportionate to organisational performance, some organisations engage in political processes to enhance goodwill and legitimacy and thereby maximise access to these resources (Choi & Eboch, 1998, p. 70). This leads to "grandstanding", where CI practices are inadequately implemented (Zbaracki, 1998) or even falsified (Baxter & Hirschhauser, 2004) as they are thought to be desired by customers.

Institutional theory is useful in explaining the contradictory evidence that implementation of CI practices results in much improved performance outcomes in some cases and disappointing outcomes in other cases as it proposes alternative motivations and mechanisms than performance improvement for implementation of CI practices. Thus, for instance, a strong direct link between quality management practices and customer satisfaction has been found, but a weak link exists when operational performance mediates quality management practices and customer satisfaction (Choi & Eboch, 1998, p. 70), which suggests that being seen to do "the right stuff" has more marketing value than performance improvement itself. It has been argued that first movers to adopt new management practices are driven by a desire to improve performance, while second movers are mainly interested in enhancing their image (Westphal et al., 1997; DiMaggio & Powell, 1983). However, Naveh et al. (2004, p.1843) found that learning is a more important factor than timing in explaining ISO 9000 performance. First movers achieve a high level of performance because they learn from their own experiences, and second movers achieve a high level of performance because they learn from the experiences of others.

2.4.4.6. Organisational Learning

Organisational learning theories have become increasingly influential as explanatory models for CMAs in general and CI in particular. Increasing environmental complexity and rates of innovation are said to drive the "need for learning in work teams" (Edmondson, 1999, p. 380) and "the need for firms to learn" (Dodgson, 1993,

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p. 376). Given that individuals are recognised as the generators of new knowledge, the question arises as to how learning at team and firm level takes place. One of the explanations offered is that CI fulfils this role: "The potential for CI to become an enabling mechanism in organisational learning is only now beginning to be recognised" (Bessant & Francis, 1999, pp. 1106-7).

Theorising in this field has been complicated by terms like "learning" and "knowledge" being used interchangeably (Linderman et al., 2004, p. 593) and by numerous theoretical models (Kim, 1993; Crossan et al., 1999; Nonaka et al., 2000; Balbastre & Moreno-Luzon, 2003) that deal with the inherent complexity of the learning process in slightly different ways. Because of the specific focus on CI, and for the sake of parsimony, two key aspects of these theories will be presented here, although it must be acknowledged that this is a simplification of the theories on the topic.

The first aspect is that of the ontological status of knowledge; in other words, where and in what form does knowledge reside? While the wellspring of knowledge is recognised to be individuals (Linderman et al., 2004, pp. 594-5; (Balbastre & Moreno-Luzon, 2003, p. 374), it is institutionalised at group and organisational levels (Kim, 1993, p. 45; Crossan et al., 1999, p. 529). Another dimension to the ontology of knowledge is that it exists in tacit and explicit forms. Often, but not always, tacit information is created and held by individuals (Balbastre & Moreno-Luzon, 2003, p. 372), which gives rise to the second aspect: what is the epistemology of knowledge? Or, how is knowledge generated and transferred from individuals to organisations?

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The issue of the epistemology of knowledge could be framed as an input-process-output model with several applications:

- input of observed information which is processed into individual knowledge;
- knowledge input from individuals that goes through a transfer process to other individuals, and;
- knowledge input from individuals, groups and organisations that goes through a transfer process to other groups and organisations.

Several theorists suggested that individual learning has four stages, as shown in Table 2.3 below:

Table 2.3: Stages in the Learning Cycle

Lewin in Kolb, 1984, p. 21	Concrete Experience	Observation & Reflection	Formation of Abstract Concepts & Generalisation	Testing Implications of Concepts in New Situations
Kolb, 1984	Experience	Reflection	Theorising	Experimentation
Argyris & Schon, 1978	Discovery	Invention	Production	Generalisation

Kim (1993, p. 39) transferred these learning stages to an organisational context as observe, assess, design, and implement, which gives rise to individual mental models that are transferred to others to become shared mental models at group and organisational levels. While the model by Kim goes some way to explaining the generation of knowledge, it does not adequately deal with transfer of knowledge. The model by Crossan et al. (1999, p. 525) proposes the stages of intuiting, interpreting, integrating, and institutionalising, of which the middle two bridge the individual, group, and organisational levels, as illustrated in Figure 2.5 below. This model also proposes feedforward and feedback processes between the different ontological levels.

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Balbastre and Moreno-Luzon (2003) integrated the models by Kim (1993) and Crossan et al. (1999) but also proposed some modifications. Firstly, they separated the cognitive and behavioural aspects of learning to indicate that while single-loop learning can effect behavioural changes, double-loop learning, involving cognitive manipulation of concepts and relationships is required to effect changes to mental models. Secondly, the influence of perspectives and/or beliefs in the form of mental models at individual or levels, on behaviour, and thirdly, the role of groups in linking

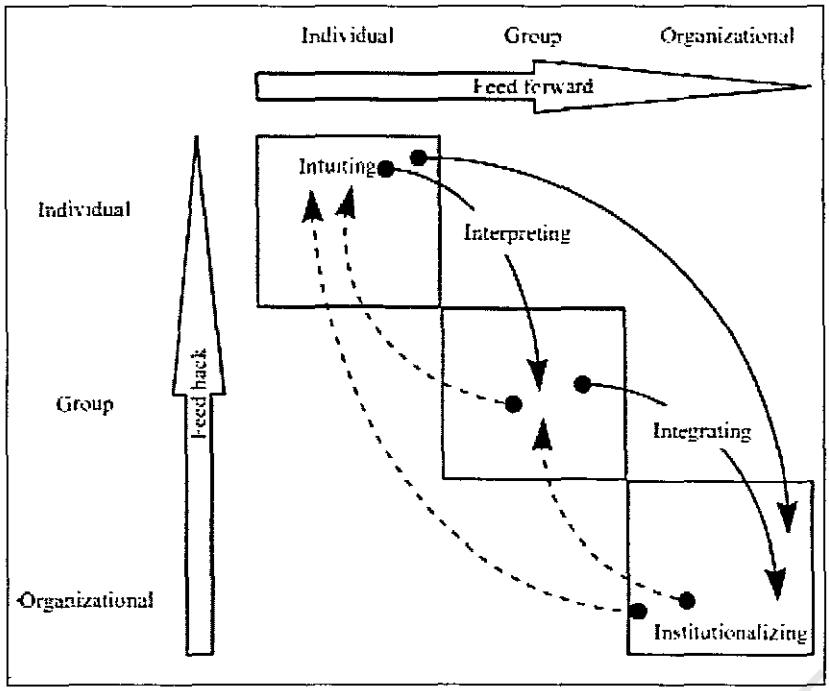

Figure 2.5: 4I Model of Organisational Learning (Crossan et al., 1999, p. 532)

the individual and organisational level (because that is the level at which most interaction between individuals takes place) are recognised (Balbastre & Moreno-Luzon, 2003, pp. 375-6).

A model of organisational learning that has become prominent in the literature is that of Nonaka et al. (2000). It emphasises the cycles of learning between tacit and explicit knowledge through the reciprocal influences of individuals on organisations and social groupings on individuals (See Figure 2.6 below). It is posited that at each stage of conversion, particular transformations of the knowledge takes place in a perpetual iterative cycle.

Knowledge creation is regarded as inherently contextual relative to individual or shared mental models which integrate time, space, and cognitive elements. Organisational knowledge is viewed as four types of assets: experiential, conceptual, systemic, and routine knowledge assets. While middle management plays an important role in the knowledge creation process, top management's leadership in managing the "knowledge vision" of the organisation is regarded as crucial (Nonaka et al., 2000, pp. 23-4).

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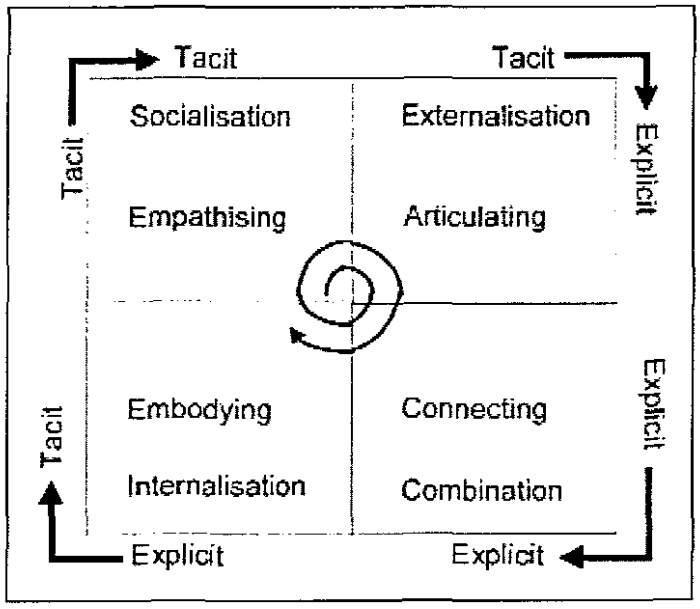

Figure 2.6: Knowledge Conversion Processes (Nonaka et al, 2000, p. 12)

Having conducted a "whistle-stop tour" through the organisational learning theory, I need to return to the two issues identified earlier and the role of organisational learning theory in CI. The ontological problem in learning organisations is that there is a gap between the intuitively generated, tacit knowledge at the level of individuals (and groups that preserve privileged knowledge) and the institutionalised explicit knowledge at the level of organisations. However, "it is only when the organization is capable of developing the capacity for transferring, sharing and fostering the fragmented knowledge and expertise existing at an individual level that it will be able to obtain the benefits derived from organizational learning" (Balbastre & Moreno-Luzon, 2003, p. 372).

While most CMA models emphasise CI practice (36 out of a possible 41 mentions in Appendix 2.1), far fewer practices that could be interpreted as institutionalisation of learning received mentions (process standardisation: 2, product modularisation: 5, parts standardisation: 6). To exacerbate this discrepancy, process documentation has been identified as crucial as a basis for CI (Cole & Mogab, 2000, p. 65; Hampson, 1999, p. 372). The first tacit organisational rule of the Toyota Production System has been said to be that "all work shall be highly specified as to content, sequence, timing and outcome" (Spear & Bowen, 1999, p. 98).

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The epistemological issue with respect to CI expresses itself in terms of the effectiveness of knowledge creation by means of CI. As documented earlier, numerous CI process techniques to create process knowledge have been developed (See Appendix 2.3). The prototypes of these CI processes, Shewhart's Plan-Do-Study-Act and Deming's Plan-Do-Check-Act CI cycles, have been mapped as consistent with the learning cycle (Kim, 1993, p. 38). It has been argued that the basic principles of the scientific method, empirical validation of theory, explain the effectiveness of these approaches to learning (Linderman et al., 2004, p. 592; Wruck & Jensen, 1998, p. 307), and indeed, CI that is executed in accordance with scientific principles has been found to be more effective at improving operational performance (Lapré et al., 2000, p. 608; MacDuffie, 2000, p. 191).

Therefore, the explanatory value of organisational learning theory is that it highlights both the ontological challenge to convert the unrealised value of tacit knowledge into explicit knowledge of exploitable economic value and it delineates the characteristics and conditions under which the epistemological process of creating process knowledge can best be effected.

2.5. *Theory on Implementation of Team-based Work Organisation*

Having reviewed theory on the two key elements of CMAs, namely teamwork and CI, I now go on to addressing the implementation of TBWO programmes. Whereas teamwork and CI are structural elements of such a programme, implementation reflects the process aspect of such an initiative.

It is necessary to address programme implementation because the design of the structure and content of an organisational initiative is inextricably linked to its implementation process (Repenning & Sterman, 2000, p. 233). In fact, it is recommended that implementation issues are given priority in the programme at the start of planning for such an initiative, rather than as an afterthought (Storey (Ed), 1994, pp. 15-6; Gunn, 1987, p. 113; Grütter et al., 2002, p. 651). Clearly, a TBWO programme including all the necessary practices may falter due to poor implementation of those practices, and therefore the theory on programme

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implementation needs to be reviewed (Bickman, 1987, p. 10; Argyris, 1999, p. 47; Narasimhan et al., 2004, p. 91).

As programme implementation is a complex phenomenon, some preliminary comments about researching it are necessary before proceeding. The first is that the rational model of more or less linear sequential stages in the implementation process may be more of a theoretical convenience than a reflection of reality. Cole (1991, p. 36) warns that while it is useful to develop rational models of small-group implementation, it is necessary to keep in mind that these relationships may be "loosely coupled" and that theory therefore has to be applied flexibly. This is also necessary because, as the phenomenon of interest is the implementation process, these models tend to take less consideration of the antecedents and conditions within which the process takes place (Sabherwal & Robey, 1995, p. 231).

Three types of process models have been identified in a review of information system programme implementations: those concerning the *overall process* that emphasise strategic objectives or general implementation patterns, *a proiri* stage models based on internal logic rather than on empirical verification, and *sequence of event* models based on empirical analysis of programme histories (Sabherwal & Robey, 1995, p. 231).

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2.5.1. Theory on Implementation of Programmes in General

In general, organisational programmes can be of three kinds:

1. Adaptive: previously known practices;
2. Innovative: practices that are new to the organisation; or
3. Radically Innovative: practices that are new to the industry (Nutt, 1986, p. 233).

In this research, the programmes could be classified as innovative practices as CMAs are by now well known in the manufacturing sector but were new to most of the firms researched.

The theory on programme implementation processes broadly addresses two aspects: Firstly, efficient decision making with respect to what to implement and, secondly, consensus-building about what and how to implement. While both aspects are regarded as necessary for effective programme outcomes to be realised, it is also

argued that managers need to make a trade-off as "efforts to build consensus decrease efficiency, whereas attempts to enhance efficiency inhibit the development of understanding and commitment" (Roberto, 2004, p. 625).

The model used by Nutt (1986) addresses, primarily, the tactics used by managers to navigate the decision-making process to adopt an organisational innovation. He proposes a transactional path model in which managers plan and facilitate adoption of a programme through a series of informational transactions (see Figure 2.7). These transactions follow a pattern whereby the manager mandates the execution of various information seeking and/or analysis stages, the outcomes of which are assessed by the sponsors of the decision-making process, and their decision then serves to authorise (or not) the next stage in the process.

The five stages of the transactional path model are:

Stage I: Formulation: Needs and opportunities are identified and problems and objectives clarified.

Stage II: Concept Development: Premises are stated by sponsor and options are developed by the support team.

Stage III: Detailing: Omissions, exceptions and errors are eliminated and detailed implementation plans are developed.

Stage IV: Evaluation: Expected performance of implementation plans are evaluated against cost/benefit of alternative plans and a final plan is chosen.

Stage V: Installation: Preferred option is implemented until performance is judged adequate, during which resource allocation, co-ordination, delegation and (dis)incentives are used.

(Nutt, 1986, pp. 235-6)

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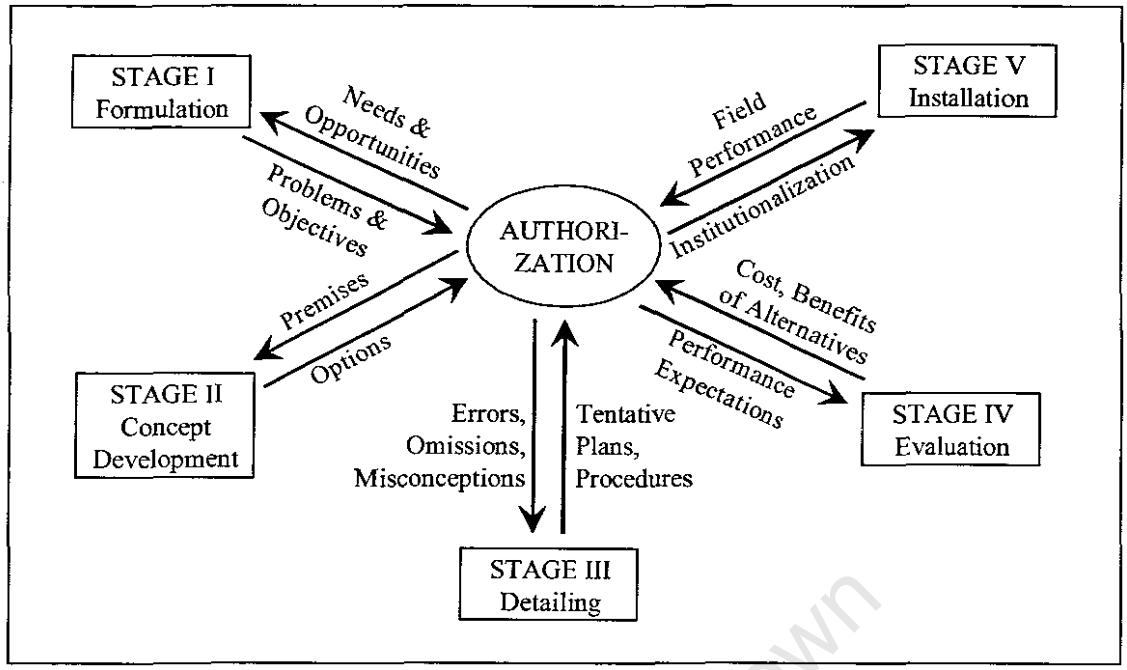

Figure 2.7: The Transactional Path Model of Planned Change (adapted from Nutt, 1986, p. 235)

In his research of 91 cases of programme planning and adoption, Nutt found that not all cases followed the full or the same set of stages. These were classified into four types of tactics, as summarised in Table 2.4 below. Their results indicate that the intervention tactic was very likely to lead to adoption of the proposed programme, although it was used in a minority of the cases. By contrast, the tactic of implementation by edict was least successful.

Table 2.4: Types of Implementation Tactics and their Usage & Programme Adoption Rates (Nutt, 1986, pp. 242-53)

Tactic	Description	Usage	Adoption
Intervention	Need for change justified by managers by demonstrating performance inadequacies. Suggest how performance can be improved.	16	100%
Participation	Need for change identified & development of action plan delegated to task force. Task force has authority to implement.	14	84%
Persuasion	Experts drive initiative & sell need for change. Little initial support from top management.	35	73%
Edict	Top management uses control & personal power to drive initiative and issue directives.	19	43%

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To call Nutt's model a model of "tactics of implementation" may be to use a bit of a misnomer in as much as only the fifth stage deals with "installation" and then only insofar as Stage V "begins with an attempt to set in place a preferred option and ends when field performance is judged to be adequate" (Nutt, 1986, p. 236). As the concern in Nutt's research was more with the decision process for innovation adoption, implementation of the innovation was of interest primarily to the extent that successful adoption served as the dependent variable (Nutt, 1986, p. 240, Footnote 8). The model does not substantively deal with the implementation process per se and should maybe have been called a model of the tactics of innovation adoption. In addition, the Nutt (1986) model does not pay much attention to the affective and/or motivational aspects of successful innovation adoption and implementation, which is regarded as necessary by numerous authors (Lawler, 1991, p.35; Monge et al., 1992, p. 271; Roberto, 2004, p. 625). Neither does it explicitly address the role of the users of the innovation.

The model by Sagie and Koslowsky (2000) offers a very general model, incorporating cognitive and motivational factors (see section 2.3.4), but a model which deals to a greater extent with the abovementioned shortcomings of the Nutt (1986) model is that of Klein and Sorra (1996). As can be seen in Figure 2.8, two sets of causal relationships are presumed to influence implementation effectiveness, defined as the "consistency and quality of targeted organizational members' use of a specific innovation", as distinct from innovation effectiveness, which is the benefit the organisation derives from the innovation implementation (Klein & Sorra, 1996, p. 1058). On the one hand is the climate for implementation, which refers to the "targeted employees' shared summary perceptions of the extent to which their use of a specific innovation is rewarded, supported, and expected within their organization", which is the result of their "shared experiences and observations of, and their information and discussions about, their organization's implementation policies and practices" (Klein & Sorra, 1996, p. 160). On the other hand, innovation-values fit, "the perceived fit of the innovation to employee's values" (Klein & Sorra, 1996, p. 1063), leads to different levels of commitment, from resistance through to enthusiastic use of the innovation.

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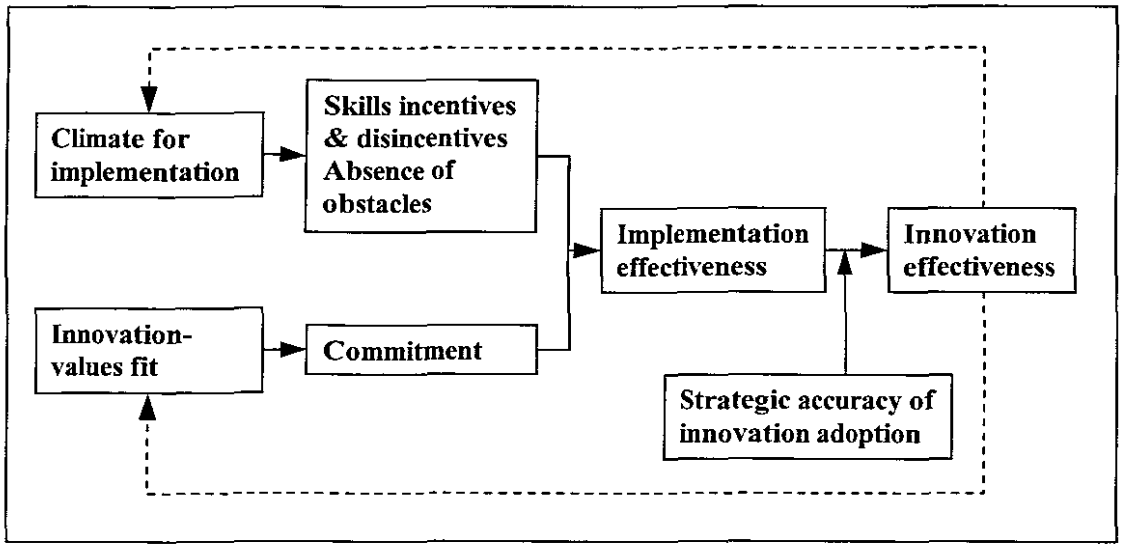

Figure 2.8: Innovation Implementation Model (Klein & Sorra, 1996, p. 1056)

This model is useful in that it incorporates both the explicit practices and policies that are the prerogative of management and the tacit affective, motivational factors influencing the affected employees' reaction to the innovation. It is also helpful in distinguishing between the different consequences of the innovation implementation at different organisational levels. Overall organisational innovation effectiveness is contingent on both implementation effectiveness at operational level and the appropriateness of the innovation to the strategic requirements of the organisation.

However, this model also does not say much about the actual process of implementation. Faull (2004) suggested eight general principles for effective implementation of operations strategy. The model is conceptualised as the response to the following question by a chief executive: How can we improve our track record for the effective implementation of operations strategy? The following principles, in two sets, are the answer (Faull, 2004, pp. 6-7):

Set A (responding to the general question):

1. Never stop asking the question.

   The process of implementation itself is a test of the hypothesis in that the strategy being implemented will have the desired effect and therefore the learning-by-doing gleaned during the implementation process is part of the answer to the question (Argyris, 1999, p. 165).

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2. Have 'dual organisation' capability.

   The formal hierarchical organisation (FHO) does not have enough capacity to deal with the implementation project as well as keep the day-to-day performance of the organisation on track. Therefore, an additional temporary organisational project structure needs to be created with people seconded from the FHO and consultants. Their re-absorption into the FHO later helps to disseminate and institutionalise the innovation (Sitkin et al., 1994, p. 548).

3. Create a fault-tolerant environment in which to learn to improve the track record in effectively implementing operations strategy.

   The implementation/learning process needs to be separated from the day-to-day controls required to maintain performance as innovation implementation is inherently risky and the people involved in implementation will be less inclined to make the mistakes they can learn from if they anticipate being penalised for occasional failures (Sitkin et al., 1994, p. 552; Van Dyck et al., 2003, p. 6).

Set B (responding to each specific strategic initiative):

4. Prepare a plan of action or project plan.

   The plan requires clarity on *what* and *how* it is to be implemented and in effect constitutes the working hypothesis of the original question posed.

5. Surface the "force for effective implementation" as a function of
   a. the clarity regarding what one wants to achieve, in outcome terms
   b. the confidence in knowing how to achieve this new outcome, or at least having a 'working hypothesis' about how to achieve it
   c. the conviction that it is necessary to achieve this new outcome.

   Furthermore, use this "force" to judge the "point of no return" or "point of commitment" for the particular initiative.

6. Use the "force for effective implementation" to elicit appropriate behaviour from stakeholders who:
   a. have the power to sabotage the intervention (negative power can be individual), or
   b. whose supportive behaviour is highly likely to determine the degree to which the outcome is achieved and sustained (positive power is collective).

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7. Take the "first small steps".

   Avoid procrastination and inaction by taking small, low-risk initial actions, possibly in the form of pilot projects, where the knowledge gained from learning-by-doing can build credibility for further roll-out of the implementation plan.

8. Lead like a relentless, but reflective, bulldozer driver.

   Demanding, but patient, leadership of the implementation process is crucial: demanding in that challenging performance targets are pursued, patient in that the process is managed in terms of progress monitoring, evaluation based on trends rather than on imposed deadlines, and follow-through in terms of moral support and resource-allocation.

While general models of programme implementation outline the principles of what is effective implementation, they need to be adapted to the specific programme content and context. Thus, for instance, the implementation of information and communication systems are arguably different from the implementation of TBWO as the hardware and software components of an ICT system are more tangible than the practices and organisational restructuring of TBWO. In the next section, I go on to consider process models of implementing TBWO and what (i.e. the content and context) implementation of TBWO entails.

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2.5.2. Implementation of TBWO Programmes

2.5.2.1. Process Steps for TBWO Implementation

Five process models of TBWO implementation were included in this review (see Appendix 2.4). They all have different perspectives on the implementation process, so there were common elements, but also significant differences. Wellins et al. (1991) are consultants who provide a model for implementation of "empowered teams" in a team design process that has four stages: vision, design, implementation and monitoring. Their process model has a socio-technical systems design approach and is at a relatively high level of abstraction. Gunn (1987) is also a consultant, but his implementation model is from a broad world-class manufacturing perspective, which includes TQM, JIT and CIM, and his model is applicable primarily to large corporate firms. The standard text on lean production by Womack and Jones (2003) contains an "action plan for the lean leap", with the implementation process divided into four

stages: getting started, creating a new organisation, introducing lean systems and completing the transformation. Suzaki (1993) provides "hints for successful shop floor management implementation" (p. 330) from a Japanese perspective. These are also divided into four stages: introduction, promotion, expansion and stabilisation. Finally, Cotton (1993) based his process steps for implementing QCs on a review of steps recommended by previous authors.

The commonalities, more or less in implementation order, are summarised in Table 2.5 below (see Appendix 2.4 for a detailed comparison):

Table 2.5: Summary of TBWO Implementation Process Steps

Step	Description
Establish Vision	Create a compelling unifying vision for the implementation
Get Informed	Acquire knowledge of TBWO and its implementation
Design Plan	Develop an implementation plan for the organisation
Set Goals	Prioritise initiatives and set goals
Remove Obstacles	Anticipate possible resistance and resource requirements
Communicate	Inform people throughout the organisation
Get Buy-in	Ensure a critical mass of stakeholders buy in to the process
Change Agent	Designate a champion for facilitating the change process
Support Staff	Ensure support staff with appropriate skills are available
Change Attitudes	Provide orientation and manage the organisational change
Do Training	Provide training in new skills, roles and thinking required
Pilot Project	Decide whether to pilot or do full-scale implementation
Restructure Organisation	Make the necessary organisational and layout changes
Continuous Improvement	Start CI projects early and involve everyone in them
Measurement	Establish measurement standards and procedures
Monitor Progress	Evaluate progress against internal and external benchmarks
Provide Incentives	Provide appropriate incentive and recognition systems
Adapt Plan	Adapt the implementation plan where necessary
Sustain Initiative	Maintain initiative over the long term until institutionalised

The major themes found in the general models of implementation are reflected here as well. As in Nutt (1986) (Stages I-III) and Faull (2004) (Steps 4 & 5), a rational planning process is recommended. However, the affective aspects of commitment to the process that are mentioned in Klein and Sorra's (1996) model and by Faull (2004)

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in Step 5c are also covered by the steps suggesting stakeholder buy-in should be secured through communication, anticipation of resistance, and change management. Clear goal setting (Nutt, 1986, Stage III; Faull, 2004, Step 5a), support staff (Nutt, 1986, p. 235; Faull, 2004, Step 2), actual implementation (Nutt, 1986, Stage V; Klein & Sorra, 1996, p. 1057; Faull, 2004, Step 7), monitoring and evaluation (Nutt, 1986, Stage V; Faull, 2004, Step 8) and sustained incremental improvement (Faull, 2004, Step 8) are also themes common to both general and TBWO process models of implementation.

The differences between the models arise mainly from their different focus and scope rather than from substantive differences. A socio-technical approach is prominent in the work of Wellins et al. (1991), which is implicitly shared by Klein and Sorra (1996) as they both have an HRM perspective. Womack and Jones (2003), Gunn (1987), and Suzaki (1993) shared an operations management perspective, although Gunn (1987) was more concerned with cost/benefit decisions, and Suzaki (1993) was more focused on shop floor discipline than the others. Cotton (1993) focused on QC implementation and he emphasised the importance of training. In summary, it is fair to conclude that the process steps, as outlined in Table 2.5, represent the collective insights of both researchers seeking generalisations and experienced practitioners who have implemented TBWO.

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2.5.2.2. Requirements for Effective Implementation

Many studies have been conducted to identify the factors that lead to successful implementation of TBWO, some of which are meta-studies. Table 2.6 contains a summary of success factors identified in six studies conducted by Fabi (1992, p. 22), Elmuti (1996, p. 14), Liker (1998, p. 500), Moses and Stahelski (1999, p. 410), Bateman et al. (2002, p. 216), and Dale and Lees (1985, pp. 43-4). The factors identified by Fabi (1992) were based on a meta-study of 40 articles on QC success factors that were selected for methodological rigour. Elmuti (1996) identified success factors on the basis of a survey of the effectiveness of self-managed teams at American manufacturers. Liker (1998) extracted the success factors he identified from case studies, reports by experienced practitioners and his own experience of implementing lean initiatives. The factors identified by Moses and Stahelski (1999) came from a study at an aluminium manufacturing plant, those from Bateman et al.

(2002) from a survey of health-care managers that identified team effectiveness as important to service delivery, and finally, Dale and Lees (1985) conducted several surveys of QC success amongst British manufacturers.

The scope of settings included in the summary should strengthen the generalisability of success factors identified; however, it should be kept in mind that some of the studies had a particular perspective or historical context (especially the earlier studies on QC effectiveness), and therefore the ranking of these factors cannot be regarded as conclusive. In any event, in the next section, the case for synergies between TBWO practices will be presented, and therefore implementation of a critical mass of these practices should be regarded as more important than the effect of particular practices. Nevertheless, the first three studies *did* rank their results, and these success factors are presented in an order that takes account of ranking and number of mentions in the different studies.

Table 2.6: Summary of TBWO Success Factors

TBWO Success Factor	Theme
Top management commitment	Commitment
Middle & line management commitment & support	Commitment
Clear vision & goals	Communication
Training in team and problem-solving skills	Skills Training
Employee involvement	Participation
Union support	Commitment
Problem -solving & group process expertise/facilitation	Resource Availability
Building trust between management and teams	Communication
Team autonomy to make decisions	Participation
Rapid implementation of suggestions	CI Focus
Encouragement of experimentation	CI Focus
Using problem-solving techniques to improve process	Skills Training
Extensive communication across organisational levels	Communication
Justifying the changes	Communication
Adequate resources to implement suggestions	Resource Availability
Visual measurement and performance monitoring	Measurement
Focus on process flow	CI Focus
Use of pilot projects vs. organisation-wide implementation	Programme Design

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Appropriate incentives	Participation
Bias to action	CI Focus
Customer orientation	Customer Value
Voluntary QC participation	Participation
Facilitator & QC leader training	Resource Availability
Job security: no lean layoffs	Pre-conditions
Programme steering committee	Programme Design
Internal stability & members' experience of QCs	Participation
Detailed programme implementation plans	Programme Design
Well-designed & organisationally integrated CI teams	Programme Design
Organisational & financial stability	Pre-conditions
Upfront awareness-by-doing before training	Communication

Specific justifications for each of these factors are available in the original studies and elsewhere and therefore will not be dealt with here. Suffice to say that the scope and diversity of the factors identified implies that implementation of TBWO is a particularly complex process. As such, the success factors need to be integrated into the process of TBWO implementation, as suggested by Kaynak's (2003, p. 427) flow model.

What does emerge is a difference of emphasis between the older QC-orientated studies and the more recent lean thinking-orientated studies. In the former, there is an emphasis on the motivational aspects of participation, particularly voluntary participation in QCs, whereas in the latter, a focus on process management, particularly CI, emerges. While the HRM aspects of programme implementation cannot be neglected (Institute of Personnel Development, 1999, para. 10), the more recent emphasis on process improvement has much in common with the organisational learning literature, which suggests that "knowledge created from deployment of quality management practices results in enhanced organizational performance" (Linderman et al., 2004, p. 602).

As can be expected, the factors that lead to poor results from TBWO implementation complement much of what has been listed above (Elmuti, 1996, p. 14; Dale & Lees, 1985, pp. 45-49; Storey, 1994, p. 12). But, in addition, as has been argued earlier, poor or inadequate programme implementation is mentioned as well (Klein & Sorra,

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1996, p. 1055), not only because of inadequate management commitment (Easton & Jarrell, 1998, p. 256) but also because of employee resistance to change (Harman et al., 2002, p. 364), the inappropriateness of TBWO for the organisational needs and/or circumstances (Heller et al., 1998, p. 234) and, last but not least, the need to sustain the programme over a long period before performance improvements can be expected (Caffyn, 1999, p. 1138).

2.6. *Performance Outcomes*

Having considered the antecedents to performance improvement due to TBWO, I now briefly consider the nature of the performance outcomes from TBWO. Firstly, the causal link between implementation of TBWO practices and performance outcomes is established, then the issue of team effectiveness and at what organisational level to measure it is dealt with, the empirical findings on the effectiveness of TBWO is reviewed, and finally, team performance over time is addressed.

2.6.1. The Link Between TBWO Practices and Performance Outcomes

The proposition that the operational performance outcomes will follow the implementation of appropriate practices is possibly the least controversial proposition in this field. It is held to be an "analytical truth" that performance outcomes follow practice implementation (Ketokivi & Schroeder, 2004, p. 172). The following quotations show that there is widely held to be a link specifically between the implementation of appropriate TBWO practices and operational performance outcomes:

> ...there is a plausible causal mechanism for the observed improvement performance—TQM, after all, does focus specifically on generating quality and operational improvements. (Easton & Jarrell, 1998, p. 301)

> The clear connection inherent in such views is that – by adopting world class practices – business performance will improve correspondingly (Harrison, 1998, p. 397)

> ...it has been argued that operating performance is a key contributor to competitiveness and business performance; and that operating best practice should improve operating performance, by implication good practice should lead to increased competitiveness. (Voss & Blackmon, 1993, p. 1)

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2.6.2. Team Effectiveness

Team effectiveness has been assessed using a wide variety of indicators, depending on the researcher's interest. Sometimes, researchers decide *a priori* what is good or desirable, but on the assumption that organisations exist to attain a goal, the extent to which goals have been reached have served as indicators of TBWO effectiveness (Schmitt & Klimoski, 1991, pp. 237-8).

Broadly speaking, two types of team goals are common: social and technical. For example, Elmuti (1996, p. 10) used the following definition:

> Effective organizations are those that produce more and higher quality products and adapt more effectively to environmental changes, at the same time maintaining high levels of satisfaction of individual members.

This conception of effectiveness is based on the socio-technical systems (STS) theory assumption that organisations function best when both social and technical considerations are accommodated (Hyer et al., 1999, p. 183), although it has been suggested that STS is more focused on quality of work-life (Kuipers, 2005, p. 40). Accordingly, measures such as individual employee satisfaction, attitude and morale, and team viability measures such as team survival rates, group maintenance versus conflict, and team members' perception of group dynamics (Kuipers, 2005, p. 42; Yeatts & Hyten, 1998, p. 50) have been used to reflect the social dimension; and customer satisfaction, economic viability (Yeatts & Hyten, 1998, pp. 51-2), cost, value, and innovation (Dunphy & Bryant, 1996, p. 681) have been used to reflect the technical dimension. Suzaki, 1993 covered both dimensions in his QCDSM (quality, cost, delivery, safety, morale) concept, which he regards as the "major criteria for an organization's success" (Suzaki, 1993, p. 58).

In this research, preference was given to the use of technical rather than social measures, and therefore productivity and quality were used as the dependent variables for the following reasons. Even though authors such as Suzaki (1993) regarded "all employees in the organization... as customers from the total company's point of view" (p. 58) and therefore included social measures in his concept of organisational effectiveness, he still said, "whoever provides better products or services to customers wins the competition" (p. 43). The point is that employee (or internal customer)

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satisfaction is an intermediate construct also ultimately geared to delivering value to external customers. This is borne out by the findings reported earlier that attitudinal improvement may not lead to performance improvement (Mohrman & Novelli, 1985, p. 109) and that self-reports of group effectiveness on the basis of perceived positive group functioning have been found to be unreliable (Gladstein, 1984, p. 502).

Yeatts and Hyten (1998) also chose to eschew social measures of teamwork effectiveness as they were concerned that social outcomes were accounted for by different theoretical explanations than technical outcomes (p. 50). While the role of HR practices is regarded as foundational in this research, the theoretical emphasis is on the role of WC and CI practices, which are of a more technical nature, and therefore technical outcome measures are preferred.

Last, due to the problems with perceptual measures, productivity and quality were chosen as measures of effectiveness because of their objective nature.

2.6.3. Levels of Analysis

Team effectiveness can have outcomes at several levels: individual, group, business unit, and the organisation as a whole (Cohen & Bailey, 1997, p. 243). Routhieaux and Gutek (1998, p. 40) added a departmental level, and Sagie and Koslowsky (2000, p. 119) a dyadic level. At the level of the team, its characteristics can even be sub-divided into global, shared, and configurational attributes, which requires specific techniques of data aggregation from individual to team level (Molleman, 2005, p.117).

Klein et al. (1994) warned that "when data do not conform to the level of the theory, data analyses that are preformed at the predicted level of theory yield artifactual results" (p. 216). Varying conclusions about the relationship between TQM and performance have been attributed, among other reasons, to differences in measurement of outcome levels (Kaynak, 2003, p. 406).

The theory that this research is based on is concerned with TBWO programmes, as a whole, which are implemented at the level of the business unit. The TBWO practices dealt with in this research are not at the level of the individual or team per se. Nor are

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TBWO practices at the level of the organisation, as a whole, in the sense that the focus is on process improvement, which takes place at the operational level. Therefore, the appropriate level for the research to be conducted is that of the operational business unit, or plant level, as has been done by Samson and Terziovski (1999, p. 397). At that level, measures such as "manpower efficiency" and "percentage defects" have been used (Bartezzaghi & Turco, 1989, p. 46), which are also the dependent variables used in this research. As the theory, data and analysis are all at one level of analysis, the issues raised by Klein et al. (1994) are avoided.

2.6.4. Empirical Findings on the Relationship Between TBWO and Performance

In this section, the empirical findings on the effectiveness of TBWO will be reviewed. Once again, a vast literature of findings, reported over many decades, exists, and this review will only cover some of the highlights most relevant to this research. General findings on the effectiveness of TBWO will be reviewed, followed by findings indicating the limitations of TBWO, and finally, findings on the use of CI by shop floor teams will be reviewed.

2.6.4.1. Evidence that TBWO Improves Performance

Some of the books on implementing TBWO programmes that are targeted at practitioners contain a section on the positive performance outcomes that have been achieved at specific firms (e.g., Womack & Jones, 2003, pp. 121, 150, 179; Gunn, 1987, pp. 172-175). The quotations below from other sources show that some TBWO initiatives across industries and continents have had very successful outcomes:

In a 22-month implementation programme at Nokia in Finland using a socio-technical systems approach,

> ...labour productivity improved 600% and through-put time reduced to 25% of the original, and two-thirds of employees were satisfied with team formation. (Leivo, 1998, pp. 12-3)

In an American plant manufacturing mechanical cable assemblies,

> ...the range of improvement is from a high of 52.7% to a low of 2.7%. On an average, the teams had an overall improvement of 25%. (Harman & al., 2002, p. 367)

At a South African jet engine gearbox manufacturer,

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> ...the results of the workplace change initiative were encouraging. From one year to the next, the output of the division increased from 34 to 107 gearboxes (a more than three-fold increase with roughly the same number of employees). Lead time decreased from 7.5 months to 20 days (an 87% improvement), and quality improved dramatically from a high of 0.406% to 0.029% out of specification concessions by the customer 35 months later. (Grütter et al., 2002, p. 650)

At an Iranian tractor manufacturer,

> ...the median transportation time decreased from 3.28 minutes to 0.32 minutes, the average rate of scrap decreased from 1.23% to 0.55% and the average transportation costs per part decreased from $0.51 to $0.05, which in turn caused the decrease of monthly transportation costs. (Shayan & Sobhanallahi, 2002, p. 512)

However, these examples could be the exceptional cases. Therefore, some findings across firms will now be presented.

> The empirical results show that technologically similar production lines achieve gains in *both* productivity (or uptime) and product quality when systems of innovative HRM practices are introduced. (Ichniowski & Shaw, 1999, p. 717, emphasis in the original)

> The findings as a whole suggest that a positive relationship exists between the extent to which companies implement TQM and firm performance. (Kaynak, 2003, p. 425)

> Overall, our results suggest that in manufacturing, the introduction of HPWSs leads to win-win outcomes for plants and workers. Plant performance in each of the three industries examined is higher on the measures that matter to the managers in those industries. (Appelbaum et al., 2000, p.115)

> Overall, the more organizations use TQM practices, the more positive results they get from the EI efforts. (Mohrman et al., 1996, p. 7)

> The major finding of this study is clear evidence that the long-term performance of firms that implemented TQM is improved... Finally, even under the most unfavorable interpretation, the results of this study clearly provide evidence against the proposition that implementation of TQM actually hurts corporate performance. (Easton & Jarrell, 1998, pp. 299 & 301)

> For two practices, shop floor employee involvement in problem solving and reengineering setups, high-performing firms operating in a turbulent market environment have significantly higher levels of these practices than high-performing firms operating in a stable market environment. This presents an

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> interesting hierarchy. High-performing firms operating in a turbulent market environment have significantly higher levels of these practices than high-performing firms operating in a stable market environment, and in turn, high-performing firms operating in a stable market environment have significantly higher levels of these same practices than low-performing firms operating in a stable market environment. (Nahm et al., 2006, p. 225)

Although opportunistically selected, these findings from a number of reputable researchers corroborate the belief that TBWO can deliver substantial performance improvements. However, not all TBWO initiatives are equally successful. A substantial literature on TBWO initiatives that failed to meet expectations also exists.

2.6.4.2. Evidence that Few TBWO Programmes Achieve Expected Performance Improvement

Negative outcomes that have been reported from implementation of TBWO include job losses, work intensification, higher levels of stress on workers, longer hours, and others (Storey, 1994, p. 9), and it has been suggested that the more "lean" the work organisation, the lower the affective benefits such as job satisfaction, esteem, commitment, and so on (Godard, 2001, p. 776), although this finding is contradicted by the findings of Angelis et al. (2004, p. 10).

However, our interest here is more in the operational performance outcomes. Although case studies of specific unsuccessful TBWO initiatives are scarce, a failed gain-sharing initiative based on implementation of employee suggestions has been reported: "When the company initiated gainsharing in 1985, management expected that suggestions from employees would save substantial production costs and improve productivity. Over time, however, management realised that the overall quality of employee suggestions was below expectations and getting worse; only a minority of them were worth implementing (Kim, 2005, pp. 644-5).

A more comprehensive picture of the limitations of TBWO emerges from large surveys and meta-studies from which a representative view of success rates can be gleaned. In a meta-study of laboratory experiments, correlational field studies, multivariate experimental field studies and controlled experimental field studies, Locke and Schweiger (1979) found that whereas employee satisfaction could improve substantially from "participatory decision making", operational performance did not

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necessarily improve as well. In fact, it was reported to have declined in an equal number of studies that reported improvement, as shown in Table 2.7.

Table 2.7: Studies Reporting Improvement/Deterioration from PDM (Locke & Schweiger, 1979, p. 317)

PDM Initiative Outcome	Productivity	Satisfaction
PDM superior	10 (22%)	26 (60%)
No difference or contextual	26 (56%)	13 (30%)
PDM inferior	10 (22%)	4 (9%)
Totals	46	43

On the other hand, Cotton's (1993) meta-study of QCs and self-directed work teams found more successful outcomes for both employee satisfaction and productivity, as illustrated in Table 2.8. However, approximately two-thirds of the positive counts come from one other meta-study, which therefore had a heavy influence on the results.

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Table 2.8: Summary of Cotton's Meta-analysis of QC & SDWT Success Rates (adapted from Cotton, 1993, pp 71 & 189)

	Satisfaction*			Productivity		
	Impr	No Chg	Worse	Impr	No Chg	Worse
Quality Circles	12	12		5	5	
Self-directed Work Teams	50	3	1	57	7	5
Total	62	15	1	62	12	5
Percentage	79.5%	19.2%	1.3%	78.5%	15.2%	6.3%

* For QCs this includes employee satisfaction for both job and programme outcomes

Cotton's analysis was criticised by Wagner III (1994) on methodological grounds, and Wagner's re-analysis of the data found that the overall effect of employee PDM on job satisfaction and performance was positive, but small. Sagie and Koslowsky's (2000) summary of the debate concludes that "satisfaction is much higher when multiple issues rather than only one are involved in the PDM process" and "although

PDM is typically better than 'tell', that is direction without rationale, in improving productivity, no parallel results were found with regards to 'tell and sell' (direction followed by rationale)" (p. 52).

These findings are consistent with what appears to be an emerging convergence of opinion on the success rate of these initiatives:

> Also, Harari (1993) argues, based on own experience, that TQM programs are ineffective, and that at best one third of the TQM programs have achieved significant improvements. (Hansson & Eriksson, 2002, p. 44)

> The conclusion of most large studies has been that only about a third of the companies that attempted the most popular NAO's (new approaches to operations) achieved the results expected – by the companies own admissions.... (Hayes et al., 2005, p. 10)

> In general, the literature suggests that self-managing teams have a modest impact on performance and the attitudes of team members, but the changes are limited to the direct targets of the intervention... Most studies have found that self-managing teams have a direct impact on quality... The findings about productivity benefits are modestly positive. (Cohen & Ledford, 1994)

> Team failures happen 50-70 percent of the time; 90 percent of that is due to contexts that do not support teaming and collaboration. (Beyerlein, 2001, p. 97)

> Overall, the evidence presented in this chapter suggests that theoretical considerations as well as practical experience and research evidence converge to set fairly narrow limits to the development of substantial and lasting participative practices in organizations. (Heller et al., 1998, p. 187)

There is a stark contrast between the previously quoted reports of successful TBWO outcomes versus these reports that only a minority of the firms that introduce TBWO derive performance improvement from it. This contradiction has even been named the "Improvement Paradox" (Keating et al., 1999, p. 120). The question, of course, is: What are the reasons for the limited success of TBWO programmes? While methodological reasons for these disappointing research results cannot be ruled out due to the complex nature of the implementation of TBWO (Hayes et al., 2005, p. 10), the growing disillusionment with TBWO demands an explanation.

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Cotton (1993), Heller et al. (1998), and Sagie and Koslowsky (2000) offer reviews of the multitude of issues that have been researched as possible antecedents of improved performance outcomes from employee involvement. These success factors have been consolidated in Table 2.9. By any standard, this is a formidable list of requirements, and the modest proportion of successful outcomes from the implementation of TBWO programmes may reflect the difficulty of achieving a sufficient degree of adoption and fulfilment of these requirements.

Table 2.9: Antecedents of Improved Performance from Employee Involvement

Management commitment and organisational support
Value congruence and trust
Group structure, norms and dynamics
Group member dependency, self-esteem, satisfaction and motivation
Organisational and group leadership style
Goal setting
Decision making and problem solving
Communication external and internal to groups
Autonomy and empowerment
Training and member skills
Boundary management
Job enrichment and redesign
Duration of, and voluntary participation in, QCs
Pay, recognition and incentive systems
Physical environment and working conditions
Quality of work life
Greenfield vs. brownfield programme start-up
Organisational development and resistance to change
Labour relations and job security
Sustained maintenance of programme implementation
Technology, industry sector and/or process type

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2.6.4.3. Empirical Research on CI by Shop Floor Teams

All of the possible factors listed above, and more, are possible causes of poor TBWO initiative outcomes. However, as this study focuses on TBWO, CI and implementation of programmes, this review of the empirical literature needs to return

to the role of CI in the effectiveness of TBWO that was highlighted in the theoretical review.

The main points that emerged in the theoretical review with respect to team-based CI were as follow:

- Continuous incremental innovation of production processes involving shop floor teams is a critical element of CMAs that drives performance improvement;
- Decision-making processes, such as the PDCA cycle, based on the scientific method of empirical validation of theories, deliver more effective process improvement suggestions;
- Process knowledge gained in the CI process needs to be made explicit and standardised into the best operating practices according to which organisational processes are executed.

Given the above considerations, the emerging empirical evidence that shop floor teams are failing to practice CI effectively is noteworthy. It has been found that the more sophisticated TQM tools are used less often, or not at all (Zbaracki, 1998, p. 625). Poor deployment and the limited scope of the issues addressed by the TQM systems implemented by firms were found to distinguish low from high financial performance by Easton and Jarrell (1998, p. 266), who also place process focus and systematic improvement at the top of their list of TQM characteristics (p. 254). The following quotations illustrate the issues:

> Perhaps the most interesting finding is that, although half of the so-called CI enablers identified from the literature were actually in place, they simply did not function. (Boer, 2003, p. 1111)

> An even smaller number of firms - approximately one-fourth - declared that they were making systematic use of quality orientated participative practices, in the sense of regularly and formally inviting employees to partake in problem-solving and process improvement activities. (De Macedo-Soares & Lucas, 1996, p. 62)

> Likewise, only a small minority - less than one-fifth - reported that they were systematically applying process improvement practices and regularly carrying out thorough statistical analyses with the help of SPC. (De Macedo-Soares & Lucas, 1996, p. 63)

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> In short, second-order problem solving may be more difficult in practice than in theory. Consistent with this supposition, recent work highlights the fact that efforts to implement total quality management, a problem solving system aimed at continuous improvement at the front lines, often fail. (Tucker et al., 2002, p. 125)

2.6.5. Implementation Dynamics of TBWO Programmes

In addition to requiring the implementation of an adequate set of practices to derive performance improvement from TBWO, the fact that TBWO programmes are deployed over time causes a time delay between implementation and outcome. In addition, the TBWO practices are implemented in an organisational context, which has implications for the dynamics of interaction and articulation between the practices implemented and other organisational factors. These will now be briefly reviewed.

2.6.5.1. Complementarities Between TBWO Practices

A prominent thread of research has been into whether the implementation of "bundles" of complementary practices is more effective than the implementation of unrelated practices at delivering performance improvement. There are two versions of this hypothesis: The "best practice" version holds that a particular set of internally consistent practices is universally more effective, whereas the "contingent" version suggests effectiveness derives from bundles of practices appropriate to a firm's external conditions, in other words, from strategic fit (Huselid, 1995, p. 643).

Proponents of CMAs generally contend that teamwork and CI can be beneficially applied to any value-creating process, which is consistent with the "best practice" version of the hypothesis. Several studies have argued for the validity of the proposition on the basis of positive interaction effects.

> Yet by themselves, these teams are not likely to elicit worker participation in continuous improvement activities. Problem solving teams may require employment security policies to be effective... Employment security will in turn be complementary with other HRM practices, including flexible job assignments... [which] requires training to provide workers with the skills needed in multiple jobs. Careful employee selection and greater employee voice also become more valuable due to the longer expected careers for employees and the lower probabilities of exit. (Ichniowski & Shaw, 1999, p. 705)

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Several studies have provided empirical support for the "internal fit" hypothesis (Ichniowski et al., 1997, p. 311; Kaynak, 2003, p. 425; MacDuffie, 1995, p. 218). In addition, it has been found that plants where bundles of quality management practices were implemented were also likely to implement bundles of HR practices and TBWO practices (Bayo-Moriones & Merino-Diaz de Cerio, 2001, p. 258) and that TQM practices complemented employee involvement practices (Mohrman et al., 1996, p. 7). Therefore, the positive interaction effects between practices are not restricted only to HR practices but also apply to an array of social and technical practices that are appropriate for the operational requirements of the production process (MacDuffie, 1995, p. 199).

2.6.5.2. Performance Improvement Lags Behind Practice Implementation

It is a logical necessity that performance improvement has to follow practice implementation. The practical question, though, is with what time delay this will occur. TBWO has been conceptualised as a technological innovation, and the relationship between TBWO practice implementation and performance outcomes has been shown to be consistent with the S-curve path of technology maturation (Field & Sinha, 2000, pp. 107-8). In addition to a typical three-stage pattern of initial delay between practice implementation and the onset of performance improvement, followed by a middle stage of rapid performance improvement before finally levelling off as the limits of potential performance improvement are reached, Field and Sinha (2000) describe three variations of the basic model: (1), an initial period of worsening performance due to teething problems; (2), a shortening of the initial practice/performance delay where the introduction of TBWO was well prepared; and (3), a shallow improvement trajectory where the room for improvement is low or there is a poor match between the employee skills and the technical complexity of the task (pp. 112-4).

Modelling the trajectory of TBWO implementation as an S-curve is consistent with the findings that performance improvement is greater for firms with more thorough implementation (Easton & Jarrell, 1998, p. 275). This is supported by Bessant et al. (2001), who suggest that the degree of success from CI implementation is not a

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function of time but "rather the key variable seems to be the amount of management effort put in to build and maintain the CI behaviour patterns" (p. 70).

Specifying the time lag between practice implementation and performance outcomes is difficult due to the contextual factors that impact on performance over the programme lifetime and unclear definitions of success. Schneiderman (1988) developed a general model of expected "improvement half-life" based on performance improvement rates from 64 recorded process improvement projects. Improvement half-life is expressed in terms of the time it takes to improve performance by 50%. By inspection, he established organisational complexity as a basis for estimating time lags and suggested the guidelines in Table 2.10.

Table 2.10: Expected Half-life of Improvement Projects (adapted from Schneiderman, 1988, p. 57)

Project Type	Description	Half-life (months)	Expected Range
Uni-functional	Projects that can be solved, approved and implemented by team within organisation.	3	0 to 6
Cross-functional	Projects that involve several functional departments.	9	6 to 12
Cross-entity	Projects across business entities.	18	12 to 24

Sterman et al. (1997) expanded Schneiderman's (1988) model into two dimensions by accounting for the technical complexity of the improvement project, as shown in Figure 2.9 below.

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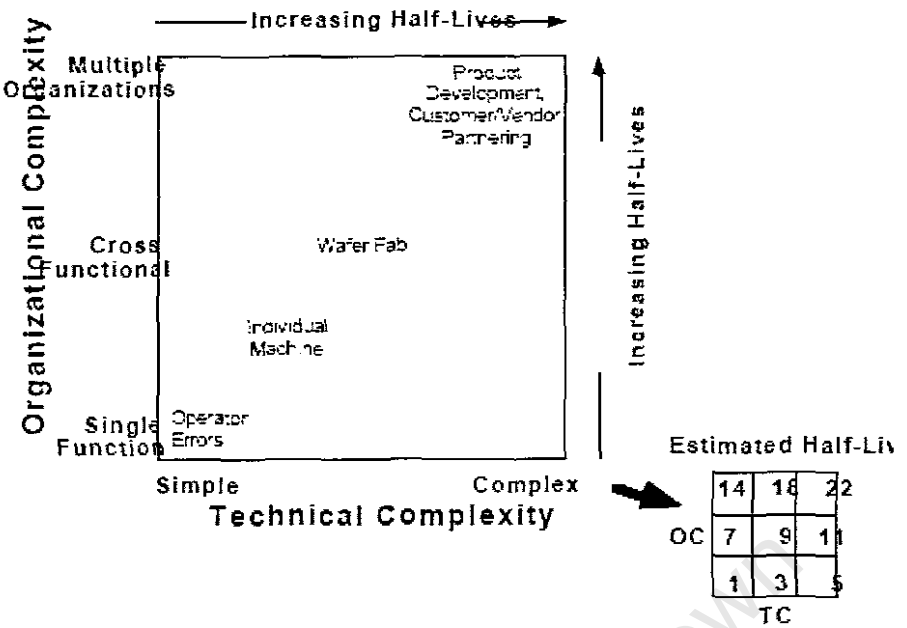

Figure 2.9: Improvement Half-lives Based on Technical and Organisational Complexity (Sterman et al., 1997, p. 37)

However, the above estimates are "half-lives" made for specific improvement projects, not complete programmes. Longer periods have been proposed for full programme implementation. Two books on these types of programmes suggest a 3- to 5-year implementation period (Womack & Jones, 1996, p. 270; Gunn, 1987, p. 131). Upton (1996) proposes three different models of how process improvement programmes are implemented that vary between 2 and 6 years in duration (pp. 222-5). Other authors say the following:

> Note that the improvement is much larger for years 3-5 than for year 1 and 2... which is consistent with the hypothesis that the most important impact of implementing TQM is on longer term performance. (Easton & Jarrell, 1998, p. 274)

> In half of the firms sampled, TQ initiatives are less than four years old, hardly a sufficient time for consolidating practices that involve significant paradigm shifts. (De Macedo-Soares & Lucas, 1996, p. 64)

> When considering the length of the learning curve for lean production and looking at the significant issues in change management that are involved, it is not too surprising that most organizations either never really get started on lean production or don't stay with it... This conversion process will take five to ten years. (Liker, 1998, pp. 474-5)

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While these authors are referring to the length of time it takes to complete programme implementation, which is not the same as the time lag between programme implantation and performance outcomes, it is reasonable to assume that performance improvement will also be largely delayed until programme implementation is substantially completed.

2.6.5.3. System Dynamics of Implementing TBWO Programmes

The unintended consequences of the organisational system dynamics of implementing TBWO programs have also been shown to thwart programme roll-out (Keating et al., 1999; Repenning & Sterman, 2001). Given that effective use of CI techniques by shop floor teams can only be expected after thorough implementation of a range of complementary practices, it is apposite to consider some of these potential programme implementation pitfalls. The following have been noted by Keating et al. (1999):

- There is a trade-off between applying available work time to direct production with an immediate production output versus applying it to process improvement activities with an uncertain future productivity improvement.
- Some improvement projects experience deterioration in performance before it improves beyond initial levels (also noted by Field & Sinha, 2000, p. 112). This may lead to premature withdrawal of management support or employee de-motivation before performance improvements have been realised.
- Because of unrealistic expectations, some managers could be tempted to harvest performance improvements by reducing resource and/or labour allocation too much and thereby starve the process improvement activity.
- Too much "management push" for quick results from process improvement can undermine the motivational effects of shop floor employees themselves making successful process improvements and disrupt the self-reinforcing incentive to contribute process improvement suggestions.
- The greater the technical and organisational complexity of the improvement project, the longer the improvement half-life (slower the improvement rate). When managers set "stretch" goals that are not based on realistic improvement rates, it can demoralise employees and weaken commitment.

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- Initial success will leave projects with increasing complexity and lower marginal returns. Therefore, expectations need to be moderated and methods adapted.
- Demand for process improvement training can outstrip capacity and result in inadequate learning, which leads to ineffective utilisation of techniques.
- Initial success can lead to expansion of the projects beyond the resources and capacity needed for success.
- Simultaneous implementation of complementary programs can create synergies but may also cause damaging competition for resources.
- If costing ratios are not adjusted for improvement in direct unit production costs while indirect costs remain unchanged, reduced profitability could result.
- Successful process improvement may lead to negative consequences for other organisational functions; for example, sales may not be able to keep up with improved production throughput.
- If sales and labour attrition cannot keep up with productivity improvement, layoffs become necessary, which threatens employee commitment.
- Perceived or real improvements of operations can lead to excessive market demand, causing capacity problems and eroding maintenance of performance standards.

Apart from resource requirements to sustain programme implementation, the abovementioned examples of possible negative consequences from *successful* process improvement highlight the complex issues that need to be managed to complete comprehensive programme implementation. To summarise the review of the research on the organisational dynamics of TBWO programme implementation: the implementation of a comprehensive set of appropriate practices needs to be resourced and sustained through a period of delayed performance improvement with relatively uncertain positive outcomes, during or after which negative organisational consequences may emerge.

2.7. Moderating Factors

In this section, the moderating factors that may impact on the performance outcomes from TBWO are reviewed.

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2.7.1. Market Conditions

Market conditions affect implementation of TBWO in several ways. It has been found that firms that adopt TQM have better financial performance than other firms (York & Miree, 2004, p. 291). The assumption that a firm operating in good market conditions will be able to generate surplus operating income that will make re-investment into a TBWO programme easier was not supported by research evidence. Foreign competition and extreme performance pressure were found to have a stronger influence on adoption of TBWO programmes (Lawler et al., 1995, p. 120). None of the above market-related factors were found to have a strong relationship with positive performance outcomes. Lawler et al. (1995) conclude that while market conditions seem likely to affect adoption of TBWO, performance outcomes are presumed to be a function of how well the programme is implemented rather than a function of market conditions (p. 123).

Despite these findings, it is reasonable to presume that a firm experiencing a severe drop in market demand will find it difficult to sustain implementation of a TBWO programme through the long gestation period required for performance to improve. Popular belief has it that plants in severe financial difficulty can be rescued from closure by employee ownership schemes, but the results of past attempts to implement such schemes have been mixed (Heller et al., 1998, pp. 34-5).

2.7.2. Organisational Stability

Organisational instability due to circumstances such as strikes, firm mergers or plant relocation can be expected to have a negative impact on the implementation of a TBWO programme. No research specifically related to such instability could be found, although general reference has been made to the many contextual factors that can intervene between the implementation of QCs and their performance outcomes (Mohrman & Novelli, 1985, pp. 108-9).

2.7.3. Process Type

Commentators have suggested that CMA practices are more appropriate for repetitive than for non-repetitive types of operations because it is easier to standardise and institutionalise repetitive processes (Schuring, 1996, p. 180), less routine work requires greater judgement and employee flexibility (Cohen et al., 1996, p 669), and more complex tasks are associated with greater learning difficulties and the effects of

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forgetting (McCreery et al., 2004, p. 387). Repetitive processes are also likely to have greater future returns as the investment in process improvements is incrementally recouped when tasks are repeated.

White and Prybutok (2001) investigated the relationship between JIT practices and process type and found that repetitive process operations were more likely to implement quality circles, focused factory layout, total productive maintenance, reduced setup times, uniform workload, Kanban, and JIT purchasing practices than non-repetitive operations (p. 121). That is not to say that these practices cannot be adapted for use in non-repetitive operations (Hensler & Klefso, 2004). For instance, the standard WCM principles have been adapted for use by make-to-order firms by deleting inappropriate principles, such as those applicable to standard product lines, and adding new principles relevant to make-to-order firms, such as integrating marketing and production functions (Muda & Hendry, 2002, p. 297). However, it is worth noting that this adapted model also included teamwork and process improvement (Muda & Hendry, 2002, pp. 303-4), which is consistent with the finding by Shah and Ward (2003) that cross-functional teams and quality management were the only two out of 22 lean practices that small manufacturers were likely to implement (p. 140).

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2.7.4. Industry Sector

Adoption of practices and performance outcomes related to TBWO have been found to differ from industry to industry. Ahmad and Schroeder (2003) found that the machinery industry lagged behind the automobile industry with respect to the use of Pfeffer's HRM practices (p. 36). Shah and Ward (2003) controlled for industry type when investigating the effects of four bundles of CMA practices on performance (p. 142). Even in Japan, the lean-thinking approach has not been found appropriate for all industries (Hayes et al., 2005, p. 12).

The fact that CMAs had their origin in the Toyota Production System was no coincidence as the high unit value of the products and the repetitive process type used in the automobile industry provide fertile ground for good returns on process improvement. When CMAs first spread to the US, it was also to automobile plants (White & Prybutok, 2001, p. 121). However, the adoption of CMAs in other

industries was uneven (Shah & Ward, 2003, p. 143). It could therefore be expected that CMAs are more prevalent in industry sectors where discrete repetitive type processes prevail and that the automobile industry has a head start on other industries as they are further down the learning curve associated with TBWO implementation.

2.8. *Formulation of Research Question and Hypotheses*

In this final section of the chapter, the key aspects of the literature reviewed are summarised as a basis for the formulation of the research hypotheses.

2.8.1. Key Aspects of Literature Reviewed

The practices associated with CMAs were compiled, and teamwork and CI were identified as essential practices associated with operational performance improvement from the use of CMAs. The theory and empirical research on the two practices were then reviewed to establish the causal mechanisms and documented performance outcomes from teamwork and CI. It was also recognised that these practices need to be institutionalised by means of an implementation programme. This introduces the issues of effective programme execution and time lags between practice implementation and performance outcomes.

2.8.2. Formulation of the Research Questions

The contradiction between the popularity of CMAs amongst practitioners and increased adoption rates of such programmes in industry (see section 1.2.1.1) and the modest performance improvement found by rigorous empirical studies (see section 2.6.4.2) raises the question of whether conventional wisdom is mistaken or whether the research results are inaccurate. In an attempt to shed light in these issues, the following two research questions were formulated.

The first research question concerns the empirical issue of whether or not operational performance improvement follows after the implementation of TBWO programmes and is formulated as follows:

> To what extent do manufacturing firms derive operational performance improvement from the implementation of TBWO programmes?

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The second research question seeks to find a theoretical explanation for why the firms that do derive operational performance improvement from the implementation of TBWO programme are able to do so. It is formulated as follows:

> Is the implementation of teamwork and process improvement practices essential to derive operational performance improvement from the implementation of TBWO programmes at manufacturing firms?

2.8.3. Formulation of Hypotheses

For the purpose of formulating researchable propositions, the research questions need to be translated into hypotheses by stating the presumed relationships between the primary constructs identified as relevant in the literature reviewed.

Following a review of the literature on programme implementation, the introduction of a new set organisational practices were causally linked with performance outcomes in section 2.6.1. The lag between programme implementation and performance outcomes was also reviewed in section 2.6.5.2. Accordingly the first hypothesis proposed for this research is:

*H*1: The implementation of a TBWO programme is associated with improved productivity and quality performance outcomes after a time lag.

The investigation of this hypothesis will, in general, test whether operational performance improvement does follow the implementation of TBWO programmes.

The literature on team-work, particularly that on team-process in section 2.3.4, suggests that HR practices such as communication, training, team-based work organisation, staff development and devolution of authority support improved performance outcomes. Likewise, the CMA practices reviewed in section 2.2 include "world class" practices such as cellular manufacturing, reduction of work-in-progress, improved job and quality skills, visual management, and housekeeping. Finally, it was established in section 2.2.1 that CI practices related to the use of problem-solving techniques to make process improvements are related to improved performance outcomes. Several explanatory theories for the nature of the relationship between

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these practices and improved performance were reviewed in section 2.4.4. Organisational learning is regarded as the theory with the greatest explanatory power in this research setting. Accordingly the second hypothesis for this research is:

H2: The implementation of HR, WC and CI practices is associated with improved productivity and quality performance outcomes.

In this hypothesis, the TBWO practices are disaggregated into three sub-constructs. These sub-constructs will enable the investigation of the role of each these bundles of practices in operational performance improvement and establish whether teamwork and CI are essential to the effectiveness of TBWO, as proposed in the literature.

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Chapter 3: Research Method

3.1. Introduction

This research can be characterised as quasi-experimental, using multiple case method with quantitative and qualitative longitudinal data. Therefore, a number of methodological issues are raised, some of which are subject to debate in the methodological literature.

This overview of the methodological issues associated with this research will address the most important of these issues and specify how methodological requirements for good quality case research were addressed in the research design.

3.2. Case Method

3.2.1. What is Case Method?

Several definitions of what cases are or case method is, as used in the social sciences, offer a starting point for clarifying what the method entails.

The classic text on case method, Yin (2003), defines a case as follows:

> A case study is an empirical inquiry that
> - investigates a contemporary phenomenon within its real-life context, especially when
> - the boundaries between the phenomenon and context are not clearly evident.
>
> The case study inquiry
> - copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result
> - relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result
> - benefits from prior development of theoretical propositions to guide data collection and analysis. (Yin, 2003, pp. 13-4)

Stake (1995), who explicitly excludes quantitative case studies from his book on case method in educational research, emphasises the systemic aspect of cases. He uses the definition of Louis Smith, who "...helped define the case as a 'bounded system', drawing attention to it as an object rather than a process... The case is an integrated system. The parts do not have to be working well, the purposes may be irrational, but it is a system" (Stake, 1995, p. 2).

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Merriam's (1998) review of definitions of case studies brings to light the following issues:

- The different ways of defining cases caused confusion. Three different bases for case definitions were identified: On the process of conducting case studies
  On the unit of study
  On the end product
- Merriam concludes that "delimiting the object of study" (p. 27) as a bounded system is the single most defining characteristic of case study research.
- Interpretation of the study matter in context enables the researcher to "uncover the interaction of significant factors characteristic of the phenomenon" (p. 29).
- That case study focuses on holistic description and explanation.
- Unlike some other research methods, case research does not rely on any particular technique for data collection or analysis.

Merriam defines case study "as the product of an investigation, a case study is an intensive, holistic description and analysis of a single entity, phenomenon, or social unit" (Merriam, 1998, p. 34). Lee (1989, pp. 119-20) and Chelimsky and Grosshans (1990, p. 15) offer similar definitions, in which complexity of subject matter and the richness of data gathered in a situated context by a researcher with relatively low power to manipulate the situation are highlighted.

Ragin bases his definition of a case on several different perspectives or approaches to case method (Ragin & Becker, 1992, p. 9), using the matrix in Table 3.1.

Table 3.1: Ragin's Perspectives on Cases

Understanding cases as:	**Case Conceptions**	
	Specific	General
Empirical units	Cases are found	Cases are objects
Theoretical constructs	Cases are made	Cases are conventions

This conception of the case makes the role, perspective and purpose of the researcher more prominent. Rather than viewing the case subject matter purely as an external

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reality with a meaning to be discovered, the researcher(s) may impose a pre-determined organising scheme, either theoretical or by general classifications, on the subject matter in order to make sense of the subject matter.

Bonoma (1985) points out that case research often involves multiple sources of qualitative and quantitative data, which makes possible "perceptual triangulation" (p. 203). He goes on to say:

> ...like other qualitative methods, case method is concerned basically with the researcher's interpretation of management's signification of events, information, and reality—that is, it depends on the researcher's perceptions about management's *meanings*, not on some 'objective reality.' Unlike some other qualitative methods, case methodology draws on numerous other data sources to triangulate these perceptions and significations within a broader context. (Bonoma, 1985, p. 204, emphasis in the original)

In contrast to imposing an organising scheme to make sense of case data, this method of triangulation relates to the veracity of the researcher's findings.

Verschuren (2003) is critical of definitions of cases or case method based on the unit of analysis or the process of doing case research. He argues that the distinguishing characteristic of case method is its holistic nature. This requires the case researcher to undertake in-depth data collection until saturation point (no more data revealing new discernable patterns of interpretation) is reached. He also asserts that then the researcher will be in a position to make robust generalisations, not only on the basis of replication logic (correspondence between theory and data) but also on the same basis that statistical generalisations are made, i.e. representativity of the research sample of the population to which the theory applies. He defines case method as follows:

> A case study is a research strategy that can be qualified as holistic in nature, following an iterative-parallel way of preceding, looking at only a few strategically selected cases, observed in their natural context in an open-ended way, explicitly avoiding (all variants of) tunnel vision, making use of analytical comparison of cases or sub-cases, and aimed at description and explanation of complex and entangled group attributes, patterns, structures or processes. (Verschuren, 2003, p. 137)

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3.2.2. Why use Case Method for this Study?

I now address the question of why the use of case method is appropriate for this research before going on to dealing with the requirements of good case method research.

In keeping with the definition of case method, several authors suggest conditions under which it is appropriate to use case method that are relevant to this research:

- When research contexts are complex, methods such as case method that can enable the researcher to capture the complexity are required (Stuart et al., 2002, p. 421);
- Where there are time lags between cause and effect (Stuart et al., 2002, p 423);
- Where the researcher has little control over the events being studied (Yin, 2003, p. 5);
- When the focus is on contemporary rather than historical events (Yin, 2003, p. 5).

While other conditions may be present that also justify the use of case method, the ones listed above are regarded as sufficient to justify the use of case method in this research. Implementation of new work organisation, as was done at the firms studied, is inherently complex as it impacts not only on technical systems such as process layout, performance measurement, and process improvement but also affects the organisational structure, as it changes from being hierarchical to being team-based, and the social system, as work relations need to adapt.

The time lag between implementation of the new practices and the consequent performance outcomes also increased the complexity of the relationship between cause and effect. Apart from different initial conditions at the firms, the firms also implemented different bundles of practices at different rates of implementation. These implementation differences result in differential impact on the hypothesised outcome variables, which are best researched with multiple methods to enable a holistic understanding.

As this research was conducted on firms participating in the WPC, the programme agenda and implementation schedule at each firm was out of the control of the researcher. However, it was possible to collect data from the start, and, in some cases, from before the start of the programme implementations at the firms, with regular

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field trips over 3 years, within a few months of events taking place, thus qualifying it as contemporaneous research.

3.2.3. Requirements for Doing Good Case Method Research

The requirements for doing good case method research can be divided into those requirements related to meeting scientific criteria and those related to good practice.

3.2.3.1. Scientific Requirements

The requirements for research to qualify as scientific are well summarised by Lee (1989), as follows:

> As a check for falsifiability, does the case study consider any predictions through which the theory of interest could be proven wrong?
> As a check for logical consistency, are all the predictions considered consistent with one another?
> As a check for empirical validity, does the case confirm the theory through empirical testing?
> Finally, as a check for relative predictive power, does the case study rule out rival theories. (Lee, 1989, p. 42)

In addition, Yin (2003, p. 17) suggests that in all good social science, the researcher should:

- attend all the evidence;
- address all major rival hypotheses;
- address the most significant aspect of his or her case study;
- use expert knowledge by demonstrating awareness of the current thinking on the topic.

In order to meet these basic requirements, this research attempts to do the following:

- It is based on propositions which are falsifiable; for instance, should the majority of firms that implemented TBWO well fail to achieve performance improvement, the research hypotheses formulated in chapter two would be falsified.
- None of the propositions are mutually exclusive.
- Empirical evidence was collected and all relevant evidence was analysed and presented.
- Rival hypotheses were considered.
- Recent literature on the topic was consulted and incorporated in the theoretical model upon which the research is based.

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3.2.3.2. Good Practice

The review of good practice for case method research starts with recommendations for theses.

"Case study dissertations should represent original research, be analytic, well-written, insightful, systematic, explicitly related to the literature of the field, and should cover their focus in depth. This focus must test propositions which are relevant to significant theoretical issues" (Garson, 2005). Garson goes on to say that for theory that is testing research, it is important to have variation in the dependent variables under study to enable some form of comparison to be made and he strongly recommends triangulation by means of multi-method design to enable validation.

More specifically, (Perry, 1998) recommends the following should be covered in the chapter on research method:

- A justification for the method used. This relates to Yin's (2003) suggestion that case method research is more suited to addressing "why" and "how" type research questions.
- Specifying the unit of analysis and subjects or sources of data.
- Stating what instruments or procedures were used to collect data, including how they were used.
- The limitations of the method.
- Any unusual treatments of the data.
- What techniques were used to analyse the data.
- Evidence that the assumptions of the analytical techniques were met.
- Ethical issues raised by the research.

Finally, Stuart et al. (2002) offer the pragmatic advice that a case study should have an explicitly stated theoretical focus while remaining flexible with respect to data-gathering methods. The focus is necessary to avoid being diverted from the research question, while flexibility is necessary to accommodate the way in which respondents express themselves and also to take advantage of unexpected opportunities to gather data relevant to the research question. They mention the risk that case studies might be perceived as a collection of "war stories" (p. 429) and, like Yin (2003), they go on

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to recommend the use of a research protocol to document and guide the execution of the research.

This research is focused on a specific aspect of the theory: why some implementations of TBWO results in performance improvement whereas others do not. While other explanations for the success or otherwise of TBWO may be plausible, this research tests whether bundles of human resource, world-class manufacturing and continuous improvement practices are associated with greater operational performance improvement. Alternative theories are considered for the purpose of improving internal validity and generalisability, but the focus remains on the factors stated above.

A particular strength of this research is the collection of quantitative data over a period of time on the dependent variable, with the specific purpose of investigating the variability in the data after implementation of TBWO, the primary independent variable. In addition, variation on the independent variable, extent of implementation of TBWO practices, makes it possible to assess a second research question, namely, whether extent of programme implementation has an impact on operational performance outcomes.

Triangulation is made possible by the collection of quantitative operational performance, interview and documentary data.

While the primary aim of this research is not exploratory theory formulation, to the extent that the theoretical predictions were not confirmed exactly as predicted, the collection of extensive qualitative information makes it possible to propose extensions to the theory on programme implementation to address questions of how and why some of the initiatives studied deviated from what was theoretically expected.

The level of analysis is dealt with in section 2.6.3, units of analysis in section 3.4.1, and the sources of data in Appendix 3.1. The data collection procedure is described in section 3.4.2.4.1 and research protocol in section 3.4.2.4.2. Limitations of the data collection methods are documented in Appendix 3.1 and discussed in section 5.6, and the use of quantitative data for triangulation in this research is explained in section

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3.4.2.2.1. The analytical techniques and evidence of their use within the limits of their assumptions are covered in section 3.4.3. Finally, ethical considerations are dealt with in the first chapter, in section 1.6.

3.3. *Theory Testing in Case Method*

This research is intended to test theory, in the first instance, before going on to suggesting possible theory modifications on the basis of the empirical findings. Theory testing is not regarded as a strength of case method (Merriam, 1998, p.45); therefore, particular attention needs to be given to the methodological requirements when using case method for this purpose. Accordingly, the additional methods used in this research to strengthen the findings from the theory-testing aspect of this research will be briefly reviewed. These are

- natural or quasi-experiments,
- longitudinal data,
- multiple cases, and
- considering alternative theories.

3.3.1. Natural or Quasi-Experiments

Lijphart (1971, p. 683) described the experimental method as the "most nearly ideal method for scientific explanations" because causal inferences about the effect of a stimulus on an experimental group, as compared to a control group, can be made with confidence if extraneous variables have been controlled for within the experimental setting. Where situational manipulation of variables is not possible, he states that it is still possible to discover controlled relationships between variables when statistical controls are possible. However, this only works where the number of cases exceeds the number of variables. In situations where only a small number of cases are available for research, he advocates the use of the "comparative method", of which case method is a subset. He went on to say that the "logic of the comparative method ... is also the same as the logic of the experimental method" (Lijphart, 1971, p. 684).

Clearly real-world organisational change takes place in circumstances far less controllable than in the laboratory. However, King et al. (1994) stated that "nothing in our set of (scientific) rules implies that we must run the perfect experiment" (pp. 6-7), provided estimates of the level of uncertainty of the inferences made are also provided.

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Lawler (1977) concurred with King et al. about the usefulness of "adaptive experiments" in organisational settings and listed the following requirements for quasi-experimental research under these circumstances: "longitudinal data, a comparison group or groups, a broad range of measures, an independent researcher, and measures of the change itself" (Lawler, 1977, p. 576).

This research meets the above requirements to qualify as quasi-experimental in that the WPC was in effect a natural experiment, where the intervention took the form of the introduction of a bundle of more or less consistent practices in all the firms that participated in the project. While each participating firm could adapt the practices implemented, a number of factors influenced the firms towards adopting similar approaches.

Firstly, there were minimum requirements for participation in the WPC, such as the establishment of steering committees made up of labour and management representatives to direct the programme implementation at each firm and a series of "capacity-building" workshops for participants in which the objectives and process of the WPC project were explained. These workshops had the effect of reducing the variety of understandings of what the WPC entailed.

Secondly, participating firms made use of consultants to help them design and implement the programmes. These consultants were screened by the WPC management to ensure that they were capable of delivering interventions regarded as appropriate by the WPC committee. In addition, most participating firms chose one of two consulting firms which had very similar approaches to implementing the programmes.

Thirdly, as part of the WPC process, the firms participated in quarterly "milestone workshops", where they shared their experiences and lessons learnt. These workshops also had the effect of coalescing the practices that the firms implemented around a set of similar practices.

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My role as researcher was clearly separated from that of the WPC project manager, the consultants or the workshop facilitators. While the funding for the research came from the WPC budget, I made my independence a condition of my involvement in the project.

It should be put on record that I did design one of the capacity-building workshops in which process improvement was introduced to participating firms. However, I did not participate in presenting these workshops for the duration of the research, and in any event, the firms adopted their own process improvement methodologies with the guidance of their chosen consultant.

Measures of change were developed for both independent and dependent variables and are reported on in Appendix 3.1. As the work organisation changes implemented at the firms were not one-dimensional, but rather bundles of practices that were implemented to a different extent at each of the firms, it was possible to measure variation across a range of independent variables. This, in turn, made it possible to categorise the firms into comparison groups, as required by Lawler's criteria above. Finally, the data collected were longitudinal, as reported in the next section.

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As all Lawler's criteria were met, this research can be characterised as quasi-experimental. A similar example of this approach to researching this topic was taken by Choi (1998).

It should, however, be noted that both Mbengue and Vandangeon-Derumez (2001, p. 287) and Campbell (1979, p. 50) warned that quasi-experimental designs involve non-random selection of subjects. This being so, there may be a degree of selection bias, making it difficult for researchers to unequivocally attribute the consequences to the intervention rather than to the self-selection of the subjects.

In the broader sense, this research is limited by the above consideration, and therefore the results cannot be generalised to similar manufacturing firms in general. However, the main thrust of this research is not the adoption rate of these kinds of workplace practices. Rather, it focuses on the results of the implementation of certain bundles of practices across a set of firms *who all made the decision* to participate in the WPC

project. Therefore, it is fair to assume that all the participating firms had at least the same initial intention to implement these practices, and the range of variation across the independent variables can substantially be attributed to the primary issue under investigation.

3.3.2. Longitudinal Research

In research such as this, where the causal effect of an organisational intervention is investigated, it is recommended that longitudinal data is collected (Menard, 2002, p. 15; Schmitt & Klimoski, 1991, p. 17). This is necessary because, logically, the cause must be temporally antecedent to the effect. Also, as is the case in this research, the effect can follow the cause with a time lag (Pil & Macduffie, 1999, p. 87; Schneiderman, 1988, p. 57), in which case, longitudinal data is necessary to assess the delayed impact. The research hypotheses also need to reflect the temporal aspects of the phenomena investigated (Monge, 1995, p. 277).

While positing a lag between the implementation of bundles of HR, WC and CI practices and the operational performance outcomes is conceptually relatively unproblematic, it is a different matter to specify the time lag between bundles of practices that are not implemented in an instantaneous way. Several issues interact to diffuse the initial impact of practice implementation (Easton & Jarrell, 2000, p. 95):

- The implementation of practices rarely starts at the same time;
- The intensity of implementation varies both at start-up and thereafter;
- The impact of certain practices can be increased (or decreased) by (un)favourable timing;
- The capacity of the organisation to derive most benefit from the implementation of new practices can be affected by internal and external circumstances.

Although the sequence of implementation of some practices is common sense (e.g., layout changes and training usually come early in the process) and the process used by most participating firms followed a plan, it was not possible for this research to rigorously investigate the sequencing of the implementation of practices because circumstantial factors not related to the primary research questions affected the exact timing of the individual practice implementations. Rather, the extent or intensity of practice implementation was assessed by the construction indexes of the

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implementation of TBWO practices and best operating practices (BOP), which are specified in Appendix 3.1.

Similarly, the effect on performance outcomes did not manifest as a clear deviation from the existing trend at any particular time. Apart from the diffused initial implementation, the very nature of numerous incremental process improvements is well documented as resulting in slow and initially small performance outcomes (Pil & Macduffie, 1999, p. 87, Fullerton et al., 2003, p. 384).

This problem has been recognised elsewhere in organisational research and is due to the inexact state of current organisational theory, and Monge (1995, pp. 270-1) suggested that "vague and inexact specification of process characteristics is preferable to no specifications at all". Therefore, a positive trend in performance outcome was interpreted to indicate improved performance, whereas level or negative trends were interpreted as no improvement in performance.

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3.3.2.1. Practical Issues Associated with Longitudinal Research

In a review of the practical research issues involved in longitudinal comparative case research, Pettigrew (1995, pp. 97-115) listed five major research implementation issues:

- Choice of research sites: Characterised as "planned opportunism" by Pettigrew, this relates to access to funding priorities and research sites and the salience of the subject of interest at the chosen research site;
- Issues related to time: when to start and end the collection of data on the subject of interest and interpreting the underlying logic in the process of unfolding events that make up organisational change;
- Issues of data collection: researcher skill and experience, triangulation of methods and data, and verification of researcher interpretation of the data;
- Data reduction and structured understanding: Being clear from the outset about research objectives, unit of analysis, the theory and method being used facilitates the process of data reduction and identifying the key emergent findings;
- The timing of research outputs: Presentation of a sequence of research outputs structured from, initially, more descriptive to, eventually, more analytical and interpretive can aid the process of pattern recognition and theory building.

With respect to the first issue raised by Pettigrew, this research can also be characterised as "planned opportunism" in that I realised, as a result of my previous involvement in the WPC, that it represented a unique research opportunity. The government's initiative to support industry in introducing new workplace organisation was, in effect, a natural experiment, based on the assumption that it would improve the firm's operational performance.

With a R24 million budget, the WPC took place on a scale for which research funding to South African researchers was most unlikely. I therefore positioned myself to take advantage of the research opportunity by withdrawing from the consulting team which undertook the initial project design (which was in any event was not accepted by the WPC steering committee) and suspending the capacity-building training I did for the WPC for the duration of the research. I was appointed as the WPC "cross-sectoral researcher", which not only gave me access to the participating firms but also secured funding from the WPC budget for direct research expenses and a small honorarium in return for writing a report on the research for the WPC.

The research started with the development of a research model (Grütter, 2001) prior to commencement of field work. The first firms participating in the WPC were from the plastics converting sector and were not selected for the research as the WPC was piloting its intervention process. Once the WPC process had stabilised, firms were considered for selection, as reported in section 3.4.1. At firm level, 10 out of the 12 firms included in the research had not taken any significant initiatives to introduce TBWO before participation in the WPC. The two firms that had implemented TBWO practices prior to the WPC participated because they wanted to deepen and consolidate the initiatives at their firms. Unfortunately, it was not possible to collect much data on the periods prior to the commencement of the WPC interventions at the participating firms because there were only a few months between firms deciding to participate and the commencement of the initiatives, and therefore the firms were not available to the researcher. The collection of data started in March, 2000.

Initially, it was envisaged that data would be collected monthly for 2 years to provide 24 data points in the quantitative data series, because the WPC process was intended to take place over a 2-year period. However, due to start-up delays and interruption

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and delays during the process at some firms, but mostly because it became apparent that the lag between implementation and performance outcome would not be captured, the data collection period was extended to 3 years, providing 36 data points for 10 of the 12 firms. Firm U had started its initiative earlier than the WPC and had good records. Therefore, it was possible to collect 72 months of data from Firm U, starting in March, 1998. Firm E closed down 2 years after starting its participation in the WPC due to poor market conditions, and therefore only 24 months of data is available for this firm.

As reported in section 1.4.2, I had experience both as a production manager and as a researcher in the field of interest (Grütter et al., 2002). This facilitated access to especially qualitative data as I could relate to both shop floor and management-level people. The fact that I personally collected all data made it possible for me to rapidly adapt to circumstances during data collection in a way which minimised the negative consequences for data integrity. For instance, on several occasions, I investigated suspect source data and discovered capturing or calculation errors by frontline workers that the management of the firm were not aware of. However, data collection by a single field worker raises validity and reliability issues, which are dealt with in section 3.4.2.

As Pettigrew (1995) maintained, clarity of research design helps with the subsequent data reduction and interpretation. A key feature of this research is the objective measures of practice implementation and operational performance that were developed with the purpose of assessing the important research variables. These are supplemented by qualitative data in the form of interviews with key informants at each firm, which enabled enriched interpretation of the quantitative findings (Eisenhardt, 1989, p. 538). Without specifying these measures at the outset, it would not have been possible to do the subsequent analyses.

Throughout the research project, research outputs were made in the form of presentations to the WPC (Grütter, 2002) and industry (Grütter, 2004), research seminars (Grütter, 2002; Grütter, 2004), and conference papers (Grütter, 2001; Grütter, 2003; Grütter, 2004), as well as a report to the WPC (Grütter, 2004). These outputs were helpful in the way suggested by Pettigrew.

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3.3.2.2. Technical Issues Associated with Longitudinal Research

Menard (2002, pp. 37-44) raised a number of issues with respect to technical issues that can arise when collecting longitudinal data.

- Changes in measures over time: These changes may occur during the period of data collection, between different studies, or the measure may become obsolete due to changes in theory;
- Missing data: Replacing missing data with estimates entails making assumptions about the patterns or similarity between the missing and estimated data. If a reasonable basis for estimation can be found, missing data can be fairly effectively replaced.
- Panel conditioning: The effects of repeated testing may damage internal validity in experimental and quasi-experimental designs, but these can be mitigated with control groups;
- Respondent recall: Respondent recall can be notoriously unreliable and is affected by several conditions such as time between event and report thereof, salience of events, and opinions and attitudes of respondents.

The measures of the independent variables used in this research did not change over the duration of the research. The same measures were used across the firms (as reported in Appendix 3.1), making comparison between firms possible. In addition, these measures are fairly easily replicable for future research.

The measures used for the dependent variables also did not change (with one minor and reconcilable exception); however, these measures were not consistent across the firms. The cross-sectional inconsistency was unavoidable because the performance outcome measures used as indicators of the dependent theoretical constructs were different at each firm due to their different production processes, which is not an unusual situation in multi-case research (Eisenhardt, 1989, p. 542). This made cross-sectional comparison at the level of primary measures problematic (Ichniowski et al., 1997, p. 292). However, standardised measures were developed to make quantitative assessments of the trends of the outcome measures in addition to the qualitative interpretations of these data.

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Some of the data series suffer from occasional missing data. A conservative approach was taken to replacing missing data, following the principle that if missing data were replaced, it should only be done where significant benefits were apparent, on the basis of an estimate which could be justified as realistic and which did not favour the research propositions unduly.

Panel conditioning was only an issue with the qualitative data collected, and then only in the sense that respondents became familiar with the types of questions likely to be asked during the interviews as they were repeatedly interviewed over 3 years. This could arguably have led to the improved quality of the data collected as respondents could have made mental notes of salient events and issues between interviews. I did not gain the impression that respondents suffered from interview fatigue as on-site interviews were spaced at intervals of about 4-6 months, with telephonic interviews in between where necessary.

Respondent recall is also not considered a significant problem as interviews were conducted at intervals short enough to make it fairly easy to recall the information at the level of detail required for this research. However, some respondents were inclined to report positive results more readily than negative results. This was counteracted during interviews by asking probing questions and consulting more than one respondent where possible. However, the qualitative data are used with caution and primarily to provide deeper insight into the qualitative data, rather than as primary measures of the variables investigated.

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3.3.3. Multiple Cases

While theoretical replication in a single case is regarded as adequate for theory development, multiple cases of the same phenomenon strengthen generalisation of findings (Voss et al., 2002, pp. 201-2; Merriam, 1998, p. 40). When using multiple cases in this way, it is important to regard each case as a replication, which means the cases are treated as a series of independent experiments that confirm or disconfirm the hypotheses (Yin, 2003, p. 47; Pagell & LePine, 2002, p. 623; Brown & Eisenhardt, 1997, p. 5).

Accordingly, in this research,

- Each case was adjudged consistent or not consistent with the hypotheses;
- Every case assessment against the theory was treated independently;
- Every case where the theory was upheld was regarded as strengthening confidence in theory and vice versa.

Interestingly, regarding the level of confidence one can place in (dis)confirming findings from multiple cases, Lijphart had this to say:

> One or two deviant cases obviously constitute a much less serious problem in a statistical analysis of very many cases than in a comparative study of only a few—perhaps less than ten—cases... Deviant cases weaken a probabilistic hypothesis, but they can only invalidate it if they turn up in sufficient numbers to make the hypothesized relationship disappear altogether. (Lijphart, 1971, p. 686)

3.3.4. Alternative Theory

Given that establishing causality is the ultimate goal in social research, but that it also presents many methodological difficulties, King et al. (1994, p. 33) suggested that "social scientists approach the issue of causal inference...with scepticism and a concern for alternative explanations that may have been overlooked."

Therefore, despite multiple confirmations of a theory, as described above, an additional test for confidence in a theory must be ruling out alternative explanations for the phenomena observed. The theory with the best fit to the data is then accepted as the one with the greatest explanatory power (Voss et al., 2002, p. 216).

An alternative theory to the efficacy of TBWO, namely performance improvement through better capacity utilisation, is considered in section 4.4.3.

3.4. Research Design

Some aspects of the research design used by Yeatts and Hyten (1998, p. 309) (which in turn is based on Yin, 1989) were also used for this research design.

3.4.1. Case Selection

Case selection is one of the early research design issues inasmuch as it determines both the extent of generalisation that can be made from the research findings and also

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is one of the few means by which the researcher can introduce control of extraneous variation not relevant to the research (Eisenhardt, 1989, p.537).

The primary consideration with respect to case selection is theoretical relevance (Yin, 2003, p. 111; Stuart et al., 2002, p. 425; Webster & Omar, 2003, p.5). Cases should be "intentionally" (King et al., 1994, p. 115) chosen for being "exemplary" rather than being statistically representative (Stuart et al., 2002, p. 426).

Multiple cases are sought to improve confidence in the generalisation of the results. Of course, the more cases that meet the selection requirements, the better for confidence in the results of the multi-case replications (Yin, 2003, p. 51; Stake, 1995, p. 5).

It has been suggested that industry, organisation size, manufacturing processes, and inter-organizational effects are taken into consideration to avoid "confounding attributes" when selecting research sites (Stuart et al., 2002, p. 426).

Therefore, the criteria for case selection (Yin, 2003, p. 78; Merriam, 1998, p. 61) in this research were based on the list provided by Miles and Huberman (1994, p. 34) and also listed in Voss et al. (2002, p. 204):

- Is it relevant to the conceptual frame and research questions?
- Will the phenomena to be studied appear? Can they appear?
- Is it one that enhances generalisability?
- Is it feasible?
- Is it ethical in terms of informed consent, potential benefits and risks and relationships with informants?

Selecting firms participating in the WPC meets the first criterion as there was a high degree of congruence between the practices implemented by the firms and the independent constructs in the theory. Likewise, the objectives of the WPC (see section 1.1.3.1) and the independent constructs in the theory were also highly consistent.

As the implementation plans of the participating firms were based on the advice of consultants who also used many of the same theoretical principles (albeit in forms

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written for practitioners such as Womack and Jones, 1996), it was highly probable that the practices that represented the independent theoretical constructs would appear. The predicted performance outcomes were not certain to occur from the researcher's perspective, given the much-reported failures of these kinds of initiatives. However, they were definitely much anticipated by the project management, consultants, and firm managements.

In pursuit of as many as possible cases to improve generalisability (within the limits of the researcher's resources and time), 17 firms were initially included in the cases selected. More than 17 firms participated in the WPC, but it was decided to focus on two geographical areas, the Western Cape and KwaZulu-Natal, where the WPC was most active at the time. One firm was excluded before data collection commenced because the firm decided to withdraw from the WPC. Two firms went out of business early in the data collection period, and two firms postponed implementation of their initiatives so data from these firms were not included as it was collected over too short a period to be of use. That left 12 firms that were included in the research, as listed in Table 3.2.

The participating firms were all located in well-established industrial areas within an hour's drive from the cities of Cape Town and Durban. Because of this, they had access to the usual infrastructure and support services common to the Western industrial world.

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Table 3.2: Summary Profile of Case Study Firms

Firm	Industry sector	Process Type	Owner-ship	Shop Floor Employees	Sales pa Rm	Region	Town
R	Furniture	Batch/Ass	Priv	57	25	KZN	Pinetown
G	Footwear	Batch/Ass	Priv	139	15	KZN	Pietermaritzburg
C	Auto component	Batch	Priv	159	15	KZN	Pinetown
K	Auto component	Batch	Corp	234	200	KZN	Pietermaritzburg
J	Clothing	Batch/Ass	Priv	70	55	WCP	Cape Town
O	Auto component	Batch	Corp	401	90	KZN	Stanger
E	Footwear	Batch/Ass	Priv	21	2	KZN	Durban
S	Auto component	Batch	Priv	126	24	KZN	Pinetown
X	Metal fabrication	Eng shop	Priv	65	18	WCP	Paarl
Y	Auto component	Batch	Priv	64	12	KZN	Pietermaritzburg
U	Clothing	Batch/Ass	Priv	191	110	WCP	Cape Town
N	Auto component	Batch	Corp	98	21	WCP	Cape Town

(Note: Sales p.a. are for year 2000 and Shop Floor Employees include direct employees only.)

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In a quasi-experimental, multi-case study such as this, "unit homogeneity" becomes an issue (King et al., 1994, p. 91). As these cases are theoretical and not literal replications, there were extraneous influences not related to the research questions that were expected to influence the values of the dependent variables. Therefore, in this research, the weaker form of unit homogeneity, namely, that there is a "constant effect" rather than exact replication of the values of the dependent variables for given independent variables, was used (King et al., 1994, pp. 92-3).

The firm characteristics that reflected unit homogeneity for the purpose of this research were that of the firms included in the research

- all manufactured discrete products;
- most were batch or batch/assembly type operations;
- all participated in at least the initial stages of the WPC with the intention to introduce new work organisation practices;

- all could be classified as formal, medium-sized enterprises;
- all had "hands-on" management who were well informed about day-to-day activities on the shop floor;
- all employed shop floor workers with similar levels of education;
- all had access to well-developed infrastructure and industrial support services;
- all received the same incentives (according to size criteria which provided relatively more support for smaller firms) from the WPC;
- all had the same obligations to pay their share of costs associated with the programme implementation and participate in the WPC processes.

None of the firms studied made significant changes to the level of technology that they employed, although some firms did make capacity expansions using similar technology to what they had used before.

The circumstances which made the research units dissimilar were:

- Different industry sectors were represented, with the auto-component sector predominating;
- Firm X was the only firm utilising the anon-repetitive engineering shop type of production process;
- Firm E went out of business 2 years into the research, whereas Firms J and C went out of business shortly after the data collection was completed.
- Two firms (Firms N & U) started their initiatives prior to becoming involved in the WPC;
- Some firms experienced organisational restructuring during the course of the research.

The initial intention with respect to case selection was to select an even spread of firms with respect to industry sector. However, it proved both not to be possible and ultimately fortuitous as the firms in the auto-component sector, as opposed to firms from other sectors, warranted analysis as categories in their own right. Another circumstantial factor related to sector was that at the time of the research, the auto-components sector was experiencing relatively good market conditions, whereas the clothing and footwear sectors were going through tough times.

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The most important factor with respect to unit homogeneity was process type as recent studies indicate that this does have implications for the way in which work is organised (Muda & Hendry, 2002; Suri, 2000). All but Firm X were batch or batch/assembly type processes. Unlike job shops or continuous process operations, these batch/assembly processes are particularly suited to the introduction of TBWO as they can usually be laid out in cells (or modules, as this configuration is known in the clothing sector).

Firm E went out of business primarily due to poor market conditions. While these circumstances loomed large during the latter stages of research at this firm, they provided impetus to the firm's efforts to implement the practices at the firm as these changes were seen as part of the survival strategy. For this reason, it was decided not to exclude the 24 months of data collected at this firm from the study.

Rather than exclude the firms that started their initiatives before the WPC and those where significant organisational restructuring took place, they were retained in the data set to provide increased "observable implications" of the theory, as advocated by King et al. (1994, p. 47). The circumstances at these firms did indeed provide findings that enabled a more nuanced interpretation of the theory, as reported and discussed in sections 4.3 and 4.4.

The final issue with respect to case selection is the possibility that there was selection bias:

> Selecting observations for inclusion in a study according to the categories of the key causal explanatory variable causes no inference problems. The reason is that our selection procedure does not predetermine the outcome of our study, since we have not restricted the degree of possible variation in the dependent variable. (Yin, 2003, p. 137)

As the cases were indeed selected for inclusion in the research on the independent variables, there is, in principle, no problem of selection bias. In addition, as there was variation of the independent variables that could be related to the dependent variables, even stronger claims to causality may be possible.

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A concern may be raised that only firms participating in the WPC were considered for selection. It is true that these firms may be more proactive than the typical manufacturing firm in general, by virtue of the fact that they chose to participate in the WPC. However, once again, this relates to the issue of adoption rates of new work organisation practices, which is not the focus of this research. Therefore, this issue is not regarded as a serious concern for this study.

3.4.2. Validity and Reliability

Where "degree of diffusion of the best practices" was researched, "it was necessary to operationalize them by means of both objective and perceptive measurements" (Panizzolo, 1998, p. 229). The quantitative data collected for this research was based on measures of the extent of the implementation of selected practices and operational outcome performance data. The qualitative data were primarily collected by means of open-ended interviews with respondents in key positions at each firm. This information was supplemented by researcher observations during field visits, company documents, and photographs taken at the firms. Issues related to rigour of both the quantitative and qualitative data that were collected for this research will be addressed below.

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According to Yin (2003, p. 34), Stuart et al. (2002, pp. 429-30), and Dooley (2002, p. 340), the main concerns about the rigour of case research can be dealt with under the following headings and by means of the tactics listed under each heading:

Construct validity: Establishing accurate measures of the constructs being studied by

- Using multiple sources of evidence
- Establishing a chain of evidence
- Having key informants review a draft case study report.

Internal validity: Establishing causal relationships by

- Doing pattern matching
- Doing explanation building
- Addressing rival explanations
- Using logic models.

External validity: Enhancing extent to which findings can be generalised by

- Using theory in single-case studies
- Using replication logic in multiple-case studies.

Reliability: The extent to which the study can be repeated by

- Documenting the data collection process
- Using a case study protocol
- Developing a case study database.

Having dealt with these issues in principle earlier, I will now go on to describe the specific techniques and tactics (Dooley, 2002, p. 340) used to meet these requirements in this research. Arguably, the above list is more applicable to qualitative research. Therefore, the section on construct validity of the quantitative measures used will focus more on the selection of variables and the indicators used to measure them, but the section on construct validity starts by briefly noting the quasi-experimental setting.

3.4.2.1. Construct Validity

3.4.2.1.1. Quasi-experimental Setting

The data were collected in a quasi-experimental setting, where a similar generic programme implementation process led to general consistency in the range of practices considered for implementation by each participating firm, thereby meeting the basic conditions of "degree to which the investigator has been successful in creating or arranging for the conditions of conceptual or theoretical interest" (Schmitt & Klimoski, 1991, pp. 28-32).

3.4.2.1.2. Quantitative Data

As documented earlier, in section 1.2.2.4, much of the existing research on the effectiveness of TBWO is criticised for being anecdotal and perceptual. Hence the need to have quantitative data in this research to enable rigorous measurement of the constructs of interest in order to make accurate descriptive inferences about the phenomena studied.

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The approach used to measure the independent variables was conceptually simple. Firstly, a number of key indicators were identified from the literature that would represent the independent construct "TBWO practices implemented". These were further sub-divided into the three independent sub-constructs, namely bundles of HR, WC practices, and CI practices, to enable testing of Hypotheses 2. Then, the indicators of these practices were operationalised by means of measures appropriate to the particular practices. The independent variables were measured in a standard way across all the firms researched.

Measurement of the independent constructs presented a methodological challenge in that while the concepts of productivity and quality are conceptually universal across manufacturing firms, they have to be measured in ways specific to the production process and products produced by each firm. Firms from different industry sectors were selected to enhance generalisability of the findings, but this came at the cost of not being able to measure productivity and quality in a standardised way. Even within industry sectors, outcome measures differed across firms due to significant differences in the design and technology of production.

Therefore, it was decided to use indicators of productivity and quality in use at the firms as the measures of outcome performance, thereby sacrificing the ability to make direct cross-sectional comparisons across the firms on the performance outcome measures. However, as each case is considered a unique replication of the theory, the comparisons that will be made across the cases will not be at the level of the measures of practices and outcomes but at the level of theoretical confirmation or disconfirmation in each case.

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3.4.2.1.2.1. Variable Selection

The variables used for this research were selected from the practices identified in Table 2.1 as being representative of the TBWO approach to managing shop floor operations, with particular emphasis on the practices associated with HR, WC and CI. Additional justification for selection is provided for some variables below. General issues of operationalisation and measurement difficulties will then be reported here, while detailed reporting of these issues on each variable is contained in Appendix 3.1.

It is important to note that the variables measured were not intended to be an exhaustive list of practices that conceivably could be part of a TBWO approach, but rather were selected to be key indicators of the constructs researched. This was necessary to limit the amount of data collected to manageable proportions as there was only one field worker available to collect the data.

3.4.2.1.2.1.1. Baseline Variables

These data were used to identify firms or periods or as inputs to other variables. For instance, when an entire workforce went on one day's training, the training hours would be calculated as: Shop Floor Employees x (Hours of Working Week/5). In other cases, the baseline data were used to standardise certain measures across the firms. For instance, the percentage training hours was calculated as the total training hours per month divided by the total hours worked per month.

Baseline data were collected on the following variables:

- Firm
- Period
- Direct and indirect shop floor employees
- Hours of the working week
- Working days in the month
- Normal hours worked
- Over-time hours worked.

3.4.2.1.2.1.2. Structural Changes

Structural changes were operationally defined as "any organisational change that is a step change or a break with the past which is likely to remain in place for the foreseeable future" (WPC Doc 1) in the monthly firm report that respondents received at the outset of the research.

A "Yes", "Some", or "No" three-category scale was developed for each of the structural variables. While scales with more categories are common, a three-category scale was also preferred by Shah and Ward (2003, p. 137) as it captures "most real information". The categorisation criteria and measurement difficulties specific to the variable are reported for each of the variables. The categorisation was done during site

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visits by the researcher by observation and/or in consultation with the relevant firm informants.

3.4.2.1.2.1.2.1. Steering Committee

Although representative structures do not appear high on the list of CMA practices, steering committees are mentioned by other authors (Faull, 1998, p. 228). Wellins et al. (1991, p. 106) suggested that steering committees should be broadly representative of the stakeholders in the change process, and Huge and Anderson (1988, pp. 100-1) suggested that steering committees should

- Approve and recommend projects;
- Appoint ad hoc multi-functional teams to work on specific problems and projects;
- Ensure resources are available;
- Review progress and revise priorities;
- Applaud success;
- Evaluate their own behaviour relative to the programme.

In the WPC, each participating firm was required, as a condition of participation in the project, to have a steering committee to ensure stakeholder involvement from the outset. These committees had representation from both management and labour charged with deciding high-level implementation issues in each firm participating in the WPC. For instance, the steering committees initially had to negotiate a "workplace change agreement", in which the principles and process of implementing the TBWO programme were agreed, and the committee also decided which consultants were selected to help the firm with the process. Thereafter, the steering committees dealt with high-level facilitation and removal of obstacles to the implementation process.

3.4.2.1.2.1.2.2. Staff Facilities

Improvement of staff facilities is not referred to, in the literature reviewed, as a practice associated with CMA, possibly on the assumption that it is basic workplace infrastructure which is already in place. However, it is often the case that staff facilities are very rudimentary or become run down. Therefore, many firms that embark on these kinds of initiatives make improvements to staff facilities to show the workforce that they also stand to benefit from the initiative. Generally speaking, upgrading staff facilities is consistent with securing early buy-in to the programme

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from the workforce, an idea which is supported in the literature (Brunet & New, 2003, p. 1443; Grütter et al., 2002, pp. 651).

3.4.2.1.2.1.2.3. Cellular Layout or Layout Changes to Improve Flow

Changing the process layout to improve flow and/or to a cellular production configuration is high on the list of CMA practices and is well supported in the literature (Lindberg & Berger, 1997, p. 91; Hyer & Wemmerlov, 2002).

3.4.2.1.2.1.2.4. Small Batches

Reducing batch size and work-in-progress inventories in general also ranks high on the list of CMA practices and is well established in the literature as a cornerstone of these practices (Womack & Jones, 1996, p. 232; Schonberger, 1996, p. 159; Henderson, 1986, p. 6).

3.4.2.1.2.1.2.5. Employment Equity

Employment equity as a CMA practice is probably unique to the South African context. It refers to a form of affirmative action whereby people from designated previously disadvantaged ethnic groups are supported to accelerate their career advancement in order to harmonise the employment profile of firms with the regional ethnic demographics. In practice, it took the form of representative committees overseeing issues of employment equity at each firm. It was arguably a practice which not only improved front-line management skills but also served as a motivator to shop floor people. It was included as an indicator of an HR practice.

3.4.2.1.2.1.2.6. Incentive Scheme

Competence- or reward-based pay schemes appears mid-range in the list of CMA practices. Team-based incentives is an organisational change which has been written about extensively (Appelbaum & Shapiro, 1991; Banker et al., 2001; Lawler, 2000), and Lawler et al., (1995, p. 19) reported that team incentives increased relative to individual incentives from 1987 to 1993. In this research, a distinction was not made between team or individual incentive schemes in the collection of quantitative data.

3.4.2.1.2.1.2.7. Retrenchment

The threat of job insecurity is regarded as detrimental to employee involvement, and it is doubtful whether much progress can be made with implementing TBWO in circumstances where retrenchments take place or are imminent (Heller et al., 1998, p. 207; Lawler et al., 1995, p. 106). Tacit organisational knowledge of a "stable and

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knowledgeable" workforce is regarded as necessary for the success of TBWO (Stratman et al., 2004, p. 692). As much of South African industry was threatened by competition from imports, it was regarded as important to include this variable.

3.4.2.1.2.1.2.8. Factory/Customer Visits

Encouraging shop floor workers to interact with their customers and suppliers shortens the information feedback loop between manufacturer and user and enables shop floor workers to contextualise their work (MacDuffie, 2000, p. 194; Linderman et al., 2004, p. 602). Lawler et al. (1995, p. 49) listed "direct employee exposure to customers" as a TQM practice. However, time spent with customers or suppliers by shop floor workers causes a direct loss of production. Thus, this indicator was regarded as a stiff test of the commitment of the firm to the implementation of TBWO.

3.4.2.1.2.1.3. Off-Production Hours

This measure contained three variables on paid time spent off production on communication and consultation, training and team work. It was regarded as an important indicator of the extent to which the firm was committed to implementation of the TBWO initiative as it involved direct cost without a concomitant return of production output.

3.4.2.1.2.1.3.1. Communication and Consultation

This measure related to the time taken off production by the shop floor employees for communication or consultation about the workplace changes. Troutt et al. (1995, p. 51) suggested that communication and consultation is important for employee buy-in to workplace change programmes. Consensus building is also recommended to build understanding and commitment in order to implement management decisions effectively (Roberto, 2004, p. 625). Nahm et al. (2003, p. 287) contrasted "control" versus "commitment" models of management and proposed that the nature of communication in the latter changes over time. Horizontal (peer to peer) communication increases and vertical communication (between management and shop floor) alters in that information and knowledge transfer increases in frequency and content. It has also been found that communication and information sharing is positively associated with innovation (Monge et al., 1992, p. 266).

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To assess the nature of communication and consultation, the use of the following practices were also documented:

- Employee briefings by management
- Off-site meetings to discuss non-production-related issues
- The addressing of issues raised by shop floor employees
- Stakeholder forum
- Circulation of meeting minutes
- Sharing of vision and/or values
- Newsletter.

3.4.2.1.2.1.3.2. Training

Training ranks high on the list of CMA practices and is universally regarded as important to facilitate the acquisition of new skills required by TBWO. It is a common practice in the majority of organisations embarking on TQM (Coyle-Shapiro, 2002, p. 60). Initial training was found to include quality awareness, team problem-solving training, or technique-specific training such as SPC or set-up time reduction (Easton & Jarrell, 2000, p. 99). Also, group decision-making/problem-solving, quality/statistical analysis and team-building were found to increase relative to other types of training when firms implemented TQM (Lawler et al., 1995, p. 14).

Apart from time off production for training and number of employees receiving training, the time spent on the following different types of training was recorded:

- Job skills
- Teamwork
- Problem solving
- Change and/ or orientation
- Quality
- Other training related to TBWO
- Other training not related to TBWO.

3.4.2.1.2.1.3.3. Teamwork

Team-based decision making also ranks high on the list of CMA practices and is recommended as a cornerstone of TBWO. Fairhurst et al. (1995, p. 287) found that a high level of horizontal integration (workers brought together in autonomous work teams, cross-functional teams, and task forces) and decentralisation of decision

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making is positively associated with improved plant performance. Some even claim that "teamworking emerged as the most distinctive feature of the new work patterns" (Institute of Personnel Development, 1999, para. 7).

Teamwork was measured in terms of the number of shop floor employees in teams and the amount of off-production time spent by shop floor employees on production-related decision making. The time spent by the following different types of teams was also documented:

- Shift teams (also known as natural work groups)
- Cross-functional teams
- Improvement/problem solving
- Safety
- Other.

In addition, two questions relating to the nature of the teamwork were included. These were whether the shift teams met daily and whether they made use of external facilitators and/or coaches to improve the functioning of the teams.

3.4.2.1.2.1.4. Practices Implemented

These variables related to the ongoing practices related to TBWO followed in the firms researched. For ease of use, they were grouped as follows:

3.4.2.1.2.1.4.1. Suggestion Implementation

Employee involvement in process improvement ranks high in the writings on CMA practices and other writings (Panizzolo, 1998, p. 232; Frese et al., 1999, p. 1139). The number of suggestions from shop floor employees that are implemented is a common metric used to assess employee involvement (Womack & Jones, 1996, p. 200; Lloyd, 1996, p. 25; Gondhalekar et al., 1995, p. 198; Kim, 2005, p. 638). It was therefore included as a measure.

Decentralisation of decision making is also emphasised, along with increased autonomy of shop floor teams (Wall et al., 1986; Schuring, 1996). To gain insight into this issue, a question was included on who took responsibility for implementation of suggestions. The question had the following categories:

- Team as a whole

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- Team leader
- Workshop staff
- Management
- Other.

The extent of formal shop floor team authority to make decisions up to a pre-determined cost and whether the team dedicated time during their team meetings for process improvement were also included as three-category questions.

3.4.2.1.2.1.4.2. TBWO Methods in Use

Percentage TBWO methods in use was a measure not seen before in the literature consulted. It was a subjective assessment of the researcher, based on field observations and made in consultation with respondents from firms regarding the extent of implementation of indicator practices associated with TBWO that are primarily the prerogative of management. The measure was included to show the extent of management's commitment to actually implementing these practices. Indicator practices are meant to provide an indication of the extent of implementation rather than be a comprehensive list of such practices.

While subjective measures are open to criticism for lack of rigour, they do have the advantage of capturing a large amount of complex data in an analysable form. To improve accurate measurement, specified criteria were used to set benchmark percentages, and the fact that the same researcher was involved in all the assessments meant that a degree of consistency was possible.

A three-category assessment of the implementation of the following practices was also included:

- Visual management
- Waste identification
- Problem solving
- Team presentations
- Resource availability
- Other.

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3.4.2.1.2.1.4.3. Best Operating Practice

Percentage best operating practice was included to assess the extent of consistent execution by shop floor employees of the practices associated with TBWO. It relates to the need to standardise shop floor processes (Suzaki, 1993, p. 98; Cole & Mogab, 2000, p. 65) and maintain shop floor discipline (Spear & Bowen, 1999, p. 98; Maskell, 1991, p. 207). It was operationalised in much the same way as percentage TBWO methods in use, and the same issues as mentioned previously apply to this measure.

The following practices were included in the three-category assessment of this measure:

- Housekeeping
- BOP documents on shop floor
- Tools in place
- Daily feedback
- Update of BOP
- Training certification
- Other.

3.4.2.1.2.1.4.4. Maintenance

Although maintenance may not be a primary focus of TBWO approaches, it ranks high amongst the CMA practices because equipment downtime impacts directly on operational performance. Another reason for inclusion was that autonomous maintenance is a form of employee involvement and many process improvements take place through modifications of equipment. The total number of hours spent on maintenance was broken down into the following categories:

- Breakdown
- Preventative
- Autonomous
- Other.

3.4.2.1.2.1.5. Dependent Variables

As explained earlier, it was not possible to measure the dependent variables using a consistent indicator as these indicators depended on the nature of the product and process of each firm (Buchanan, as cited in Storey, 1994, p. 211). Consequently, these

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data were collected by means of the relevant measures in use at each firm. This made assessment of longitudinal trends possible although direct comparisons across firms were not possible.

3.4.2.1.2.1.5.1. Inventory

Lower inventory levels is a core concept in the TBWO literature (Womack & Jones, 1996, p. 15; Suzaki, 1993, p. 163) and scores high in the CMA practice list. Depending on what measure is used, inventory reduction can be an independent, intermediary or dependent variable (Fullerton et al., 2003, p. 391). Clearly, the introduction of smaller batch sizes or Kanban systems are independent variables; however, there are also systemic effects (such as less defective product on the shop floor due to better process quality) that lead to lower inventory levels. Other variables dealt with previously mentioned practices that were presumed to directly cause lower inventory levels. Here, the aggregate inventory levels of raw materials, work-in-progress, and finished goods was measured and treated as a dependent variable.

3.4.2.1.2.1.5.2. Sales and Output

Sales and/or (where possible both) output figures were collected for the business unit relevant to the research. Although these measures were not the dependent variables of primary interest, they served two purposes. Firstly, they provided a gross indication of firm performance, although it must be kept in mind that these figures were in some cases affected by factors not related to production, such as market conditions, strikes, seasonality, and so on. Secondly, in some cases, these figures were used in the calculation of derivative measures such as productivity. In all cases, where nominal Rand values were used, they were discounted to March 2000 Rand values against the price increases relevant to the specific firm.

3.4.2.1.2.1.5.3. Productivity

Productivity is a common measure of operational performance of firms (Ichniowski et al., 1997; Bartezzaghi & Turco, 1989, p. 46). The productivity measure (and in some cases more than one measure) in use at the firms was researched and collected. In some cases, productivity measures were constructed against baseline data such as number of employees and/or hours worked (Kim, 2005, p. 639). Measure selection was based on measures that were

- aggregate measures of operational performance,

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- based on physical output rather than value,
- based on labour productivity rather than other less relevant productivity measures,
- based on accuracy of raw data collection at the firm, and
- based on ease of data collection.

3.4.2.1.2.1.5.4. Quality

Quality is also a common measure of the operational performance of firms (Banker et al., 2000; De Toni et al., 1995). Therefore, quality, as measured at the firm, was included as a variable. A wide variety of quality measures were in use at the firms, depending on their products, process and organisational circumstances. The preferred quality measures were

- aggregate measures of quality reflecting the operation as a whole,
- direct measures close to the operation, rather than downstream from production,
- ease of data collection.

However, it was not always possible to obtain the preferred types of quality measures and then the next best measure was collected.

3.4.2.1.2.1.5.5. Time-based Performance Measures

Other measures, such as percentage on-time delivery, were collected because, initially, the research design included time-based performance measures (Maskell, 1991, p. 123; Nahm et al., 2003, p. 282). However, these measures proved not to be in use at many of the firms researched and therefore only a few readily available measures were collected.

3.4.2.1.2.1.5.6. Absenteeism

Absenteeism data were collected as a proxy measure for employee satisfaction with working conditions (Cotton, 1993, p. 188; Carson et al., 2004, p. 154). Once again, absenteeism as measured at the firm was used.

3.4.2.1.2.2. Operationalisation

Operationalisation of measures is reported in detail for each measure in Appendix 3.1.

A general issue of operationalisation was that care had to be taken to measure only aspects of the operation relevant to the business unit investigated. In most cases, this was not a problem as the entire firm constituted the business unit. However, in the

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case of Firm J, the unit investigated was a department of a larger firm (because that is where the teamwork initiative was implemented) and care had to be taken to collect only data relevant to the department. At Firm U, this was also the case, although there, the firm kept separate records for the department.

The "TBWO methods in use" and "best operating practices" were intended to be measures of two conceptually distinct constructs. However, it is questionable whether the original intention to distinguish between the practices listed under "TBWO methods in use" versus those listed under "best operating practices" worked. Whether a practice was, or was not, well implemented because of management or shop floor commitment could not be reliably ascertained, and therefore these measures could not be used as valid separate variables. However, the variables did serve as good measures of the extent of practice implementation in general, whatever the source of the drive to implement.

3.4.2.1.2.3. Measurement Difficulties

While objective data are much sought after, there are recognised difficulties with the collection of such data (Kaynak, 2003, p. 428). Difficulties with specific measures are reported in Appendix 3.1, where necessary. Three general issues regarding measurement difficulties are reported here.

Firstly, as the research relied heavily on data generated at the firms for their own purposes, especially for the dependent variables, the recording of data was done by people not well versed in data collection for research purposes. To minimise data errors, the raw source data were collected where possible rather than using derivative measures such as percentages or other relative measures. Spot checks were carried out to verify these data where possible.

Secondly, where estimates needed to be made, or where categorisations were made on the basis of the researcher's or respondents' subjective assessments, the criterion "as long as it is not misleading" was used. Where there was uncertainty beyond this criterion, the data were not recorded.

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Thirdly, in several instances, data were not available due to circumstances beyond the control of the researcher, for instance, when employees responsible for data collection were absent due to ill health. These data were not replaced with estimates, and as a result, some of the data series are truncated. This had negative consequences for the power of data analysis, but it was regarded as advisable to take a conservative approach.

Having dealt with the issues of construct validity of the quantitative data collected, I will now go on to dealing with these issues as relevant to the qualitative data collected.

3.4.2.1.3. Qualitative Data

Having obtained quantitative data with which to construct implementation indices and performance trends, an empirical foundation was laid for the research. However, as is common in case method research, rich qualitative data were also uncovered (King et al., 1994, p. 4). This was necessary to understand the context in which the TBWO practices were implemented and to interpret the performance outcomes. However, as Reichardt and Cook (1979, p. 25) pointed out, collecting qualitative data presents significant obstacles, particularly of researcher time and research costs.

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The primary source for the qualitative data was tape-recorded interviews, which were transcribed. A total of 80 interviews, with a combined total duration of approximately 45 hours, were conducted with 38 respondents at the 12 participating firms (See Appendix 3.2 for further details). While most information at each firm was provided by one or two primary respondents, more were interviewed to clarify particular issues or to provide an alternative perspective. Respondents are identified by initials only to ensure confidentiality.

In addition, documents, field observations and photographs were used to collect evidence on an *ad hoc* basis. Taken together, this provided a comprehensive picture of the unfolding of events at the firms as they implemented their TBWO programmes.

Interviews were numbered and transcribed so that a chain of evidence could be established, and during the interviews, possible interpretations of developments at the

firms were discussed with the respondents in order to ensure that the correct interpretations were made.

The qualitative data are documented in case summaries in which the implementation initiatives of each firm are briefly described. These case summaries are primarily based on the interview data but also contain the observations and documentary evidence collected. While the qualitative data augment the quantitative data in the testing of the hypotheses, they were mainly useful for interpretation and theoretical discussion of the findings.

3.4.2.2. Internal Validity

As suggested by several authors (Yin, 2003, p. 34; Stuart et al., 2002, pp. 429-30), three techniques were used to enhance internal validity: triangulation, pattern matching and alternative explanations.

3.4.2.2.1. Triangulation and Convergence of Evidence

The purpose of triangulation is to corroborate whether the phenomena observed or recorded through qualitative data collection are indeed as the observer "sees" them. By "seeing" is meant both the perceiving and the interpretation of the phenomena. Triangulation is important to confirm both constructs and the relationships between constructs (Eisenhardt, 1989, p. 538). This is best achieved by more than one source of data on the same phenomenon, which often also implies more than one method of data collection (Voss et al., 2002, p. 206). Indeed, Yin (2003, p. 99) distinguishes four types of triangulation:

1. of data sources (data triangulation)
2. among different evaluators (investigator triangulation)
3. of perspectives of the same set of data (theory triangulation)
4. of methods (methodological triangulation).

While triangulation is mostly used in a confirmatory mode when evidence converges, Perlesz and Lindsay (2003, p. 35) pointed out that "making sense of dissonant data" in fact is also very useful. This is supported by Schmitt and Klimoski (1991, p. 118), who said, "As skilful observers, qualitative researchers are interested in the variance of measures as well as any central tendency. The deviant cases are looked to for new insights." This relates to the consideration of the cases that did not support the

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research hypotheses (in section 4.4.1) and alternative explanatory theories (in section 4.4.3).

A robust form of data triangulation is used in this research inasmuch as extensive quantitative data were collected on the primary constructs of interest. Qualitative interview data were the other main form of data, augmented by field observations, documentary evidence, and photographs, used for corroboration.

As this research was conducted by one researcher, not much use was made of investigator triangulation. However, throughout the long period of data collection, several research seminar presentations and conference papers were produced and, in this way, interpretations of the research were tested.

Theoretical triangulation will be dealt with later in section 4.4.3, when an alternative explanation for the data is considered.

Finally, methodological triangulation was used in that, apart from analysis by pattern matching, simple correlations were also used to corroborate the interpretation of the findings, as reported in sections 3.4.3.1 and 3.4.3.2.

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3.4.2.2.2. Pattern Matching

Whereas the technical requirements for validating quantitative research are fairly commonly accepted, the requirements for validating qualitative research are less well known and therefore less well accepted (Wruck & Jensen, 1998, pp. 143-4). "Those who customarily use mathematical analysis may view this reliance on the researcher's logical reasoning to deduce relationships as a highly subjective practice, since such deductions cannot be verified with the ease or precision afforded by mathematics" (McCutcheon & Meredith, 1993, p. 244).

One technique used in qualitative research that is the logical equivalent of the mathematical model used in quantitative research is the conceptual map, and it is tested against the data by means of pattern matching. "A pattern is any arrangement of objects or entities...Pattern matching always involves an attempt to link two patterns

where one is a theoretical pattern and the other is an observed or operational one" (Trochim, 2005, para. 3 & 4), as illustrated in Figure 3.1.

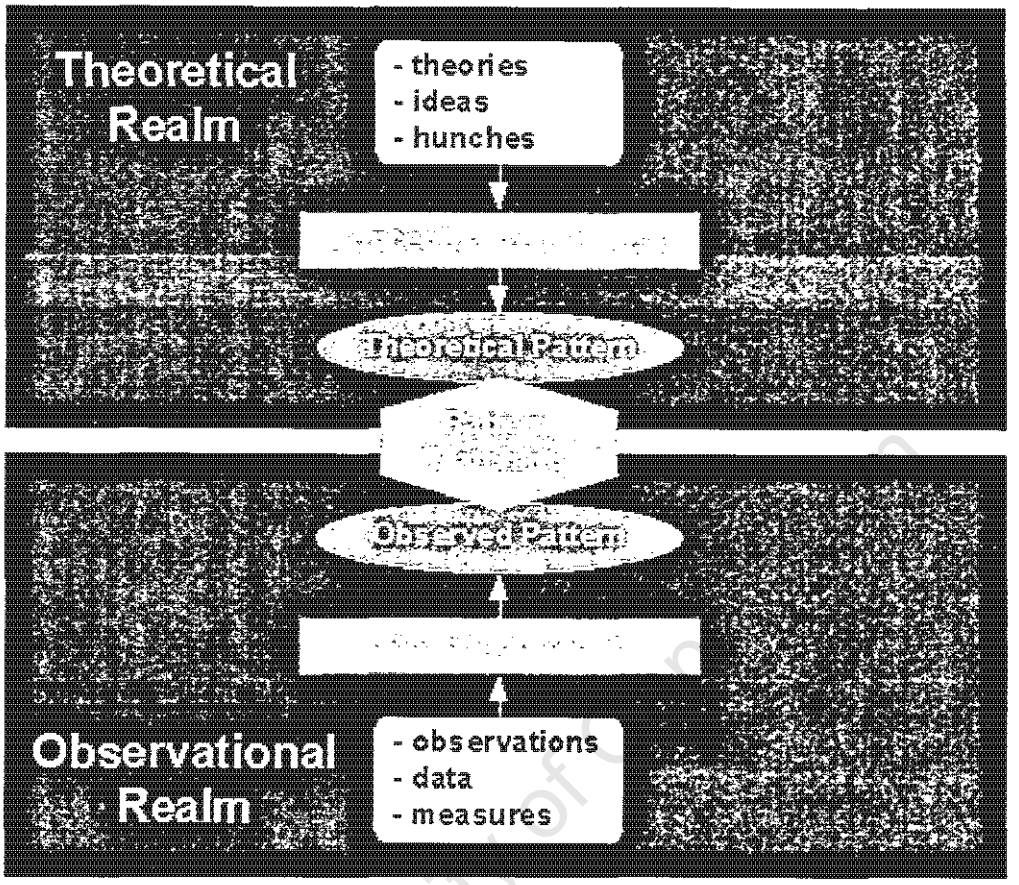

Figure 3.1: Trochim's Model of Pattern Matching

Yin (2003) regarded pattern matching as a "most desirable technique" (p. 116) to strengthen internal validity and made the following points about pattern matching:

- in explanatory case studies, patterns may be related to the dependent or the independent variables (or both);
- where quasi-experimental design is used, there may be multiple dependent variables. If the pattern of these outcomes matches the theoretically predicted pattern, and does not match the patterns derived from alternative theoretical explanations, strong causal inferences can be made;
- different patterns among independent variables where the same outcome occurred (i.e., dependent variables have the same patterns) may be explained where alternative and mutually exclusive theories are used to establish causality;
- pattern matching can also be used for explaining simpler patterns; with few variables provided, there are clearly distinct patterns;

- there are no generally accepted standards for testing the quality of assessment made on the basis of pattern matching. Meeting benchmarks defined prior to the research are probably the best form of test for significance.

(Yin, 2003, pp. 116-120)

This research relied to a large extent on pattern matching to interpret the qualitative findings. There was variation in the independent variable (extent of TBWO practice implementation) and matching variation in the dependent variable (extent of operational performance improvement). The pattern used to assess Hypothesis 1 was formulated on the basis of the theoretical propositions which predicted that the greater the extent of TBWO implementation, the greater the expected performance improvement. Hypothesis 2 was assessed on the correspondence between the extent of implementation of HR, WC, and CI practices in relation to the respective firm's performance outcomes.

While these are conceptually simple patterns, it is not a simple matter to make a qualitative assessment of the extent to which these variables changed. A small improvement in performance for a firm facing difficult market conditions and which has access to few resources may well be more significant than a large performance improvement for a firm in growing markets with good access to resources. For this reason, the benchmark that was defined as constituting performance improvement was set as improvement of any magnitude after implementation of TBWO practices.

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3.4.2.2.3. Alternative Explanations

As argued earlier, in section 3.3.4, theory testing with case method relies heavily on ruling out alternative explanatory theories. In quasi-experimental, multi-case research such as this, it may not be quite as crucial as in single case research to use this method of establishing internal validity. Nevertheless, in this research, one other theory that may explain the performance improvement in the firms studied, namely, that better capacity utilisation may explain performance improvement was explicitly considered. The theoretical relevance of capacity utilisation and its assessment were dealt with in section 4.4.3.

There are, conceivably, other explanatory factors that could have been considered, such as leadership (Hackman & Powell, 2004; O'Connell et al., 2002), organisational culture and/or climate (Beech & Crane, 1999; Sinclair & Arthur, 1994), innovation adoption and dissemination (Bailey & Sandy, 1999; El Quardighi & Tapiero, 1998; Lowe & Sim, 1993), and others. However, these were outside the scope of this research, and therefore data for assessing these theories were not available.

3.4.2.3. External Validity

Methodological issues relating to generalisability have been dealt with earlier in this chapter, in section 3.3.1 on quasi-experimental research and in section 3.3.3 on multiple-case research. Suffice to say here that the quasi-experimental, multi-case design of this research enhances the generalisability of this research. In terms of the scope, a strict approach to generalisation would limit it to medium-sized manufacturing firms of discrete goods operating in well-established industrial areas with access to infra-structure and resources. These conditions may be relaxed, as would be appropriate for theoretical generalisations beyond these boundaries; however, care will have to be taken to ensure commensurate circumstances.

3.4.2.4. Reliability

Reliability concerns the extent to which the study can be repeated by other researchers to test the findings of the research. This requires making data collection procedures and/or the data itself explicit, so that analysis can be replicated. In quantitative research, this is a relatively simple matter as procedures are formalised and data are in transferable formats. Case research suffers from the disadvantage that complex contextual data are often only available after being filtered by the researcher for relevance and salience, which introduces issues of subjectivity and bias. Furthermore, large amounts of data are not easily summarised or reduced to meaningful indicators.

On the other hand, McCutcheon and Meredith (1993, p. 248) pointed out that quantitative representations of reality can avoid problems of reliability by the way in which variables are defined. However, that approach to operationalisation does not necessarily make for good correspondence to real-world conditions. The case researcher is said to have an advantage in this respect as he or she has more direct access to real-world conditions (Voss et al., 2002, p. 208).

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These and other challenges of making causal inferences lead to what is termed the "fundamental problem of causal inference" (King et al., 1994, p. 79). King et al.'s advice is that "...even though certainty is unattainable, we can improve the reliability, validity, certainty, and honesty of our conclusions by paying attention to the rules of scientific inference" (pp. 6-7).

With respect to reliability, in this case research, the issues of the data collection process, data collection protocol, and case study database, raised earlier in section 3.2.3.2, are addressed next.

3.4.2.4.1. Data Collection Process

The first issue with respect to data collection was that it was all done by one researcher. This is unusual as projects of this size are usually done by a team (Pettigrew, 1995, p. 97). Therefore, investigator triangulation was foregone, although this was not necessarily a critical drawback in this research. Firstly, much of the data collected were objective quantitative data and the qualitative data are available in transcribed format for examination. Secondly, having only one person collecting the data eliminated the need to communicate data collection procedures to ensure consistency between multiple data collectors and restricted investigator bias to that of one researcher (Menard, 2002, p. 37). Finally, it meant that, within the limits of the research design, I could be flexible in pursuing emerging issues in depth without having to consider the impact on other researchers. This is regarded as an advantage of case research (Chelimsky & Grosshans, 1990, pp. 24-5; Stuart et al., 2002, p. 425).

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The second issue was the choice of respondents at the firms, particularly for the interview data. The principal respondent was chosen on the basis of being the person most informed about the TBWO initiative at the firm (Voss et al., 2002, p. 206). This was usually the managing director, owner/manager, or production director/manager. Where necessary, interviews were conducted with additional respondents to gain further information or to corroborate information from the principal informant (Lindberg & Berger, 1997, p. 100; Glick et al, 1995, p. 141).

Finally, the data collection itself was initially intended to take place mostly by means of a monthly questionnaire to be completed by the principal respondent at each firm

(see Appendix 3.5). This started early in 2000, but it very soon became apparent that there were problems with collecting the data in this way. Apart from poor response rates, some questions were incorrectly completed despite definitions and guidelines having been included in the monthly report.

It was then decided that I would make field trips to the firms and collect the data first hand. In spite of the significant time demands this placed on me, it turned out to be a most fortuitous decision. In addition to being able to collect more accurate quantitative data directly from the sources, it made the collection of qualitative data possible. Some questions were changed to facilitate easier collection of more accurate data. The site visits also made it possible to understand the production processes more thoroughly and to see first hand what process improvement initiatives were undertaken by the shop floor teams.

A typical site visit would take about half a day to collect both the quantitative and qualitative data. On occasion, I would spend whole days at a site when it was necessary to work through a large volume of source data. The quantitative data was entered directly into an Excel spreadsheet and the interviews were tape recorded. As far as possible, I would try to cause as little disruption as possible to the production, and I found all respondents very willing to participate, within their time constraints.

A working relationship was built up with most respondents over the 3 years of data collection, and I am convinced that it facilitated greater access to information than if the data had been collected by a survey. I always made it clear that I was an independent researcher, and although the WPC was paying my expenses, I was not answerable to it for the research results. Occasionally, queries of an administrative nature came from respondents which I referred to the WPC project management. At no point were the comparative case findings discussed with the respondents, but issues of fact or interpretation were often checked with them.

I also attended some events peripheral to the firm initiatives, such as meetings at which participants were recruited, milestones workshops in which participants shared their experiences, and consultant information meetings. However, I found these

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meetings of relatively little value as the research focused on implementation at the firms.

The original research design called for a 24-month data collection period. However, due to implementation delays at some of the firms and because it became apparent that it was premature to expect significant performance improvement at some of the firms after only 24 months, the data collection period was extended to 36 months. Even this was possibly too short as several authors refer to a 3- to 5-year implementation period (Womack & Jones, 1996, p. 270; Gunn, 1987, p. 131); however, it was not possible to extend data collection further due to time and cost constraints.

3.4.2.4.2. Data Collection Protocol

Most guidelines for case study protocols concentrate on the data collection instrument with the purpose of maintaining consistency of data collected across multiple cases by multiple researchers (Voss et al., 2002, p. 204; Panizzolo, 1998, pp. 227-9).

In this research, the protocol for the quantitative data was contained in the Excel spreadsheet, inasmuch as the spreadsheet was structured to facilitate the capture of the appropriate data for each question (see file WPC Data.xls available from author). The same spreadsheet template was used for each firm, and the question definitions were contained in comments at the top of each column, for easy reference.

The interviews were open-ended and usually started with obtaining an update on what had happened with the implementation process at the firm since my previous site visit. Then, issues of interest or clarification were dealt with, and the interview usually ended with a question as to whether there was anything that was left out that the respondent wanted to add.

3.4.2.4.3. Case Study Database

It is recommended that a case study database be established to facilitate access to data and to establish a chain of evidence (Yin, 2003, p. 102).

All the quantitative source data are contained in one file: WPC Data.xls. All analysis done in other Excel spreadsheets refers directly or indirectly to this file, through links.

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The first level of summary, longitudinal trend analysis and graphical representation, was done in a separate spreadsheet for each firm. A second level of comparative analysis and graphical representation was done in another file called WPC Comparative Analysis.xls, which is linked to the individual firm spreadsheets. Therefore, the chain of evidence for graphs of firm data and summary statistics are directly linked to the original data set.

Analysis done in SPSS is based on a data set imported directly from the Excel source data spreadsheet (See WPC Data 1d PracPerf Indexes.sav available from author).

The interview data were recorded onto cassette tapes and transcribed into Word files, and each interview was allocated a unique reference code. Apart from some of the initial interviews, the transcriptions were done by a professional firm. Unfortunately, parts of the first few interviews were lost due to poor transcriptions (See Appendix 3.2 for details of the interview database).

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3.4.3. Data Analysis

Case analysis can be done by a myriad of analytical techniques. This can be somewhat bewildering (Stuart et al., 2002, p. 427), but a basic guiding principle is that data analysis should be guided by the research questions or, more specifically, the theoretical propositions being developed or tested (Stuart et al., 2002, p. 425; Yin, 2003, p. 111). A two-step process of first doing within-case analysis, followed by cross-case analysis, was followed (Eisenhardt, 1989, p. 540). As suggested by McCutcheon and Meredith (1993, p. 244), data reduction techniques were used to extract the salient information from the data collected and logical analysis was used to build explanations for the findings.

Of the five analytical techniques suggested by Yin (2003, p. 109), pattern matching, explanation building, time-series analysis, logic models, and cross-case synthesis, most use was made of

- Pattern matching to assess the extent to which each firm derived performance improvement from implementing TBWO practices;
- Correlation analysis to assess the impact of the bundles of HR, WC, and CI practices on performance outcomes over time;

• Cross-case synthesis to aggregate findings across the 12 cases studied.

In this study, Hypothesis 1 was first evaluated by means of a general assessment of the extent to which implementation of TBWO programmes was related to performance improvement. Thereafter, a case-by-case assessment was undertaken to assess to what extent the research findings supported Hypotheses 1 and 2.

3.4.3.1. General Assessment of Hypothesis 1

In this assessment of Hypothesis I, the variable "average off-production time as a percentage of total paid time worked by shop floor employees" was used to reflect the independent construct "TBWO programme implementation". It was qualitatively assessed against a 7-category classification of the performance outcomes of the firms, as described below. This qualitative assessment was triangulated by doing a one-tailed Spearman correlation between the means of the off-production time as a percentage of total paid time worked by shop floor employees with the linear slope of the productivity performance outcomes of the 12 firms studied. Yin (2003) also used correlation analysis in a small sample of cases where quantitative data were available (p. 143).

3.4.3.1.1. Independent Variables

The variable "TBWO programme implementation" was constructed by adding the time spent on communication/consultation, training, and teamwork per month and dividing that by the total paid time worked by shop floor employees per month (see Appendix 3.1) and taking the average over the period for which data were available. For most firms, this was 36 months, except for Firm U, which was over 72 months, and Firm E, which was over 24 months.

Of course, communication/consultation, training and team work does not constitute a comprehensive TBWO initiative. However, it was used because paying a shop floor employee to engage in activities other than production can be regarded as a robust indicator of a firm's commitment to implementation of some of the core practices associated with TBWO. Firms scoring high on this indicator also scored high on other practices associated with TBWO, such as changing shop floor layout towards cells,

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small batches, daily housekeeping, and performance feedback (see Figures 3 & 10 in Grütter, 2004).

Dividing the time spent on off-production activities by the total paid time worked by shop floor employees standardises this measure for the size of the firm. Taking the average over the period for which the data were available aggregates the different patterns of implementation across two dimensions.

Firstly, firms had different patterns of implementation with respect to timing. Some implemented intensively in the early months (because often a lot of training was done then) and then maintained a minimum critical mass of practices to sustain the initiative. Other firms spread their implementation more evenly over the implementation period. Secondly, different mixes of practices were implemented by the different firms. For the purpose of the question as to whether implementation of TBWO practices in general led to improved performance, a measure indicating the average level of implementation was considered appropriate.

3.4.3.1.2. Dependent Variables

The independent variables were based on the productivity and quality data of each firm. Although the extent of performance improvement was based on quantitative data, it was not possible to do the analysis on the basis of purely quantitative analysis for several reasons. Firstly, the performance outcome measures were not standard across the firms. Secondly, account had to be taken of the stage at which the firm was in its implementation. Rapid improvement is possible at a firm with low process capability, whereas marginal improvements become progressively more difficult at firms where basic improvements have already been made (Zangwill & Kantor, 1998, p. 916; Yeatts & Hyten, 1998, p. 139). Thirdly, improvement trends are not linear nor without fluctuation, depending on circumstances that were identified from the interview data. And finally, as reported in Appendix 3.1, the quality data of some of the firms was not reliable, and therefore qualitative assessments had to be made on data known to be unreliable.

The performance outcomes were classified into a 7-category scale, comprising the categories "slight", "moderate" or "substantial improvement/deterioration", together

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with a "no-change" category in the middle. The classifications were made by the researcher, based on interpretation of the productivity and quality trends displayed by the available data (Eisenhardt, 1989, p. 542; Mohrman & Novelli, 1985, p. 102). In some cases, a "simple eyeball test" (Yin, 2003, p. 26) was all that was necessary to make the assessment, but in other cases, careful interpretation of the trends in the light of the firm's circumstances were required (See the justification for the classifications in the detailed case studies in Appendixes 4.1-4.12 and Appendix 4.13 for a summary of the categorisations that were made).

For the triangulation by means of a Spearman correlation, only the productivity performance data of the firms could be used as there were too few firms with reliable indicators of quality performance outcomes to do the same with the quality performance data. To eliminate the scale effect of performance improvement off different base values, the monthly productivity performance measures for each firm were indexed as a percentage of the initial value of the productivity measure regarded as most reliable, as documented in Appendix 3.4. The Spearman technique was used because it requires fewer assumptions about the underlying data dispersion than the Pearson's correlation. A scatter plot of the variables correlated was used to ascertain whether outlying data points had undue influence, but none was found.

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3.4.3.2. Multi-Case Assessment of Hypotheses 1 and 2

In addition to the general assessment of Hypothesis 1, the qualitative and quantitative data available for each case were used to make assessments of whether the two main research hypotheses were supported or not. The justifications for each assessment are reported in section 4.3 of the findings chapter. The qualitative findings on Hypothesis 2 were corroborated by means of one-tailed Spearman correlations between the averages of three independent variables, the HR, WC, and CI indexes, and the productivity performance outcomes of the firms described in the previous paragraph.

3.4.3.2.1. Independent Variables

This section explains the construction of the indices to measure the implementation of bundles of practices related to the HR, WC, and CI theoretical constructs. The HR and WC bundles of practices are in some ways conceptually similar to the TQM1 and TQM2 groups of practices used by Hammer and Champy (1993, p. 1114). The construction of the indices are, in principle, similar to the HR bundle variables used

by MacDuffie (1995, p. 207), where he first compiled variables into sub-indices, which were then standardised by conversion into *z*-scores (Moses & Stahelski, 1999, p. 403) before being summed into the respective indices. As Macduffie did, no weightings were applied to the variables within the sub-indices. An average of the indices over the period of the research was calculated to provide an overall index for each bundle of practices for each firm. In this research, the variables included in the sub-indices were as documented in Table 3.3.

Table 3.3: Composition of HR, WC, and CI Indexes

HR Index	**Variables included in Sub-Index**
HR Structural Changes	Sum of Steering Committee, Staff Facilities, Employment Equity, Incentive Scheme, Retrenchment (neg), Customer/Supplier Visit Scores
Comm/Consult Time	Total Hours Communication/Consultation as a Percentage of Total Working Hours
Comm/Consult Practices	Employee Briefings, Indaba, Address Issues, Representative Forum, Display Meeting Minutes, Share Vision/Values, Company Newsletter
Training Time	Total Training Hours as a Percentage of Total Hours Worked
Employees Trained	Number of Employees who received Training as a Percentage of Total Shop Floor Employees
HR Training Time	Team Work & Change Orientation Training Time as a Percentage of Total Training Time
Employees in Teams	Number of Employees in Teams as a Percentage of Total Shop Floor Employees
Team Work Time	Total Teamwork Hours as Percentage of Total Hours Worked
Team Facilitator & Presentations	Sum of Team Facilitator and Team Presentation Scores
CI by Team	CI driven by Team plus CI driven by Team Leader minus CI driven by Staff minus CI driven by Management
WC Index	**Variables included in Sub-Index**
WC Structural Changes	Sum of Cells and Small Batch Scores
WC Training Practices	Job Skill plus Quality Training Hours as a Percentage of Total Hours Worked
WC Team Time	Shift plus Cross-Functional plus Safety Team meeting Time as a Percentage of All Team Meeting Time
TBWO Method in Use Score	Average TBWO Method in Use Percentage Score
WC Methods in	Sum of Visual Management plus Waste Identification Scores

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Use Practices	
BOP Score	Average Best Operating Practice Percentage Score
WC BOP Practice	Sum of Housekeeping plus Documents Available plus Tools in Place plus Daily Feedback plus Update Documents plus Training Certification Scores
CI Index	**Variables included in Sub-Index**
CI Training	CI Training as a Percentage of Total Hours Trained
CI Team Work	CI Team Work as a Percentage of Total Team Work Time
CI Practices	Sum of CI Focus plus Problem-Solving plus Resource Availability plus Team Authority Scores

[1] "Indaba" is an African word for a consultative meeting.

3.4.3.2.2. Dependent Variables

The same productivity measures as were used as the dependent variable for the general assessment of Hypothesis 1 were used for these correlations, as explained in section 3.4.3.1.2 above. Inspection of the scatter plots also did not reveal any untoward outliers.

The findings of this research will be reported in the next chapter.

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Chapter 4: Research Findings

4.1 Introduction

Presenting the findings of multi-case research is quite a challenge in itself because of the amount and diversity of data that need to be reduced. Merriam (1998) suggested that

> findings can be in the form of organised descriptive accounts, themes, or categories that cut across the data, or in the form of models and theories that explain the data. Each of these forms reflects different analytical levels, ranging from dealing with the concrete in simple description to high-level abstractions in theory construction. (p. 178)

The detailed accounts and the findings with respect to each case are recorded in Appendixes 4.1-4.12, as was also done by Brown and Eisenhardt (1997, pp. 5-6). In this chapter, the case findings will be summarised by means of categorisations and the multi-case comparisons made, as suggested by Eisenhardt (1989, p. 540). First, a general assessment of the extent to which Hypotheses 1 is supported or not is done by means of a table (Yin, 2003, p.134; MacDuffie, 2000, p 192) and is corroborated by means of correlation of TBWO programme implementation with productivity performance outcomes, as was done by Yin (2003, p.141). Then, a multi-case assessment of both Hypotheses 1 and 2 is done, taking into account moderating factors, which is corroborated by correlation analysis similar to that done by MacDuffie (1995, p. 207).

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4.2 General Assessment of Hypothesis 1

Hypothesis 1 was stated as:

*H*1: The implementation of a TBWO programme is associated with improved productivity and quality performance outcomes after a time lag.

Table 4.1 summarises the research findings with respect to practice implementation and performance outcomes. In this table, the firms are sorted according to the % Off-Production Time (%O-PT) in support of TBWO practices, as explained in section 3.4.3.1.1. This is regarded as a robust indicator of the independent variable, namely, the extent to which firms implemented TBWO practices. While we are primarily

interested in the dependent variables of productivity and quality performance outcomes, the findings with respect to WIP, sales and output are also presented.

The categorisations of the dependent variables in Table 4.1 were made by the researcher on the basis of the quantitative performance outcome data and qualitative interview data. The categorisations are justified in the detailed cases in Appendixes 4.1 to 4.12. The arrows in Table 4.1 were colour coded to facilitate pattern matching by visual inspection.

Table 4.1: Assessment of Productivity and Quality Performance Outcomes

Firm	%O-PT	WIP	Sales	Output	Productivity	Quality
R	0.26%	↗	↗	↗	↗	→
G	0.40%	→	→	→	↘↘	↘↘ ↗↗
C	2.31%	→		↗	↘↘	↗↗
J	2.37%	↗↗		↘	↘	↗↗
K	2.51%	↗↗		↘↘	↘	↘↘
O	2.63%	→	↗	↗	→?	↘↘↘
E	3.45%		↘↘↘		→	
X	3.77%	→	↗↗↗		↗↗	→
S	3.81%	↗↗	→		↗	↗↗?
Y	5.44%	↗↗		→	↘↘	↘?
U	5.89%	↗↗↗		→	↗↗	→
N	6.23%	↘↘		↗↗	↗↗↗	↘↘↘

- The number of arrows indicate slight, moderate or substantial change;
- Moderate and substantial improvement/deterioration were coded green/red respectively;
- Level and slight improvement/deterioration were coded black;
- A reduction in the WIP and quality measures amount to performance improvement (indicated by the arrows pointing down being coded green and vice versa);
- A question mark indicates that the categorisation may be interpreted differently by other analysts.

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4.2.1. Assessment of Quality Performance

While the quality data have to be interpreted with caution due to the reliability problems of some of the data, as reported earlier, the finding is that sustained moderate or substantial quality improvement occurred in only three of the twelve firms (K, O and N). Although one of these three firms scored highest on percentage off-production time spent on TBWO-supporting practices, the other two firms were slightly below the average of 3.26%, with respect to the percentage off-production time. As none of the low-scoring firms on percentage off-production time could improve or sustain quality improvement, the pattern that appears to emerge is that quality improvement has a weak positive associated with implementation of TBWO programmes.

It is noteworthy that all three of these firms were in the auto-component sector, where their customers had active supplier management initiatives, and that firms K and O were the only firms with senior managers dedicated exclusively to quality management.

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4.2.2. Assessment of Productivity Performance

Of the twelve firms studied, three firms (N, U and X) improved their productivity performance moderately or substantially and all three had above-average scores for percentage off-production time. Most of the below-average firms, with respect to practice implementation, in fact experienced a slight or moderate decline in productivity performance. However, Firm R, with the lowest off-production percentage, experienced slight productivity improvement, and Firm Y, with a high off-production percentage, experienced a moderate productivity decline. The pattern therefore appears to be a moderate positive association between TBWO programme implementation and productivity performance outcome, with some exceptions.

Of the three firms where moderate or substantial productivity improvement took place, Firm X is unusual in that it has a non-repetitive type of production process and is the only firm with substantial sales or output growth. What is notable about the other two firms, U and N, is that they had the two highest off-production percentage scores and that they were the only firms in the panel that had initiated their TBWO programmes some time before the WPC project started.

4.2.3. Quantitative of Assessment of Hypothesis 1

A purely quantitative assessment of the relationship between the implementation of TBWO programmes and performance outcomes cannot take account of the many circumstances reported in the detailed case reports as a qualitative assessment does. However, a quantitative assessment can be useful to corroborate qualitative assessments despite the limitations of a low number of data points and the data collection and quality problems reported earlier. To do the corroboration, the mean percentage off-production time over the research period was correlated with the linear slope of the productivity performance outcome indexes of the 12 participating firms. The slope was determined by fitting a "least squares" regression line to the productivity data, where the independent variable was taken to be monthly periods and the dependent variable was the firm's productivity performance, indexed as a percentage against the first value in the data series.

The mean monthly off-production time over the research period was used as an indicator of the implementation of TBWO programmes because the firms had different patterns of practice implementation. A number of the firms undertook the bulk of their training early in the implementation process. Others spread the training through the research period, but sometimes training was also concentrated into short periods. Communication and consultation mostly occurred throughout, but was also punctuated by quarterly or annual company-wide briefings. The different possible trend patterns would therefore not provide meaningful indications of the extent of TBWO programme implementation. What is important for the assessment of Hypothesis 1 is the extent or overall effort by the firms to implement the TBWO programmes. It was therefore decided to use an aggregate indicator of the level of TBWO programme implementation by calculating the mean monthly percentage off-production time over the research period.

The productivity performance measures were different for each firm, and therefore those outcome measures were indexed as a percentage change against the first value (except for Firm J, where the first productivity data were in period 8) of each firm's productivity data series to allow comparisons to be made across firms, which takes account of the base from which each firm started. Therefore, the first value was always 1, and it was removed from the calculation as it included no random variation.

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The Spearman correlation was used as it is appropriate when the underlying data are ordinal measurements. The correlation of average percentage off-production time with percentage productivity improvement of the 12 firms was found to be 0.294, with a one-tailed *p*-value of 0.177. Although not significant, the estimated correlation is positive, which is consistent with the assessment made on a qualitative basis.

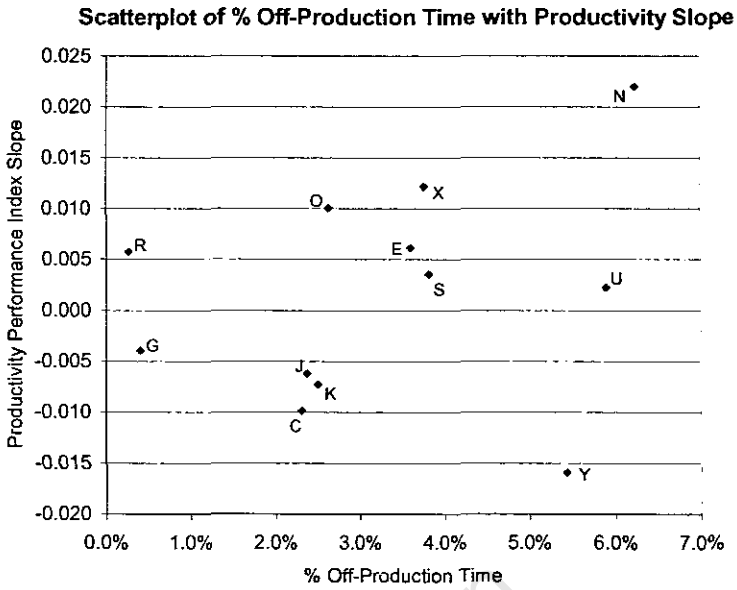

Figure 4.1: Scatterplot of Off-production Time with Productivity Slope

The scatter plot of the two variables shown in Figure 4.1 shows that Firm Y (and to a lesser extent, Firm R) had a substantial weakening influence on the results, given the already diminished statistical power due to the small sample size. Possible explanations for these contrary findings are discussed below, in Section 4.4.1. However the implication of this result is that despite the direction of association being consistent with the hypothesis, this result does not unequivocally support or refute the hypothesis.

4.3. Multi-Case Assessment of Hypotheses 1 and 2

Hypothesis 1 was stated as

*H*1: The implementation of a TBWO programme is associated with improved productivity and quality performance outcomes after a time lag,

and Hypothesis 2 was stated as

*H*2: The implementation of HR, WC and CI practices is associated with improved productivity and quality performance outcomes.

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A nuanced interpretation of the findings needs to take account of the moderating factors: market conditions, organisational stability, process type, and industry sector, as identified in section 2.7, on a case-by-case basis, as noted in section 3.3.3. The assessments made in this section are summarised in Table 4.3 at the end of the section.

4.3.1.1. Firm R

Firm R operated in a difficult market at the time of the research due to low consumer spending on furniture. The mere fact that the firm was established by employees retrenched from the dominant firm in the sector confirms this. The firm experienced no significant organisational instability during the research period and had a repetitive process suitable for the introduction of TBWO, although this type of work organisation was not well known in the sector.

On balance, it is found that the influence of the moderating factors was neutral in the case of Firm R. Firm R was a very weak implementer of TBWO practices and, as such, little performance improvement was expected. Due to the quality measure being a proxy measure, it is considered prudent to regard the quality performance outcome as inconclusive, whereas the slight improvement of the firm's productivity performance is not consistent with Hypothesis 1.

Assessment of Hypothesis 2 requires a clear distinction in emphasis by the firm on practices associated with each of the three sub-constructs, HR, WC, and CI. Accordingly, a conservative approach is taken with respect to interpreting whether this hypothesis is supported or not. In the case of Firm R, there was an explicit decision not to implement TBWO practices. Therefore, it is not possible to make an assessment of the distinctive contribution to improved performance by each of these bundles of practices.

4.3.1.2. Firm G

The footwear sector was going through a very difficult time at the time of the research, with numerous firms closing due to poor market conditions. Firm G managed to survive, but job security was under threat throughout. There was no organisational instability at the firm during the research period, other than that its production manager was replaced with someone who had a similar approach to the

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previous incumbent. Its process type was repetitive. TBWO was not well known in the sector, and in many footwear firms, a strongly hierarchical traditional approach to management prevailed.

Firm R was a weak implementer of its TBWO programme, if it can be called a programme at all since the little implemented was done in a haphazard and uncoordinated manner. The difficult market conditions and strong traditions in the sectors could be regarded as marginally negative for the implementation of TBWO. Although quality performance initially improved, it was not sustained and reverted to previous levels of performance. Productivity declined moderately. Both performance outcomes were consistent with Hypothesis 1.

The firm's approach to HR was bordering on exploitative. Some workers did not know from day to day whether they would have work for the day when arriving at the factory. Quality was managed by end-of-the-line inspection, and because there was a market for defective products as "seconds", sold through the factory shop, there was little effort to improve management of quality. The disused suggestion box at Firm G indicated that there was some attempt at involving employees in CI. However, there was no evidence of supporting practices whatsoever. Given the firm's poor performance outcomes, these findings are consistent with Hypothesis 2.

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4.3.1.3. Firm C

Firm C produced aluminium and zinc castings for industrial and consumer markets, for which the market was weak, but stable. However, the market for its automotive components, locally and for export, had potential. This led to a buy-out of the firm during the research period, and after an initial capital injection to buy additional casting equipment on the basis of potential export orders, the firm experienced severe cash flow problems and eventually collapsed just after the data collection ended. The new management decided to continue with the implementation of their TBWO programme, but after the programme champion left, there was little real support for it due to their attention being diverted to financial survival after they lost an important export contract. The production process was repetitive, although the labour intensive part of it (fettling and final finishing of the castings) involved diverse manual

operations. Supplier accreditation by automotive sector customers exposed the firm to new forms of work organisation.

Firm C's WPC facilitator put a great deal of effort into implementing TBWO, but the initial momentum was dissipated after the take-over and due to a stand-off by the employees over a pay dispute. As the financial difficulties and organisational instability at the firm dominated management attention, the circumstances for successful TBWO implementation at the firm could regarded as poor. Altogether, this resulted in a weak implementation of its TBWO programme. Both quality and productivity performance declined, which is consistent with Hypothesis 1.

While Firm C initially had an enthusiastic WPC facilitator, the dominant approach to HR management at the firm was traditional. Some efforts were made at quality control, but there was no integrated quality management and little was done to improve the layout of the shop floor. The introduction of team-based problem solving in support of CI practices was superficial and met with resistance due to the pay dispute. The poor performance outcomes are therefore consistent with Hypothesis 2.

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4.3.1.4. Firm J

Firm J experienced difficult market conditions throughout the research period as the clothing sector was facing stiff competition from Chinese imports, and it also closed down shortly after data collection was concluded. It went through two senior management changes. A general manager with a traditional approach was replaced with one who was very supportive of workplace change, and he also brought in a supportive production manager. When the firm experienced financial difficulties, he was replaced with traditional management again. The process type was repetitive, and the concept of TBWO was known, but not much practiced, in the clothing sector. Taken as a whole, the moderating factors were negative for the introduction of TBWO at Firm J.

The significant efforts to introduce TBWO at Firm J during the time of the supportive management were substantially undermined by the management changes at the firm. Together with the overall negative influence of the moderating factors, the changes of management led to a weak implementation of the firm's TBWO programme. Both the

productivity and quality indicators of the firm deteriorated, as predicted by Hypothesis 1.

The HR management at Firm J could be described as "firm, but fair". However, despite efforts to improve communication between senior management and the shop floor, incidents such as the strike resulted in less than ideal workplace relations. There was a relatively high level of quality consciousness in the firm, but it was executed mostly by "inspecting quality in". The changes toward a cellular layout were incomplete inasmuch as the cells were in effect short lines, rather than true circular flow cells. Almost all training focused on job skills rather than CI activities, and the shop floor employees had no time allocated for team meetings or process improvement activities. The firm's declining performance outcomes are therefore consistent with Hypothesis 2.

4.3.1.5. Firm K

This firm produced automotive electronics and shared in the generally positive market conditions of the automotive sector as a whole. However, it experienced substantial organisational disruption due to the merger of the operations of two plants taken over by the firm during the research period. The process type was repetitive, and as the firm was in the automotive sector, CMAs were well known. Conditions were generally favourable for implementation of TBWO, although the organisational disruption was substantial.

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While Firm K's management was supportive of the introduction of TBWO, the effort to implement their programme was below average. This was probably due to the distractions of integrating the operations of the two plants bought by the company. Although the firm's productivity declined marginally, which would be consistent with Hypothesis 1, the measure is based on a value of output rather than on a standardised unit measure of output, and therefore it is considered prudent to classify it as inconclusive. Quality performance improved, which is not consistent with Hypothesis 1.

The firm maintained a pleasant working environment and provided good quality staff facilities. Quality management received a lot of attention by a dedicated quality manager, and the plant layout was changed to improve flow more than once.

Employee suggestions were not recorded, but the production manager reported putting an emphasis on implementation of suggestions made by employees. The clear improvement in quality performance supports Hypothesis 2, but no conclusive finding can be made on productivity performance due to the nature of the measure.

4.3.1.6. Firm O

Firm O experienced good market conditions as it produced wiring harnesses for the automobile industry. The transfer of a part of the operation to a nearby sister plant caused some organisational disruption during the research period. The firm's process type was repetitive, and as it was a subsidiary of Toyota South Africa, staff were well versed in the concept of CMAs. Overall, the moderating factors were positive for Firm O's implementation of TBWO.

Firm O scored slightly below average on the percentage off-production time in support of TBWO practices, although its management was very committed to implementation of their TBWO initiative. This could be because the organisation was the largest employer of the firms researched, with an average of 401 employees (almost double the next largest firm), and had a time-efficient system of training. Its initiative also only started in earnest 6 months after the data collection commenced, which reduced the average percentage off-production time. The two available productivity indicators indicated a slight decline and improvement, respectively, whereas the quality performance showed a substantial improvement. The firm's productivity performance is interpreted as inconclusive with respect to support for Hypothesis 1, and quality performance is interpreted as consistent with Hypothesis 1.

There was strong emphasis on securing employee buy-in, as evidenced by the canteen improvement project. The firm had a dedicated quality manager and undertook many of the practices associated with CMAs, such as cellular manufacturing and the use of *Kanban* systems. Implementation of CI practices was also initiated with their Bright Ideas project, but it declined after some time. Implementation of practices associated with the HR, WC and CI sub-constructs could therefore be regarded as moderately strong, and the quality performance outcome was therefore as expected, according to Hypothesis 2, although the productivity outcome for this hypothesis was inconclusive.

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4.3.1.7. Firm E

This firm experienced extremely difficult market conditions, and eventually ceased operations due to insufficient sales 2 years into the research period. It was a small family-owned and managed firm throughout the research period, but even though the management was stable, the battle for survival caused organisational disruption. The process was repetitive, and as in the footwear sector, there was little familiarity with CMAs. The moderating factors were dominated by the poor market conditions, and overall, the conditions for the introduction of TBWO were negative.

While the management of Firm E were distracted by the firm's marketing and financial difficulties, they were strongly supportive of the introduction of TBWO practices. Because the firm was so small, it was also possible for the WPC consultant to be directly involved with bedding down the new practices. Productivity performance remained at more or less the same level through the research period, and quality performance could not be assessed as the data series was too short. In both cases, no conclusive assessment could be made with respect to support for or against Hypothesis 1.

Hypothesis 2 could also not be assessed because, although the firm implemented some of the HR, WC and CI practices associated with TBWO, the firm's dire circumstances had a far larger influence on performance. It is also not clear how much of the performance change could be attributed to the shop floor employees as opposed to the changes introduced by the WPC consultant.

4.3.1.8. Firm X

Despite difficult market conditions, as experienced by other stainless steel product manufacturers that closed down during the research period, Firm X managed to increase sales by combining its engineering and project management skills with its production capabilities. The firm experienced no organisational instability during this time. It was an engineering shop, which is a process type not particularly suited to repeatedly gaining the benefits of process improvement, and CMA was not well established in the engineering sector.

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Although Firm X implemented somewhat different practices from most of the other firms researched, for instance, they did not change the functional shop floor layout, the firm's management did put a lot of effort into improving staff facilities and effective communication and skills training. The two available productivity indicators both showed a moderate improvement, which supports Hypothesis 1. The two quality indicators are proxy measures, and they both show little change in level of performance. Therefore, no conclusive assessment can be made on whether quality performance at Firm X supports Hypothesis 1.

Hypothesis 2 cannot be conclusively assessed as there was little systematic process improvement by shop floor employees. The nature of their work was such that individual skills rather than best operating practices determined performance, and therefore CI was not emphasised at Firm X. Assessment of Hypothesis 2 was therefore inconclusive.

4.3.1.9. Firm S

Firm S fabricated metal parts such as bumpers and fuel tanks for car and truck assemblers. This market was growing at the time of the research, although substantial increases in raw material prices put severe pressure on the firm's margins. There were many minor organisational disruptions as the firm experienced a fair amount of ongoing change such as introducing new product lines, plant expansion and changes in line management. The process was mostly repetitive, but due to a very customer-orientated approach, the firm often took on new work at short notice. Being in the automobile sector, they had exposure to CMAs.

Management were very committed to their TBWO initiative; the managing director was chair person of the WPC sector committee and undertook some of the training himself. Many practices such as cellular manufacturing, team meetings and shop floor performance measurement were introduced. Productivity improved slightly after quite some time, providing weak support for Hypothesis 1. Quality deteriorated, but the available quality information is unreliable, so these findings are inconclusive with respect to Hypothesis 1.

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The HR management at the firm was somewhat ambivalent in that the management strongly supported employee empowerment but also intervened in the daily work due to short-term pressures. Nevertheless, a team-leader committee was responsible for much of the daily management, and staff facilities were improved. There was a quality department, but after a change of experienced personnel, it did not function well. The involvement of employees was encouraged but was not managed systematically, and it lapsed after about 2 years of operation. The relatively weak implementation of these practices was consistent with the slight productivity improvement, but it is inconclusive with respect to the firm's quality performance due to the unreliable quality data.

4.3.1.10. Firm Y

Firm Y produced wire and spring products, mostly for the automotive market, which was buoyant during the research period. There was no organisational instability, and although the firm ran a number of diverse production processes, its process type was repetitive. Staff also had significant exposure to CMAs through the car assembler's supplier accreditation programmes.

The firm was a strong implementer of its TBWO programme, with extensive training being provided and personal interest taken in the teams by the management. So much so that it was visited by many other firms and secured significant new business on the strength of being held up as a model of how to implement such a programme. However, its productivity performance showed a moderate deterioration, and its quality performance a slight deterioration over the research period. This outcome is not consistent with Hypothesis 1.

The firm was run as a close-knit family business, with a benevolent approach to HR management. Its quality management practices were good enough for it to be among the first to achieve new industry quality accreditation requirements, and the shop floor was run, as are a number of focus factories, on cellular manufacturing principles. It was one of the few firms where suggestion implementation data were actually available, although dedicated process improvement projects were not in evidence. The decline in productivity and quality performance is therefore not consistent with Hypothesis 2.

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4.3.1.11. Firm U

Firm U manufactured clothing and survived very difficult market conditions due to competition from cheap imports. It experienced little organisational disruption apart from some retrenchments. The process type was repetitive, and the concept of "modular manufacturing" was known, but not widely practiced, as is common in the clothing industry.

Over a period of about 5 years, the firm progressively converted its production lines, using the bundle system, to cells (modules). The production manager actively supported this change through difficult times in the firm and industry. The productivity shows a moderate improvement, which was sustained over a 6-year period and, in addition, comparative data of the productivity of the lines versus the modules shows that the modules performed better. Quality data were only available for the last 2 years and showed little change. Therefore, the productivity data support Hypothesis 1, but the quality data are inconclusive.

Firm U had good canteen facilities and maintained good formal industrial relations, but the cost pressure on the firm at times strained the working relationship between management and the employees. It had good quality management systems due to being a sole supplier to a retailer with high quality requirements. However, CI practices were not actively pursued. The productivity improvement is therefore not consistent with Hypothesis 2, while the quality outcome is inconclusive.

4.3.1.12. Firm N

Firm N produced sintered metal products, mostly for the automobile market, and therefore experienced good market conditions during the research period. There was no organisational instability in the firm over this time, its production process was repetitive, and it had exposure to CMAs through contact with other firms in the automobile sector.

Firm N was a strong implementer of TBWO practices. Not only did it spend the highest proportion off-production time of all firms researched on TBWO supporting activities but it also went to considerable lengths to move large presses to improve the

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shop floor layout. Both productivity and quality performance improved substantially, providing strong support for Hypothesis 1.

The management were actively involved in training, and employees had access to financial information and participated in strategic planning sessions. Shop floor quality control and performance measurement by teams in cells was well established. Shop floor employees used a systematic process improvement method and were assisted by a facilitator to learn to use the techniques. They also had small budgets for implementation of their suggestions. The substantial improvement in productivity and quality performance in this case is therefore clear support for Hypothesis 2 as well.

4.3.2. Quantitative of Assessment of Hypothesis 2

Hypothesis 2 disaggregates the TBWO programmes into three sub-constructs, bundles of human resource (HR), world-class (WC), and continuous improvement (CI) practices. Indices of the implementation of these sub-constructs were compiled as documented in section 3.4.3.2.1 and Appendix 3.3, making use of not only the time each firm spent on TBWO supporting activities but also taking account of various practices associated with each of the sub-constructs.

Once again, the average of the indexes representing the independent variables was used to correlate with the linear slope of the productivity performance for the 12 firms. The results of the Spearman correlations are summarised in Table 4.2.

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Table 4.2: Spearman Correlations of HR, WC, CI Indexes with Productivity Performance

	Slope of Productivity Performance	
	Correlation	*p*-value (1-tailed)
Average HR Index	0.2098	0.256
Average WC Index	0.0560	0.431
Average CI Index	0.2867	0.183

The directions of the correlations obtained were as hypothesised, but were neither strong nor significant. Inspection of the scatter plots revealed no outliers exerting an

undue influence. While these findings do not contradict Hypothesis 2, the results at best indicate tentative support for Hypothesis 2.

4.3.3. Summary of Multi-Case Assessment of Hypotheses 1 and 2

Table 4.3 summarises the assessment of the hypotheses for each of the firms.

Table 4.3: Case-by-Case Assessment of Hypotheses 1 & 2

Firm	Market Conditions	Organisational Stability	Process Type	Sector	Support for *H*1		Support for *H*2	
					Quality	Productivity	Quality	Productivity
R	×	✓	✓	×	–	No	–	–
G	×	✓	✓	×	Yes	Yes	Yes	Yes
C	×	×	✓	✓	Yes	Yes	Yes	Yes
J	×	×	✓	–	Yes	Yes	Yes	Yes
K	✓	×	✓	✓	No	–	Yes	–
O	✓	×	✓	✓	Yes	–	Yes	–
E	×	×	✓	×	–	–	–	–
X	–	✓	×	×	–	Yes	–	–
S	–	–	✓	✓	–	Yes	–	Yes
Y	✓	✓	✓	✓	No	No	No	No
U	×	✓	✓	–	–	Yes	–	No
N	✓	✓	✓	✓	Yes	Yes	Yes	Yes

✓ Positive moderating factor.

× Negative moderating factor.

– Neutral moderating factor.

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On balance, the multi-case assessment of Hypotheses 1 and 2 supports both hypotheses, albeit with certain caveats. Firstly, a large proportion of the assessments were regarded as inconclusive because a conservative approach was taken to interpreting ambiguous, unreliable or incomplete data. Secondly, the hypotheses were supported "in the breach" to a greater extent, in that more firms that were weak implementers did not achieve marked performance improvement than did firms that were strong implementers provide a positive affirmation that implementation of

TBWO practices leads to performance improvement. Thirdly, results from some firms directly contradicted the hypotheses, although they were in the minority. Finally, the moderating variables appeared to play some role in influencing the outcomes of the implementation of TBWO.

Having noted the above caveats, it should be borne in mind that this study had an unusually strong focus on objective data for this type of case method application. Despite the numerous problems encountered with the reliability of the data, having access to objective data enabled interpretation of qualitative data to be checked against facts and figures, and it was also possible to provide some level of corroboration of the findings by means of purely quantitative analysis. Therefore, it is considered feasible to proceed with further discussion and analysis on the basis that the hypotheses were not rejected, although this should be done with caution.

4.4. Discussion of Findings

In this section, the main findings are interpreted. Firstly, the findings that contradict the hypotheses are discussed. Then, the findings are briefly interpreted on a thematic basis, taking into consideration the effects of moderating and other factors in order to contextualise the main findings, given the complex organisational and environmental dynamics in which the implementation of TBWO at each firm took place. Alternative explanatory theories are also considered to test the confidence with which the findings can be accepted.

4.4.1. Interpretation of Contrary Findings

While the findings that did not support the hypotheses were in the minority, it is still necessary to examine them to assess whether any of these findings fundamentally undermine the main findings that support the hypotheses.

4.4.1.1. Firm R

At Firm R, the productivity outcome did not support Hypothesis 1 as the implementation of TBWO practices was virtually non-existent. This is not a serious threat to the main findings as the firm's improvement in productivity was slight, but more importantly, the fact that the firm's productivity improved for other reasons (as suggested in the detailed case study) does not preclude the possibility of it improving even more had TBWO been implemented.

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4.4.1.2. Firm K

As Firm K was a relatively weak implementer of its TBWO programme (which suffered from organisational disruption despite the good intentions of management), its quality outcome does not support Hypothesis 1. This outcome is probably explained by the fact that the firm had a dedicated quality manager and relatively sophisticated quality control systems. This finding is also not regarded a threat to the main findings, for the same reason as given for Firm R.

4.4.1.3. Firm Y

Firm Y was a strong implementer of a comprehensive set of TBWO practices under positive conditions and with good management support. As both the productivity and quality performance outcomes were poor, these findings do not support Hypotheses 1 and 2. This is a more serious threat to the main findings as it directly contradicts the propositions.

The most plausible explanation for the contrary findings at Firm Y, in the context of this research, is that performance improvement at the firm was yet to come as its programme was relatively immature, having started soon after the beginning of the data collection. The other possible explanation is that this study measured labour productivity, whereas the benefit of performance improvement at Firm Y could conceivably have gone into material cost reduction and/or product development rather than into an improvement of direct labour productivity (See the discussion in the case report in Appendix 4.10.).

4.4.1.4. Firm U

While overall implementation of the TBWO programme at Firm U was strong, the implementation of supportive HR and CI practices was weak. The improvement of its productivity performance therefore did not support Hypothesis 2. This is also a significant contradiction of the hypothesis.

It is possible that the substantial, but incremental, change from lines to cells over a long period at Firm U was sufficient to result in the productivity improvement found. It may also be that the very poor market conditions spurred the machinists on to simply work harder as Firm U managed to survive while many other clothing manufacturers were going under. As the firm had strict quality control, with rapid

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feedback to the machinists, it may also be that process improvement took place in a "top down" fashion rather than through employee participation. Further research is necessary to verify this possible explanation.

4.4.2. Discussion of Moderating and Other Factors

4.4.2.1. Market Conditions

While it is unclear whether positive market conditions had a decisive effect on stronger implementation of TBWO, a number of firms in this research (C, J and E) experienced adverse market conditions which did impact negatively on implementation and consequent performance outcomes. Particularly in the case of Firm E, there was the hope that its initiative would help the firm to survive, but it did not succeed. A secondary finding of this research is therefore that TBWO is not a substitute for basic business viability.

4.4.2.2. Organisational Disruption

A number of firms (C, J, K, O, & E) that were relatively weak implementers of TBWO practices also experienced organisational disruption of various kinds. It appears that a minimum level of organisational stability may also be necessary for effective implementation of TBWO programmes.

4.4.2.3. Process Type

As almost all the firms in the research had repetitive process types and the one firm with a non-repetitive process improved productivity performance, no finding could be made with respect to the effect of process type on practice implementation due to inadequate variation of this independent variable. However, the fact that so many firms had repetitive processes may indicate that process type had a role to play in the firms' decision to adopt TBWO.

4.4.2.4. Industry Sector

There is little doubt that the firms in the automotive sector were more open to the adoption and more thorough in the implementation of their programmes. This can be ascribed to a longer acquaintance with these CMAs and support by their major customers. Some firms in the footwear (G), clothing (E and J) and furniture (R) sectors seemed to struggle more to implement these practices; however, this may also

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be due to management ambivalence about these CMAs, despite their decision to participate in the WPC.

4.4.2.5. Quality Management

Firms O and K had senior quality managers dedicated to improvement of quality performance. The firms made substantial and moderate improvement of quality performance despite below-average efforts to implement TBWO practices as a whole and experiencing organisational disruption. It is conceivable that as they had dedicated quality managers, the performance outcomes at these two firms were skewed in favour of quality performance.

4.4.2.6. Time Lag between Practice Implementation and Performance Outcome

The best performing firm in terms of productivity and quality outcomes was Firm N. It was also the firm with the highest percentage off-production time in support of TBWO practices and one of the two firms that had started implementing their programmes well before the data collection period started. The other, Firm U, also had a long history of implementing TBWO and experienced improved productivity.

This finding suggests that there are significant time lags between practice implementation and performance outcomes. This may also account for the lack of improved performance at Firm Y, which was a very strong implementer of TBWO practices but which was also only about 2½ years into the implementation of their programme by the end of the research.

4.4.3. Assessment of Alternative Explanatory Theory

As indicated in sections 3.3.4 and 3.4.2.2.3, the explicit consideration of alternative explanatory theories is an important test of the validity of the research. For instance, after finding that firms that make serious efforts to implement TQM have superior financial performance, Easton and Jarrell (1998) also tested whether continued excess performance may have been due to reinforcement from early success or from downsizing (p. 298).

Several respondents mentioned in interviews that the introduction of a TBWO initiative was an effective marketing tool regardless of whether performance

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improvement had taken place or not (Interview C010919AT, p. 11; Interview J020620WS, p. 9; Interview Y020424RR, p. 7). This raised the issue of whether the productivity performance improvement was due to process improvements or to increased capacity utilisation from higher sales. As productivity performance improvement as result of higher capacity utilisation is a well-known phenomenon (Helper, 1997, p. 3) and it has been noted to be an alternative explanation for productivity improvement where TBWO was introduced (Mohrman & Novelli, 1985, p.103), it has to be considered here as an alternative explanation for the findings obtained.

The strongest evidence against capacity utilisation as an explanation for the research findings was that all the firms where TBWO implementation was above average and where productivity improvement took place also expanded capacity. Firms X and U, both of which had labour-intensive manual production processes, increased their employment, Firm S installed a new stainless steel pipe production cell as well as a cell dedicated to roll bars, and Firm N commissioned another metal powder press.

In addition, quality performance was also found to have improved, and quality performance cannot be related to capacity utilisation. On the contrary, an argument can be made that high capacity utilisation is likely to be associated with worse quality performance due to the employees being under greater pressure.

Therefore, capacity utilisation appears not to be an adequate explanation for the findings. Nevertheless, if the introduction of TBWO is said to be good for sales, then capacity utilisation must be affected, even if it is with a time lag, and therefore this issue warrants further research.

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Chapter 5: Conclusion

5.1. Introduction

This chapter starts with a summary of the research and then goes on to discuss the implications for theory on TBWO, further research, management of TBWO initiatives and policy on the support for such initiatives. It concludes with a statement regarding the limitations of the research and methodological recommendations for conducting research of this kind

5.2. Summary of the Research

This study investigated the association between the implementation of practices associated with TBWO and operational performance outcomes, using a multi-case, longitudinal, quasi-experimental research design. In particular, teamwork and process improvement were identified as central to improved operational performance.

It was found that thorough implementation of TBWO programmes was moderately associated with improved productivity performance and weakly associated with quality improvement. The findings with respect to the association between HR, WC, and CI practices and productivity and quality outcomes were less strongly supported. Organisational disruption and poor market conditions were found to be inhibiters of effective implementation, whereas being in the automotive sector seemed to facilitate programme implementation, and mature TBWO implementation programmes showed the greatest performance improvement.

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5.3. Implications of the Research

5.3.1. Replication of Previous Research

The calls for more longitudinal field studies on this topic have been noted in section 1.2.2.3. Two other multi-case studies have been found on this topic. The one investigated seven auto-components manufacturers (Choi, 1998) and the other eight engineering firms (Done et al., 2006). This research is not only more comprehensive with respect to the number of firms studied but also includes more in-depth collection of qualitative and quantitative data over a longer period of time. As such, the implications of the findings of this research for the replication of previous research are of considerable value.

5.3.1.1. Few Firms that Implement TBWO Programmes Achieve Performance Improvement

This research focused primarily on the post-adoption decision phase of TBWO programme implementation and the subsequent outcomes, that is, implementation effectiveness. The literature review on implementation effectiveness (see section 2.6.4.2) indicates that a minority of TBWO programmes succeed in improving performance outcomes. The first contribution this research makes to knowledge is to extend the application of these research findings by testing it in small and medium-sized South African manufacturing firms.

The consensus of existing research is that approximately one-quarter to one-third of TBWO programmes are reported to have improved operational performance outcomes (Locke & Schweiger, 1979, p. 317; Hansson & Eriksson, 2002, p. 44; Hayes et al., 2005, p. 10). In this research, both productivity and quality outcomes were moderately or substantially improved at three (although not the same three) out of twelve firms. These research findings, with respect to Hypothesis 1, are therefore remarkably consistent with the existing research. They answer the call for "consistent research results among multiple studies using a variety of research methods to make strong statements about the strength and generality of the findings" (Kaynak, 2003, p. 425).

5.3.1.2. Implementation of TBWO and CI and its Association with Improved Performance Improvement

In section 2.6.4.3, the findings of existing research that CI techniques are used poorly or not at all were reviewed (Zbaracki, 1998, p. 625; Boer, 2003, p. 1111; De Macedo-Soares & Lucas, 1996, pp. 62-3; Tucker et al., 2002, p. 125). These research findings confirm that CI techniques were used by only three of the twelve firms (S, Y and N) and only one of these firms (N) used them extensively. Furthermore, Firm N was also the only firm that unequivocally improved both productivity and quality performance. Therefore, this study replicates these earlier findings and provides confirmation of the importance of the effective use of CI techniques by shop floor teams.

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5.3.1.3. Association of Comprehensive and Sustained Implementation with Improved Performance Improvement

The literature on "bundles of practices", dealt with in section 2.6.5.1, suggests that implementation of an appropriate and comprehensive set of CMA practices is associated with greater performance improvement (Ichniowski et al., 1997, p. 311; Kaynak, 2003, p. 425; MacDuffie, 1995, p. 218).

The discussion on the time lag between practice implementation and performance outcome in section 2.6.5.2 raises the question of how mature TBWO programme implementation needs to be before performance improvement can be expected. Several authors have suggested periods of 3 to 5 years are necessary to consolidate the implementation of TBWO programmes (Womack & Jones, 1996, p. 270; Gunn, 1987, p. 131; Upton, 1996, pp. 222-5; Easton & Jarrell, 1998, p. 274; Yasin et al., 2003, p. 223).

The only firm to unequivocally improve productivity and quality was Firm N. In addition, it was also the only firm to reduce WIP. The fact that of all the firms researched, Firm N implemented the most comprehensive TBWO programme and sustained it over a period of 5 years replicates the findings on the positive association between comprehensive and sustained implementation and improved performance improvement.

The findings at some of the other firms suggest that comprehensive and sustained implementation is collectively necessary but not individually sufficient to achieve performance improvement. Firm Y implemented a comprehensive set of practices but did not have a mature programme, which may explain its lack of performance improvement. Firm U had a long history of incremental implementation but little evidence of the CI practices identified as key to quality performance improvement.

5.3.1.4. Influence of Moderating Factors

As little research could be found on the influence of market conditions and organisational stability on performance outcomes, this aspect of the findings of this research may be exploratory rather than a replication. The findings on market

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conditions and organisational stability were consistent with the discussion in section 2.7.1 and 2.7.2, in which these circumstances were held to have an asymmetrical effect: good market conditions and/or organisational stability do not appear to have a particularly positive effect on effectiveness of programme implementation. However, poor market conditions and/or organisational instability were found to inhibit effective implementation and consequent performance improvement.

In section 2.7.3, a repetitive process type was identified as a suitable environment in which to implement TBWO practices and also more likely than non-repetitive processes to result in performance improvement, and in section 2.7.4, firms in the automobile sector were identified as more likely to adopt CMAs, implement them well, and derive improved performance outcomes. The findings of this research corroborate these previous researches.

5.3.2. Theoretical Implications of this Research

In this section, the implication of the findings are extended to theoretical explanations for the (in)effectiveness of shop floor improvement teams.

5.3.2.1. Explanation of Findings for Performance Outcomes from TBWO Programme Implementation

While this research was not designed to assess all the theoretical explanations reviewed in section 2.4.4, the best fit between the findings and the theories is probably with the theory on organisational learning. While the explanations rooted in quality management (section 2.4.4.1), learning curve (section 2.4.4.2) and goal theories (section 2.4.4.4) are not inconsistent with these findings, they are essentially explanations of *how* process improvements are made, rather than answers to the more deep-rooted question of *why* they work when they do.

Probably the most persuasive explanation for the finding that the firm with the most comprehensive and sustained implementation of TBWO and CI practices experienced the most performance improvement lies in the formalisation of tacit knowledge held by shop floor employees, as proposed by organisational learning theory. As discussed in section 2.4.4.6, the most appropriate organisational structures for eliciting tacit knowledge are probably teams and the most effective mechanisms for facilitating the

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learning processes are probably CI techniques. Captured into standardised work routines, the investment of time and resources in this learning is most likely to provide the most returns when applied in repetitive processes, as in many of the cases studied here.

Agency theory (section 2.4.4.3) is not entirely irrelevant to the finding that difficult market conditions affected programme implementation at some firms inasmuch as the relationship between employees and the management/owners of the firm may become strained and affect the employees' motivation to make their tacit knowledge available to the firm.

Finally, the finding that mere implementation of CMA practices is a good selling proposition for firms indicates that institutional theory (section 2.4.4.5) may play a larger role in the effectiveness of these programmes than generally recognised. This research did not shed much light on this issue as it had a different focus, but "window-dressing" of CMA practices has been shown to occur (Baxter & Hirschhauser, 2004, p. 207; Choi & Eboch, 1998, p. 70), and therefore it warrants further investigation.

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5.3.2.2. Explanation of Findings on Role of TBWO and CI

In section 2.4.4.6, the role of CI was highlighted as the mechanism by which shop floor teams execute organisational learning. Insofar as Hypothesis 2 was upheld in this research, the importance of the adoption and regular use of process improvement decision-making techniques in eliciting better work practices that deliver improved performance was confirmed.

While this research only found the use of CI practices to be associated with improved performance, the explanation for why CI practices are effective needs to go a little beyond these findings into the way CI practices work. It has been stated that "it is very important to note that, in TQM organisations, where the relevant specific knowledge does not exist, application of science aids in its creation" (Wruck & Jensen, 1998, p. 313). In section 2.4.4.6, mention was made of how CI techniques mimic the scientific process (Kim, 1993, p. 38; Linderman et al., 2004, p. 592; Wruck & Jensen, 1998, p. 307). In other words, CI is the mechanism by which process

knowledge is discovered, just as science is the mechanism by which general knowledge is discovered.

In this regard, it is interesting to note that Firm N used the 8D-TOPS CI technique, which is based on Deming's PDCA cycle (MacDuffie, 2000, p. 185), which, in turn, has been characterised as based on the scientific method (Kim, 1993, p. 38). In contrast, most other firms in the research study made incomplete, little, or no use of CI. The lack of productivity improvement in the context of quality circles has been attributed to "no improvement in group functioning... no indication of use of systematic problem-solving techniques... [and] impatience with record-keeping and follow-up steps required to bring ideas to fruition..." (Mohrman & Novelli, 1985, p. 107), which succinctly explains the issues in this research context as well.

5.3.3. Further Research

5.3.3.1. Performance Measurement

The first suggestion for further research is methodological. This research relied heavily on operational performance data generated by the firms studied, on the assumption that the records kept for management purposes could be collected and used for this research. In a number of firms, these records were poorly kept and despite the researcher's efforts to improve the quality of the data collected by working from the original source documents where possible, it proved to be a significant constraint. In similar research conducted in the United Kingdom recently, the researchers concluded, "We were surprised by the limited measurement taking place at most of the companies...The lack of measurement is not just an impediment to assessing effectiveness, but potentially limits deployment, sustainability and continuous improvement" (Done et al., 2006, p. 21).

It is therefore suggested that future research be conducted into this issue: firstly, to establish what exactly is being done with respect to operational performance measurement in firms that implement CMA programmes, secondly, to investigate the costs and benefits of operational performance measurement systems in relation to programme objectives, and lastly, to collect reliable operational performance data for research purposes. It might be possible to do this in a mutually beneficial way for the

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firm and the research by planning to allocate more resources to data collection so that part of the research design entails helping the firm to establish adequate performance measurement systems.

5.3.3.2. Patterns of Implementation

Several researchers have undertaken studies on the patterns of CMA programme implementation at various stages of the implementation process. Nutt (1986) studied the tactics for adopting programmes (see section 2.5.1), Upton (1996) proposed three models of how CI programmes are implemented, each having different implications for programme sustainability (p. 223), Field and Sinha (2000) (see section 2.6.5.2) and Done et al. (2006, p. 10) used an S-curve model of CMA programme implementation to study outcomes and sustainability, and Easton and Jarrell (1998) used the Baldridge award criteria to establish how advanced the TQM initiatives of firms were, for the purpose of investigating the effect on financial performance (p. 266).

It is widely recognised that the patterns of implementation have complex implementation dynamics (see section 2.6.5), and determination of the antecedents of performance outcomes are further complicated by issues of equifinality. It is suggested that further research, using a more sophisticated matrix of programme implementation measures, may shed more light on the association between CMA programme implementation and performance outcomes.

In particular, it is proposed that the construct of programme implementation be disaggregated into three sub-constructs to provide a more rich understanding of the complexity and dynamics of programme implementation. Preliminary suggestions for these sub-constructs are as follow:

Comprehensiveness: The proportion of TBWO-supporting practices and/or techniques appropriate to the operation that are implemented.

Intensity: The proportion of paid time dedicated to TBWO-supporting activities, measured as was done in this research.

Depth: The proportion of shop floor/front-line employees that are trained and make regular use of TBWO practices and/or techniques.

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The research on the issue of practice implementation suggests that "more is better":

> Our study showed that the relationship between TQM practice and organisational performance is significant in a cross-sectional sense, in that TQM practice intensity explains a significant proportion of variance in performance. (Samson & Terziovski, 1999, p. 393)

> The piece-meal approach to adopting JIT used by US manufacturers occurs despite research findings that suggest the synergic benefits desired by US manufacturers cannot be fully realized until all JIT practices are integrated into a holistic management system. (White & Prybutok, 2001, p. 114)

> Klein et al. (2001) found that manufacturing plants that established numerous high-quality implementation policies and practices were more successful in implementing manufacturing-resource planning, a major technological innovation, than were manufacturing plants whose implementation policies and practices were meager and of lesser quality. (Klein & Knight, 2005, p. 245)

By conducting research with the programme implementation construct disaggregated, as suggested, it may be possible to ascertain not only whether all practices are equally important but also whether particular implementation patterns emerge. For instance, is comprehensive, intense and in-depth implementation early in the programme, followed by lower levels of support to maintain use of the practices, more effective than a gradual build-up of programme implementation? Also, is it necessary to implement a programme with equal emphasis on all three dimensions or is it possible to conserve implementation resources by intensively implementing only with a particular target group of employees or some other configuration?

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5.3.3.3. Output/Improvement Role Conflict

This research has found that very few of the firms that participated in the WPC paid much attention to CI activities and the one that did, Firm N, had the best performance outcomes. Other studies suggest that managers do not make the optimal trade-off between allocating the time of shop floor employees to CI activities to make process improvements versus direct production to increase current output (Keating et al., 1999, p. 121) and that shop floor employees have difficulty integrating the dual TQM roles of standardised production and CI tasks (Victor et al., 2000, p. 104).

This may be due to the delay and uncertainty of the return on the investment in improvement activities. Several studies have pointed to the fact that normal production requires a control mentality to avoid failure, whereas process improvement requires a learning mentality and the willingness to risk failure (Sitkin et al., 1994, p. 552; Prajogo & McDermott, 2005, pp. 1107-8). These two approaches are inherently irreconcilable. Psychological safety has been found to be an important facilitator of employee participation in process improvement (Edmondson, 1995, p. 13), and it has been suggested that a supportive error-management culture is positively related to firm performance (Van Dyck et al., 2005, p. 1236).

It is suggested that further research into the conditions under which the output/improvement role conflict are most effectively resolved will be of value to our understanding of the topic.

5.3.3.4. Understanding the Effectiveness of CI

In section 2.4.4.6, it was argued that CI techniques are effective at making process improvements to the extent that they mimic the scientific method. It has been shown that theory formulation and testing is necessary for long-term process improvement by converting the knowledge gained into improved production technology (Lapre & Van Wassenhove, 2002). However, much process improvement is not captured in technology but rather in the organisation of work practices (Ketokivi & Schroeder, 2004, p. 173). Hence, the importance of shop floor discipline to maintain best operating practices (Spear & Bowen, 1999, p. 98; Cole & Mogab, 2000, p. 65; Hampson, 1999, p. 372). The difficulty of maintaining optimal work practices and CI activities has been noted (Jørgensen et al., 2003, p. 1260). This may be a consequence of the complexity of social systems that are subject to human choice in contrast to physical systems that obey natural laws of probability.

Research has already been conducted into the adoption and effective use of CI techniques to make process improvements (Garcia et al., 2006; Boer, 2003; De Macedo-Soares & Lucas, 1996), but it may be helpful to the development of explanatory theory on this topic to investigate how shop floor employees undertake problem solving and decision making when they do CI. Goal theory raises the issue of the match between task complexity and cognitive skills of the people undertaking the

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task (see section 2.4.4.4). Ashby's Law of Requisite Variety states that to control the variety inherent in a complex system, the control mechanism needs to be capable of generating greater variety than that of the system (Waelchli, 1989, p. 54). In the context of shop floor teams undertaking process improvement, this requires investigation of the role of cognitive skills and mental models in generating improvement recommendations that match the complexity of the process or work situation.

Some initial research into this topic has already taken place. It has been documented that "templates" (or mental models) are formed of problems which occurred when new machines were commissioned (Von Hippel & Tyre, 1995, p. 4). Communication between team members to create a shared mental model of a complex task has also been shown to lead to greater task effectiveness (Millward, 2006, p. 232). The work of Roger Bohn in developing a taxonomical framework of organisational knowledge enables the "mapping and evaluation of levels of knowledge" (Bohn, 1994, p. 61). This framework could be used to map the theories that shop floor employees hold about the determinants of performance and investigate the relationship between the characteristics of their mental models and that of the process in which they are working and trying to improve. Research of this kind could shed much light on the effectiveness or otherwise of shop floor improvement teams.

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5.4. *Implications of the Research for Management of TBWO Programmes*

This research has several implications for the management of TBWO programmes. They are listed more or less in the order they would become relevant should a company consider implementing such a programme.

5.4.1. Programme Adoption

When considering whether to adopt a TBWO programme, managers must keep in mind that it is likely that such a programme would be more suitable for an operation with a repetitive type of process. This means that the nature of the process needs to be investigated before management assumes that implementation of a TBWO will be appropriate and effective. This does not mean that performance improvement is not possible in non-repetitive type operations, as was the case with Firm X, but it is likely

to come from other practices such as improved job skills, communication, or work co-ordination.

It is also important for firms that are considering whether to adopt a TBWO programme to appreciate that considerable investment of time and money is required to effectively implement an adequate bundle of TBWO practices and to see it through the time lag between implementation and performance improvement.

5.4.2. Programme Design

As the use of CI techniques by shop floor improvement teams has been shown to be related to improved performance, it is important for the programme to be designed in such a way that, in addition to all the other practices that are necessary, the effective use of these techniques is built into the programme. Not only does this entail providing the required training but also provision for time dedicated to CI activities must be made, support given to consolidate the correct use of CI techniques, and resources and authority given to implement improvement recommendations.

5.4.3. Programme Implementation

There appear to be no shortcuts to effective implementation of TBWO programmes. Thorough, sustained effort is required to institutionalise these practices in order to build up the synergy that seems to be necessary to eventually derive aggregate performance improvement from the repeated incremental contributions of individual process improvement projects.

The negative impact of organisational disruption should also be considered where possible. For instance, a company considering the merger of operations may want to manage and/or time it in such a way as to minimise the disruption to programme implementation.

5.4.4. Performance Outcomes

Expectations regarding performance outcomes should be realistic. It may be critical to manage expectations in such a way that the programme is not called into question prematurely because of the long time lag between implementation and performance improvement. It is equally essential for top management to monitor the adequacy of

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programme implementation if they want to see the fruits of their initial investment in it.

Most importantly, the conventional wisdom that TBWO is a universal panacea for improved performance appears to be a myth. Managers need to carefully consider the fact that research evidence converges on only about a quarter of TBWO programmes delivering demonstrable operational performance improvement. This is probably not because TBWO is inherently incapable of being the source of performance improvement but rather because of inadequate programme implementation.

5.5. *Implications of the Research for Industrial Policy and Project Management*

This research took place in the context of a government-sponsored project to support firms in implementing TBWO programmes. The WPC formed part of the government's policy to support the manufacturing industry with "supply-side" initiatives after South Africa subscribed to the World Trade Organisation and "demand-side" initiatives were no longer allowed. Due to the relative strength of the local currency at the time, firms in some of the sectors, such as clothing and footwear manufacture, were experiencing intense competition from imported products. These "sunset" sectors, as they were referred to, were included in the WPC specifically to provide them with support to counter international competition.

5.5.1. Firms in Distress

Given the findings that the minority of firms showed demonstrable performance improvement and that effective implementation of TBWO programmes require a considerable investment of resources over a long period of time, it is questionable whether this kind of intervention is suitable for supporting firms in distress. Two firms in which the research was started went out of a business a few months into the data collection period (and were therefore excluded from the 12 cases), one after 2 years and another two soon after the data collection was completed. The investment of public resources in these firms was largely wasted. It is recommended that an assessment of the viability of potential participants in such a project be conducted and careful consideration be given to the inclusion of marginal firms. Other types of

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interventions designed to support failing firms may be more effective at helping them to survive.

5.5.2. Defaulting Firms

This research also showed that some firms were poor implementers of TBWO practices. The use of a robust indicator such as the proportion of non-production time spent in TBWO-supporting activities, which is also relatively easy to collect and verify objectively, should enable managers of projects such as the WPC to gain an early indication of a firm's level of commitment to programme implementation. While the firm's circumstances will always need to be taken into consideration, a robust indicator could possibly be used to cull defaulting firms from the programme.

5.5.3. Project Assessment

The participating firms were required to report performance data to the project manager on a regular basis for the purpose of assessing the project's impact. The finding that the performance measurement systems of many of the firms studied left much to be desired meant that assessment of the project defaulted to anecdotal information, selective reporting, and opinion surveys of participants. All these methods have serious methodological drawbacks when used in a context such as this, where various interests may not be aligned with the project objectives. While it is important to relate "success stories" for the purpose of disseminating the lessons learnt, it is equally important not to confuse isolated and partial successes with aggregate, sustainable improvement of firm performance.

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With respect to evaluation of the management of the project rather than of the effectiveness of the programme at the firms, the modest success rate in terms of operational performance improvement that can be expected, considering the findings of this and other research, should serve as a benchmark. Managers of projects such as the WPC that are expected to deliver substantial performance improvement at even just the majority of participating firms are set up to fail. Project sponsors should be made aware of what can be realistically expected in order to have meaningful project evaluation, especially when the viability of some of the firms targeted for participation is known to be at risk at the outset, as was the case in this study.

5.5.4. Extended Support for Participating Firms

One of the limitations of participation in the WPC project was that firm programme implementation was planned to take place over a 2-year period, although in some cases, this was extended. Even though the data collected for this research were gathered over a 3-year period, the fact that some of the firms had not yet experienced performance improvement may be due to the long time lag between implementation and improvement. It may therefore be necessary for this kind of industrial support project to be designed to take a longer programme implementation period into consideration. This may not have to involve equally resource-intensive support over the whole period as firms may need less support as their programmes mature. However, continued low-level support, for instance, by continuing to sponsor the quarterly milestones workshops, could help firms through the long gestation period.

Another consideration for extended support may be that, arguably, only one of the twelve firms studied reached a relatively sophisticated level of use of TBWO and CI practices and techniques. Even then, certain organisational and systemic changes, such as strategy-aligned performance measurement, team-based incentives systems and statistical process control were not much in evidence. Even firms that did relatively well may need further support to really become "world-class". Given some of the challenges facing South African industry, such as low levels of education of the shop floor workforce, further government support may be required for the development of practices adapted for these circumstances.

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5.6. *Limitations of the Research*

Last, but not least, the limitations of this research should be noted.

Despite this study being multi-case, longitudinal, quasi-experimental research, which strengthens confidence in these research results, in a minority of cases, the findings contradicted the research hypotheses. The explanations offered for these findings would need to be confirmed by further research, leaving the main finding, that the two primary research hypotheses should not be rejected, open to further verification.

The primary methodological difficulty experienced was the poor quality performance data at some of the firms studied. To some extent, this could be compensated for by

the availability of qualitative data. While the study relied on objective data to an unusually high degree, compared to other studies of this topic, the fact that a single researcher conducted the whole study may have introduced elements of bias. The analysis of the quantitative data for validation purposes was also limited by the small sample size.

It should be kept in mind that the study was conducted in small and medium-sized manufacturers who chose to participate in a South African government-sponsored project to introduce the types of changes to work organisation that were studied. While none of the firms studied were out of the ordinary, compared to typical Western enterprises, some experienced unusually difficult market conditions during the data collection period.

In spite of all the abovementioned limitations to the research, the fact that the main findings of this research are consistent with previous research should allow it to be used with a fair degree of confidence.

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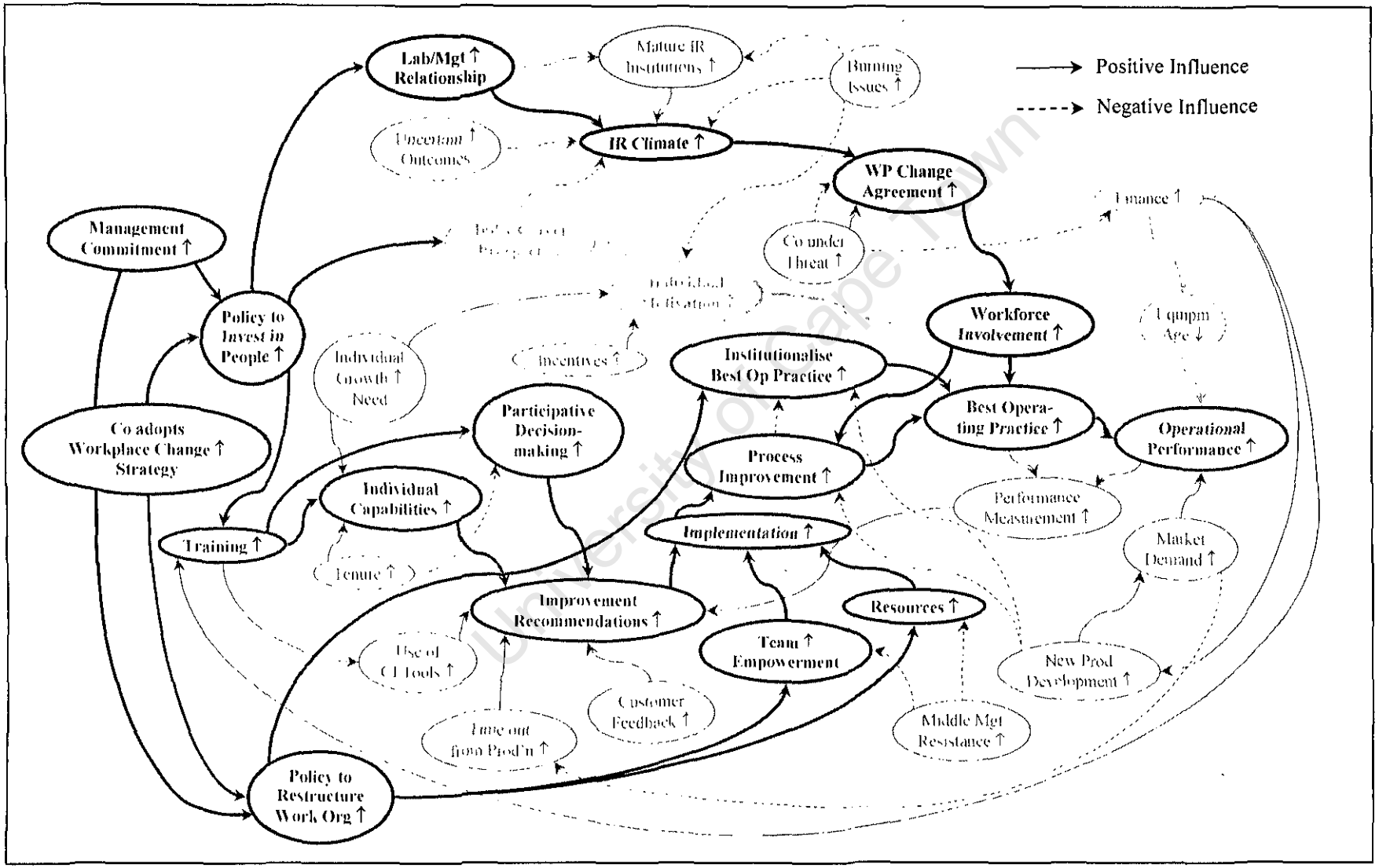
Appendix 1.1: Researcher's Model of TBWO Influence on Operational Performance



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Primary Constructs and Influence Paths

Co adopts Workplace Change Strategy: Strategic decision by company to improve operational performance by investing in team-based work organisation and shop floor employee involvement in process improvement.

Management Commitment: Management commitment to design, implement & sustain change of work organisation & shop floor employee process improvement systems.

Policy to Invest in People: Policy decision to build shop floor employee capability to work in teams & make process improvements.

Policy to Restructure Work Org: Policy decision to introduce team-based work organisation and shop floor employee involvement in process improvement.

Training: Training & education aimed at increasing individual capabilities & participative decision making.

Individual Capabilities: Knowledge, skills & resourcefulness of individual shop floor employees.

Lab/Mgt Relationship: Nature of the working relationship between management & labour.

IR Climate: Perceptions of the nature of the working relationship between management & labour.

WP Change Agreement: Explicit or implicit accord between management and labour to change work organisation & improve BOP.

Indiv. Career Prospects: Extent to which individual shop floor employees perceive good career prospects to exists as result of constructive engagement in adhering to & maintaining BOP.

Individual Motivation: Motivation of individual employees to collectively participate in maintaining BOP.

Workforce Involvement: Motivation of shop floor employees to work according to BOP.

Participative Decision Making: Collective process of investigation & decision making.

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Improvement Recommendations: Suggestions by shop floor employees for process improvement.

Team Empowerment: Increase in team decision-making authority.

Resources: Material, financial or knowledge resources required by teams to make process improvements.

Implementation: Activity of changing BOP to achieve higher process performance.

Process Improvement: New BOP following implementation of improvement recommendations.

Best Operating Practice: Current best working practices of operating the mnfct/service process.

Institutionalisation of BOP: Structures & systems to enable & promote adherence to BOP.

Operational Performance: Process performance measured in terms of output parameters such as productivity, quality, delivery, flexibility, etc.

Secondary Constructs and Influence Paths

Equipm Age: Age of equipment used in process.

Finance: Availability of financial resources.

Co under Threat: Threat to company due to poor market conditions, competition, etc.

Market Demand: Demand for products & services from company.

New Prod Dev: Development & bringing to market new products.

Performance Measurement: Systems to record and rapidly inform shop floor employees of process performance.

Middle Mgt Resistance: Resistance by middle management to introduction of new forms of work organisation.

Burning Issues: Serious concerns by shop floor employees over working conditions, etc.

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Mature IR Institutions: Well-established organisational structures & procedures for industrial relations dispute resolution.

Uncertain Outcomes: Perception of uncertain outcome of introduction of new work organisation.

Incentives: Employee reward & motivation systems.

Individual Growth Need: Propensity of shop floor employees to be open to learning & personal development.

Customer Feedback: Rapid & accurate feedback from customers to shop floor employees.

Time out from Production: Employee availability to engage in process improvement activities.

Use of CI Tools: Use by shop floor employees of continuous improvement tools to make process improvements.

Tenure: Length of service of shop floor employees.

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Appendix 2.1: Frequency of Mention of Contemporary Manufacturing Practices

CMA identified as: (INT: Integration of more than one approach.)	LP	LP	LP	INT	INT	INT	TQM	TQM	INT	TQM	INT	JIT	INT	LP	INT	JIT	WCM	
Practices **Literature Sources**	Panizzolo, 1998, p. 228	Shah & Ward, 2003, p. 131	Roth 1992 in O'Hehir & O'Mahony, 1994, p. 21	O'Hehir & O'Mahony, 1994, p. 16	Gunn, 1987, p. 52/6	Storey (Ed), 1994, p. 5	Easton & Jarrell, 2000, p. 90/1	Lawler et al, 1995, p. 49	Tan & Wisner, 2003, p. 1311/2	De Macedo-Soares & Lucas, 1996, p. 59	Sriparavastu & Gupta, 1997, p. 1218	Mullarkey & Jackson, 1995, p. 62/3	Cua et al, 2001, p. 678	Rasch, 1998, p. 105-8	Slack et al, 2004, p. 522	Bartezzaghi & Turco, 1989, p. 44/5	Schonberger, 1996, p. 24/7	**Total Number of Mentions of Practice**
Continuous process improvement	1	12	1	1	1	1	1	1	1	1	1	1	9	1	1	1	1	36
Pull flow control/JIT production/Kanban	1	17	1	1	1	1					1	1	3	1	1	1	1	31
Worker involvement (in CI)	1	12		1	1	1					1	1	9	1	1	1	1	31
Set-up reduction	1	17			1				1		1		4	1	1	1	1	29
Flow lines/process focus	1	17					1						7		1		1	28
Worker training	1	12	1	1					1	1	1		5	1	1		1	26
Multi-functional/skilled workers	1	12		1	1						1	1	5	1		1	1	25

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Small lot sizing/reducing inventory	1	15		1	1	1			1		1	1		1		1		24
Expansion of autonomy and responsibility	1	12	1	1			1		1	1	1	1		1	1	1		23
Preventative maintenance/TPM	1	12		1	1				1		1			1	1	1	1	21
Visual management/information feedback	1	12									1		3	1	1	1	1	21
Team decision-making	1	11		1	1	1	1	1		1	1			1				20
Quality at the source/self-inspection	1	12	1	1				1				1		1		1	1	20
Error-proof equipment/Jidoka	1	12					1									1	1	16
Cellular manufacturing	1	7						1			1	1	3			1		15
Order and cleanliness in the plant	1	12			1									1				15
Supplier involvement (in CI)	1		1		1	1		1			1		6	1	1	1		15
Customer orientation			1	1	1	1	1	1		1	1		4				1	13
JIT deliveries/purchasing	1			1		1		1	1		1	1	3		1	1		12
Focused factory production		7									1	1				1		10
Top-management/strategic support							1			1	1		7					10
Continuous reduction of cycle time	1	6					1				1							9
Quality control/performance measurement					1			1		1	1	1		1	1	1	1	9
Process capability improvement	1	6															1	8
Synchronised scheduling	1	1							1			1		1	1	1	1	8
Reduction of number of suppliers & distances	1		1	1					1		1			1		1	1	8
Statistical process control				1	1	1		1		1	1			1			1	8

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Strategic planning													7				1	8
Competence/performance pay systems	1			1				1		1	1			1			1	7
Multifunctional design teams	1												6					7
Levelled production	1	1			1						1				1	1		6
Parts standardisation	1				1				1		1					1	1	6
Zero defect principle/broad focus on quality			1		1	1	1			1				1				6
Cross-functional teams/planning							1	1			1				1	1	1	6
Work time flexibility/job rotation	1			1										1	1	1		5
Product modularisation/simplification	1				1				1							1	1	5
Design for manufacturability/product quality	1				1				1						1	1		5
Progressive use of new process technologies	1	3																4
Mixed model scheduling	1	1													1	1		4
Under-capacity scheduling	1	1											2					4
Open orders	1	1									1					1		4
Long-term contracts/supplier partnerships	1						1							1		1		4
Supplier evaluation/review	1										1			1		1		4
Safety improvement programs		4																4
Communications programme			1	1					1		1							4
Waste elimination					1		1					1			1			4
Innovative performance appraisal	1			1						1								3

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Early information exchange on prod'n plans	1	1			1													3
Supplier involvement in product design & dev.	1		1				1											3
Competitive benchmarking		1							1								1	3
Re-engineered production process		1						1		1								3
Union agreements/representative committees			1	1	1													3
Involvement of customers							1	1									1	3
Decision-making/problem-solving by fact/ Root cause elimination							1					1					1	3
Small simple machines															1	1	1	3
Overlapped production	1															1		2
Few levels of management	1			1														2
Mushroom concept/ High level BOM diversification	1															1		2
Standard containers					1						1							2
Involvement of support functions							1				1							2
Steering committee/quality council					1			1										2
Quick implementation of suggestions											1			1				2
Process standardisation/shop floor discipline															1	1		2
Phase overlapping	1																	1
Maintenance optimization		1																1
Careful staff selection				1														1

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Reduced grades for flexibility				1														1
Use of temporary workers				1														1
Gain sharing/share ownership				1														1
Efficient research culture			1															1
Unitarist enterprise culture			1															1
Role change for supervisors to team leaders			1															1
QFD/Taguchi methods					1													1
Concurrent engineering					1													1
Egalitarianism															1			1
Quality of work life															1			1
Align performance measures with customer requirements																	1	1
Use new work organisation for marketing																	1	1
Number of Practices in Source	42	30	15	24	25	10	16	14	14	12	31	14	16	24	23	32	28	646

Notes on practices from reference Cua et al, 2001, p. 678:

1. TPM practices not counted as only JIT, TQM & common practices were considered relevant.
2. (2) Flynn et al. (1994); (10) McLachlin (1997) & (11) Sakakibara et al. (1997) were excluded from the count because these papers were already included in the Shah & Ward (2003) count.
3. Nine counts of CI were included although not explicitly mentioned in the listed practices because it is implied by both "employee involvement" and "process management", and it is explicitly mentioned in the text.

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Appendix 2.2: Characteristics of Teams

Source / Characteristic	Purcell (1992, p. 33) in Storey (Ed), 1994, p. 205	Wellins et al, 1991, p. 3-5	Yeatts & Hyten, 1998, p. xiii/iv	Cohen et al, 1996, p. 653	Katzenbach & Smith, 1993, p. 43
Name used	"teamworking"	self-directed work team	self-managed work team	self-managed work team	team
Group unit		intact group of employees	group of 5-15 employees	group of members	small no of people
Work unit	work on a common task	'whole' work process or segment that delivers a product or service	technical tasks	organised around particular customer service	committed to a common purpose
Accountable to		internal or external customer	internal or external customer	customer	
Task responsibilities		manage themselves to get work done, order materials, keep inventories, deal with suppliers, quality of products or services	managing all or most aspects of work e.g. assembling a computer board to verifying claims & completing monthly reports	task assignments & methods for carrying out the work	
Process improvement		handle day-to-day problems; improve their operations		making necessary corrections	
Goal setting		set own goals		setting their own goals and objectives	committed to performance goals
Monitoring		inspect own work, review own performance	responsible for monitoring	get feedback & regulate own performance	hold themselves accountable
Co-ordination	organise their own task allocations	plan & control own work, create own schedules, co-ordinate with other departments	responsible for planning & scheduling		
Skills	multi-skilling encouraged		rotate responsibilities among themselves		complementary skills

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Training	members organise own training	responsible for acquiring training			
Autonomy	discretion over work methods & time	empowered to share *management functions*		high levels of employee *involvement in decisions*	mutually account-*table*
Leadership	has a leader	share leadership			
Recruitment	influence recruit-ment to their team	may hire their own replacements	responsible for staffing		
Discipline		may discipline own members			
Budgeting		prepare own budgets			
Interdependence			high inter-dependence	interdependent members	common approach
Duration			not short-term task team		

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Appendix 2.3: Approaches to the CI Process

Lee & Chuah, 2001, p. 691	Moses & Stahelski, 1999, p. 400	Grunberg, 2004, p. 529	Jones & Holloman, 2000, p. 78	He et al., 1996, p. 41	Grütter & Faull, 1997, p. B5	Furuhashi, 1996
Identify customer requirements		Pre-study				Understand scope & objective
Select process	Problem definition	Problem-identification	*Find process to improve*		(Project focus given by management)	Understand operations
			Organise a team that knows the process			Prepare project schedule
Map process tasks		Process mapping	Clarify understanding of process	Assess process	Understand process activities	Complete process flow chart
Identify problem areas					Identify activities that add value	
					Decide measures to use	
Benchmark performance	Potential cause analysis	Measurement	Understand the sources of variation	Identify problem	Collect data and measure	Measure productivity & efficiency
Set improvement goals					Classify into VA, NVBN & waste	Classify & identify wastes
Analyse potential causes				Establish causes	Identify causes for NVBN & waste	
					Identify biggest losses	Compile findings & identify problem *areas where improvement is possible*
Identify & select *solutions*	Possible solution *identification*	Select what to *improve*	Select the process *improvement*		Identify & investigate improvement suggestions	Analyse problems with detailed data, Brainstorm countermeasures
	Select best solution			Propose solutions	Estimate improvement	
Develop action plan	Develop action plan		*Plan the improvement*			
Implementation	Implement solution	Implement	Do the improvement	Implement solut'n	Implement recommendations	Test trial of countermeasures
Evaluate improved process	Evaluation	Evaluate results	Check the results of the improvement	Review for documentation	If it works disseminate new work practice, if not do project again	Review trials
Refine improvement & monitor results			Act to hold the gain & continue to improve process			
		Next problem				Present learning points & future plan

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Appendix 2.4: Process Steps for TBWO Implementation

Team Design Process (Wellins et al., 1991, p. 102)

Vision	Design	Implementation	Monitoring
Envision the future Create awareness of the need for change: • Read the literature • Visit other sites • Scan the environment Clarify the organisation's mission, vision, & values Make a commitment by setting goals & objectives Involve key stakeholders: • Steering committee • Design team	Assess the current vs. the desired state: • Technical analysis • Social analysis Optimise technical & social system in tentative design Examine &, if appropriate, change the organisational system Agree process & result measures Develop a plan for moving forward	Assess readiness Plan roll-out: • Decide pilot vs. full-scale roll-out • System modification • Training needs • Obstacle removal • Progress measurement Provide orientation & training Execute roll-out Re-evaluate design & make needed changes	Evaluate: • Attitudes • Performance Renew: • Awareness • Commitment • Skills • Redesign, if appropriate

Action Plan for the Lean Leap (Womack & Jones, 2003, p. 270)

Getting started (first 6 months)

- Find a change agent & free him or her to do the job.
- Get lean knowledge (or a guru).
- Find a lever for change (create a crisis?).
- Map your value streams.
- Tackle a pilot project (create high visibility).
- Expand when you have demonstrated success.

Creating a new organisation (by end of year 2)

- Re-organise by product/service family.
- Get somebody to promote & train lean thinking.
- Make policy for redundant people.
- Rather re-invest resources freed up than take profit.
- Remove the anchor-draggers.
- When you've fixed something, fix it again.
- Two steps forward & one back is OK, no steps forward is not OK.

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Introduce lean systems (year 3 & 4)

- Introduce lean accounting (balanced scorecard).
- Align incentives with team performance.
- Implement transparency.
- Prioritise initiatives by agreement.
- Introduce lean learning.
- Right-size your equipment & systems.

Completing the transformation (by year 5)

- Expand lean thinking to your suppliers & customers.
- Develop a global/export strategy.
- Convert from top-down leadership to bottom-up initiatives.

Linking Business Strategy to Action on the Shop Floor and Implementing a World-Class Manufacturing Program (Gunn, 1987, Chaps 4 & 5)

- Establish strategic vision of the manufacturing capabilities required to compete in the firm's chosen marketplace.
- Obtain commitment for change from functional departments by listing actions each department has to take and working through the implications until buy-in is reached.
- Establish task force to break programme up into projects that are fully specified in terms of skills, resources, costs and schedule to implement programme. (See Appendix 2.1 for practices required)
- Re-confirm mandate for programme from top management after priorities and costs/benefits have been determined.
- Appoint senior executive to manage implementation by project leaders of implementation teams guided by high-level steering committee and supported by small programme staff.
- Manage people through the organisational change of less hierarchy, broader job scope, flexible work and more complex technology by education to change attitudes and training in new skills required.
- Communicate progress with newsletters, video-tapes and WCM open days.
- Update implementation plan over 5-10 year roll-out period to take account of competitive, technology or internal changes.

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Key Ideas for implementing Shop Floor Management (Suzaki, 1993, p. 323)

- Understand the key elements of SFM, their interrelationships, and the big picture.
- Practice the PDCA cycle, starting with "check".
- Analyse the situation by constraints and potential and cause-and-effect relationships.
- Address key areas first. Remember, the wind may shift, but we adjust our sails to go where we want to.
- As we succeed, share the experience and reward, provide recognition, standardise the process, and move forward by attacking the untouched problems.
- When things fail, do not give up. How we handle unfavourable situations shows the true skills of the individual.

Hints for Successful Shop Floor Management Implementation (Suzaki, 1993, p. 330/2)

Introduction Stage:

- Build understanding of SFM by reading books, attending seminar/workshops, company visits, consulting experts, collaboration with other firms, etc.
- The situation and culture of every firm is different, so you have to find your own solution.
- Develop a long-term vision and programme and confirm commitment to the journey.

Promotion Stage:

- Develop and execute an internal training programme that can adapt to changing needs.
- Use internal facilitators and trainers who have hands-on shop floor experience and balance theory and practice to keep learning relevant.
- Encourage everyone to contribute suggestions and as small improvements are implemented, invite top management to show-and-tell sessions on the shop floor.
- Use pictures, displays, newsletters, rallies, etc. to share success internally and externally.
- Conduct presidential audits supported by experts, but be patient.

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Expansion Stage:

- Entrench use of PDCA cycle and summarise experience to promote learning.
- Provide more settings to share successes and failures, emphasise openness.
- Develop healthy internal competition by appropriate recognition and awards.
- Compare with world-class firms and aim for national award.
- Improve spread of information by shop floor scoreboards & glass wall displays.
- Find the "fire" in people. Once a critical mass of people buy in, others will follow.

Stabilisation Stage:

- Check effectiveness of different approaches and take proper action.
- Make sure everyone practices PDCA diligently throughout the organisation.
- Further improve quality of work, programmes, training and management processes.
- Go back to the basics to re-assess vision, goals, problem-solving skills, leadership and management support system.
- Introduce stimulation and challenges by special task forces, expert visits, etc.
- When everything seems to be going well, be humble. Remember the hard times. Many firms fail because of their success.

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Overall Steps when Implementing Quality Circles (Cotton, 1993, p. 85/6)

1	Get management commitment:	Do they understand what type of commitment is necessary?
2	Assess the organisation:	Some organisations are not ready for QCs.
3	Select objectives:	What is expected of the QCs? Quality, productivity, employee attitudes, or all of the above?
4	Prepare & train middle mgt & supervisors:	As they feel the greatest threat support of these individuals is necessary for program survival.
5	Select & train facilitators:	Facilitators act as link between QCs & management. Difficult role & critical to QC success.
6	Inform employees & ask for volunteers:	This eliminates problem of employees who do not want more involvement. Typically, not all employees are involved.
7	Train QC leaders:	Not a normal supervisor role, requires new skills.
8	Train participants:	Should include both decision-making & group process training.

9	Set goals & boundaries:	QCs should have clear notion of what they do & why.
10	Give QCs time to establish roles:	Groups need time to establish roles, thrash out conflicts, develop climate of trust, mutual respect & innovation.
11	Recognise & implement:	Try to recognise the group & what it is doing.
12	Evaluate QCs:	Measure agreed goals in terms of economic value & QC maintenance. Evaluation necessary to keep QCs going.

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Appendix 2.5: Comparison of Models of Process Steps for TBWO Implementation

Sources / Step	Wellins et al, 1991, p. 102	Womack & Jones, 2003, p. 270	Gunn, 1987, Chaps 4 & 5	Suzaki, 1993, pp. 323 & 330/2	Cotton, 1993, pp. 85/6
Vision	Envision the future		Establish strategic vision	Develop a long-term vision	Get management commitment
Get Informed	Read the literature, Visit other sites	Get lean knowledge (or a guru).	*List actions each dept. has to take & work through the implications*	*Understand the key elements of SFM*, Read books, attend workshops	
Design Plan	Plan roll-out, Redesign if appropriate	Map your value streams	break programme up into projects that are fully specified	*Analyze the situation by constraints & potential*, & cause-effect relationships	*Assess the organization*
Set Goals	Set goals & objectives,	Prioritise initiatives		Go where we want to	*Select objectives, set goals & boundaries*
Remove Obstacles	Obstacle removal / Make policy for redundant people Remove the anchor-draggers		Specify skills, resources, costs & program implementation schedule upfront		
Communicate	Create awareness of the need for change	Create high visibility, Implement transparency	Communicate progress	Share success internally and externally, Show-and-tell sessions	
Buy-in	Involve key stakeholders Make a commitment	Find a lever for change (create a crisis?), Initiatives by agreement / Obtain commitment, Re-confirm mandate		Confirm commitment to the journey, Once critical mass of people buy in, others will follow	Inform employees & ask for volunteers
Change Agent		Find a change agent & free them to do the job	Appoint senior executive		
Support Staff	Steering committee, Design team	Get lean-thinking champion Re-invest resources freed up / Establish task force, high-level steering committee supported by small programme staff		Use internal facilitators and trainers who have hands-on shop-floor experience	Select and train facilitators
Change Attitudes	Provide orientation		Education to change attitudes, Manage the organisational change		Give QCs time to establish roles
Training	Provide training	Train lean thinking, Introduce lean learning	Training in new skills required.	Internal training programme, Balance theory & practice to keep learning relevant	Prepare and train middle management, supervisors, QC leaders & participants
Pilot Project	Decide pilot vs. full-scale roll-out / Tackle a pilot project				
Restructure Organisation	Change the organisational system	Re-organise by product/service family Right-size your equipment & systems / Less hierarchy, broader job scope, flexible work & more complex technology			
Continuous Improvement		When you've fixed something, *fix it again*		Encourage everyone make suggestions, Entrench use of PDCA cycle	Implement what group is doing
Measurement	Agree process & result *measures*	Introduce lean accounting *(balanced scorecard).*		Conduct presidential audits	
Monitor Progress	Progress measurement, *Evaluate: attitude, perform.*			Compare with world-class firms, Check effectiveness of approach & take proper action	Evaluate QCs
Incentives		Align incentives with team performance		Appropriate recognition and awards	Recognise the group
Adapt Plan	Re-evaluate design & make needed changes		Update implementation plan to take account of competitive, technology or internal changes	Adapt to changing needs, The wind may *shift, but we adjust our sails*	
Sustain Initiative	Renew: awareness, commitment, skills	2 steps forward & 1 back is OK, no steps forward not OK, 5 year process / 5-10 year roll-out period		When things fail, do not give up, Be patient, Assess vision, goals	

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Appendix 2.6: TBWO Programme Implementation Success Factors

Source / actor	Fabi, 1992	Elmuti, 1996 p. 14	Liker (Ed), 1998, p. 500	Moses & Stahelski, 1999, p. 410	Bateman et al, 2002, p. 216	Dale & Lees, 1985, p. 43/4
op mgt commitment	Top mgt commitment	CEO leadership & support	Informed, active leadership			*Visible top mgt support*
liddle & line management ommitment & support	Middle & line mgt commitment & support					Middle & line mgt support & *involvement*
lear vision & goals		Clear goal statement	Systems vision & explicit guiding principles		Clear team performance objectives	
roblem-solving skills	QC member training	Build cross-functional teams	Focussed training and immediate application	Team members trained in problem solving	Team members adequately trained and competent	Adequate training for people involved
mployee involvement	Employee involvement		Bottom-up involvement	Team members from entire organization		
nion support	Union support		Flexible union agreement			Support of trade union
roblem-solving & group rocess expertise/facilitation	Appoint full-time facilitator	Mgt with authority to oversee must drive process	Lean experts as coaches, Internal lean co-ordinators	Facilitators can provide expertise in group processes & problem-solving		Appoint enthusiastic and committed facilitator
uild trust between anagement and teams	Supportive mgt philosophy	Trust between management & teams	Build trust			
eam autonomy to make ecisions	QC member participation in decision-making	Authority & capacity to make decisions		Teams should have information that can solve problems		
apid implementation of uggestions	Rapid implementation of QC suggestions		Kaizen blitz events, Go for quick visible improvements			
ncouragement of *xperimentation*		Challenging environment to promote innovation	Atmosphere of experimentation		Team constantly improving products & work systems	
se problem-solving techiques to improve process		Implementation in steps: PDCA, Problem-solving methods: 5 whys		Use of problem-solving techniques to improve productivity		
xtensive communication ver organisational levels	Briefing middle management, employees & unions	Effective communication	Intense communication			
ustify the changes			Compelling need for change (crisis)		Teams share sense of purpose	
dequate resources to nplement suggestions		Adequate resources to do work	*Engineering support*	*Management cooperation to implement team solutions*	*All resources are used effectively*	
isual measurement and erformance monitoring		Benchmark to improve performance	*Visual measurement: target vs. actual*		*Standards are identified and monitored*	
ocus on process flow			Focus on process flow	*Focus on work processes*		
se pilot projects			Use of model lines			Pilot-study approach
ppropriate incentives	Non-financial extrinsic rewards					*Recognise & publicise QC success*
ias to action	Mgt must show courage & hard work		Action orientation: just do it!			
ustomer orientation		Leverage technology to service customer			High level of customer awareness	
oluntary QC participation	Volunteers for QCs					Voluntary QC participation
ther	Facilitator & QC leader training		Job security: no lean layoffs			Programme steering committee
ther	Internal stability & members' experience of QCs	Detailed implementation plans		Well-designed & organizationally integrated problem-solving teams		
	Org & financial stability		Upfront awareness-by-doing before training			

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Appendix 3.1: Variable Operationalisation

1.1.1. Baseline Data

1.6.1.1. Firm

Firms were coded by the last letter of the name of the firm (except for one where the second last letter was used to avoid duplication) to avoid identification of the firm where firm specific information was reported but, at the same time, to make it easy for the researcher to know which firm was being dealt with.

1.6.1.2. Period

Data was collected monthly over a period of 36 months for most firms. The exceptions are Firm U, for which there are 72 data points, and Firm E, for which there are 24 data points.

1.6.1.3. Direct and Indirect Shop Floor Employees

Shop floor employees were operationally defined as people who "regularly touch the product or process" during the course of their duties. Therefore shop floor employees includes people that some firms do not consider "direct" production employees but who spend time on the shop floor, such as supervisors, packers, quality controllers, maintenance staff, schedulers, expediters, and so on, but excluding management, sales or administrative staff.

Shop floor employees were further divided into "direct" and "indirect", according to whether they spent most of their time directly adding value to the product or not.

1.6.1.4. Hours of the Working Week

The standard hours of the working week before overtime was paid was recorded here for each firm.

1.6.1.5. Working Days in the Month

The actual number of days worked in the month was recorded here for each firm.

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1.6.1.6. Normal Hours Worked

The total hours worked by all the shop floor employees paid at the normal hourly rate was recorded from the monthly unemployment insurance or payroll records. In some cases, this information was recorded for weekly paid employees only and adjustments had to be made for shop floor employees who were paid monthly.

1.6.1.7. Overtime Hours Worked

This measure was collected in the same way as for normal hours worked.

1.1.2. Structural Changes

1.6.1.8. Steering Committee

The scale categories were: Yes: Representative committee active, Some: Representative committee exists, but inactive, No: No committee.

No significant measurement difficulties were experienced with this variable as it was easy to verify whether committee meetings took place or not.

1.6.1.9. Staff Facilities

The scale categories used were: Yes: Significant staff facilities upgrade, Some: Minor staff facilities upgrade, No: No staff facilities upgrade.

In some cases, the changes to staff facilities were implemented soon after the decision was made to do so and completed quickly. In other cases, there were delays between the decision and implementation, and execution was over several months. Sometimes, there were extensive consultations with shop floor employees, but at other times, the delays were due to management inaction. There was room for interpretation as to whether the particular implementation was decisively acted upon and how this would be interpreted by the workforce. A conservative approach was taken to the categorisation on this variable and "Yes" or "Some" categorisations were only recorded in months when there was actual implementation activity.

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1.6.1.10. Cellular Layout or Layout Changes to improve Flow

The scale categories used were: Yes: Significant shop floor layout change to cells, Some: Some shop floor layout change towards cells, No: No shop floor layout change.

Initially this variable was conceptualised as strictly related to U-shaped cells. However, soon after data collection commenced, I realised that significant changes to improve flow through the process were being made by some firms and these were coded as "Some". Firms where the layout was cellular before the research commenced were coded as "Yes" from the outset.

1.6.1.11. Small Batches

The scale categories used were: Yes: Significant and sustainable reduction in batch size, Some: Batch size reduction not fully implemented, No: No batch size reduction.

Where batch size was reduced in part of the process or where there was a general reduction in inventory, it was coded as "Some". Introduction of a Kanban system was interpreted as a reduction of batch size and coded "Yes" where appropriate.

1.6.1.12. Employment Equity

The scale categories used were: Yes: Active Affirmative Action/Employee Equity policy implementation, Some: AA/EE policy not fully implemented, No: No AA/EE policy.

In practice, implementation of an AA/EE policy often entailed oversight by a representative committee. Therefore, committee meetings and initiatives like mentoring of designated employees were coded "Yes".

1.6.1.13. Incentive Scheme

The scale categories used were: Yes: Shop floor incentive scheme has paid out, Some: Shop floor incentive scheme exists, but no/little payout, No: No shop floor incentive scheme.

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No significant measurement difficulties were experienced with this variable as it was easy to verify whether incentive bonuses were paid or not.

1.6.1.14. Retrenchment

The scale categories used were: Yes: Retrenchments have been announced, Some: Retrenchments are possible, No: No retrenchments under discussion.

While the "Yes" and "No" categories were easy to verify, it was not always possible to verify whether retrenchment was under discussion at the firm because there was usually a fair amount of uncertainty before retrenchment was actually announced and it was sensitive issue for the workforce.

1.6.1.15. Factory/Customer Visits

The scale categories used were: Yes: Most shop floor employees have visited other factories/customers, Some: Some shop floor employees have visited other factories/ customers, No: No shop floor employees have visited other factories/customers.

It was relatively easy to verify whether shop floor employees were given time off to visit customers or suppliers.

1.1.3. Off-Production Hours

1.6.1.16. Communication and Consultation

This measure was defined as "total hours of paid time or hours of off-site meetings paid for by the firm dedicated to communication or consultation efforts, i.e. NOT directly related to production." Regular events such as stakeholder forums were calculated by multiplying the number of employees involved x hours of event duration x number of events in the month. The use of communication and/or consultation practices was assessed by categorisation into three categories, as follows:

Employee Briefings	Briefings to all/most employees by management during paid time. Yes: Occurs regularly; Some: On ad hoc basis; No: Does not occur
Consultative Meetings	Consultative meeting(s) between representatives and stakeholders. Yes: Occurs regularly; Some: On ad hoc basis; No: Does not occur

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Address Issues	Commitment from management to address "burning" issues on shop floor. Yes: Management open to address issues; Some: Issues addressed when forced; No: Does not occur
Stakeholder Forum	Workers' committee, workplace forum, union structure exists. Yes: Meets regularly; Some: Meets on ad hoc basis; No: Does not exist
Circulation of Meeting Minutes	Minutes of meetings, etc. displayed on notice boards. Yes: Promptly & always; Some: Delayed & sometimes; No: Never
Sharing of Vision/Values	Efforts aimed at developing common vision or understanding cultural diversity. Yes: Significant efforts; Some: Some efforts; No: No efforts
Newsletter	Company newsletter to shop floor employees. Yes: Regularly; Some: Occasionally; No: Never
Other	Any other communication/consultation with shop floor employees.
Description of other	Notes on communication/consultation in month.

While no significant problems were experienced with the measurement of these variables at most firms, at Firm K, no data was available for these variables for the first 5 months of the data collection period. The missing values were replaced with 0 for hours spent on communication/consultation as this is the most conservative assumption. The missing practice variables were not replaced as they were incorporated into the sub-construct by addition and therefore did not cause calculation problems.

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1.6.1.17. Training

Training included any time, paid or unpaid, when employees are released from normal duties for training, on-site or off-site, excluding informal on-the-job training. The time dedicated to different kinds of training was calculated by multiplying the number of employees who received training x duration of training x number of times training took place in the month.

Trainees	Number of shop floor employees who received training in month.
Hours Trained	Total hours of training for shop floor people in the month.
Job Skills	Training to improve employee's normal work.
Teamwork	Teamwork training, e. g. communication, conflict resolution, team

	leadership, etc.
Problem-solving	Training to use problem-solving techniques, e. g. run charts, pareto analysis, fish bones, brainstorming, etc.
Change/ Orientation	Training to understand workplace change, negotiation, business orientation, etc.
Quality	Training to improve product or process quality (e.g. inspection, ISO 9000, etc.)
Other related to TBWO	Any other training to shop floor employees related to teamwork or process improvement.
Other not related to TBWO	Any other training not related to shop floor teamwork or process improvement.

No significant problems were experienced with the measurement of these variables.

1.6.1.18. Teamwork

Teamwork was defined as collective decision making about production issues by more or less the same group of people on an ongoing basis or for a project. The time dedicated to different kinds of teamwork was calculated by multiplying the number of employees involved in a team meeting x duration of the team meeting x number of times they met in the month.

Employees in Teams	Number of shop floor employees in teams.
Hours Teamwork	Total hours spent in team meetings in the month.
Shift Team (Natural Work Group)	*Permanent teams* made up of shop floor employees who normally work together e. g. Level 1 teams, Cell teams, etc.
Cross-functional Team	Teams made up of employees who co-ordinate production or inter-departmental issues, e. g. Level 2 team, team leaders/supervisor's meeting, etc.
Improvement/ *Problem-solving* Team	Temporary or permanent teams made up of employees who address unresolved production problems, make process improvements, e. g. Level 3 meet, production managers meeting, etc.
Safety Team	Employees who meet to address safety or related issues.
Other	Any other team meetings.

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Description	Notes on teamwork in month.
Daily Shift Meetings	Do shift teams meet sometime during working day? Yes: Every working day; Some: Some days; No: Do not meet
External Facilitator	Do external facilitators/coaches help with team meetings? Yes: Regularly; Some: Occasionally; No: No

Conventional production management meetings were categorised as *improvement/problem-solving meetings* as it became apparent that production problems were often addressed at these meetings. While this would arguably not qualify as structured process improvement, it was decided to make the conservative choice and include the time spent in production management meetings in improvement/problem-solving team meeting time.

In months where firms undertook no teamwork, either because it was before their TBWO initiative started (Firm U), because the firm closed down (Firms E and C) or because the firm implemented no teamwork throughout the research period (Firm R), the WCTm and CITmSC sub-construct calculations in SPSS produced missing values due to division by 0. These missing sub-construct values were replaced by 0 as 0 correctly represents the firm's implementation of these practices.

1.1.4. Suggestion Implementation

To make this measure more robust, only actually implemented suggestions from shop floor employees were included in the measure.

Suggestion Implementation	Number of actually implemented suggestions from shop floor employees in month.
Team	Team as a whole responsible for driving implementation. Yes: Yes; Some: To some extent; No: No
Team Leader	Team leader responsible for driving implementation. Yes: Yes; Some: To some extent; No: No
Workshop Staff	Workshop staff responsible for driving implementation. Yes: Yes; Some: To some extent; No: No
Management	Management responsible for driving implementation. Yes: Yes; Some: To some extent; No: No

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Other	Others responsible for driving implementation. Yes: Yes; Some: To some extent; No: No
Description	Notes on suggestions implemented in month.
Team Authority	Teams do not need permission to implement suggestions up to a pre-determined cost level. Yes: Yes, or strong encouragement by management to implement; Some: Need to clear suggestion with management; No: No authority to implement.
Improvement Focus	Do teams dedicate time specifically for process improvement? Yes: Yes; Some: Ad hoc process improvement; No: No

The number of suggestions implemented per month turned out to be the measure which presented great difficulties. At most firms, the question was met with the response that suggestions were implemented on an ongoing basis all the time and that there was no formal system for counting them. Even at Firm S, where this data was initially recorded, the measurement of this data eventually lapsed. This raised questions as to whether these were substantial process improvement suggestions or merely everyday co-ordination and/or quick-fixes. As this was an important measure, I made serious efforts to capture this data, but even attempts to institute measurement and recording of suggestions implemented had to be abandoned as the data was not reliable.

The data on who took responsibility for implementation, team authority and improvement focus were measured on 3-category scales and did not present significant data measurement problems.

1.1.5. TBWO Methods in Use

Percentage TBWO methods in use was a subjective assessment of the researcher, based on field observations and made in consultation with firm respondents, of the extent of implementation of indicator practices associated with TBWO that are primarily the prerogative of management.

Indicator practices are meant to provide an indication of the extent of implementation, rather than be a comprehensive list of such practices. For instance, visual management and waste identification are quite common practices, and therefore a high score on

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these indicators does not necessarily indicate extensive implementation. On the other hand, team presentations are not common practices, and therefore this practice was included to discriminate implementation at the high end of the scale.

The following criteria were used to make the assessments:

% TBWO Methods in Use	Extent to which methods associated with team-based work organisation was practiced. 25%: Little evidence of use on shop floor; 50%: Sporadic use of some methods; 75%: Extensive use of several methods, VM on shop floor up to date; 90%: Sophisticated methods, such as SPC, in use.
Visual Management	Visual management: performance measures, photographs, operating practices, etc. displayed on shop floor. Yes: Yes, & up to date; Some: Some evidence of use; No: Not used.
Waste Identification	Shop floor employees understand creating value for the customer and continuously try to eliminate waste. Yes: Yes, & active; Some: Some evidence of waste elimination; No: Not practiced.
Problem solving	Shop floor employees use CI techniques such as run charts, pareto analysis, fishbone (cause and effect) diagrams, brainstorming, etc. Yes: Extensive use; Some: Some use; No: No use.
Team Presentations	Teams make presentations on their work, projects, etc. to fellow employees or management. Yes: Regularly; Some: Occasionally; No: Not done.
Resource Availability	Resources such as access to technical experts, availability of engineering or maintenance staff and/or budget for small changes are available and used by teams. Yes: Yes & easily available; Some: Limited or not easily available; No: Not available.
Other	Any other method in use.
Description	Notes on methods used in month.

In practice, these measures were relatively easy to assess as examples of more or less extensive implementation of the practice could be given when, in the opinion of the researcher, firm respondents made over or under estimates, and a more realistic estimate resulted. But, due to the problems of operationalisation reported in section 3.4.2.1.2.2, these practices could not be used to distinguish whether the extent (or lack) of practice implementation was due to management and the shop floor employees.

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1.1.6. Best Operating Practice

This measure was operationalised in the same way as TBWO in use, and the same comments made previously apply to this measure.

The following criteria were used to make the assessments:

% Best Operating Practice	Assessment by researcher in consultation with primary respondent of extent to which BOP are in active use by shop floor employees. 100% is "ideal" (i. e. fullest use of BOP under the circumstances)
Housekeeping	Housekeeping or 5S practices are in active regular use. Yes: Extensive regular use; Some: Some irregular use; No: No use.
BOP Documents on Shop Floor	The operating procedure documentation is available to shop floor employees. Yes: Easily available; Some: Available, but not accessible; No: Not available.
Tools in Place	Designated storage space for tools/jigs near work stations. Yes: Clearly designated; Some: Poorly designated; No: Not designated.
Daily Feedback	Performance feedback to shop floor employees. Yes: Regular; Some: Irregular; No: No feedback.
Update BOP	System in place to update BOP documentation quickly. Yes: Well-functioning system; Some: Poorly functioning system; No: No system.
Training Certification	Shop floor employees are trained and/or certified according to latest BOP. Yes: Extensive certification; Some: Some certification; No: No certification.
Other	Any other practice to promote best operating practice.
Description	Notes on BOP in month.

1.1.7. Maintenance

Time spent on maintenance was measured in hours per month and broken down into the categories below. It could not be standardised as the times recorded for breakdown and preventative maintenance were from a number of different sources (e.g. internal maintenance staff, contractors) and were not always mutually exclusive with autonomous maintenance as they included simple maintenance and condition monitoring tasks by shop floor employees.

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Total Maintenance Time	Sum of maintenance hours recorded for sub-variables below.
Breakdown	Paid hours (contractor or internal) spent on breakdown maintenance.
Preventative	Paid hours (contractor or internal) spent on scheduled maintenance or *maintenance required by condition monitoring.*
Autonomous	Paid hours spent by shop floor employees on minor maintenance.
Other	Paid hours spent on other maintenance.
Description	Notes on maintenance.

This variable proved highly problematic as most firms did not keep records of time spent on maintenance. Attempts were made to make estimates based on the hours for which maintenance staff were paid, but this was unreliable as their duties were often mixed with other tasks such as building maintenance, equipment modification, tool-making, etc. As a consequence, this variable was omitted from the data collection for most firms.

1.1.8. Inventory

An attempt was made to measure three types of inventory: raw materials, work-in-progress and finished goods, by whatever indicator was available from the firm's own records. This was usually an accounting measure in value, although sometimes physical stock measures were available. Only the work-in-progress measure turned out to be of any value. The available measures at the respective firms were as follows:

Firm	Work-in-Progress
R	% WIP Value/Sales
G	% WIP Value/Sales
C	% Kg WIP/Shots cast
K	% WIP Value/Output
J	% WIP Units/Output
O	% WIP Value/Sales

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E	% WIP Units/Output
S	% WIP Value/Sales
X	% WIP Value/Sales
Y	% WIP Value/Production Value
U	% WIP Units/Output
N	% WIP Value/Production Value

This indicator varied from firm to firm in its reliability. Where it was based on regular physical stock counts, it was reliable, while some accounting-based indicators were affected by book entries (such as stock returns for credit) that did not relate to production. In some cases, figures were not available on a monthly basis as stock counts were only conducted quarterly. Nevertheless, it served a purpose as a broad measure of inventory levels over the 3-year data collection period.

1.1.9. Sales and Output

The following measures were used to record sales and output at the respective firms: (*Note that where necessary Rand values were discounted to March 2000 against the relevant price increases for each firm.*)

Firm	Sales	Output
R	Sales in 2000 R	Units Produced
G	Sales in 2000 R	Units Produced
C		Total Castings per month
K		Production Value in 2000 R'000
J		Units Produced
O	Sales in 2000 R'000	Production Value in 2000 R'000
E	Sales in 2000 R	Units Produced
S	Sales in 2000 R	
X	Sales in 2000 R	

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Y		Production Value in 2000 R
U		Units Produced
N		Production Value in 2000 R

Two measurement difficulties were encountered with sales and/or output measures, the first being that, in some firms, it was not possible to obtain figures relating to the business unit where the research was being conducted. The other related to getting physical output data, the preferred measure of output. In some cases, this was due to difficulty in counting high volumes of small parts or where there was no standard unit of physical output. Where necessary, the discounted sales figure for the business unit was used as a measure.

1.1.10. Performance Outcomes

1.6.1.19. Productivity

Productivity figures were collected directly from firm data or constructed from sales or output figures against baseline data such as number of employees or hours worked. The more reliable measures that were used as the preferred measures for analysis of quantitative data are in the Productivity 1 column.

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Firm	Productivity 1	Productivity 2
R	Units Produced/Hours Worked	% Manufacturing Wages/Sales
G	Units Produced/Hours Worked	% Factory Efficiency
C	Units Produced/Hours Worked	
K	Output Value 2000 R/Hours Worked	
J	Units Produced/Hours Worked	% Factory Efficiency[1]
O	Output Value 2000 R/Hours Worked	% Std Hrs Prod/Direct Hrs Worked
E	Units Produced/Hours Worked	
S	Sales 2000 R/Hours Worked	
X	Sales 2000 R/Hours Worked	

Y	Output Value 2000 R/Hours Worked	
U	% Factory Efficiency	Units Produced/Hour Worked
N	Output Value 2000 R/Hours Worked	% Factory Efficiency

[1] Not reliable due to impact of increased downtime recorded in last year on available hours.

On the whole, there were few measurement difficulties with productivity measures, possibly because productivity is the one measure that managements are most interested in.

1.6.1.20. Quality

Quality data were also collected from measures in use at the firms. A variety of measures were used, depending on the circumstances at the firm. The more reliable measures that were used as the preferred measures for analysis of quantitative data are shown in the Quality 1 column.

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Firm	Quality 1	Quality 2
R		Customer Queries[6]
G	% Defects/Units Produced	% Rejects/Units Produced[2]
C	% Zinc Rejects/ Castings Produced	% Aluminium Rejects/Castings Pr'd
K	Internal Failures ppm	Field Failures ppm
J	% Defects/Units Packed	
O	Toyota External ppm	Toyota Internal ppm
E		% Defects/Units Produced[3]
S		% Rework/Inspected Units[1]
X		Customer Complaints
Y	External ppm[4]	Internal ppm[5]
U	Internal Defects	
N	Rejects at Customer ppm	% Cost of Non-Quality

[1] Not reliable data due to inconsistent sampling methods used by new quality staff.

[2] Not reliable data due to varying criteria for classifying units as reject.

[3] Not reliable because data not recorded accurately and short data series.

[4] Highly variable data due to mixture of high volume small parts with low volume big products in one measure.

[5] Note outlier in October 2002.

[6] Not all queries were related to product quality.

As is evident from the number of table notes, there were a number of measurement difficulties with quality indicators. In some cases, direct product or process data were not being recorded. Where possible, proxy measures, such as customer complaints, were collected. Where my investigations resulted in suspicions about the reliability of the data, I traced the source data and, in some cases, compiled the quality indicators from raw source material. However, in a number of cases, it was not possible to collect data as source measures were not available, and some of the quality data series are missing data for extended periods.

It also became apparent that some employees charged with compiling quality data were lacking in skills such as

- maintaining discipline with data capture,
- sampling procedures,
- quality calculations,
- data manipulation in Excel.

Unfortunately, the above considerations make the quality data of limited use.

1.6.1.21. Time-based Performance Measures

Few firms collected this data as measures such as throughput time, lead time and cycle time required a special effort to measure. Therefore, these measures were collected only for supplementary purposes.

Firm	Other Performance Measure
R	

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Firm	Other Performance Measure
G	
C	
K	
J	
O	% Orders Delivered on Time
E	% Late Delivery/Units Produced
S	% Consumable Cost/Sales
X	% Jobs Overdue
Y	% Outstanding Orders/Prod'n Value
U	
N	% On-time Delivery

No particular measurement difficulties were encountered where the data were available.

1.6.1.22. Absenteeism

Almost all firms had good quality absenteeism data as it usually had a direct impact on wages paid. A wide variety of measures were in use.

Firm	Absenteeism
R	% Days Absent/Days Worked
G	% Hours Sick Leave Paid/Worked Hours
C	% Sick & Compassionate Leave Hours/Hours Worked
K	% Hours Absent w/o Leave/Required Hours
J	% Absenteeism
O	% Non-Chronic Absenteeism

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Firm	Absenteeism
E	
S	% Number of Absentee Days/Work Days pm
X	% (AWOL+Sick+Suspended Days)/Total Days Worked
Y	% Absenteeism
U	% Absenteeism[1]
N	Unplanned Hours Absent/Actual Work Hours

[1] Initially recorded general absenteeism then changed to machinist absenteeism, because firm changed the way it measured absenteeism. However the overlapping period shows two measures are consistent.

No particular difficulties were experienced with gathering the absenteeism data.

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Appendix 3.2: Workplace Challenge Interview Transcriptions Log

Notes:

- The tape numbering is out of sequence between tapes 10 to 13 because some interviews were inadvertently taped over after transcription (marked T/O).
- Some interviews with firms that were excluded from the research are not included in this log.
- Firm CD is a consultancy that helped design and implement the TBWO programmes at several participating firms.
- Interviewees are identified by initials only to preserve confidentiality.

Tape No	Date	Firm	Interviewee	Position
1a/b	30-Oct-00	E	KA	Owner/Manager
2a/b	31-Oct-00	O	YN	Training Officer
3a	1-Nov-00	K	AE	HR Manager
3b	2-Nov-00	R	BN	Owner/Manager
3b	14-Nov-00	X	AV	Managing Director
5a	23-Nov-00	C	CW	Quality Manager
5b	14-Feb-01	X	AV	Managing Director
6a/b	16-Feb-01	N	EA	Production Director
7a	5-Mar-01	O	YN	Training Officer
7b	6-Mar-01	R	BN	Owner/Manager
8a	7-Mar-01	E	KA	Owner/Manager
9a/b	9-Mar-01	Y	JV	Managing Director
10a	12-Mar-01	G	RS	Production Manager
10b	12-Mar-01	K	AE	HR Manager
13b	13-Mar-01	Y	BA	Production Director
T/O	14-Mar-01	C	CW	Quality Manager
11a	23-Mar-01	J	SS	Work-study Officer
12a	10-May-01	U	DH & HS	Product'n Manager & Ass
12b	18-May-01	J	SS	Work-study Officer
13a	6-Sep-01	X	AV	Managing Director
14a/b	13-Sep-01	E	KA	Owner/Manager
15a	14-Sep-01	Y	GJ	Production Manager

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Tape No	Date	Firm	Interviewee	Position
15a	14-Sep-01	Y	JV	Managing Director
15b/16a	17-Sep-01	G	RS	Production Manager
16a/b	18-Sep-01	Y	BA	Production Director
16b	19-Sep-01	R	BN	Owner/Manager
16b/17a	19-Sep-01	C	AT	Production Manager
17a	20-Sep-01	O	NS	HR Director
17b	21-Sep-01	K	LB	Production Manager
17b/18a	12-Feb-02	N	EA	Production Director
18a/b	13-Feb-02	X	AV	Managing Director
18b/19a	19-Feb-02	U	DH	Production Director
19a	4-Mar-02	C	DS	Managing Director
19a	5-Mar-02	E	YA	General Manager
19a	6-Mar-02	C	GW	Managing Director
19a	6-Mar-02	R	BN	Owner/Manager
19a/b	6-Mar-02	Y	GJ	Production Manager
19b/20a	7-Mar-02	Y	BA	Production Director
20a	8-Mar-02	O	NS	HR Director
20a/b	11-Mar-02	G	PS	Production Manager
20b	12-Mar-02	K	AE	HR Manager
20b/21a	13-Mar-02	Y	JV	Managing Director
21a	22-Apr-02	E	YA	General Manager
21b	24-Apr-02	Y	RR	Managing Director
21b/22a	24-May-02	J	WW	Production Manager
22a	24-May-02	J	SS	Work-study Officer
22b/23a	20-Jun-02	J	WS	Managing Director
23a	8-Jul-02	R	BN	Owner/Manager
23a	8-Jul-02	C	JS	Production Supervisor
23b	9-Jul-02	G	AS	Production Manager
23b/24a	10-Jul-02	Y	BA	Production Director
24a	11-Jul-02	O	RK	Quality Manager
24a	11-Jul-02	O	MS	Quality Assurance

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Tape No	Date	Firm	Interviewee	Position
24a	11-Jul-02	O	NS	HR Director
24b	12-Jul-02	C	DS	Managing Director
24b	12-Jul-02	Y	JV	Managing Director
24b/25a	16-Jul-02	C	GW	Managing Director
25a	16-Jul-02	CD	DF	Consultant
25b	18-Jul-02	X	BS	Production Director
25b/26a	5-Aug-02	N	EA	Production Director
26a/26b	4-Sep-02	U	DH	Production Manager
26b	4-Sep-02	J	WW	Production Manager
27a	7-Feb-03	Y	JV	Managing Director
27a/b	8-Feb-03	Y	GJ	Production Manager
27b	17-Feb-03	C	JS	Production Supervisor
27b	17-Feb-03	C	GW	Managing Director
27b/28a	18-Feb-03	G	PN	Production Supervisor
28a	18-Mar-03	Y	JB	Production Manager
28a	20-Feb-03	K	BS	Quality Manager
28a	21-Feb-03	O	JC & C	Lean Manager & Assist.
28b	21-Feb-03	O	NS	HR Director
28b	21-Feb-02	O	RK	Quality Manager
28b/29a/b	27-Feb-03	U	MS	HR Manager
29b/30a	25-Mar-03	N	EA	Production Director
30a	15-Apr-03	X	AV	Managing Director
30a/b	17-Apr-03	J	WW	Production Manager
30b	30-Apr-03	U	DH	Production Manager
31a	28-May-03	U	MS	Financial Director
31a	28-May-03	U	DH	Production Manager

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Appendix 3.3: Construction of HR, WC, CI Bundle Indexes

The variables used and transformations made in the calculation of the HR, WC and CI indices in SPSS were as follow:

Sub-variable	Values	Max	Variable Construction
HRStrctChg	y=2, s=1, n=0	12	StCm+StfFcl+EmpEq+Incntv+Rtrnch+Visit
ComHr	Actual hours	6.70%	HrCom/(NrmlHr+OTHr)
ComPrct	y=2, s=1, n=0	14	EmpBrf+Indaba[1]+AdrIss+Forum+MtMin+VisVal+Nwslt
TrgHr	Actual hours	11.46%	(JobSkill+TmWrk+CITrg+ChgOrtn+Qlty+OthRel)/(NrmlHr+OTHr)
EmplTrg	No of employees	100%	EmpTrg/(Indrct+Direct)
HRTrgPrc	Actual hours	100%	(TmWrk+ChgOrtn)/(JobSkill+TmWrk+CITrg+ChgOrtn+Qlty)
EmplTm	No of employees	100%	EmpTm/(Indrct+Direct)
TmHr	Actual hours	9.67%	(ShftTm+CrsFnc+CITm+Safety)/(NrmlHr+OTHr)
FclPrstn	y=2, s=1, n=0	4	ExtFac+TmPrsn
TmCI	y=2, s=1, n=0	4	Team+TmLdr-Staff-Mgt
HR Index			**Average of sub-variable Z-scores over the period of the research**
WCStrctChg	y=2, s=1, n=0	4	Cells+SmlBat
WCTrgPrc	Actual hours	100%	(JobSkill+Qlty)/(JobSkill+TmWrk+CITrg+ChgOrtn+Qlty)
WCTm	Actual hours	100%	(ShftTm+CrsFnc+Safety)/(ShftTm+CrsFnc+CITm+Safety)
Method	Percentage	100%	Method
WCMthPRc	y=2, s=1, n=0	4	VisMgt+WstelD
BOP	Percentage	100%	BOP
WCBOPPrc	y=2, s=1, n=0	12	Hskp+Docs+Tools+Fdbck+Updte+TrgCrt
WC Index			**Average of sub-variable Z-scores over the period of the research**
CITrgSC	Actual hours	100%	CITrg/(JobSkill+TmWrk+CITrg+ChgOrtn+Qlty)
CITmSC	Actual hours	100%	CITm/(ShftTm+CrsFnc+CITm+Safety)
CIPrc	y=2, s=1, n=0	8	CIFcs+PrbSlv+RsrcAvl+TmAuth
CI Index			**Average of sub-variable Z-scores over the period of the research**

[1] *Indaba* is an African word for consultative meeting.

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The indexes calculated are in the SPSS file WPC Data 1d PracPerf Indexes.sav, with the monthly firm data captured in the following order and case numbers:

No	Firm	Cases	No	Firm	Cases
1	Firm S	1-36	7	Firm C	241-276
2	Firm X	37-72	8	Firm K	277-312
3	Firm N	73-108	9	Firm J	313-348
4	Firm O	109-144	10	Firm Y	349-384
5	Firm U	145-216	11	Firm R	385-420
6	Firm E	217-240	12	Firm G	421-456

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Appendix 3.4: Standardization of Dependent Variables

This appendix lists productivity measures used as the dependent variable in the correlation analysis, as described in section 3.4.3. They were standardised by dividing the monthly values by the base value as shown below.

Firm	Productivity Measure	Index Base Value	Why index base value chosen
R	Units Produced/Hours Worked	0.41	1st period value
G	Units Produced/Hours Worked	0.62	1st period value
C	Units Produced/Hours Worked	6.71	1st period value
K	Output Value 2000 R/Hours Worked	R389.09	1st period value
J	Units Produced/Hours Worked	4.64	1st series value
O	Output Value 2000 R/Hours Worked	R64.65	1st period value
E	Units Produced/Hours Worked	0.92	1st period value
S	Sales 2000 R/Hours Worked	R134.69	1st period value
X	Sales 2000 R/Hours Worked	R129.98	1st period value
Y	Output Value 2000 R/Hours Worked	R75.33	1st period value
U	% Factory Efficiency	52.5%	1st period value
N	Output Value 2000 R/Hours Worked	R60.16	1st period value

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Appendix 3.5

WORKPLACE CHALLENGE FIRM MONTHLY REPORT

This is the form for use by firms participating in the Workplace Challenge (WPC) to report on structural changes and measures of practices and performance as explained on the next page. If you would like to know more about why this new way of reporting monthly performance measures has been implemented please contact Anton Grütter (Cell 082 202 3153 or Email: agrutter@uwc.ac.za).

Please follow the instructions and explanations to complete it and fax it to Anton Grütter at (021) 447 2750 as soon as possible, but not later than the 15th of every month. The form has been designed to be taken apart so that only those pages where information has been entered need to be faxed.

There are no right or wrong answers to this report. Every firm's circumstances are different and therefore they will do some things that other firms do not do as part of their Workplace Challenge initiative. All that is required is to report the situation at your firm as it actually happened during the month that you are reporting for.

Every effort has been made to make it as easy and quick as possible to complete the report and to gather enough information for meaningful conclusions to be drawn from the data. The **accuracy of the information** submitted is important, so it would be preferable to respond on basis of actual information collected. However we appreciate that recorded information will not always be readily available. A **well-informed estimate** will be acceptable provided the information is **not misleading**. (Please add a question mark after a bit of information where it is more of a guess than an estimate.)

For the purpose of this report a **participating firm** is taken to be a manufacturing facility that is managed as one unit or geographically separate entity, e.g. an entire firm, one plant of a company, a division of a corporation, etc.

The information for this report is **limited to the month that is being reported on.** (For instance when reporting the total hours of training all the hours of training received by each trainee in a particular month should be added up.)

Some firms have participated in the WPC before the new monthly reporting system came into effect. A **separate survey of activities from before the new reporting system** will be undertaken as soon as possible.

Although some measures may remain the same for your firm from month to month, it is still important information as it is the changes (or stability) of measures over time that are of interest to the researchers. Similarly, the activities that your firm is not undertaking are as important to the research as the activities that are undertaken. So please enter a nil response where appropriate.

Firm specific information provided for the monthly report will be treated as confidential.

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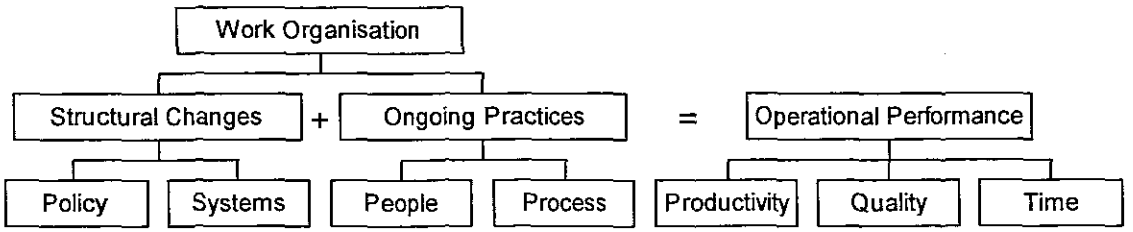
Please use a black or blue pen & write clearly so we can read the fax.

RESEARCH MODEL

The model of work organisation underpinning the data collection is that *structural changes* together with *ongoing practices* have an impact on *operational performance* over time, as depicted below:



The monthly report makes provision for any structural changes to be included in your report, whereas for ongoing practices and operational performance information is collected on particular practices and performance variables.

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Structural Changes
Structural changes can be broadly described as any organisational change that is a step-change or a break with the past which is likely to remain in place for the foreseeable future. (In some instances there may be some overlap with practices.)

For example, when a decision is taken at a firm to change the job grading system, or to implement teamwork, or to give training on how to problem-solve to everyone on the shopfloor that would qualify as a structural change. In terms of the manufacturing process things like changing the layout of the plant, outsourcing certain functions, introducing visual displays of plant performance would also be examples of structural changes. In short any change in organisational policy or systems would be considered a structural change.

Please report what structural changes your firm has decided to undertake and the degree of compliance or implementation every month thereafter. So if in January it was decided to change the grading system, but it only came into effect in June then 0% implementation should be reported for the months of February till May. Thereafter an estimate of the % of the workforce subject to the new grading system should be reported. The degree of implementation or compliance of other structural changes should also be reported as a % of an appropriate completion standard.

C2a	Name of Change:	Give the change being reported a name for future reference.
C2b	No of Change:	Give the change being reported a consecutive number for future reference. Start with 1 for the first change that you report.
C2c	% Implementation: or Compliance	Estimate to what extent has the change been implemented or complied with in the month being reported for.

It is important to note that it *is entirely up to the firm as to what structural changes they implement*. However anything that could possibly have an impact on work organisation should be reported. If in doubt rather report it.

Please use a black or blue pen & write clearly so we can read the fax.

General Information:

C1a. Firm Name: .....

C1b. Your Name: .....

C1c. Period of Report: Month: ..... Year: .....

FIRM MONTHLY REPORT ON STRUCTURAL CHANGES

Structural Changes in this Month

C2a. Name of Change: .....

C2b. No of Change: ..... C2c. Implementation/Compliance .....%

C2d. Description of Change (Need only to report when change first decided on):

.....

.....

.....

.....

C3a. Name of Change: .....

C3b. No of Change: ..... C3c. Implementation/Compliance .....%

C3d. Description of Change (Need only to report when change first decided on):

.....

.....

.....

.....

Structural Changes already reported in previous Months:

C4a. Name of Change: .....

C4b. No of Change: ..... C4c. % Implementation/Compliance .....%

C5a. Name of Change: .....

C5b. No of Change: ..... C5c. % Implementation/Compliance .....%

C6a. Name of Change: .....

C6b. No of Change: ..... C6c. % Implementation/Compliance .....%

C7a. Name of Change: .....

C7b. No of Change: ..... C7c. % Implementation/Compliance .....%

C8a. Name of Change: .....

C8b. No of Change: ..... C8c. % Implementation/Compliance .....%

If more changes need to be reported please use additional pages.

Please fax this page back to Anton Grütter at (021) 447 2750 asap.

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Please use a black or blue pen & write clearly so we can read the fax.

D1a List the main objectives of the WPC project at your firm.

D1b Briefly describe how the WPC project is being/will be implemented at your firm.

D2a **Shopfloor Employees** refers to people who "regularly touch the product or process" during the course of their duties. Therefore it includes people that some firms do not considered "direct" production employees, but who spend time on the shopfloor such as supervisors, packers, quality controllers, maintenance, schedulers, expediters, etc.

D2b The standard hours per week worked by an employee before overtime.

D2c The number of days actually worked in the month (excluding publ holidays, short time.)

D3 **Communication/Consultation** refers to efforts made to address employee concerns and to develop a favourable response to workplace change initiatives and is not normally directly related to production.

D3a The total hours of paid time **or** hours of off-site meetings paid for by the firm dedicated to communication or consultation efforts should be reported for this measure. To calculate total hours multiply the number of employees involved by the time taken.

D3b Communication/Consultation activities:

Employee Briefings:	Briefings to all employees by senior management during paid time.
Indaba/Bosberaad:	An off-site meeting between representatives and stakeholders.
Address Issues:	Commitment to address "burning issues".
Stakeholder Forum:	Stakeholder Representative Committee, Workplace Forum or similar high level consultative committee.
Minutes on Noticebds:	Minutes of stakeholder forum meetings are distributed to notice boards.
Vision/Value-sharing:	Efforts aimed at developing a common vision or understanding of cultural diversity amongst stakeholders.
Newsletter:	Regular internal newsletter to keep stakeholders informed.

D4 **Training:** Any time, paid or unpaid, when employees are released from normal duties for training, on-site or off-site should be included. Informal on-the-job training is not included in this report.

D4b To calculate total hours multiply the number of employees trained by the time taken.

D4c Type of Training:

Job Skills:	Training to improve or extend trainee's ability to perform their normal work.
Teamwork:	Inter-personal, communication, conflict management, team leadership or facilitation training.
Problem-solving:	Training in continuous improvement techniques such as run charts, pareto analysis, fishbone (cause and effect) diagrams, brainstorming, etc.
Change/Orientation:	Training in understanding workplace change, negotiation, cultural diversity, business orientation, change management, etc.

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FIRM MONTHLY REPORT OF PRACTICES & PERFORMANCE

D1. WPC Information

D1a. WPC Project Objectives: .....

.....

D1b. Describe Implementation: .....

.....

.....

D2a. Number of Shopfloor Employees: .....

D2b. Hours of Standard Working Week: .....

D2c. No of Working Days in Month: .....

PEOPLE PRACTICE MEASURES:

D3. Communication/Consultation

D3a. Hours of paid time for comm/consult'n: .....Hrs

D3b. Communication/Consultation activities:

(Circle your choice) Employee Briefings: Yes / No

Indaba/Bosberaad: Yes / No

Address Issues: Yes / No

Stakeholder Forum: Yes / No

Minutes on Noticebds: Yes / No

Vision/Value-sharing: Yes / No

Newsletter: Yes / No

Other: Yes / No

Explain Other: .....

D4. Training

D4a. No. of employees who received training: .....

D4b. Total hours of training: .....Hrs

D4c. Type of training: Job Skills: .....%

(estimate %) Teamwork: .....%

Problem-solving: .....%

Change/Orientation: .....%

Other: .....%

Total of Hrs above: 100 %

Explain Other: .....

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D5 **Teamwork** is normally characterised by some form of collective decision-making about production issues by the more or less the same group of people for a specific project or on an ongoing basis.

D5a Include all shopfloor employees that are a member of a team.

D5b To calculate total hours of teamwork multiply the number of employees involved in team meetings or activities by the *paid time dedicated to teamwork only.*

D5c Team Types:

Shift:	Permanent teams that are made up out of employees who normally work together. Sometimes known as natural work groups.
Cross-functional:	Teams that are made up of employees from different production departments, staff (eg. maintenance, engineering), scheduling, sales, etc. to improve co-ordination or undertake projects.
Improvement:	Teams that are put together specifically to make an improvement to the production process or work practices and that disband when their objective has been reached.
Safety:	Teams that focus on safety issues.

D5d Team meetings at the beginning of the shift/day refer to meetings mostly for co-ordinating normal activities and reviewing performance.

D5e Team meetings to make improvements refer to meetings dedicated exclusively to improving the production process or working practices.

D5f External facilitator refers to someone who is not a team member and who primarily tries to facilitate better teamwork.

D6 **Methods in use** refers to methods or techniques commonly associated with team-based work organisation. If another method with the same objective as described below is used place a tick next to the appropriate method.

D6b

Visual Management:	Information such as code of conduct, operating practices, performance measurement, photographs, etc. displayed in team meeting area.
Waste Identification:	Shopfloor employees understand the concept of creating value for the customer and continuously look for ways to eliminate waste.
Problem-solving:	Continuous improvement techniques such as run charts, pareto analysis, fishbone (cause and effect) diagrams, brainstorming, etc.
Team presentations:	Teams make presentations on their work, projects, etc. to fellow employees or management.
Resource availability:	Resources such as access to technical experts, availability of engineering or maintenance staff and budget for small changes are available and used by teams.

D7 **Implementation of Suggestions** refers to suggestions from shopfloor employees whether by way of suggestion schemes, from teams or any other way.

D7a Count only suggestions or recommendations from teams of which the implementation has been substantially completed in the month being reported.

D7c Team have authority to implement small suggestions refers to teams not needing to get permission to implement suggestions up to a pre-determined cost level.

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D5. Teamwork:

D5a.	No of employees in teams:		.....
D5b.	*Total hours of paid time in* teamwork:		.....Hrs
D5c.	Employees by team type: Shift:		.....%
	(estimate %)	Cross-functional:	.....%
		Improvement:	.....%
		Safety:	.....%
		Other:	.....%
		Total of Employees:	100 %

Explain Other: .....

D5d.	Do teams meet at beginning of shift/day?		Yes / No
D5e.	Do teams meet to make improvements?		Yes / No
D5f.	Do teams use external facilitators?		Yes / No

D6. Methods in use:

D6a.	% of teams *actively* using (some) methods:		.....%
D6b.	Methods used:	Visual Management:	Yes / No
	(Circle your choice)	Waste Identification:	Yes / No
		Problem-solving:	Yes / No
		Team Presentations:	Yes / No
		Resource availability:	Yes / No
		Other:	Yes / No

Explain Other: .....

D7. Implementation of Suggestions

D7a.	No of suggestions implemented in month:		.....
D7b.	Implementation responsibility/authorisation:		
	(Who drives impl.?)	Team as a whole:	Yes / No
		Team leader/Superv:	Yes / No
		Workshop/Staff:	Yes / No
		Management:	Yes / No
		Other:	Yes / No

Explain Other: .....

D7c.	Team have authority to do small suggestions	Yes / No

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D8a **Value-adding:** For this measure please break down the number of shopfloor employees reported in question D2a into "direct" (people who spend most of their work time actually producing) and "indirect" (people who spend most of their work time supporting production) employees. Please report the actual numbers, not the ratio.

D9 **Stock-holding:** Indicate units in which amount of stock-holding is reported or report Rand value consistently every month. Use any units of stock-holding as appropriate for your firm. If stocktaking is not done every month report an estimate for the months between stocktakes.

D10 **Maintenance:** Maintenance reported should include all types of maintenance. Where shopfloor employees are involved in autonomous maintenance an estimate of their time spent on maintenance should be included in the total reported.

D10a To calculate total hours multiply the number of employees involved in maintenance activities by the time taken.

D10b Type of Maintenance:

On Breakdown:	Equipment gets fixed when it breaks down.
Manufacturer's Spec:	Equipment is maintained according to manufacturer's specifications.
Planned:	Planned maintenance is done according to a maintenance schedule.
Preventative:	Preventative maintenance is done when required by condition monitoring.
Autonomous:	Shopfloor employees involved in monitoring equipment and undertaking simple regular maintenance.

D11 **Best Operating Practice** refers to working according to the current best known way to run production. Although the process may have been documented for the purpose of ISO 9000, BOP documentation primarily serves the purpose of promoting consistent best work practices.

D11a For this measure please estimate of the extent to which the work procedures of the production process have been documented.

D11b BOP in *active* use:

Housekeeping/5S:	Housekeeping or 5S practices are in active regular use.
BOP docs on shopfloor:	The operating procedure documentation is available to shopfloor employees in a format they can understand easily.
Tools/Jigs in place:	Storage place for tools and/or jigs in regular use have been designated near the appropriate workstation.
Daily feedback:	Performance feedback for each team/work area is made available on a regular basis.
System to update BOP:	System in place to update BOP documentation quickly.
BOP training/certificat:	Shopfloor employees are trained and/or certified according to latest BOP.

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PROCESS PRACTICE MEASURES:

D8. Value-adding

D8a. No of indirect/direct employees on shopfl. ...../.....

***D9.* Stock-holding** (at *month-end*)

D9a. Amount or value of raw materials: .....

D9b. Amount or value of work-in-progress: .....

D9c. Amount or value of finished goods: .....

D10. Maintenance

D10a. Total paid hours worked on maintenance: .....Hrs

D10b. Type of *maintenance*: On Breakdown: .....%

(estimate %) *Manufacturer's Spec*: .....%

Planned: .....%

Preventative: .....%

Autonomous: .....%

Other: .....%

Total of Hrs above: 100 %

Explain Other: .....

D11. Best Operating Practice

D11a. % of process documented for BOP: .....%

D11b. BOP in *active* use: Housekeeping/5S: Yes / No

(Circle your choice) BOP docs on shopfloor: Yes / No

Tools/Jigs in place: Yes / No

Daily feedback: Yes / No

System to update BOP: Yes / No

BOP training/certificat: Yes / No

Other: Yes / No

Explain Other: .....

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E1, 2 & 3 **Performance Measures**

In this section we ask that you report a measure of performance on a number of pre-determined variables. How to measure the performance with respect to the variables has been left to your discretion, as different measures will be appropriate for each firm. Provision has also been made for other measures to be reported if there are performance measures that are more appropriate to your business than those that have been suggested in the table below. Please try to provide information for as many variables as possible.

Below are listed examples of measures that you can choose from to report for each variable or you can use your own measure. Please indicate what unit of measure you are using in the space provided and ensure that a brief description of how you calculated the measure is reported for each measure.

Productivity Performance:

Variables	**Measures** (choose one per variable or use your own measure)
Output	Actual output/budgeted output.
Labour Productivity	Good product output/labour input.
Downtime	Number unscheduled stoppages or % downtime.
Factory Efficiency	Overall equipment efficiency or % capacity utilisation.
Yield	Good product output/raw material input.

Quality Performance:

Variables	**Measures** (choose one per variable or use your own measure)
Product Rejects	Number/Volume of finished products not shipped to customer
Product Defects	Rework rate.
Customer Satisfact'n	Number of complaints, Number of returns.

Time-based Performance:

Variables	**Measures** (choose one per variable or use your own measure)
Cycle Time	Length of cycle or Designed cycle time/Actual cycle time.
Throughput Time	Average throughput time of representative products.
Delivery	% On-time deliveries, Avg. age of outstanding jobs.

E3a Cycle Time is the time from starting an activity at a workstation on a unit of production until the start of the same activity on the next unit of production.

E3b Throughput Time is the time from starting production on a particular unit of production until the production of that unit is complete.

Thanks very much for the time and effort taken to do this report.

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PERFORMANCE MEASURES:

E1.	**Productivity**		(Units)
E1a.	Output:	.....	.....
	How calculated:		
E1b.	Labour Productivity:	.....	.....
	How calculated:		
E1c.	Downtime:	.....	.....
	How calculated:		
E1d.	Factory Efficiency:	.....	.....
	How calculated:		
E1e.	Yield:	.....	.....
	How calculated:		
E1f.	Other:	.....	.....
	How calculated:		
E2.	**Quality**		(Units)
E2a.	Product Rejects:	.....	.....
	How calculated:		
E2b.	Product Defects:	.....	.....
	How calculated:		
E2c.	Customer Satisfaction:	.....	.....
	How calculated:		
E2d.	Other:	.....	.....
	How calculated:		
E3.	**Time-based Performance**		(Units)
E3a.	Cycle Time:	.....	.....
	How calculated:		
E3b.	Throughput Time:	.....	.....
	How calculated:		
E3c.	Delivery:	.....	.....
	How calculated:		
E3d.	Other:	.....	.....
	How calculated:		

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Appendix 4.1: Firm R Case

Background

Firm R was a manufacturer of "case" furniture products, mostly wardrobes and other types of "wall units". Case furniture is produced primarily from flat composite boards like chipboard or medium-density fibreboard (MDF), which has a laminated or spray-painted finish. The factory occupied premises in a well-established industrial area near Durban and had an open-plan layout with production moving around the factory in single circular flow. Apart from offices, there was a sales display area, as well as a product development area, which was separated from the production floor.

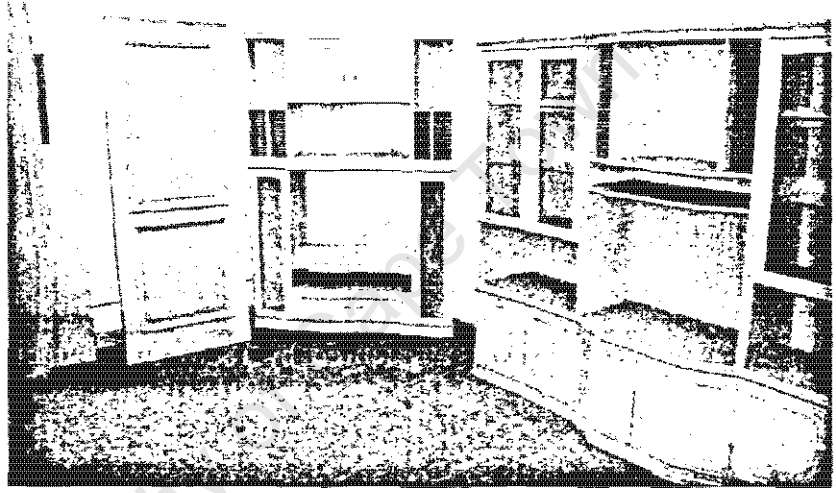

Figure 1: Typical Products of Firm R

The average nominal monthly sales of Firm R, over the research period, was R2.1m p.a. and the average employment was 66 employees. The firm was started in 1998, about 2 years prior to this research, by management and shop floor employees who had been retrenched by one of the dominant firms in the South African furniture manufacturing industry. Initially, all employees owned shares in the firm, but in the middle of 1999, most shop floor employees sold their shares to the firm's management.

Firm Profile

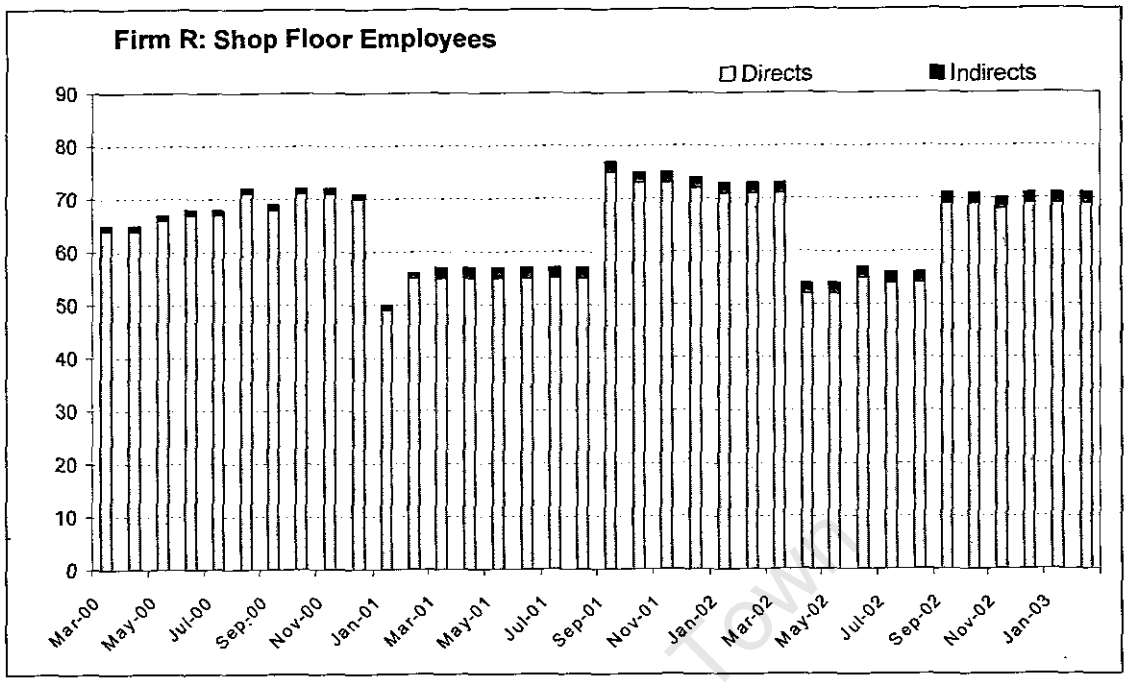

Figure 2: Firm R Shop Floor Employees (Excluding Management)

Employment at Firm R fluctuated with seasonal demand. A core of about 55 permanent employees was augmented by 18 to 20 contract employees from about September each year until after the Christmas demand had been met.

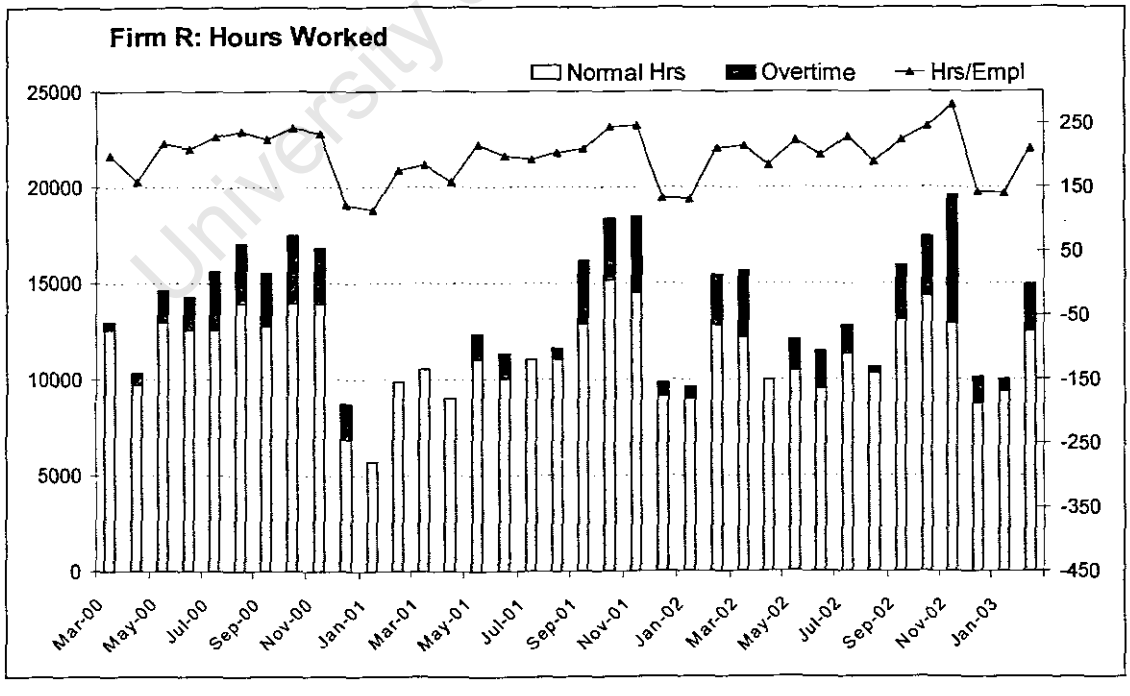

Figure 3: Firm R Hours Worked

The hours worked at Firm R also fluctuated seasonally. An issue in the minds of management when they started the WPC was whether to work more overtime or to

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run a second shift, and the WPC consultant they engaged in May 2000 was a work-study expert, who advised them that their existing arrangements with respect to shift arrangements was correct (Interview R001102B, p. 1).

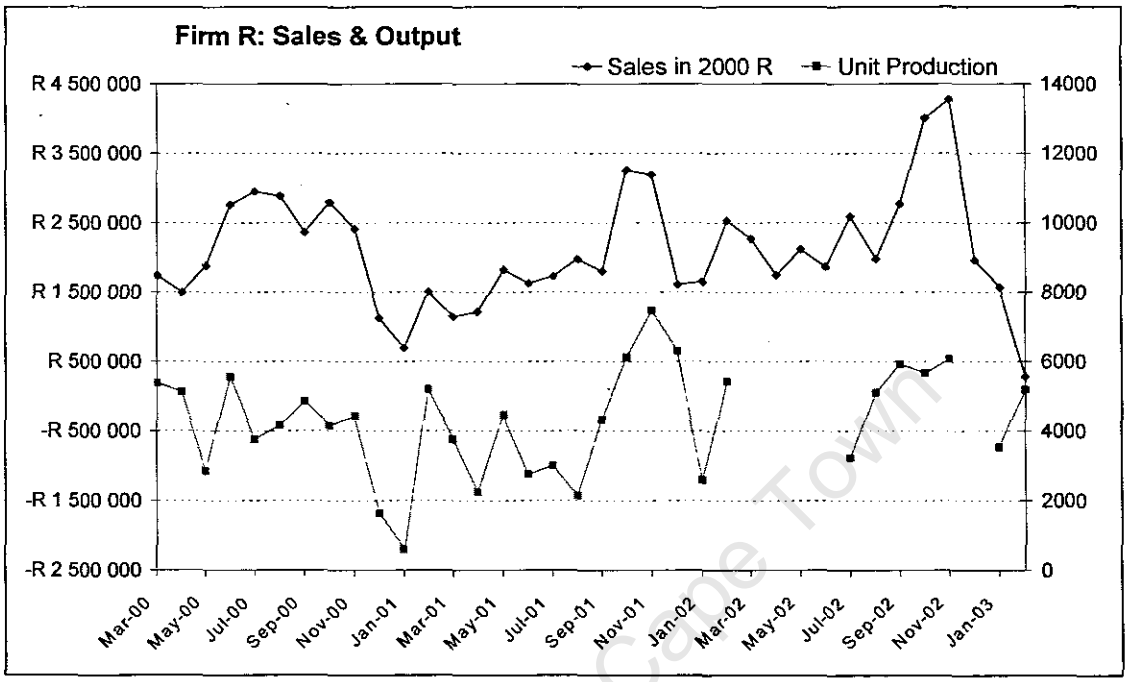

Figure 4: Firm R Sales (Discounted Against Firm's Price Increases to Rand in 2000)

While the market for furniture was generally very tough, Firm R did relatively well with a strategy to produce higher value wall units for a niche market. When sales turned down in 2001, it produced lower margin bedroom furniture to fill capacity until the end-of-year Christmas demand started (Interview R010919B, p. 1).

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Implementation of TBWO Programme

The management of Firm R thought "it was a good idea to go along with the WPC" (Interview R001102B, p. 1) and had representative steering committee meetings until the consultant was appointed (Interview R010306B, p. 1). However, they were more interested in technical productivity analysis rather than changing the traditional approach to work organisation and management style at the firm. The firm's managing director said, "There's [the production manager] and the supervisors and the machinists and the labourers; it is basically one team" (Interview R010306B, p. 4).

The employees who joined the firm after being retrenched had an average cross-section of skills but had a better work ethic than average. Although workplace relations were reported to be good, it was clear that the production manager ran a disciplined operation. Even though the workforce was unionised, employees were made to understand that they had to "fit in or go away" (Interview R020708B, p. 4).

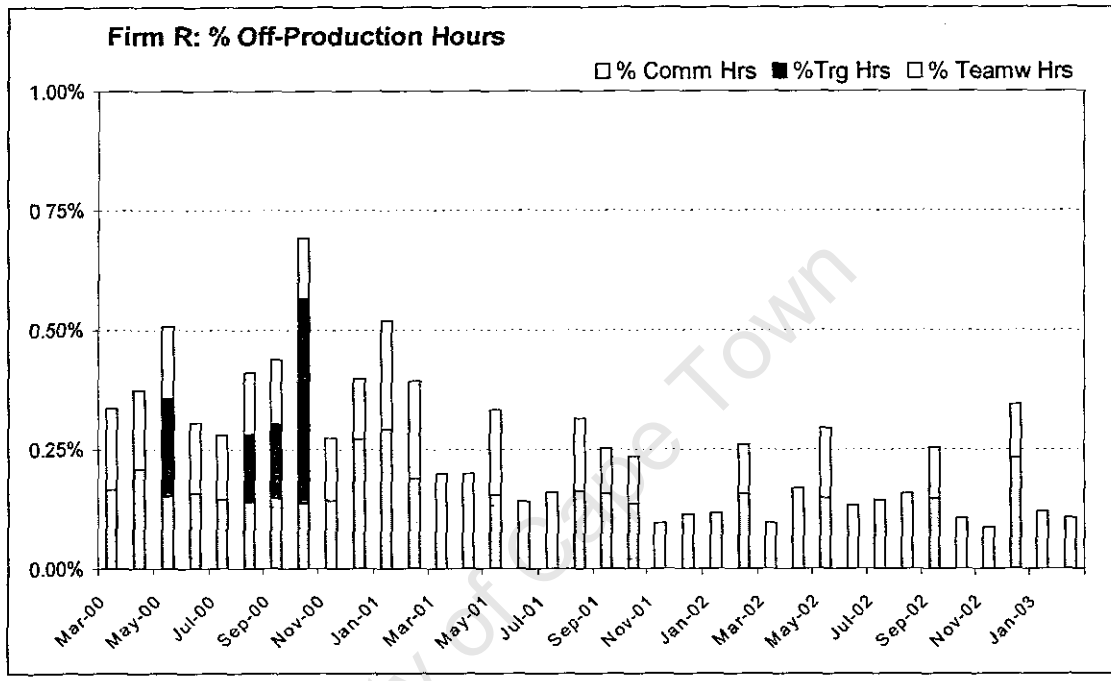

Figure 5: Firm R Hours off Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked.

Figure 5 shows that the percentage time off production in support of TBWO activities was low. Some training took place during the orientation phase of the WPC, but nothing further was offered. There were short monthly meetings with the entire workforce in 2000, but these became less regular thereafter. The time spent on teamwork was solely when the supervisors had a daily production meeting with the production manager as the other shop floor employees were not organised to work in teams.

Whereas all the other firms researched made at least some structural changes, no such changes were made at Firm R (Therefore the figure to show the extent of structural changes for Firm R is omitted.). Figure 6 shows there were relatively high amounts of WIP on the shop floor as no batch-size reduction was implemented. There was also no cellular layout, team meeting area or shop floor recording of performance. It must be

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said that the production process was not particularly complicated and the factory was relatively small, and therefore, it could be argued that TBWO was superfluous.

Figure 6: Firm R Shop Floor

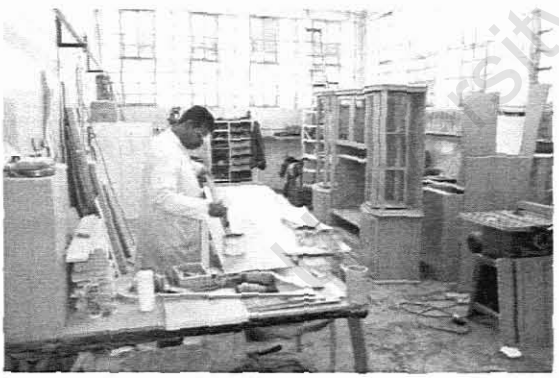

Figure 7: Product Development

Figure 8: Assembly of Wall Units

Performance Outcome Trends

These graphs report the intermediate (WIP & absenteeism) and operational (productivity and quality) performance outcomes at Firm R over the research period.

Figure 9 below reports WIP as a percentage of sales, and it shows that WIP remained at more or less the same level for most of the research period. The data for February 2003 is anomalous in that the value for WIP was almost exactly the same as the

average over the period during which sales for the month were about 15% of the average. These figures are based on accounting values and therefore may not be an exact reflection of the actual operation situation.

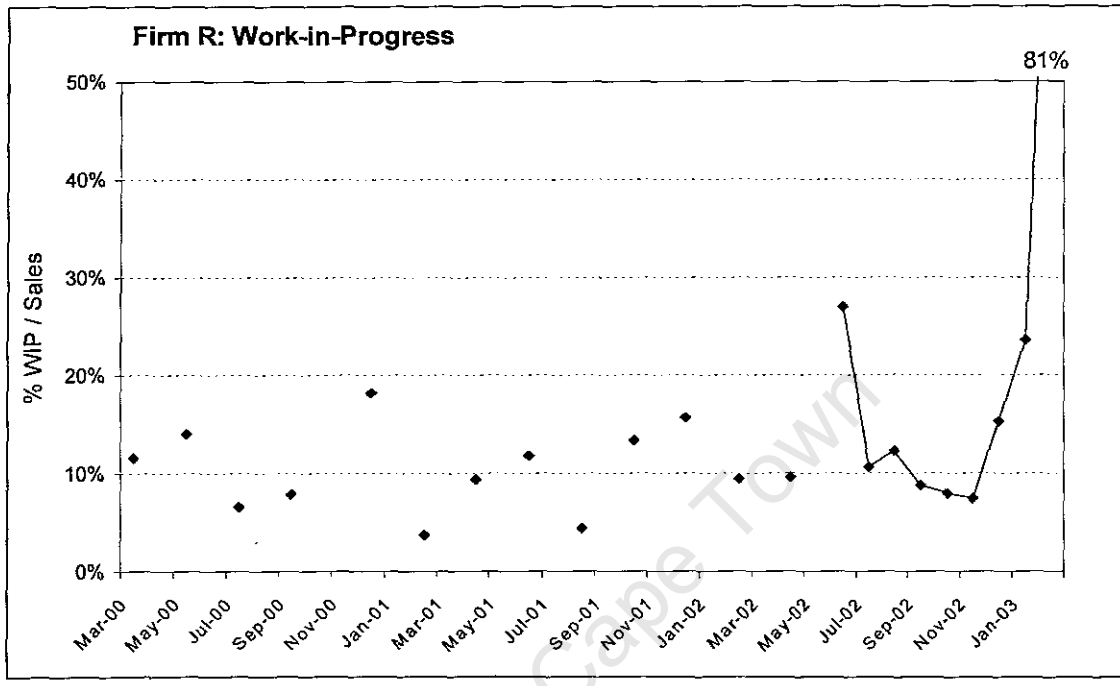

Figure 9: Firm R Work-in-Progress as a Percentage of Sales

The absenteeism at Firm R was 2.65% on average and, as shown in Figure 10, it remained at more or less the same level throughout the research period.

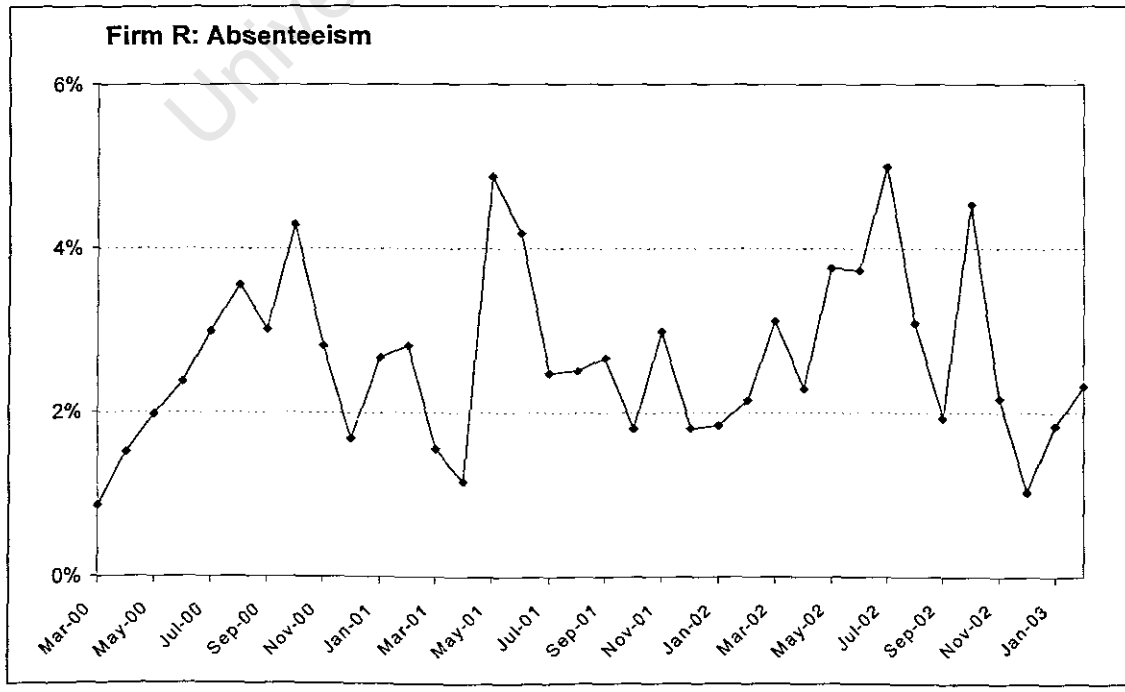

Figure 10: Firm R Absenteeism

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Productivity at Firm R improved slightly, as shown in Figure 11. While both measures were not perfect in that the production manager seemed to use a rule-of-thumb rather than a rigorous definition to standardise the units of production, and manufacturing wages as a percentage of sales was an accounting measure subject to influence by non-operational factors, the fact that the measures showed consistent improving trends allows some degree of confidence in these findings. Productivity performance for Firm R is classified as a "slight improvement" in Appendix 4.13.

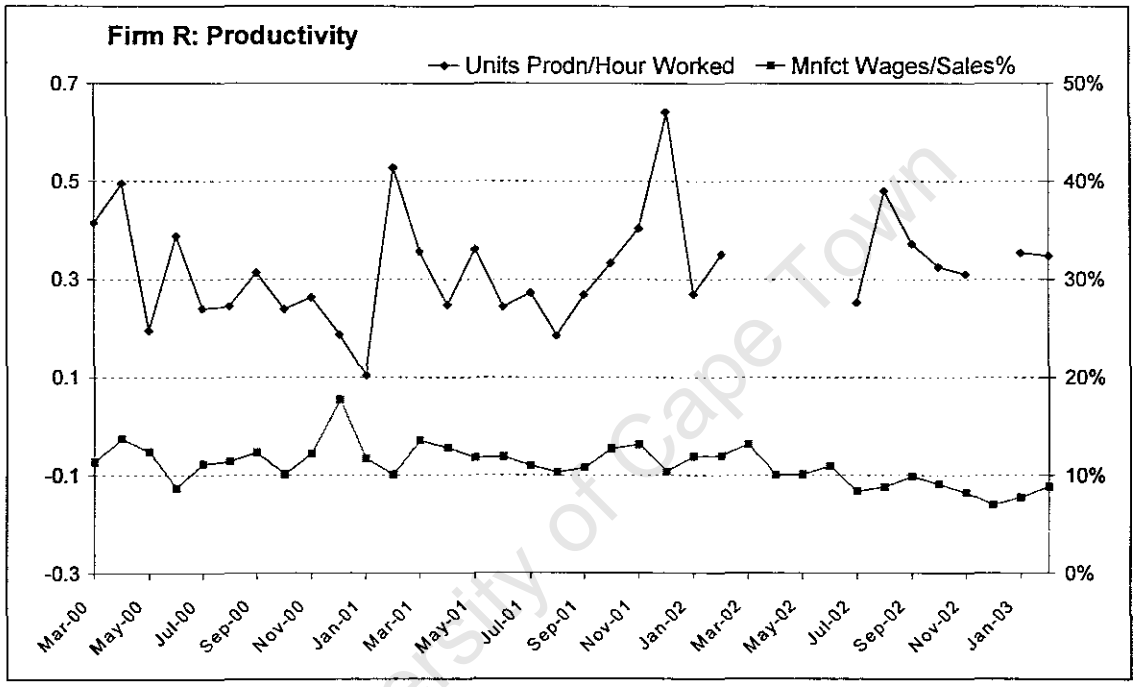

Figure 11: Firm R Productivity

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Unfortunately, there was no specific operational quality data available at Firm R. The production manager claimed that it produced no defective items and therefore measuring quality was unnecessary. Management did keep a record of customer queries, but these queries were not all related to production defects. Using customer queries as a proxy measure, there appears to be no change in the quality performance of the firm and therefore quality performance is reported as "level" in Appendix 4.13.

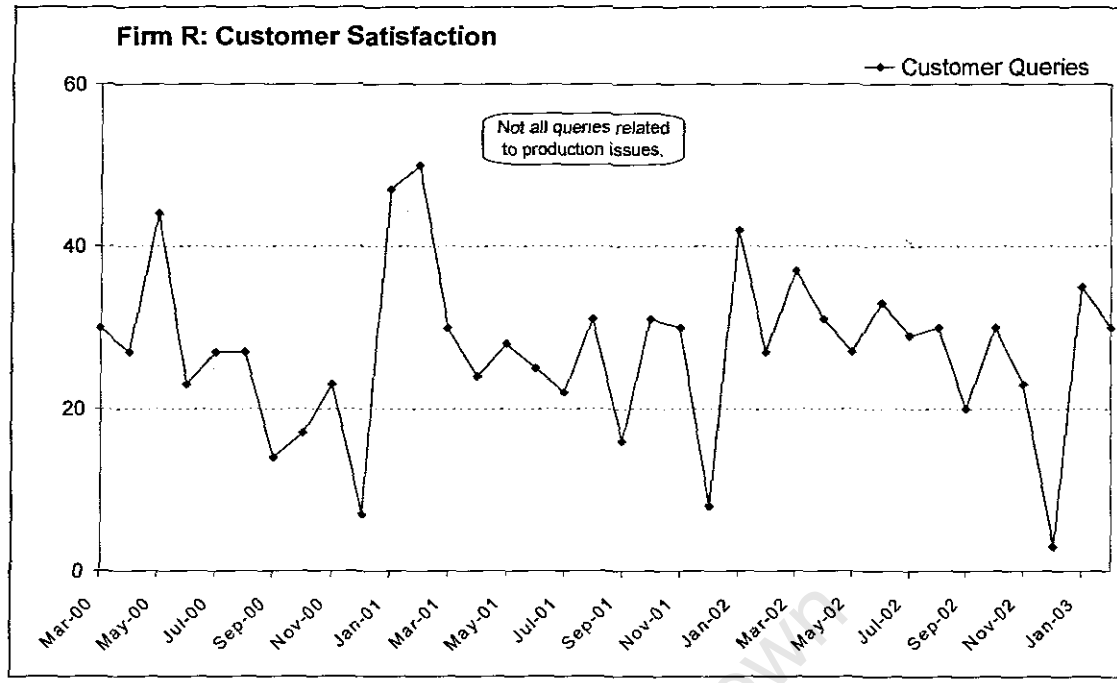

Figure 12: Firm R Quality

Summary and Interpretation of Case Findings

Firm R did virtually nothing to implement the practices associated with TBWO. At 0.26%, the time off production in support of TBWO activities was the lowest of all the firms researched. It was a conscious management decision not to implement a TBWO initiative, based on the belief that their operation was running well and that workplace relations were sound, albeit based on a traditional hierarchical work organisation. This may have been the correct strategic decision for the firm as the relatively small operation was closely controlled by a hands-on production manager who could address operational issues fairly easily and quickly, and therefore the benefit to be had from the significant efforts involved in implementing TBWO may not have been worth the investment.

The slight productivity improvement, despite TBWO not having been implemented at Firm R, may be explained by better capacity utilisation, as the firm's sales and output improved over the research period, and a learning curve effect, as the firm had started operating only 2 years before the research took place. A tentative conclusion that Firm R's quality performance remained at the same level can be made on the basis of the available information.

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Appendix 4.2: Firm G Case

Background

Firm G was a shoe manufacturer in Pietermaritzburg, a town outside Durban in KwaZulu-Natal. It is a region with severe unemployment, particularly in the footwear industry, which was adversely affected throughout the time of the research by the depreciation of the local currency, leading to competition from importation of much cheaper shoes from the Far East and India. The average number of shop floor employees at the firm over the research period was 141 and the firm's average monthly value of production was R1,241m. The firm was run by owner-managers who had an accounting background and were not directly involved in the day-to-day operations of the firm.

Firm Profile

The following graphs provide an indication of how the firm's profile changed over the research period.

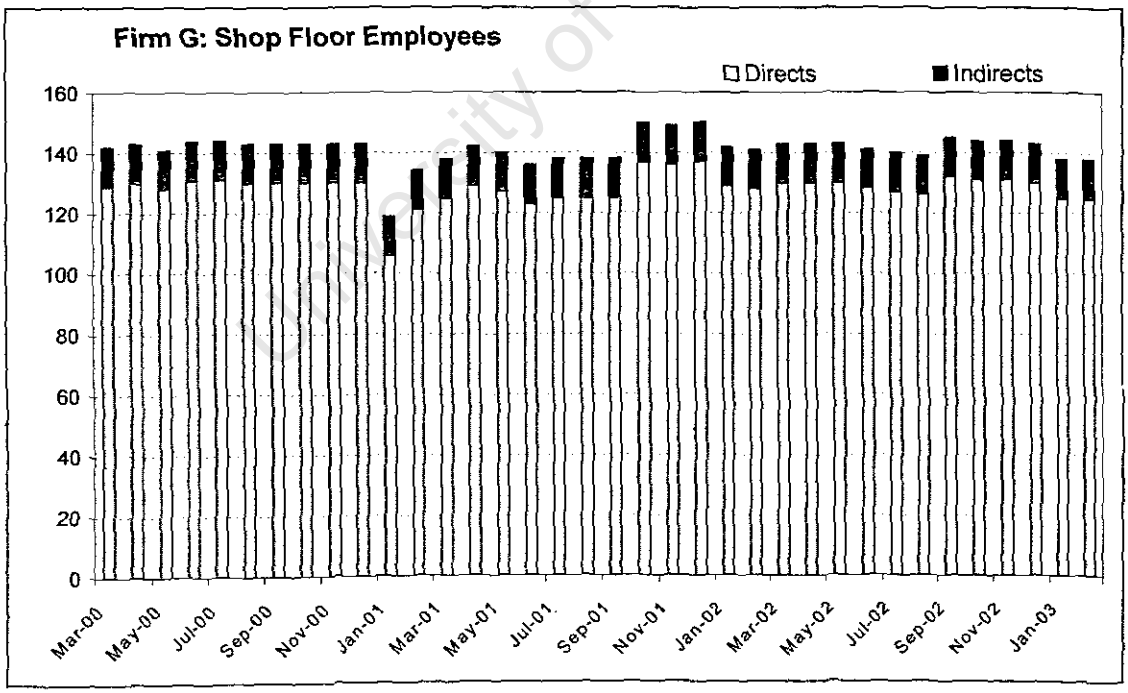

Figure 1: Firm G Shop Floor Employees (Excluding Management)

Apart from January 2001, when contract works were put off because orders were low after Christmas, Figure 1 shows that employment at Firm G remained fairly stable throughout the research period. Almost all the employees and management in the firm were members of the large Indian community in and around Durban.

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At Firm G, the data on hours worked were only available by week. In Figure 2, the hours worked for most months are the total over 4 weeks; however, the figures for the months of July and September 2000, April, July and October 2001, and March, June and September 2002 are the total hours worked over 5 weeks. The data used to calculate hours worked per employee in these months have been adjusted to 4 weeks per month to standardise the figures.

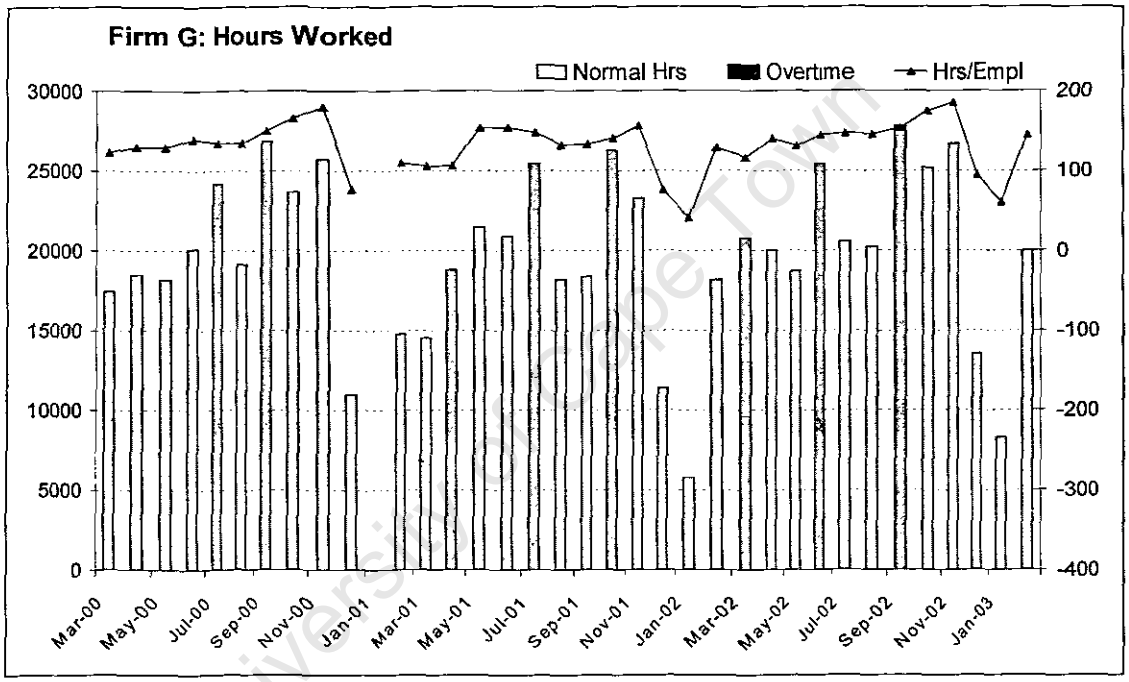

Figure 2: Firm G Hours Worked

Figure 2 shows that the firm did not work overtime at all as it was able to adjust the hours worked by calling in labour, day by day, as required. This was possible due to unemployed skilled operators being readily available.

Both measures of sales in Figure 3 below show the seasonal fluctuations in Firm G's demand quite clearly. During 2000 and 2001, demand was lower than in previous years due to cheaper imports (Interviews G010312RS, p. 1 & G010917RS, p. 11). At the end of 2001, the firm started production of welted shoes, a stronger type of shoe construction, which gave it access to government markets such as for the police and nurses (Interview G020311S, p. 2).

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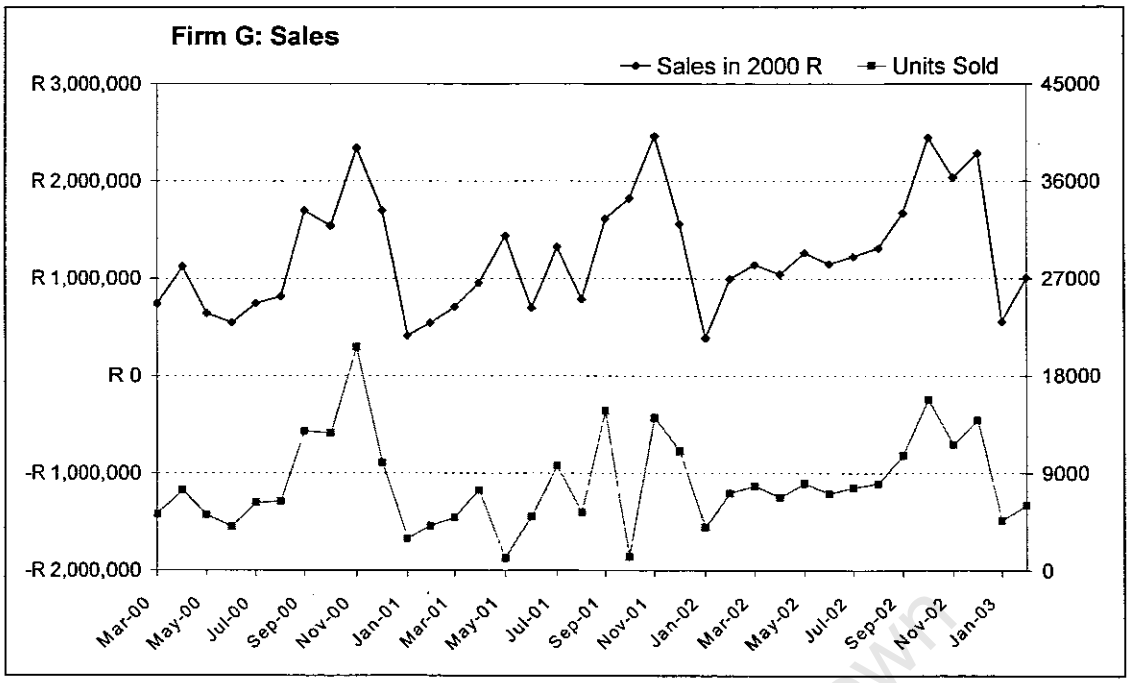

Figure 2: Firm G Sales (Discounted Against Firm's Price Increases to Rand in 2000)

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Implementation of TBWO Programme

According to the production manager at the time, the firm's management "had a few sessions" with the WPC consultant in November 2000, dealing mainly with human resource issues and training. Thereafter, work pressure at the end of 2000 and short-time at the beginning of 2001 caused a hold-up in the firm's programme implementation, which was to be completed with training in March 2001 (Interview G010312RS, p. 1). The training was on understanding how a business operates and was provided to all shop floor employees (Interview G010312RS, p. 2).

The team meeting time shown in Figure 4 below reflects only the daily meetings of supervisors with the production manager as shop floor employee team meetings were not normally held. During the first half of 2001, there was an attempt to have shop floor team meetings, but this was discontinued because the production manager regarded it as a waste of production time. He said, "I was actually losing out quite badly. Quite badly... I mean, you know it if can be streamlined to like 10 minutes in the morning, then it's fine, but whatever they discuss there, does anything materialise from it?" (Interview, G010917RS, p. 8). These meetings were not included in the data on team meetings as on field visits no evidence of team meeting areas, performance measurement or process improvement activities was found.

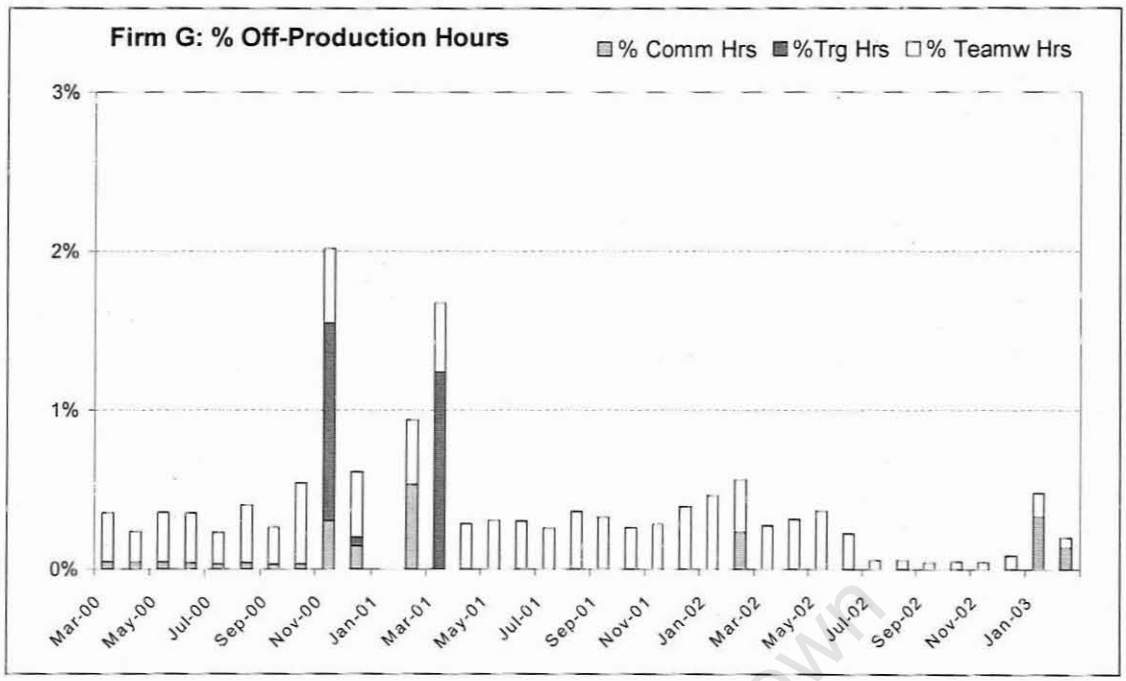

Figure 4: Firm G Hours Off-Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked.

Only the disused suggestion box, shown in Figure 5, suggested that there had been an unsuccessful attempt to gather inputs from the shop floor employees. Communication with shop floor employees also did not take place regularly and dealt with issues such as short-time when it did.

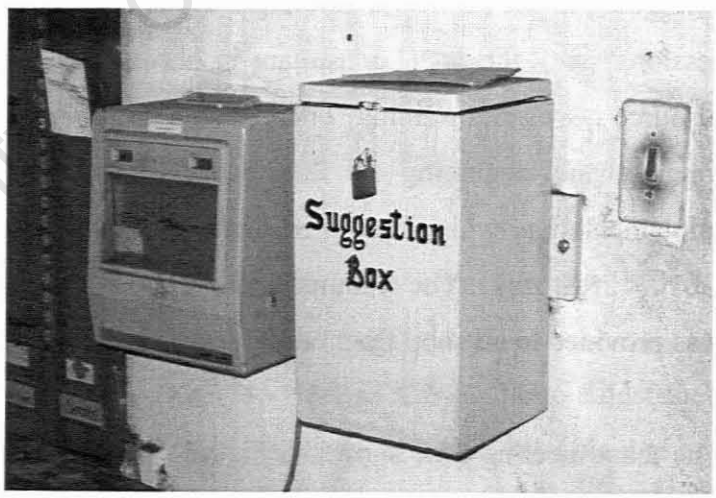

Figure 5: Disused Suggestion Box at Firm G

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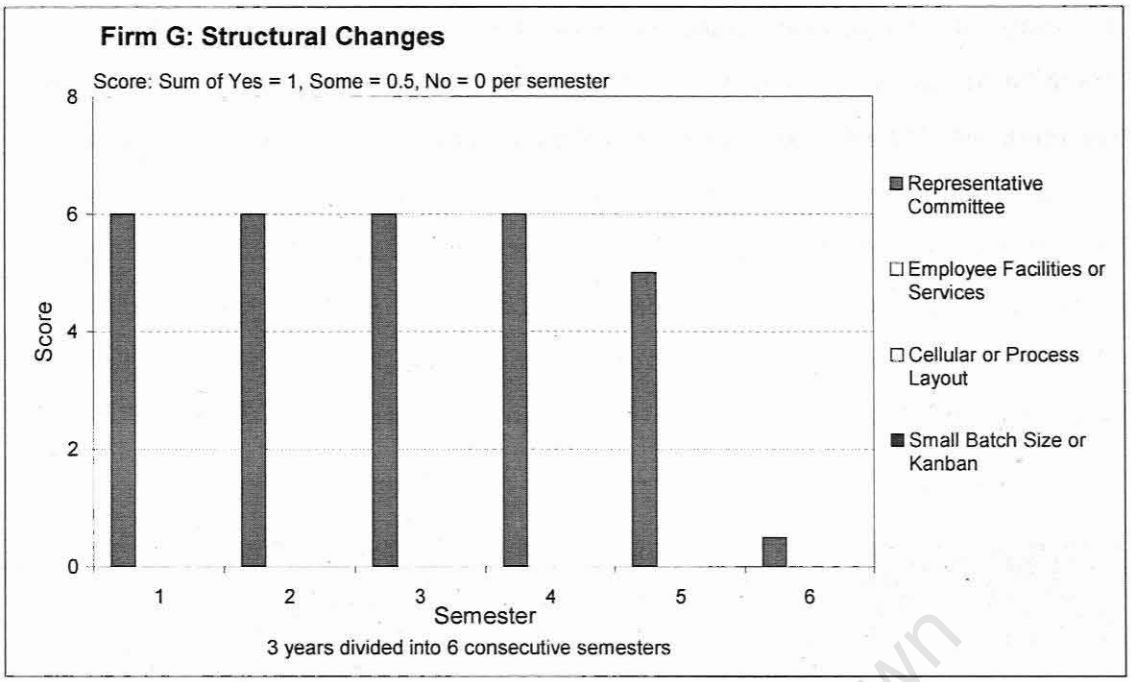

Figure 3: Firm G Structural Changes (Permanent Work System Changes)

Firm G did have a WPC steering committee, with union and non-union employee representatives, from the outset of the WPC project and the new production manager (the original production manager left in February 2002 amid rumours of fraud) thought that it was a good communication channel with the employees (Interview G020311S, p. 5). However, after he left a few months later, the committee met less regularly and was eventually discontinued. No other structural changes associated with TBWO were made and, as can be seen from Figure 7, the firm's shop floor remained laid out in traditional straight lines.

Figure 4: Shop Floor Layout at Firm G

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The only other significant initiative undertaken by the firm as part of its WPC initiative was to commission a consultant's report on changing the layout in the shoe-closing room, but its recommendations were regarded as too costly to implement at the time (Interview G010917RS, p. 10). There were some *ad hoc* attempts at "reorganising the closing room in terms of work flow because what's happening now, apparently they are pulling these boxes that have got the work in to and fro and obviously, you know, that's not the ideal situation in production" (Interview G020311S, p. 4), but as is apparent from Figure 8, there was so much WIP in the factory that at times it was difficult to move anywhere.

Figure 5: Final Quality Inspection and Packing at Firm G

Management commitment to the TBWO programme at Firm G appeared to be ambivalent at best. The WPC consultant had to push the firm to get the training completed, and despite reporting improved employee motivation from the training, the production manager said that "it's a bit difficult to actually assess the benefits from this you know" when justifying the delay in training (Interview G010312RS, p. 1). No training in teamwork, process improvement, or other practices usually associated with TBWO, was done. The management chose not to implement the consultant's recommendation to change the shop floor layout, despite of the costs associated with it being partially funded by the WPC. The turnover of production managers was also disruptive (Interview G020311S, p. 5).

Performance Outcome Trends

These graphs report the intermediate (WIP & absenteeism) and operational (productivity and quality) performance outcomes at Firm G over the research period.

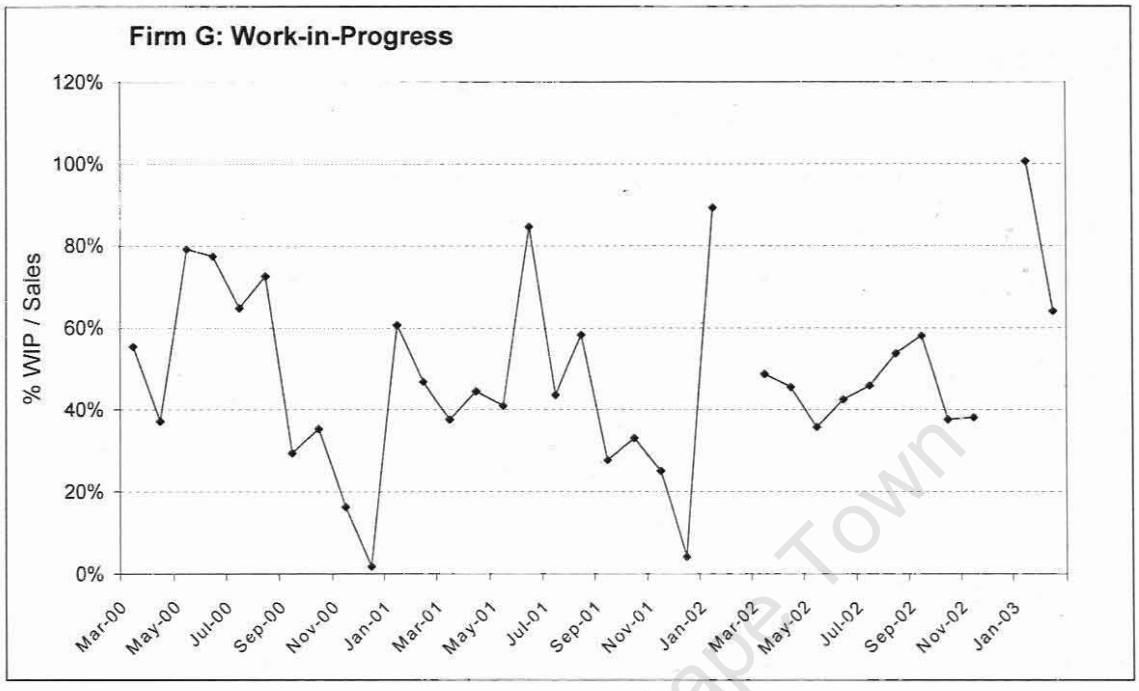

Figure 6: Firm G Work-in-Progress as a Percentage of Sales

The value of WIP as a percentage of sales appears to be relatively high as the stock appeared to turn over about twice per year. Although the data is incomplete, there appears to be little improvement over the research period.

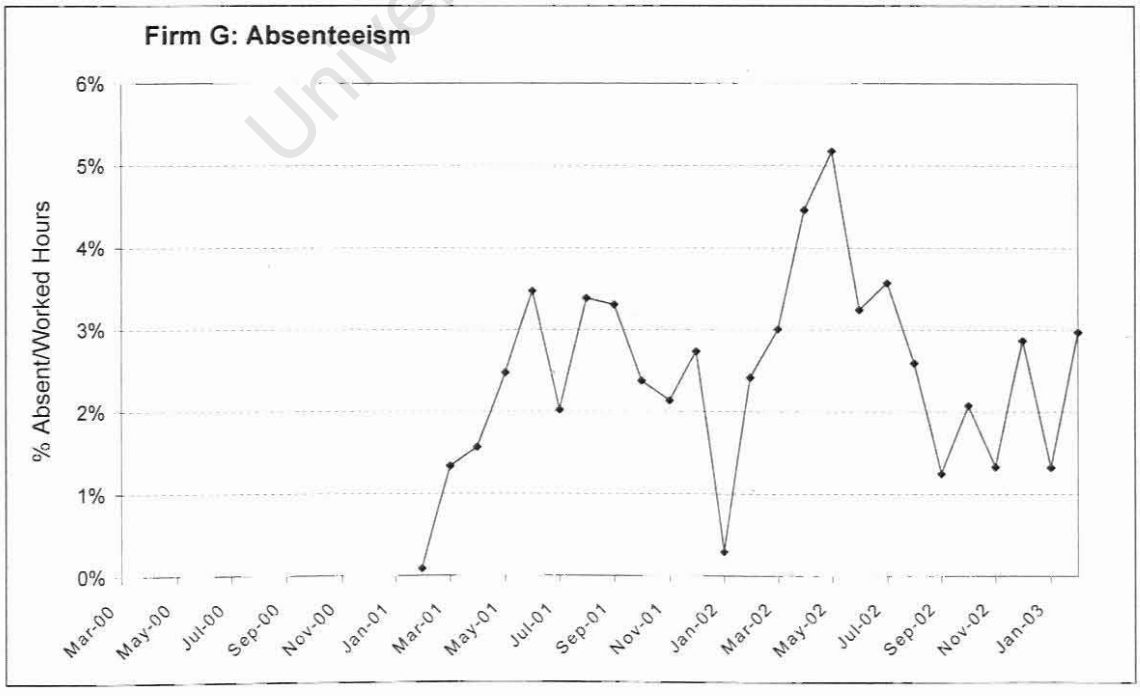

Figure 7: Firm G Absenteeism

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Absenteeism data were not available before 2001. The very low absenteeism early in 2001 and 2002 was probably due to the short-time being worked at that time of the year (see Figure 2). It is not known why the absenteeism at the firm peaked in May 2002. From the available data, it appears that there was no improvement in absenteeism.

The data for Figures 11 and 12 also come from Firm G's weekly production reports but are not affected by the different number of weeks in the month as data with the same number of weeks in a month was used to calculate the productivity rates.

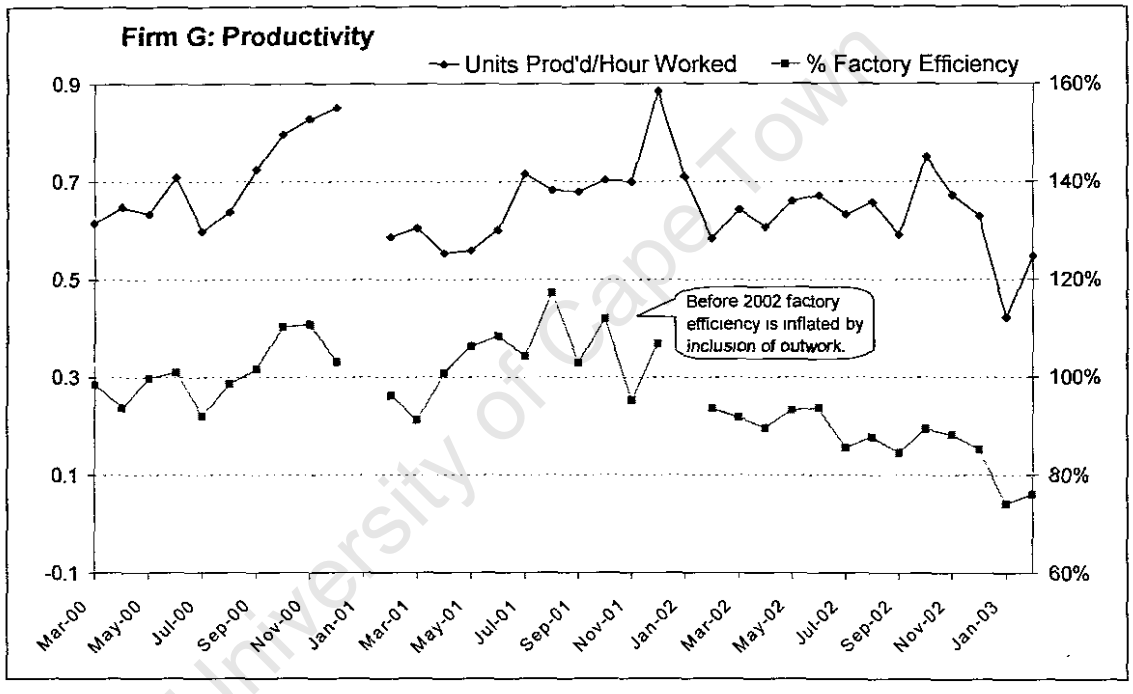

Figure 8: Firm G Productivity

Firm G outsourced some of its production, and before 2002, it was included in the factory's output data, which inflated the factory efficiency figures, as indicated in Figure 11. The measure of units produced per hour worked was not affected by this problem. A downturn in the firm's productivity over the last year of the research is evident from both indicators, and therefore, despite the anomalous data, it can be concluded that there was a "moderate deterioration" in productivity, as reported in Appendix 4.13.

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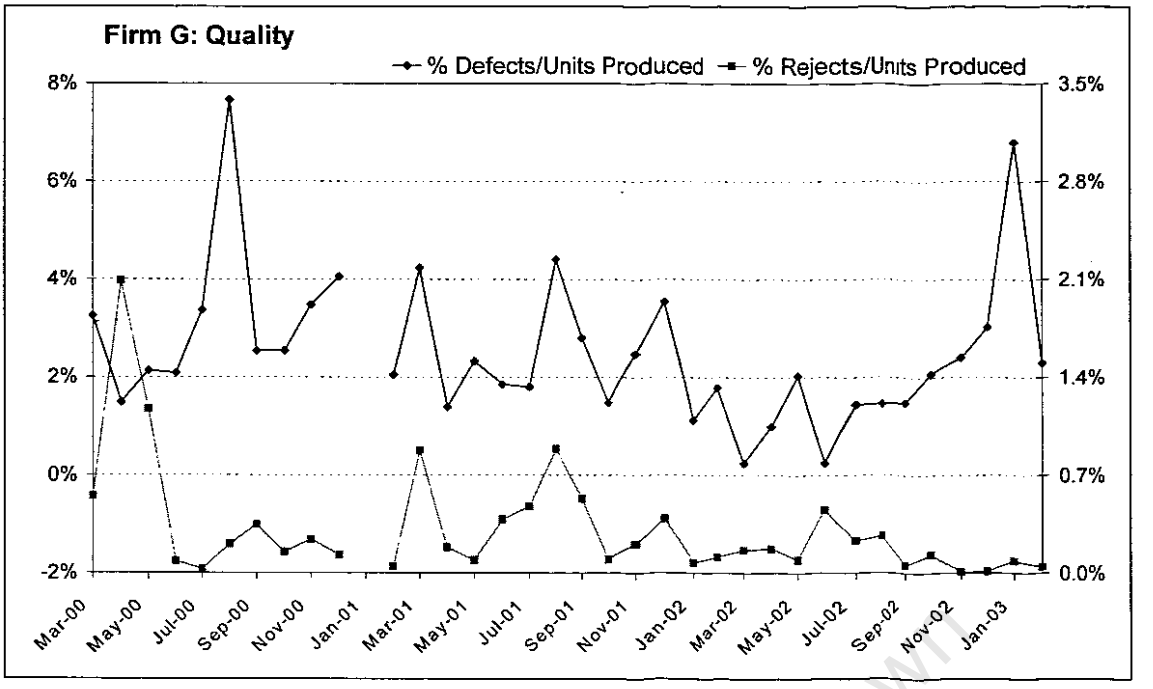

Figure 9: Firm G Quality

Firm G provided two measures of quality. However, the rejects as a percentage of units produced is not a reliable measure of quality inside the factory as most of the units that were classified as rejects were in a very early stage of production and were written off due to leather imperfections rather than process failures. Defects per unit produced initially improved, but towards the end of the research period, the trend reversed. Therefore, it was classified as a "moderate improvement" followed by a "moderate deterioration" in Appendix 4.13.

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Summary and Interpretation of Case Findings

Firm G appeared to be firmly locked into a traditional approach to managing shop floor operations, as reflected by the very low percentage off-production time of 0.40% spent on TBWO activities. Despite the incentives offered by the WPC project, the management used the opportunity and resources only to do basic business literacy training and resisted the recommendations by consultants to change the layout of the production lines while investing in new production equipment. The difficult market environment may have exacerbated the adversarial relationship between management and the workforce as the employees had to endure severe job insecurity due to the day-to-day uncertainty about employment.

Although the available performance data has to be interpreted with caution, the more reliable parts of the data indicated that productivity had declined and that after improving for some time, the trend in quality performance was reversed. As the firm's quality systems were elementary at best, it is difficult to explain why the defect rate improved at all, but the lack of any systematic process improvement could account for the deterioration towards the end of the research.

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Appendix 4.3: Firm C Case

Background

Firm C produced aluminium and zinc castings, mostly for the automotive sector. The firm was located in the industrial area of Pinetown outside Durban, in old, but serviceable, facilities. The foundry, where components were fettled to remove casting imperfections, was in a separate building, adjacent to the finishing area. It had limited die-making capacity. Figures for the firm's sales were not available but were estimated to be about R1.25m per month, and the average shop floor employment was 134 over the research period. It was a family-run company for many years but was sold to a new owner shortly before the research began, although many of the original managers remained involved in the firm.

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Firm Profile

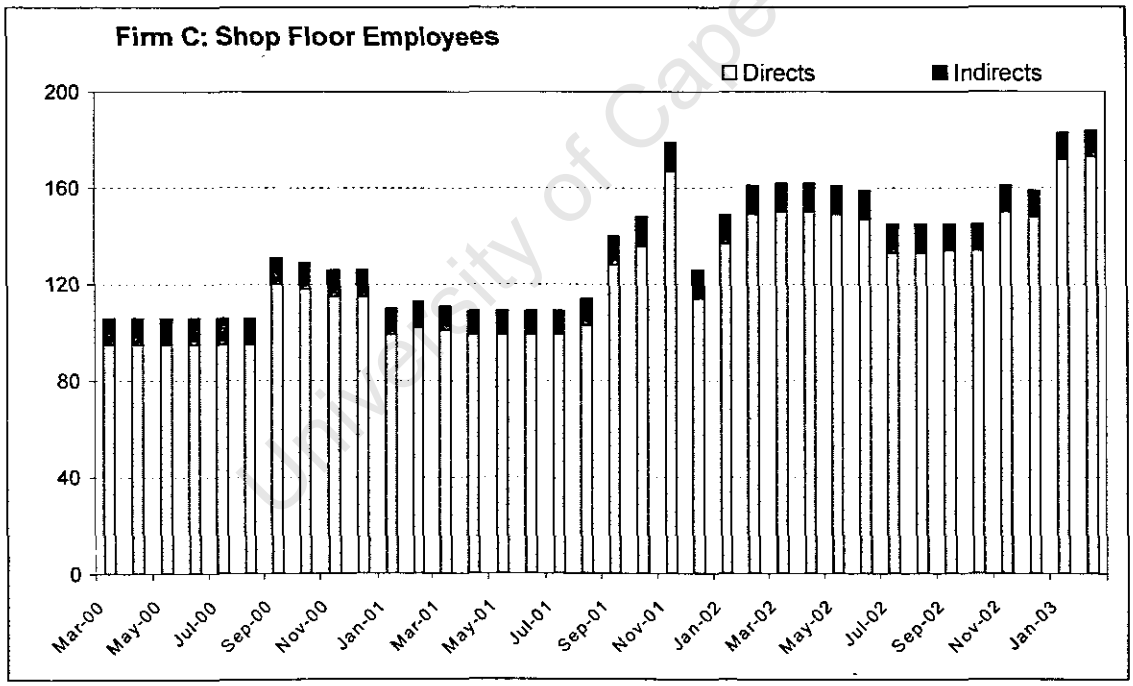

Figure 1: Firm C Shop Floor Employees (Excluding Management)

A feature of Firm C's circumstances during the research period was that the new owner introduced several changes to the company. Most prominent was aggressive marketing, particularly targeting export markets, which resulted in increased orders (Interview C020304DS, p. 2). Employment was therefore increased from the end of 2001, as shown in Figure 1. The operations of another plant belonging to the new

owners were rationalised into Firm C and additional production equipment purchased to cope with the anticipated increase in demand (Interview C020304DS, p. 3).

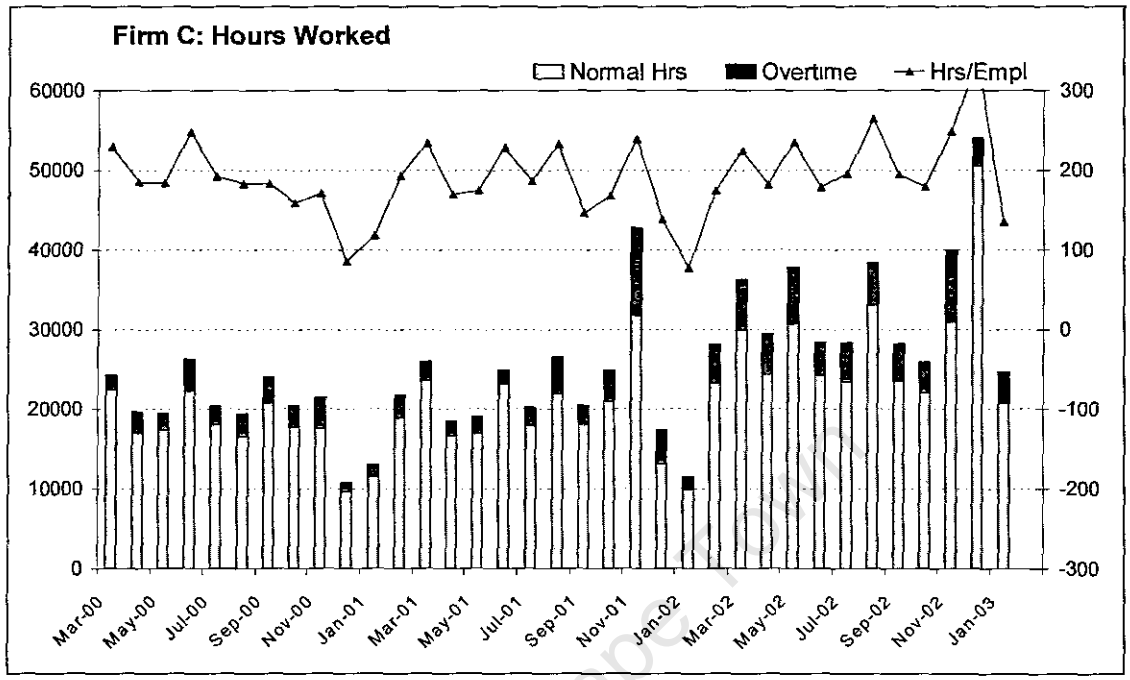

Figure 2: Firm C Hours Worked

Figure 2 shows that the increased employment led to an increase in absolute hours worked, but the hours worked per employee remained relatively constant.

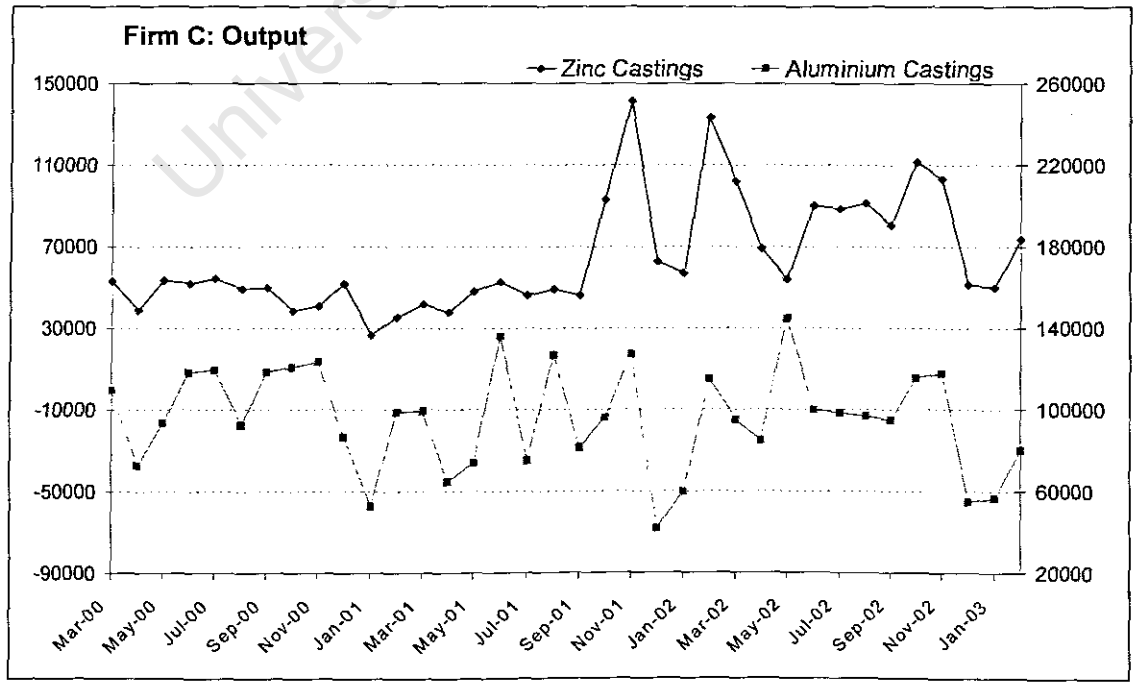

Figure 3: Firm C Output

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Output of zinc castings peaked at the end of 2001 and early 2002 but then consolidated, albeit at a slightly higher level than in previous years. Aluminium castings remained at more or less the same level throughout, as shown in Figure 3. It should be noted that the casting operation was paced by the cycle time of the equipment, whereas the subsequent finishing operation was done almost entirely by manual labour. Due to the varied requirements of finishing, no standard measure of output was possible. Therefore, the entire operation was assessed using casting output as a measure.

Implementation of TBWO Programme

Firm C's TBWO programme was initiated by the previous owner, and a representative steering committee was formed and trained in July 2000. There was some delay with further implementation until the new owner could be informed, but after he gave his approval for it to proceed, training and implementation of the "mini-businesses" started in late 2000. Figure 4 shows that shop floor team meetings started in January 2001, although a supervisor/team leader meeting started earlier.

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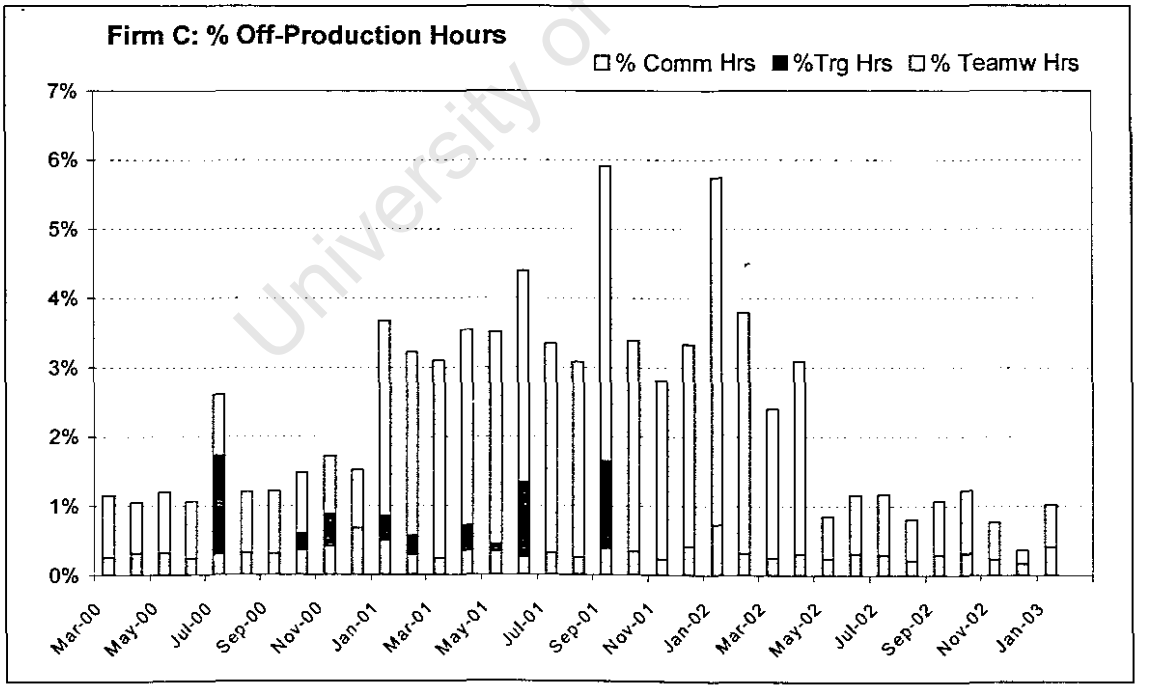

Figure 4: Firm C Hours off Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked.

The firm's WPC facilitator reported that there were some difficulties with establishing measures for the finishing departments, and therefore it took quite long to get performance measurement by the teams up and running (Interview N010314CW, p. 1). He also initially spent a lot of time making up graph templates for the teams, as can be seen in the background of Figure 5. In June 2001, he left the company and a promising team leader was promoted to facilitate the programme. This had the advantage of the training being conducted in the vernacular language; however, as the new facilitator was lower in the management hierarchy, he was not in a position to champion the programme as effectively as his predecessor had.

Figure 5: Manual fettling to finish Castings at Firm C

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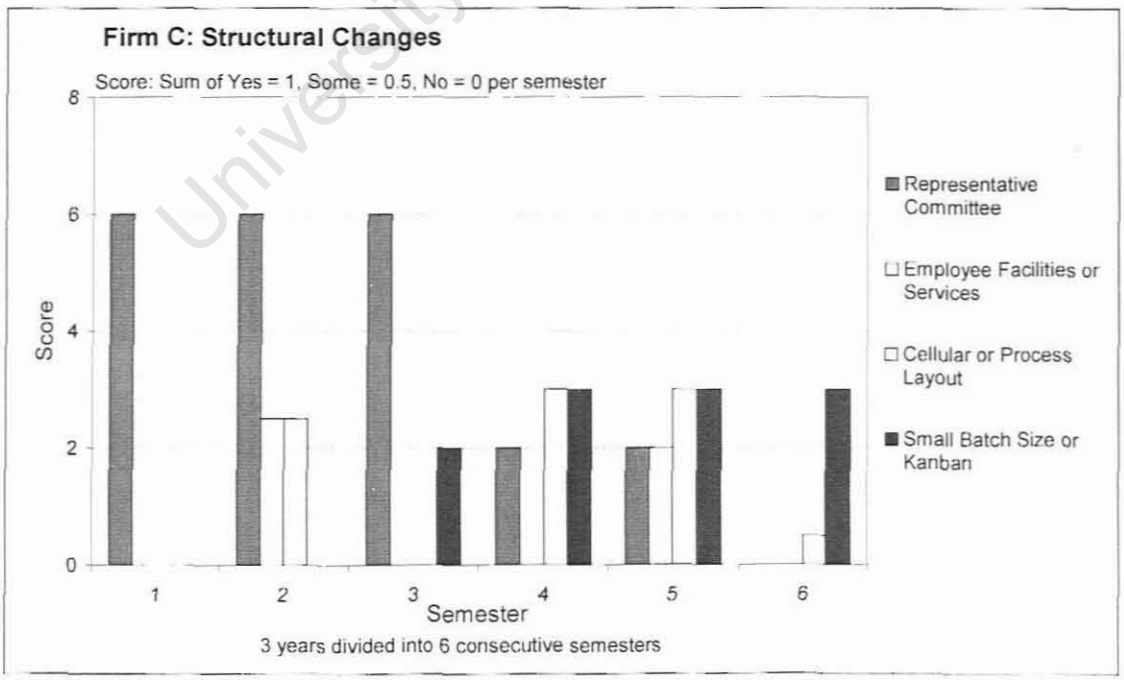

Figure 6: Firm C Structural Changes (Permanent Work System Changes)

As can be seen in Figure 6, the firm made relatively few structural changes. This was partly due to the awkward layout of the site and the fact that the different functional departments lent themselves to teams being made up of natural work groups. Some effort was made to reduce lot sizes by introducing crates, although, as Figures 7 and 8 show, work-in-progress was predominantly moved in pallets. The firm did introduce an incentive scheme for the operators of the casting machines, but it was not extended to other parts of the workforce (Interview C020306GW, p. 1).

Figure 7: Drilling Department at Firm C

While the firm's sales improved, there were problems getting the new casting machines and scheduling software to work well. In addition, the general manager at the time said that they were in a "massive state of change" due to the integration of the operations of the new owner's other company and a another small company that he had bought (Interview C020712DS, p. 5). This was compounded by considerable uncertainty within the organisation due to a high turnover of management under the new ownership. Apart from the WPC facilitator leaving, the production director was replaced in March 2001, and a new general manager was appointed in mid-2001, only to be replaced at the end of 2001.

Figure 8: Quality Control at Firm C

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Then, in May 2002 (see Figure 4), the shop floor employees refused to participate in shop floor team meetings without additional pay. The firm reverted to the previous supervisors doing the tasks of team leaders, such as recording performance measures (Interview C020708JG, p. 1). Despite efforts by the union representatives and the new WPC facilitator to get the programme back on track, the shop floor team meetings could not be revived. Early in 2003, it was reported that the firm was experiencing cash-flow problems and that the employees were concerned about short-time and retrenchments (Interview C030217JG, p. 3). Shortly after the data collection period ended, the firm ceased production and was liquidated.

Performance Outcome Trends

These graphs depict the intermediate (WIP & absenteeism) and operational (productivity and quality) performance outcomes at Firm C over the research period.

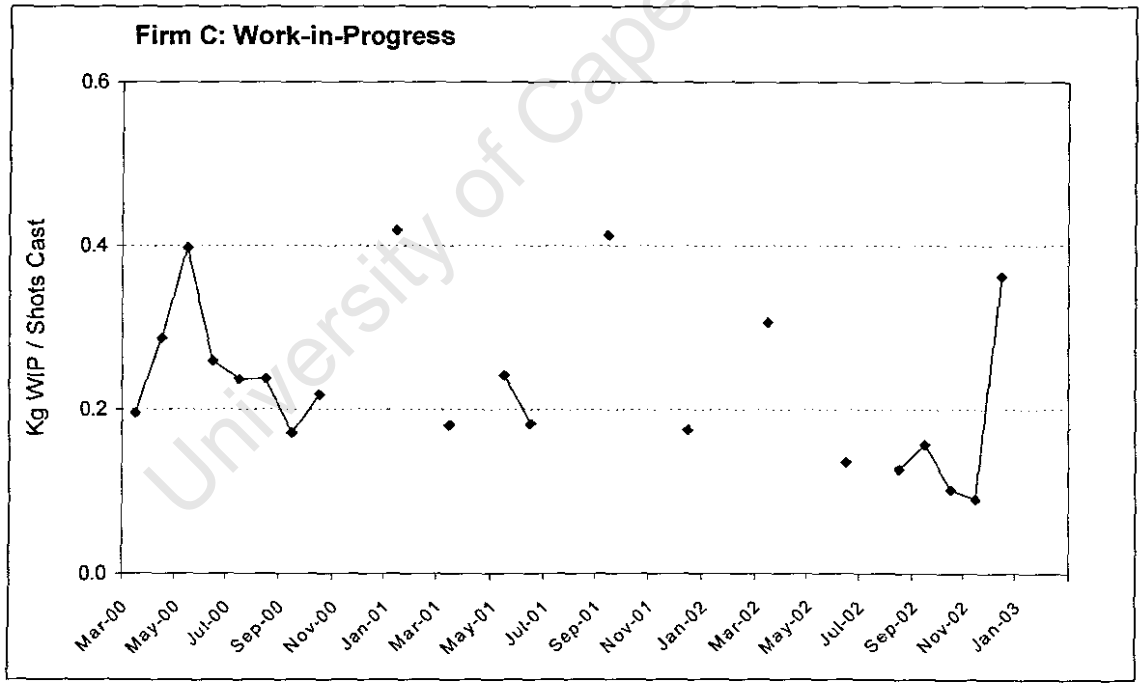

Figure 9: Firm C Work-in-Progress as a Percentage of Sales

Unfortunately, WIP data was only available intermittently, but from the available data, it appears that significant reduction in WIP did not take place.

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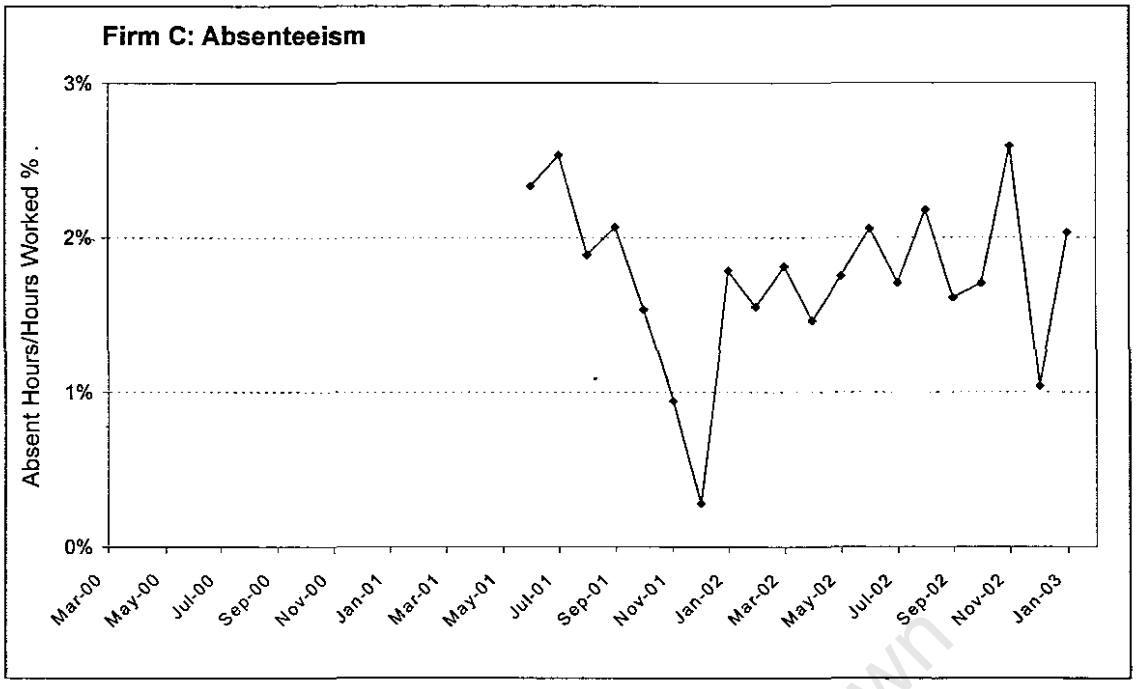

Figure 10: Firm C Absenteeism

The available data on absenteeism indicates no change in the rate of absenteeism. What is perhaps surprising is the low level of absenteeism compared to the other firms researched.

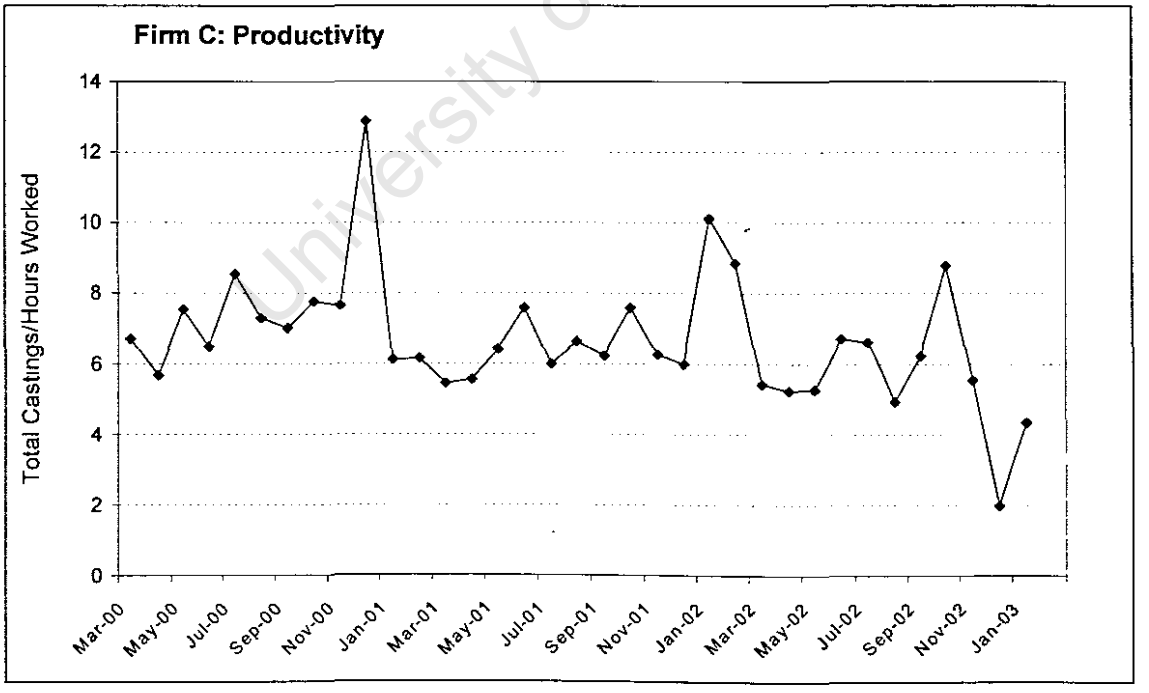

Figure 11: Firm C Productivity

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If "castings per hour worked" is taken as an overall measure of performance, then the graph in Figure 11 indicates that the firm's productivity declined over the research period. In Appendix 4.13, this was classified as a "moderate deterioration".

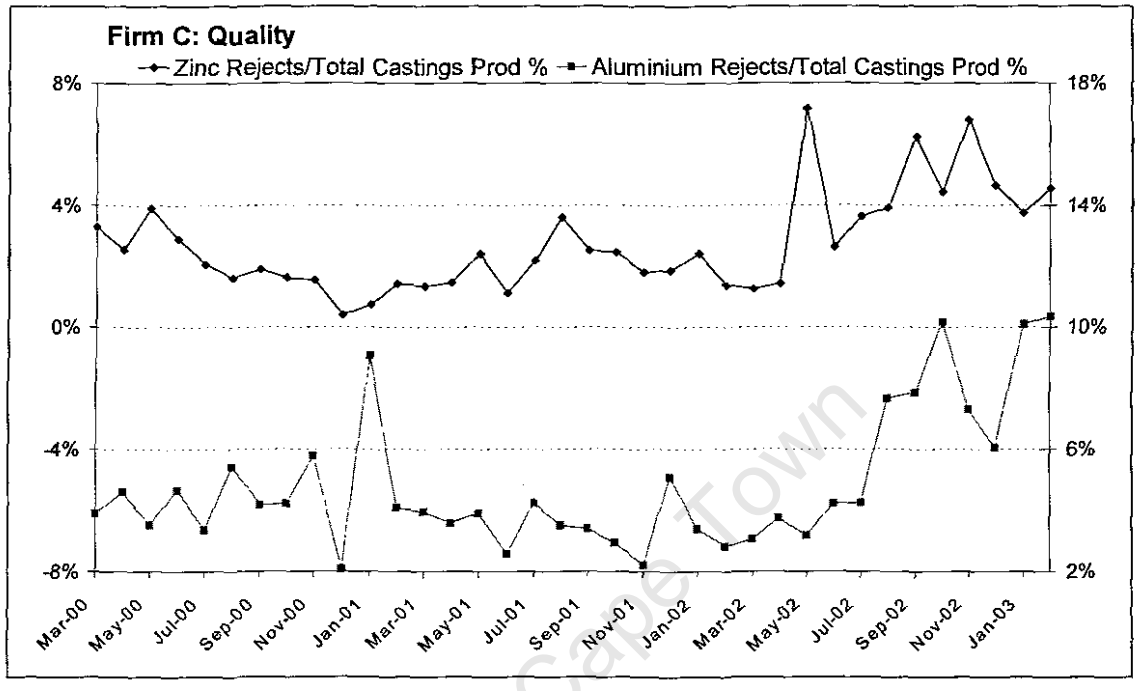

Figure 12: Firm C Quality

Data on reject rates were only available for the casting section of the operation. The deterioration evident in Figure 12 may be due to the problems experienced with the integration of the equipment inherited from the other company and the difficulties with commissioning the new equipment. Nevertheless, the mere fact that quality data was not available, despite quality inspections being carried out (see Figure 8), does not bode well for the quality performance of the finishing department. Quality performance was classified as a "moderate deterioration" in Appendix 4.13.

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Summary and Interpretation of Case Findings

Firm C suffered a number of substantial setbacks with the implementation of its TBWO programme:

- There was a delay with the initial implementation due to the change of ownership of the firm.
- The new management had a marketing orientation and perhaps did not pay sufficient attention to the operational capability needed to meet increased demand.

- The firm experienced substantial organisational disruption due to the merging of other firms into its operations.
- No significant changes in shop floor layout to improve process flow were introduced.
- The firm experienced high management turnover.
- There were problems with commissioning new production equipment.
- The workforce resisted changes to the work organisation and used participation in teams as a bargaining chip in a labour dispute.
- Towards the end of the research period, management attention was diverted from supporting the TBWO programme to financial crisis management.

There can be little doubt that the substantial organisational disruption at the firm impacted negatively on the implementation of its TBWO programme. This resulted in a relatively low percentage of off-production time to support TBWO activities of 2.31% compared to the other firms researched. While there may be alternative explanations, such as problems with equipment, for the firm's deteriorating operational performance on both indicators, it is fair to conclude that weak programme implementation contributed to the firm's poor operational performance.

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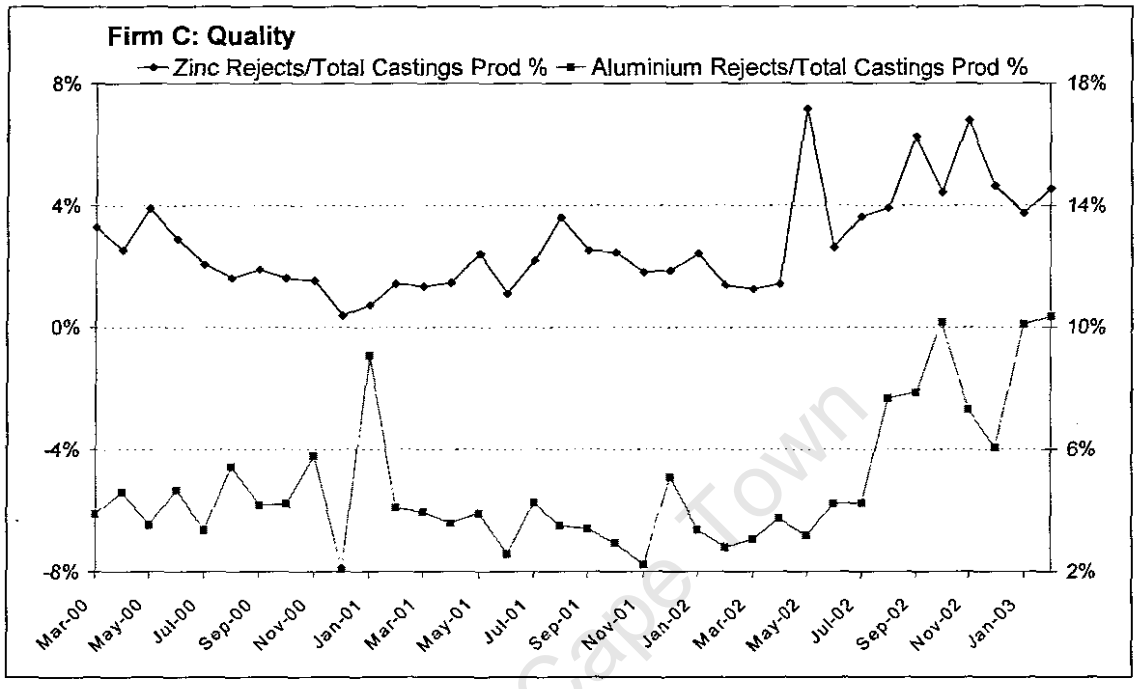

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Appendix 4.4: Firm J Case

Background

This firm produced knitted garments for the local and export markets. The company sales increased from R42m to R72m during the research period. It was established in 1951, privately owned, and was located at premises in Cape Town. The facilities were old and had been added to over the years in a somewhat haphazard way. It was an integrated operation in that it dyed and knitted yarn into panels that were made up into garments. These garments were then folded and packed according to customer requirements.

The case research was confined to the "rough make-up" (RM) department (where knitted panels received from the knitting room were sewn together into full garments) because this is where the most significant changes to work organisation took place. This department employed an average of 74 employees over the period of the research.

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Firm Profile

The following graphs provide an indication of how the firm's profile changed over the research period.

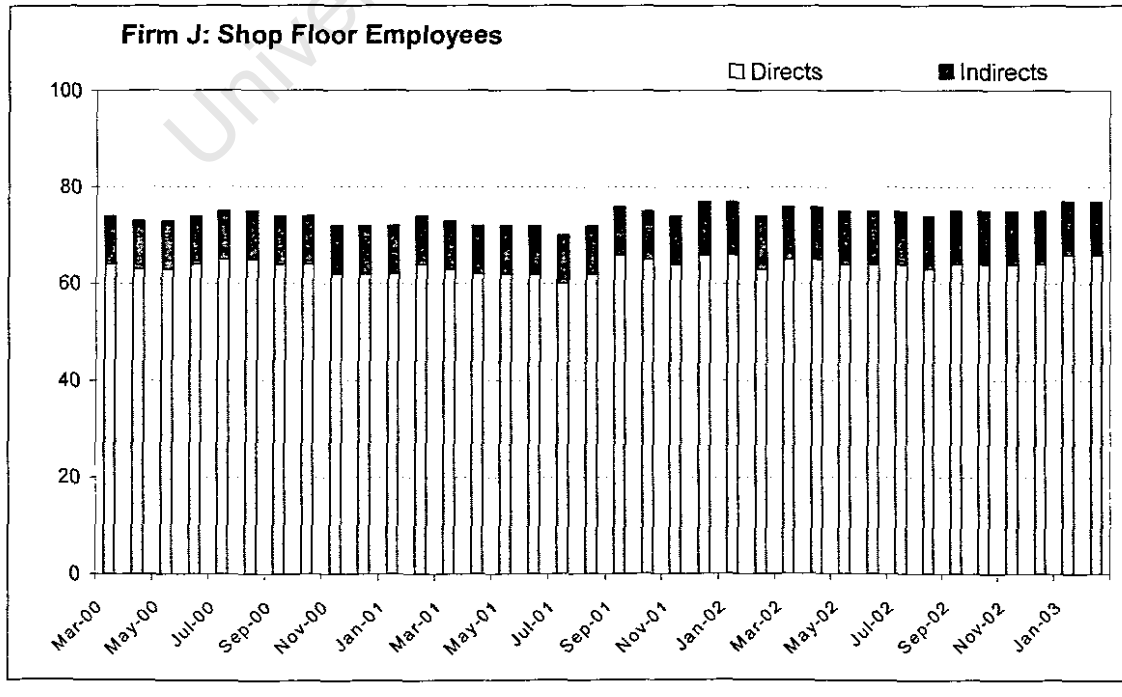

Figure 1: Firm J Shop Floor Employees in the Rough Make-up Department

The employment levels in the RM department were stable throughout the research period, although other departments in the firm were affected by retrenchments at various times during the research. This is probably because RM was a core value-adding operation, whereas the "cut-and sew" department that was closed down completely was not (Interview J010323SS, p. 1).

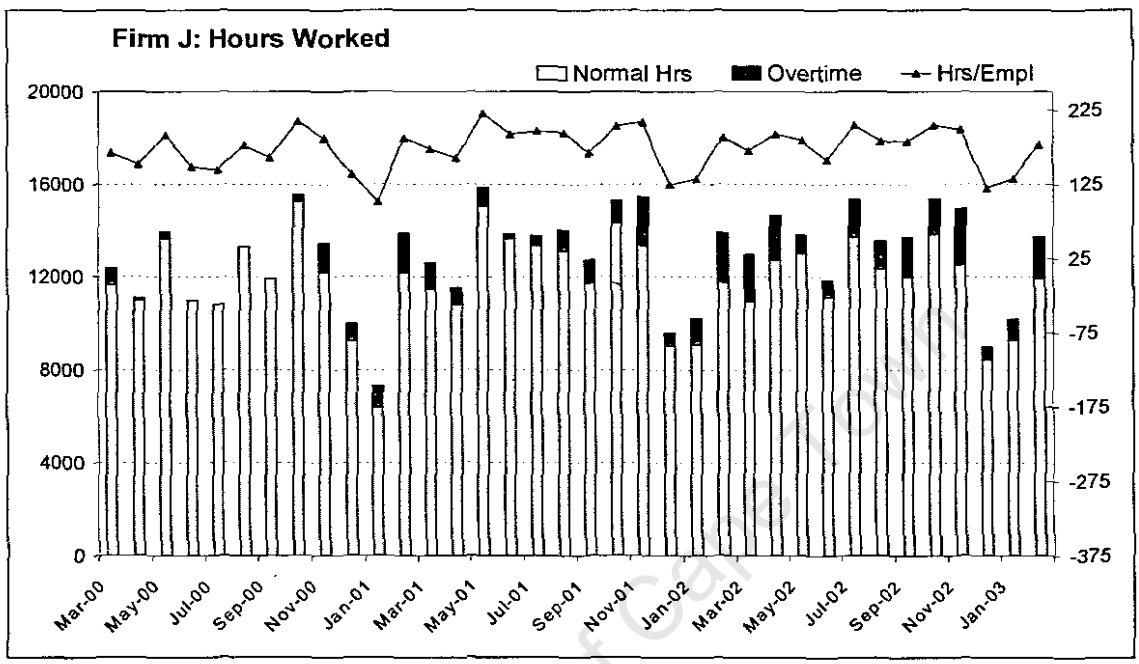

Figure 2: Firm J Hours Worked in the Rough Make-up Department

Figure 2 shows that the hours worked in RM followed the normal seasonal pattern. Overtime increased as a proportion of total hours worked, probably because the firm increased turnover in 2002.

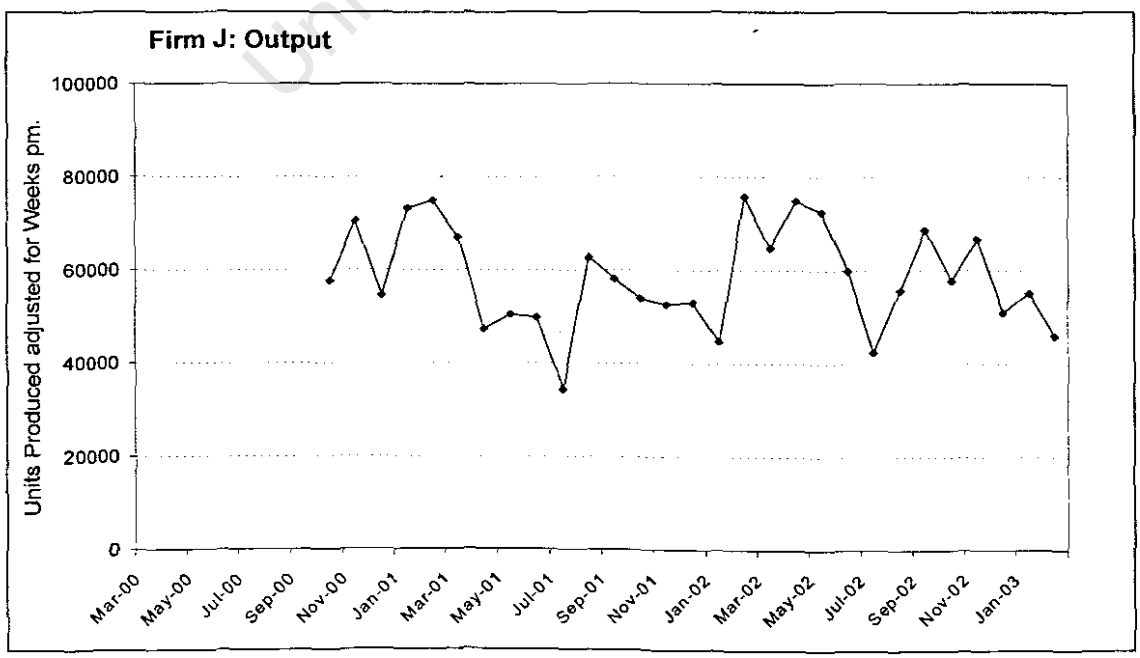

Figure 3: Firm J Output of the Rough Make-up Department

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Output of the RM department remained at more or less the same level during the research period. The data used in Figure 3 has been standardised to 4 weeks per month as the firm kept output figures by week, and some months did not include 4 week's data. The following months were affected: January 2001 included 2 weeks; December 2000, February 2002 and January 2003 included 3 weeks; and March 2001, September 2001 and July 2002 included 5 weeks.

Implementation of TBWO Programme

The TBWO programme at Firm J started with discussions between the union and management, followed by the election of a steering committee in October 1999. The firm decided to pilot the cellular manufacturing concept, and after preparations that included a skills need analysis and setting new work standards based on time studies, the installation of lighting, power points and workstations was completed in January 2000. Multi-skilled operators for the cell were selected, and they and their elected team leader received training on how to work in a cell (Greenwood, 2000). The cell started operating in the following month, and after modification to the work process and putting in place of a short-interval performance feedback, the firm reached the target of 75% efficiency within a few months (Interview J010323SS, p. 1).

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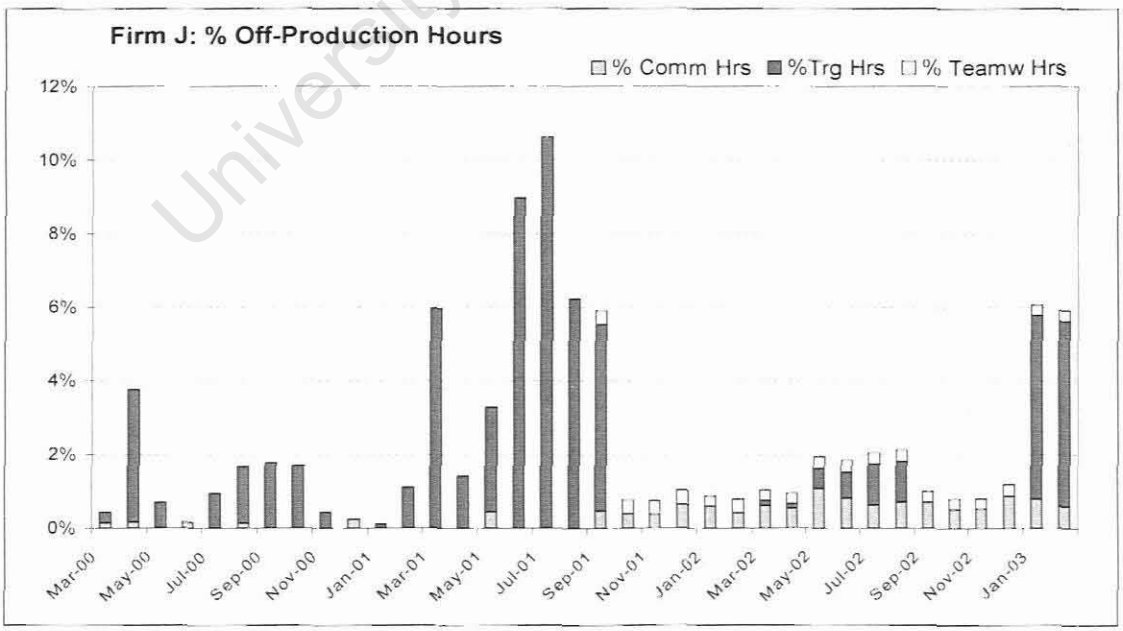

Figure 4: Firm J Hours off Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked.

By April 2000, cellular production was introduced throughout RM. However, the machinists there were given the minimum of training, although there was support from the work-study department to get the new cells up and running (Interview J010323SS, p. 7). Figure 4 shows that substantial training took place in the first half of 2001; however, that consisted mostly of operator-specific job skills training. The firm had a system called "boosting" whereby a machinist who was identified as working too slowly would be taken off the line for remedial training to improve his or her production rate. In the clothing sector, there is generally a focus on job skill training as output is very dependent on operator dexterity. Very little teamwork and/or problem-solving training took place at Firm J as the management took the traditional approach focussed on work-study to manage performance on the shop floor. The teams were also not given dedicated time for shop floor team meetings.

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Figure 5: A Cell in the Rough Make-up Department of Firm J

By the second half of 2000, the cells in RM were running reasonably well, but towards the end of the year, and early in 2001, the performance of the cells became erratic. Some of the teams questioned the work standards but these were found to be correct by the work-study department as the pilot line was able to make target to the same work standards. An investigation by the work-study officer found that the team leaders and line managers were not removing superfluous operators from the cells and more than one style at a time was being produced on a cell. This caused obstacles to the process flow through the cell (Interview J010130SS, p. 1). Figure 5 shows that the

cell layout in RM was not in a U-shape but arranged along a long work bench. When an additional operator prevented WIP from being passed from hand to hand, it was placed into bins, which obstructed the flow of WIP through the cell.

Although cells were in operation from the outset of the research period, for the purpose of documenting the layout changes, the cells were coded as only partially converted, as reflected in Figure 6, because of the hybrid line/cell layout illustrated in Figure 5. The firm's steering committee stopped meeting soon after the pilot project was completed.

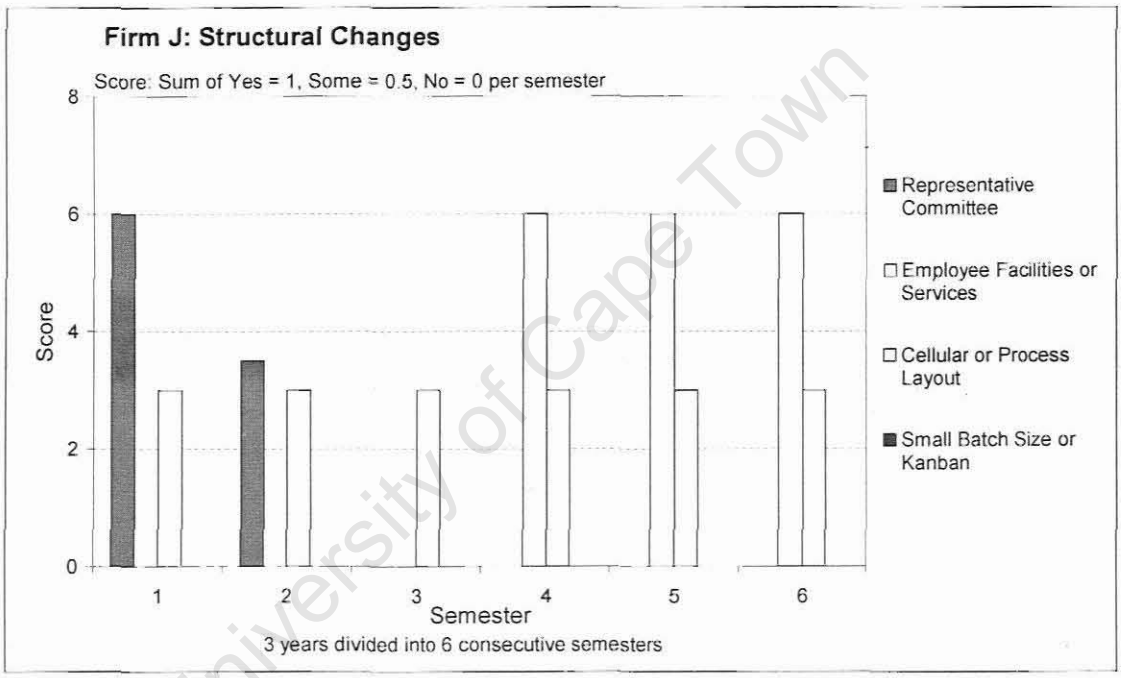

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Figure 6: Firm J Structural Changes (Permanent Work System Changes)

The firm experienced buoyant market conditions during 2000 because it was price-competitive in the export market due to the weakness of the local currency. Because of high demand, some shop floor employees were asked to work through part of the December 2000 annual shutdown. This led to considerable unhappiness among the workforce and caused minor work disruptions early in 2001. Many of the long-serving employees, used to the traditional way of working, resented the changes to the work organisation, and that contributed to the breakdown of work disciplines in the cells. The work study officer reported that when a cell's production was monitored, targets were generally reached, but questioned whether "we should police them all the time?" (Interview J010130, p. 2).

In April 2001, the general manager who had been instrumental in introducing the TBWO programme resigned, and the production manager who was designated to replace him was tragically killed in a car accident a few days later. The new CEO was very supportive of the new TBWO programme, and he soon appointed a production manager with experience in TBWO and lean production. Over the next 18 months, numerous practices in support of the TBWO programme were introduced:

- Hourly target boards were established at the end of each cell with a "traffic light" system to indicate whether the cell was performing on target or had quality or downtime problems, as shown in Figure 7 (Interview J020904WW, p. 1);
- Production output counts were changed to close an hour before knock-off time so that a same-day performance review could be done (Interview J020524SS, p. 3);
- A 3-hourly performance feedback to line management was introduced to take corrective action in "real time" (Interview J020524SS, p. 4 & J020424WW, p. 4);
- Weekly team briefings cascaded from management through team leaders to employees and monthly workforce briefings were done by the CEO (Interview J020904WW, p. 2/3);
- Employee and department-of-the-month awards were instituted (Interview J020904WW, p. 3);
- A team feedback system, whereby written questions from shop floor employees are answered by management, was introduced (Interview J020524SS, p. 8);

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Figure 7: Hourly Performance Boards and "Traffic Light" Indicators at Firm J

- Training and personal development for the team leaders and line managers was presented by the production manager (Interview J020904WW, p. 4);
- Each cell had off-line teambuilding workshops (Interview, J020620WS, p. 16).

The new CEO also undertook a major spring clean of the premises, which had become rather run down, and he had the internal corridors and rooms repainted (reflected in the improvement of staff facilities in Figure 6). Apart from boosting morale amongst the employees, this was intended to make the plant presentable for customer visits as he had embarked on a marketing campaign aimed at local and export clients (Interview, J020620WS, pp. 4 & 9). As a result of his initiatives, the firm's sales went from R42m p.a. to R72m p.a. (Interview J030417WW, p. 4).

However, there were also significant set-backs. Soon after the new CEO took over, the knitting room was identified as a constraint on the whole operation, and to meet the increased demand, it was put onto a 3 x 7 24-hour shift system. The knitters were dissatisfied with the arrangement, and a 3-week strike ensued (Interview J020524SS, p. 6). The dispute was eventually resolved, and in addition, new knitters were recruited, but then quality problems arose due to the inexperience of the new knitters, which affected the knitted panels that went through to RM (Interview J020524WW, p. 6). These problems were exacerbated by serious problems with yarn availability from the firm's main supplier (Interview J010518SS, p. 2). A change to the incentive system, whereby incentive bonuses would start at 75% efficiency instead of 60% efficiency, also affected employee morale (Interview J030417WW, p. 6).

Early in 2003, the Rand exchange rate recovered and competition from imported Far Eastern suppliers increased. The quality and delivery problems caused order cancellations from the firm's export customers and the firm experienced financial problems. The CEO resigned at the end of 2002 due to differences with the firm's board, and the production manager expressed concern about the differences between his and the new CEO's management style (Interview J030417WW, p. 3). The incentive system was changed back to one based on individual performance, and team-building for the cells was discontinued (Interview J030417WW, p. 5). A few months after the research period ended, the firm went into liquidation and closed down.

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Performance Outcome Trends

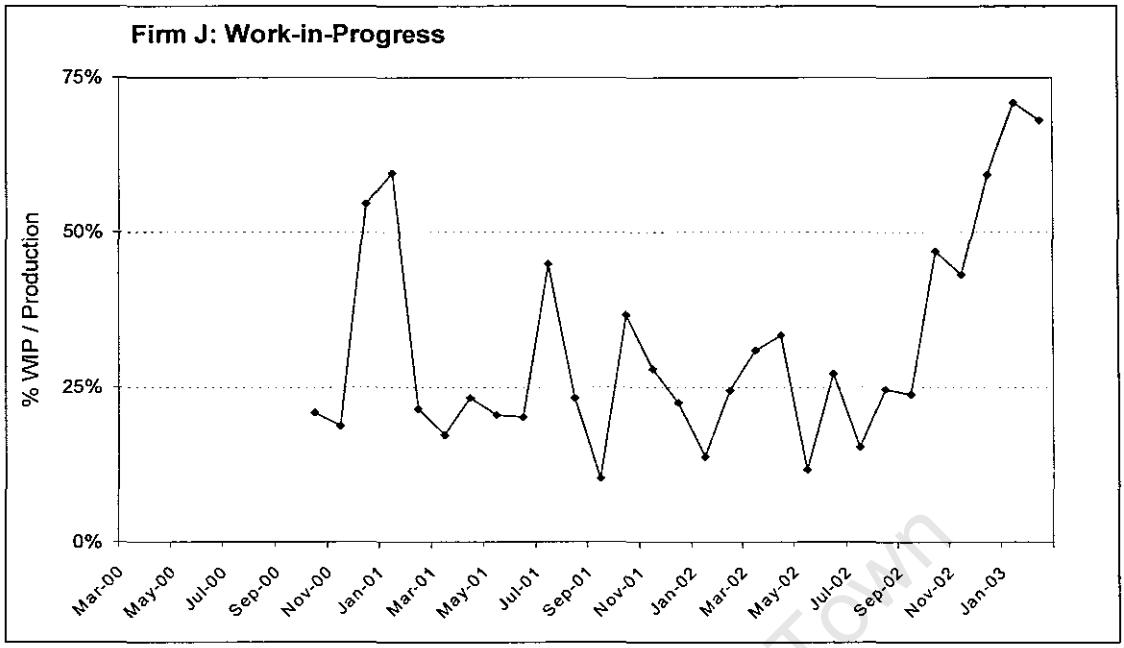

Figure 8: Firm J Work-in-Progress in the Rough Make-up Department as a Percentage of Production

In Figure 8, both the level and variability of WIP as a proportion of production in RM appears to be decreasing until the middle of 2002. It then deteriorates quite badly, probably as the result of the extra mending due to the problems with the incoming knitted panels and possibly due to returns from customers.

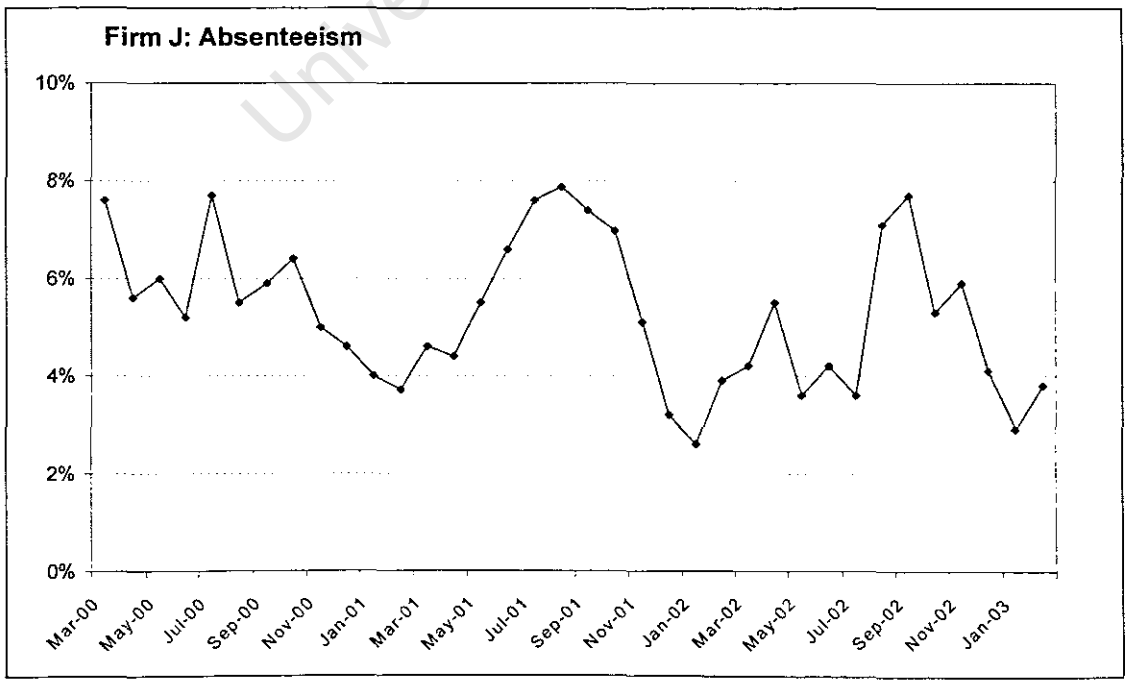

Figure 9: Firm J Absenteeism in the Rough Make-up Department

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The only discernable pattern in the absenteeism data of Firm J may be that absenteeism is high during the winter months. However, the level of absenteeism does not seem to change substantially over the research period.

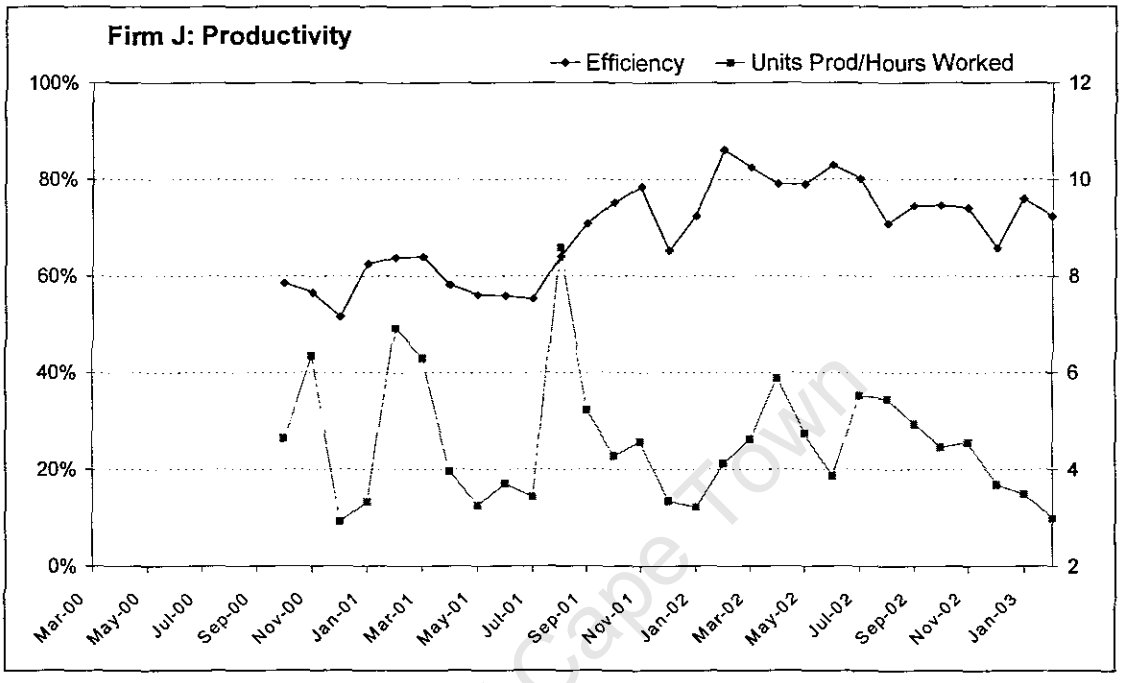

Figure 10: Firm J Productivity in the Rough Make-up Department

The efficiency data on the productivity of the RM department is unreliable because "off-standard" allowances were not booked consistently. Off-standard time included machine down-time, allowances for mending due to poor quality received from the knitting room, and various other factors. These allowances were deducted from the time worked that was used as a base against which the standard time produced was calculated as a percentage efficiency. More off-standard time was allowed for costing purposes, but this was curtailed when the production manager realised that it caused higher production bonuses to be paid out (Interview J030417WW, p. 7). As there was no record of what off-standard times were allowed at what stage, the efficiency data cannot be relied on.

The data in Figure 10 on physical output against time worked is more or less level, although highly variable for most of the research period, but then deteriorates towards the end of the research. For this reason, the RM department's productivity performance was classified as a "slight deterioration" in Appendix 4.13.

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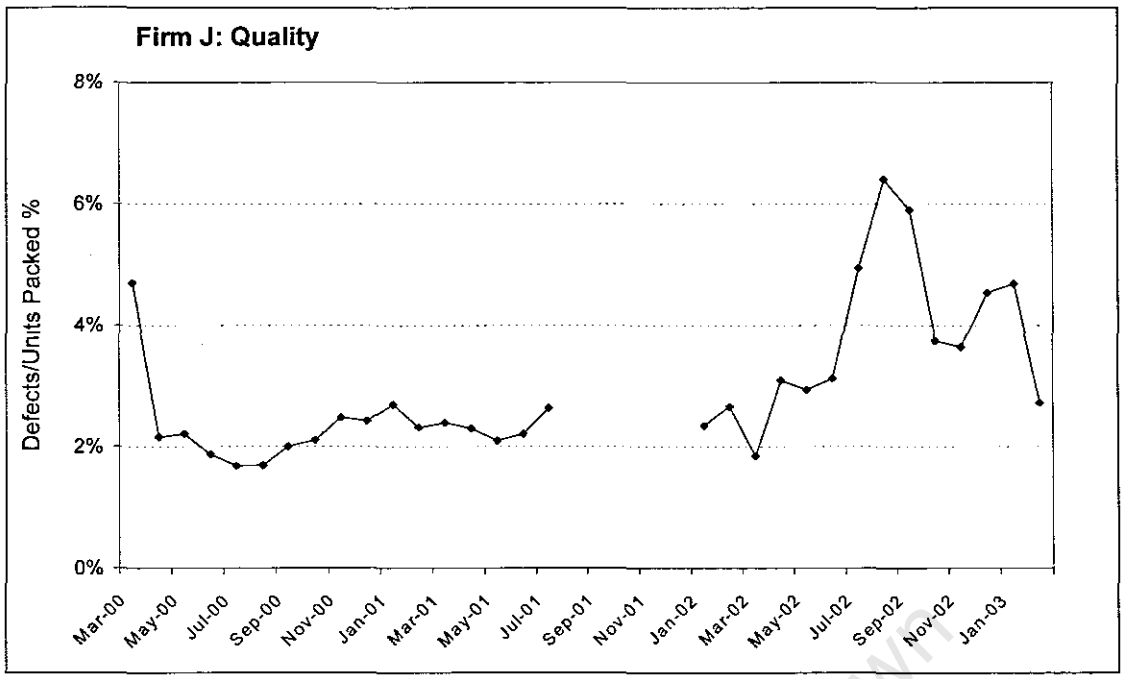

Figure 11: Firm J Quality in the Rough Make-up Department

The quality data for the RM department was obtained from defect records recorded at the next stage in the process, that of the fold-and-pack department. Only defects related to the part of the process related to RM were included in this measure. In Figure 11, a slight deterioration shows until middle 2002, when there is a serious decline in quality performance. This could be due to the problems in the raw material received by RM, but as allowances were given for the extra mending, the RM department was responsible for defects recorded thereafter. Quality performance was therefore classified as a "moderate deterioration" in Appendix 4.13.

Summary and Interpretation of Case Findings

At 2.37% off-production time in support of TBWO, Firm J was well below the average of 3.27% for the firms researched. In addition to the relatively low amount of time spent on programme implementation, the confusing message sent by the changes in style of the successive CEOs undermined the well-intentioned efforts of the production manager. Coupled with the substantial organisational disruption due to the problems in the knitting room and the later financial problems, implementation of the TBWO at the firm could be expected to suffer. Both the productivity and quality measures indicate that the performance of the RM department declined.

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Appendix 4.5: Firm K Case

Background

Firm K produced electronic components such as car alarms and immobilisers for automobiles. The firm had modern facilities that were spread over multiple sites in Pietermaritzburg, Kwazulu-Natal. It was a subsidiary of an industrial conglomerate, and over the research period, the average nominal value of production output was R12.3m per month and the average number of shop floor employees was 202.

Firm Profile

The following graphs provide an indication of how the firm's profile changed over the research period.

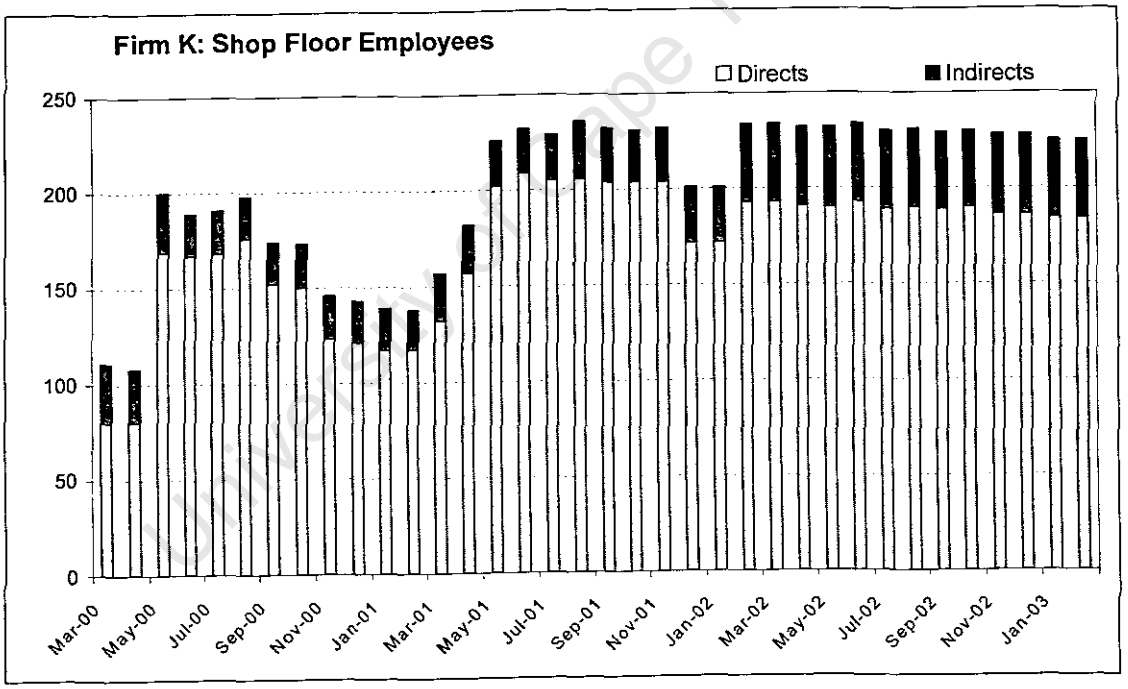

Figure 1: Firm K Shop Floor Employees (Excluding Management)

Firm K incorporated employees from the rationalisation of a local plant in May 2000, and again early in 2001 from a firm that they had bought, into their existing plants, which accounts for the step-change in headcount increases. However, thereafter, the headcount gradually decreased through natural attrition.

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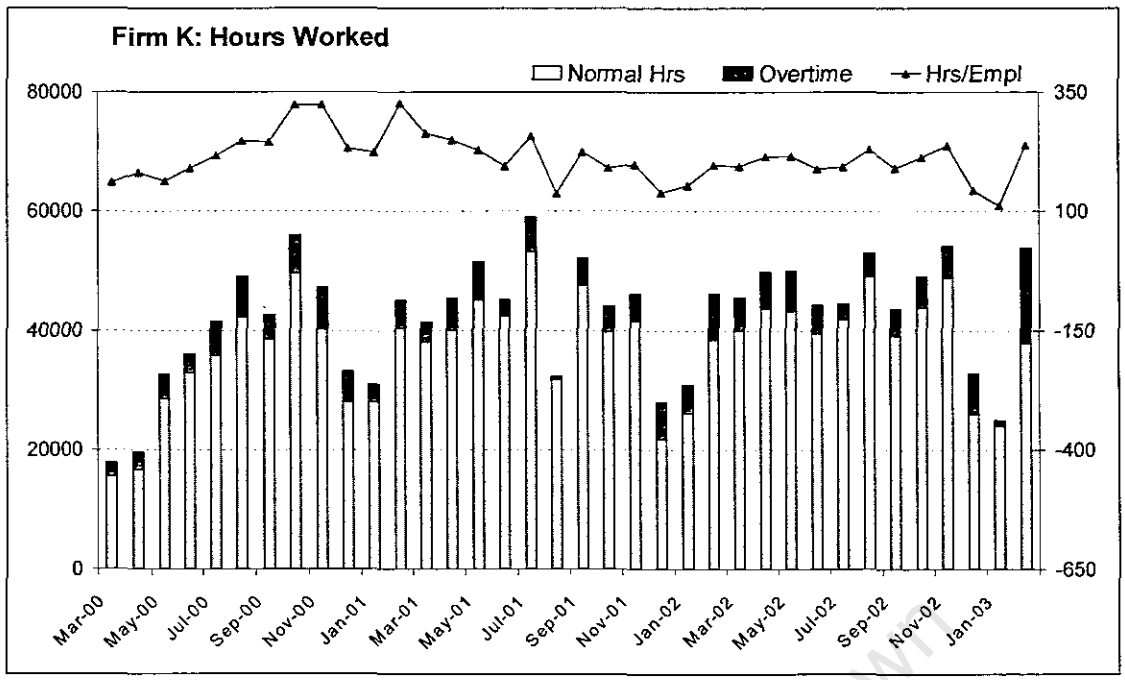

Figure 2: Firm K Hours Worked

The absolute hours worked followed a fairly stable seasonal pattern, although the hours per employee appeared to decrease, possibly due to the increased headcount.

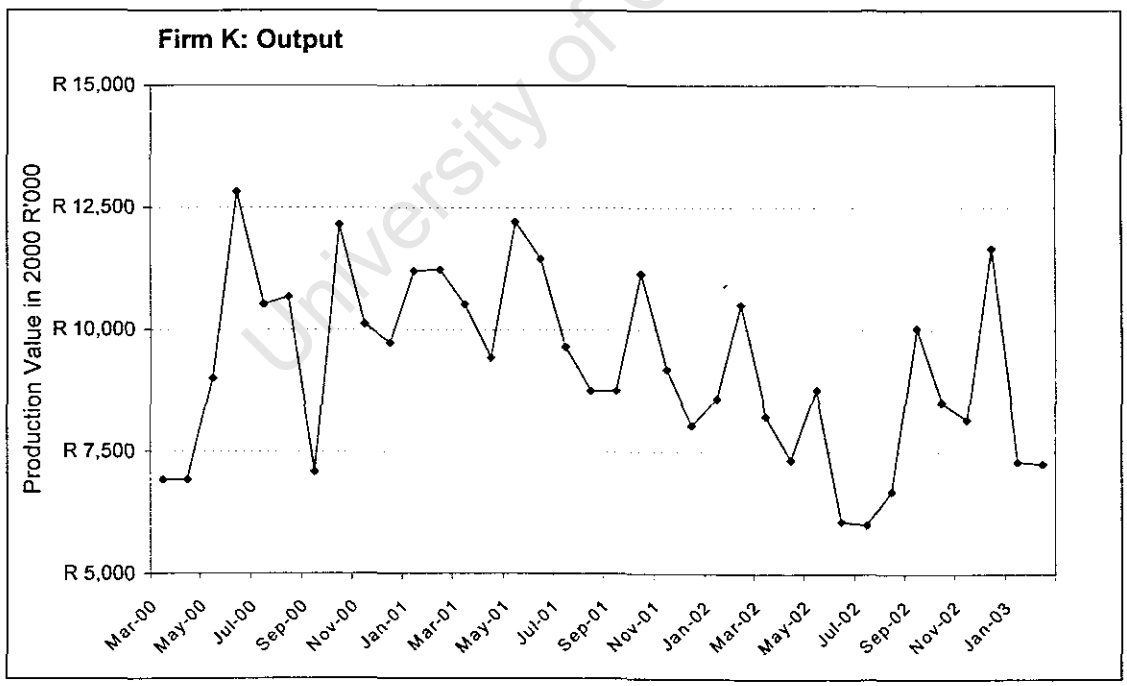

Figure 3: Firm K Output (Discounted against Firm's Price changes to Rand in 2000)

Firm K did not measure unit output as numerous components with varying work content made meaningful comparison of unit output difficult. The value of its output

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was contractually determined by the Rand/US$ exchange rate. While nominal value of its output increased during the research period, the substantial depreciation of the Rand had the effect of overstating its output. After discounting production value to Rand in 2000 terms, the value of production showed a decreasing trend over most of the research period.

Implementation of TBWO Programme

The firm's TBWO programme was initiated by the firm's operations director, but after establishing the representative steering committee which selected the WPC consultant in 2000, the firm's implementation of the programme lagged somewhat behind the other Kwazulu-Natal firms participating in the WPC. By the end of 2000, it had completed most of the orientation training of supervisors and team leaders through to senior management and was ready to implement the first teamwork training, based on the mini-business model of their consultant (Interview K001101AE, p. 1). The HR manager responsible for implementation of the programme attributed its slow progress to the fact that it had "an enormous amount to deal with" as it had taken over the automotive section of another plant, upgraded its own facility, and acquired a new plant, which was moved to Pietermaritzburg, at the same time as implementing the WPC programme (Interview K001101AE, p. 5)

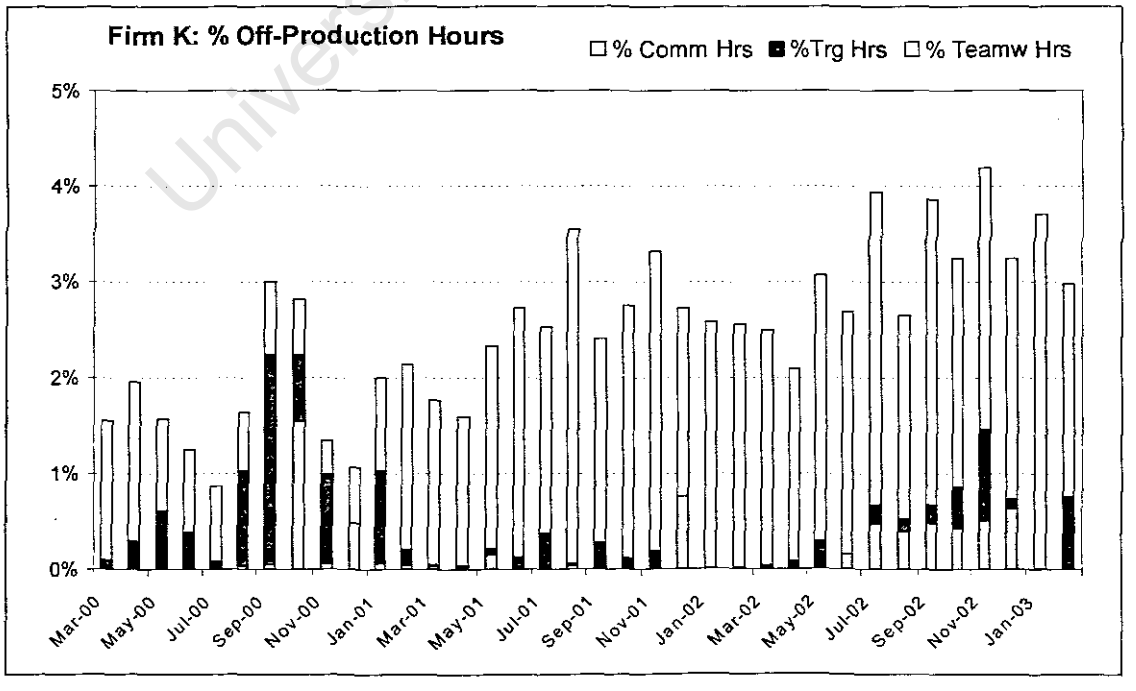

Figure 4: Firm K Hours off Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked.

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By January 2001, the first mini-businesses were set up, and the members received their teamwork training. In April 2001, the firm decided to make substantial changes to the shop floor layout. The firm had had customer-focussed cells since 1990, each making products with a variety of manufacturing requirements. Management decided to separate high and low volume production and also to re-arrange the cells around a central conveyor belt feeding the bottleneck machine (Interview K010921L&B, p. 2).

In September 2001, the mini-businesses were running well, with morning shop floor team meetings taking place regularly. The firm's orders were slightly up on forecast, although in August 2001, a strike at the auto-assemblers caused a build-up of finished product (Interview K010921L&B, p. 10). Then, in the second half of 2001, a major project to overhaul the purchasing systems, reduce the supplier base, improve forecasting and production planning, rationalise production between the three plants, introduce surface mount technology and improve process flow, and implement IT systems was undertaken (Interview K010921L&B, p. 14). This resulted in another change in the layout and composition of the mini-businesses, and the HR manager reported a lull in the firm's TBWO programme implementation because "people were very tired and very stressed still from this whole exercise" (Interview K020312AE, p.1). Not much training took place during 2002 (see Figure 4), although the team meetings were reported to be taking place regularly. In April 2002, the HR manager left the company, and shortly after that, the production manager involved in many of the process changes left as well (Interview K020312AE, p. 5).

Early in 2003, the new production manager reported that "we've actually stagnated, although what we've put in place now is working". He expressed the conviction that the programme would "take off" again as 2003 was designated company-wide as a year of consolidation (Interview K030220, pp. 2/3). He also mentioned that the team members continued to make improvement suggestions, although they were loath to use the suggestion documentation system. He regarded it as important to implement their suggestions rapidly to avoid them losing interest in making suggestions (Interview K030220BD, p. 3).

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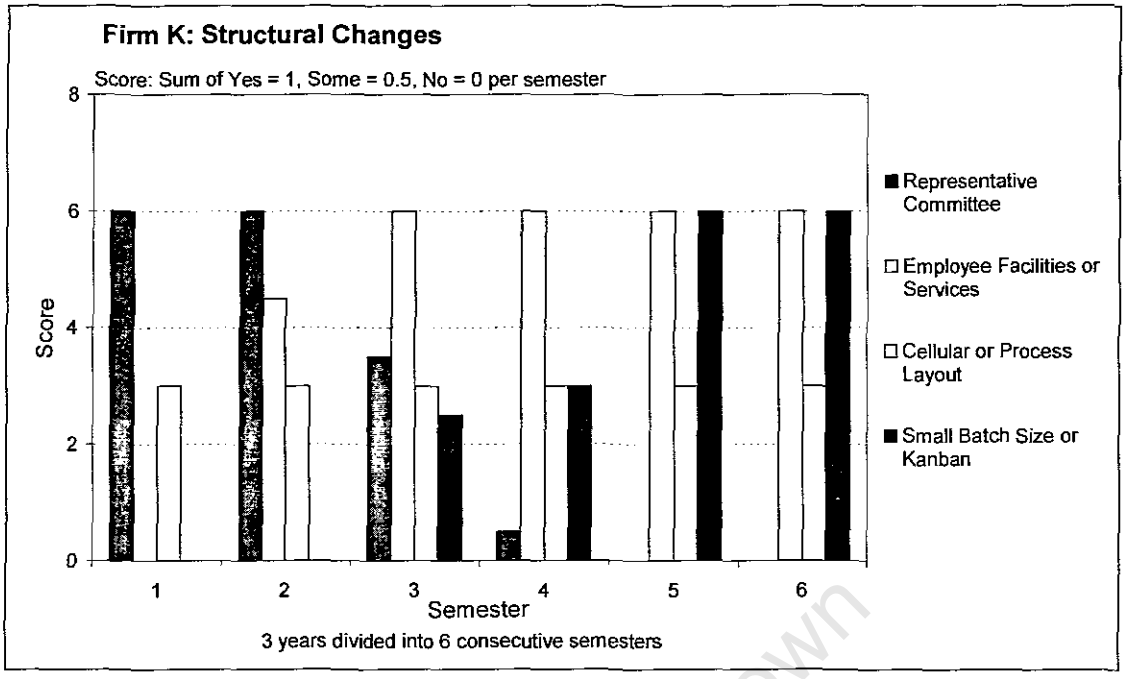

Figure 5: Firm K Structural Changes (Permanent Work System Changes)

Although the steering committee of Firm K played an important role in the early stage of the programme, they stopped meeting after the major process changes were implemented. Employee facilities at Firm K were of a relatively high standard. Being a clean-room facility, the work environment was pleasant, and an outside rest area was available for when employees were off duty. Although the existing cells were broken up, the changes to a hybrid cell/line layout improved the process flow, given that most production had to go through a bottleneck machine. In April 2001, crates were introduced to limited-production lot sizes, and in March 2002, a barcode/Kanban system was commissioned. In some ways, Figure 5 does not reflect the extent of all the structural changes, although arguably there were so many changes to the process that it became disruptive to production.

Performance Outcome Trends

These graphs depict the intermediate (WIP & absenteeism) and operational (productivity and quality) performance outcomes at Firm K over the research period.

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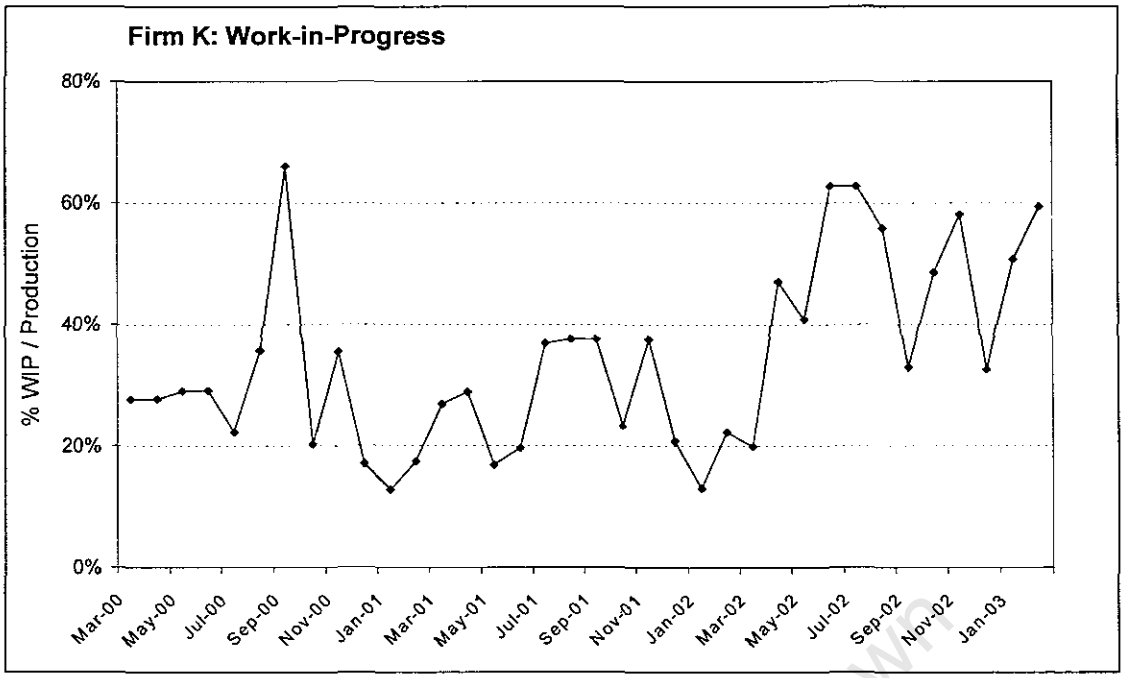

Figure 6: Firm K Work-in-Progress as a Percentage of Production Value

The percentage in Figure 6 was calculated using nominal values for both WIP and production values. The level of WIP inventory appears to have made a step-change increase early in 2002. The WIP figures were probably affected by the merging and rationalisation activities undertaken by the firm. However, on the face of it, it appears that the WIP levels of Firm K did not reduce. Both measures in Figure 7 indicate no substantial change in absenteeism.

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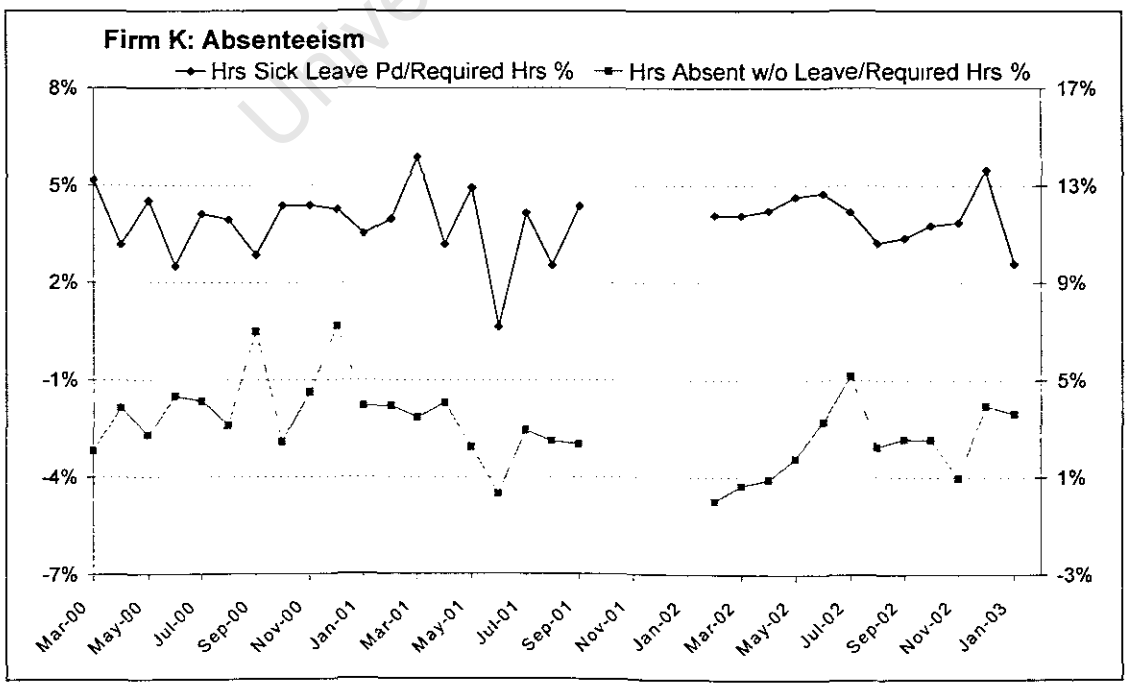

Figure 7: Firm K Absenteeism

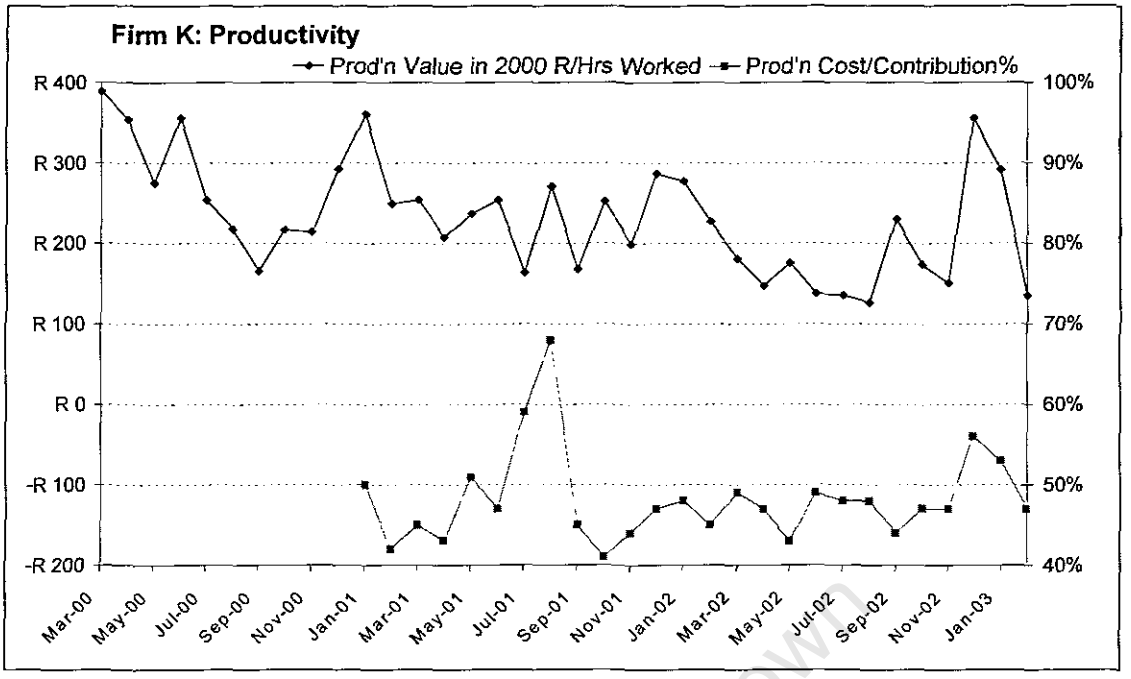

Figure 8: Firm K Productivity

It appears that the substantial process and system changes during 2001 and 2002 caused a decline in the production value per hour worked, as shown in Figure 8. However, once these changes were completed, early signs of a recovery appear in 2003. Production cost as a percentage of contribution remained fairly steady; however, due to the impact of accounting practices not related to production, this is regarded as a less reliable indicator of operational productivity. Firm K's productivity was therefore classified as a "marginal deterioration" in Appendix 4.13.

Like most component suppliers in the automobile sector, Firm K maintained relatively comprehensive data on quality. In Figure 9, below, internal failures refer to defects identified during or after the production process at Firm K, plant failures occurred at Firm K's customers' assembly plants, and field failures occurred at the end consumer. The increase in internal failures could be due to lower process capability and/or more vigilant quality inspections; however, the decreasing trend in plant and field failures indicate that overall quality performance at the firm has improved over a long period of time. Therefore, Firm K's quality performance was assessed as a "moderate improvement" in Appendix 4.13.

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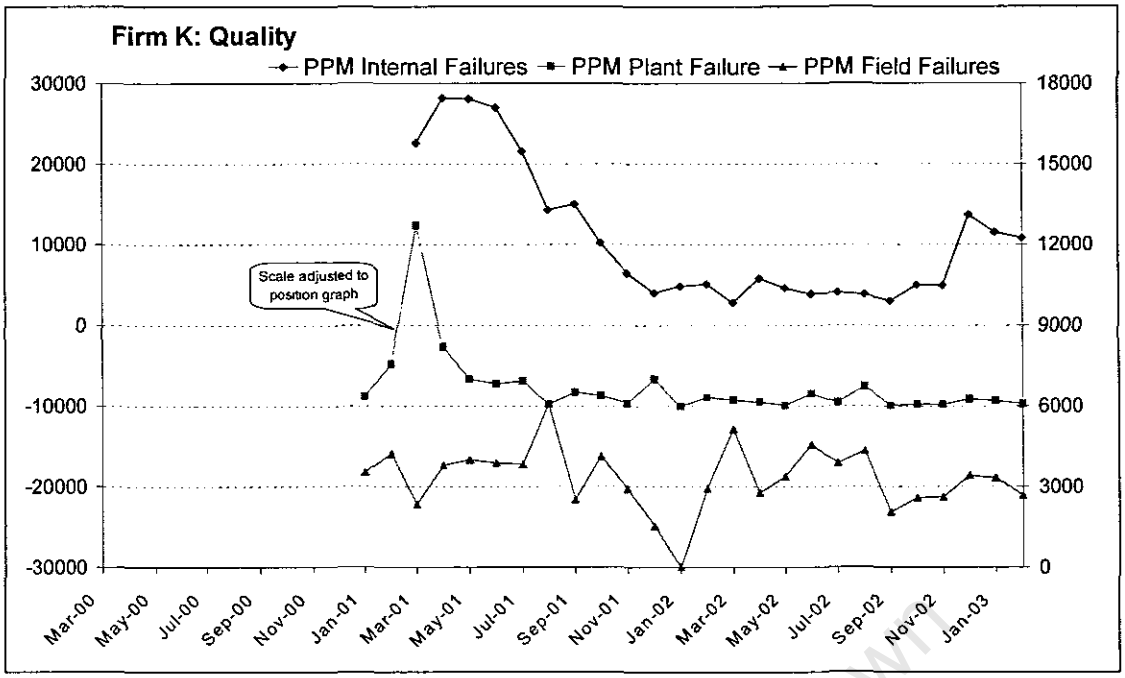

Figure 9: Firm K Quality

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Summary and Interpretation of Case Findings

Although Firm K started off with a cellular layout already in place, the firm's implementation programme suffered substantial setbacks due to the distractions of several major organisational disruptions. Apart from merging the operations of firms bought by Firm K, management also made two major changes to the shop floor layout during the research period. Training did not progress much beyond the initial basic teamwork module, and at 2.51%, Firm K's off-production time in support of TBWO activities was below the average of 3.27% for the firms researched.

Quality performance improved as can be expected given that the firm had an active quality management department. The firm's productivity appeared to decline, although it should be noted that the available measure of productivity may be affected by complications such as not having a standardised measure of output. It may be that the firm's productivity was already at a relatively high level at the outset of the research, making substantial further improvement difficult. However, the decline in productivity indicates that the most important finding for this firm should be that its TBWO programme implementation was curtailed by substantial organisational disruption, which appears to have impacted negatively on productivity performance.

Appendix 4.6: Firm O Case

Background

Firm O was a manufacturer of vehicle wiring harnesses in Stanger, a town about 80 km from Durban in KwaZulu-Natal. It was located in the town's industrial area, in a relatively new purpose-built factory. Its parent company also owned the local South African Toyota assembly plant, which was one of its most important customers. It had average sales of R7.99m per month over the research period. With an average of 515 shop floor employees, it was the largest of the plants researched. While the company has been in existence since 1989, the plant at which the research was conducted was built in 1996.

Firm Profile

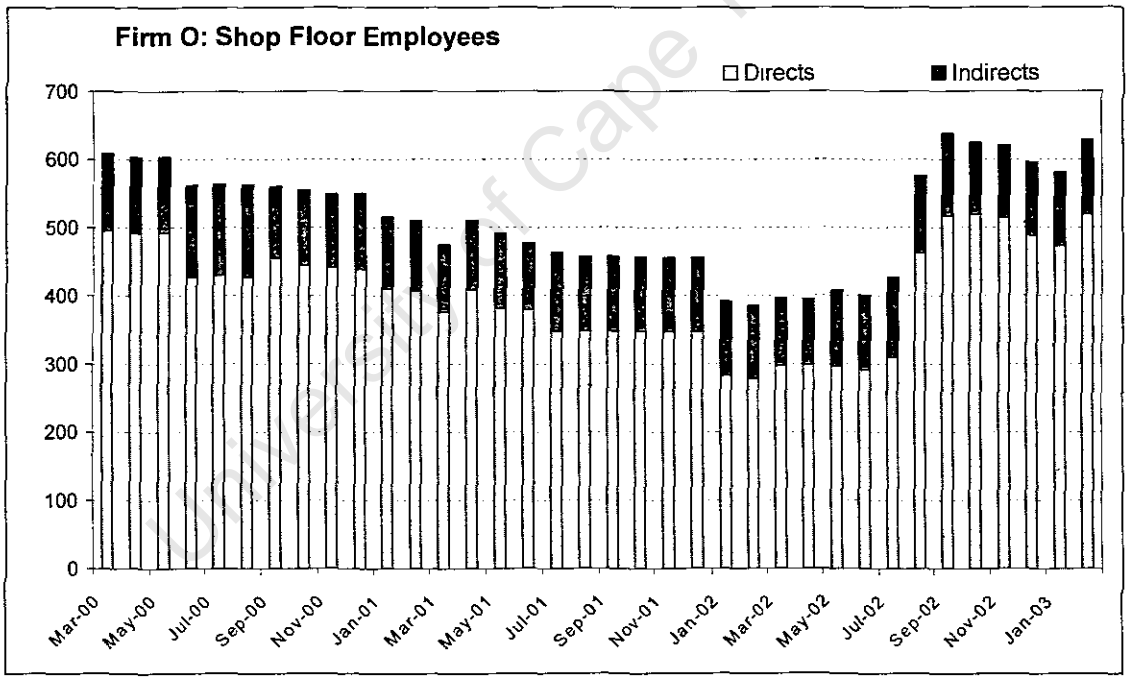

Figure 1: Firm O Shop Floor Employees (Excluding Management)

Many of the employees at the plant were Indian women. The decline in employment at the plant, shown in Figure 1, was partly due to the transfer of some production, and the associated employees, to the firm's other plant in a nearby town. However, as can be seen in Figure 4, a sharp increase in demand in September 2002 could not be met by working overtime alone (see Figure 3) and required expansion of the workforce.

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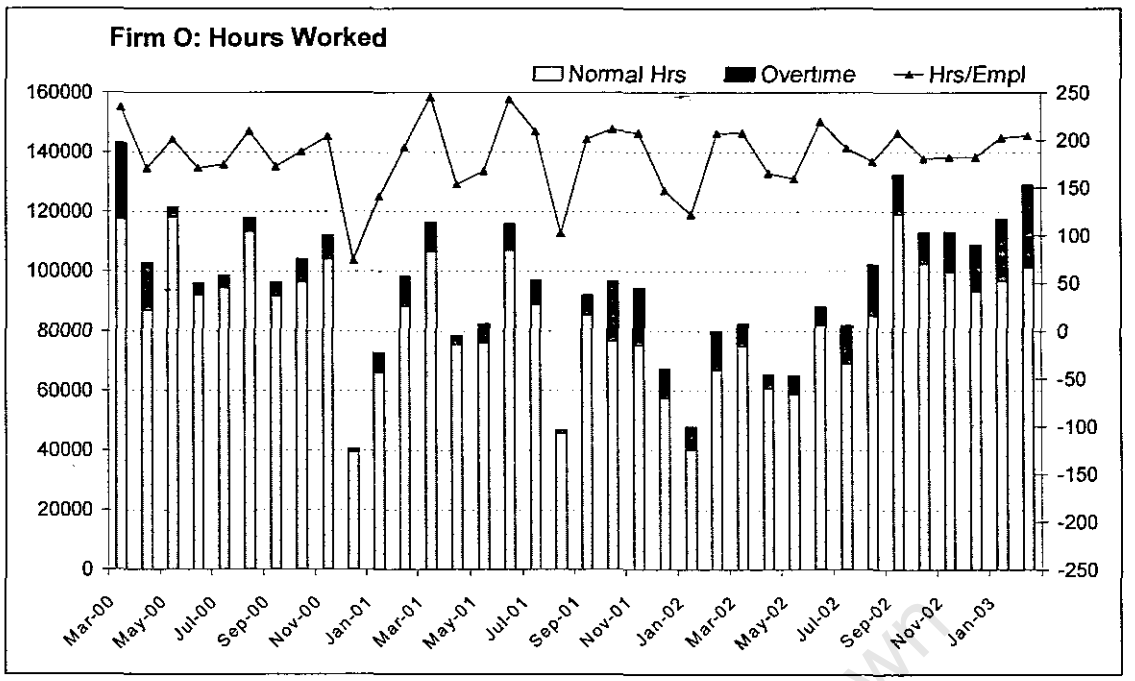

Figure 2: Firm O Hours Worked

The usual seasonal pattern of work hours can be seen in Figure 3, with the exception that short-time was worked in August 2001 during the strike at the motor vehicle assemblers at that time.

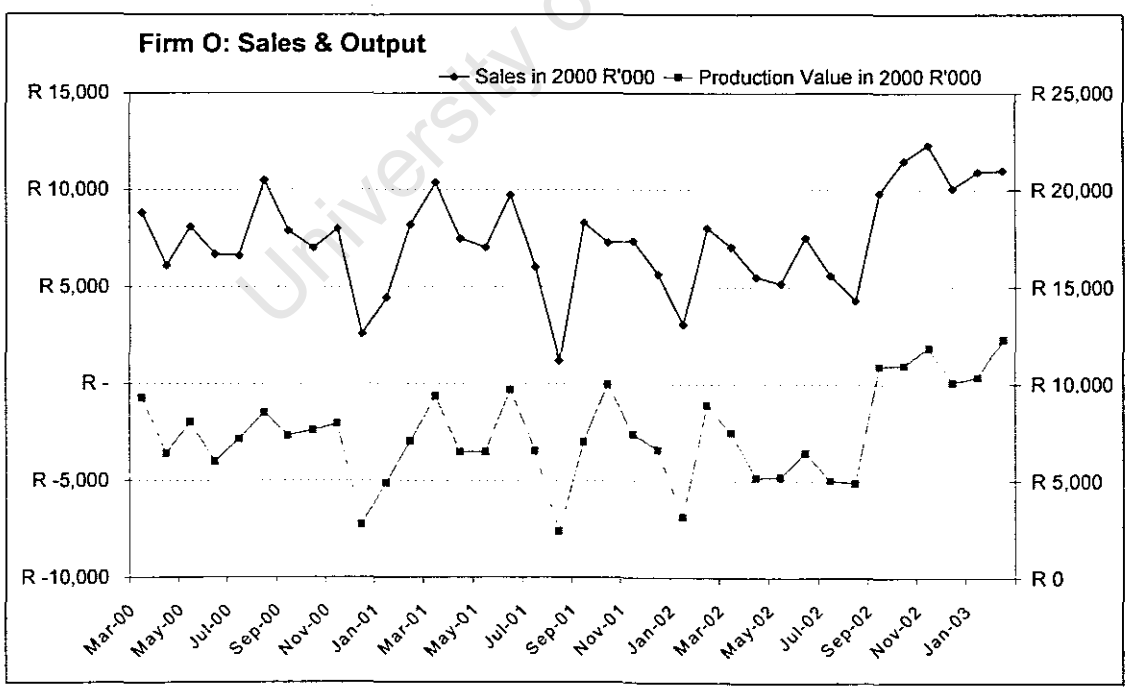

Figure 3: Firm O Sales and Output (Discounted against Firm's Price Increases to Rand in 2000)

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The firm experienced positive market conditions during the research period as the vehicle manufacturing industry in South Africa was growing due to local market growth, exchange rates favourable for exports, and supportive industrial policies. In 2002, Firm O was involved in the product development for a new model launch for Toyota, and this brought it the "largest business we've ever done" (Interview O020711NS, p. 3), as can be seen from the step-change in sales in September 2002.

Implementation of TBWO Programme

Well before the WPC project, in 1996, the plant converted from batch to Kanban production with help from the Toyota Support Group, and it also had a Bright Ideas programme, whereby implementation of suggestions from individuals on the shop floor was facilitated by a dedicated champion (O020711MS, p. 1). By 1998, the Bright Ideas initiative had declined because the champion left, and when the firm's management became aware of the WPC project, they decided to participate. Until then, the firm's initiative had a somewhat technical approach, inherited from the Toyota Support Group, and the WPC project's emphasis on human resource development was welcomed (Interview O010920NS, p. 2).

Figure 4: Wire Harness Production at Firm O

The first high-profile initiative under the auspices of the WPC project was the revamping of the canteen in Sept/Oct. 2000, which was almost entirely managed by a shop floor employee committee. The administrative staff also participated in a similar way in the designing of a new layout of the offices (Interview O010305Y, p. 1). Thereafter, the firm used CD as their WPC consultant and, after training senior and middle management, used the CD approach to implement TBWO. The firm employed

full-time facilitators to teach the various teamwork and problem-solving training modules in the CD programme, in parallel with the process of implementing team meeting areas, and introduced performance charts throughout the plant by the middle of 2001 (Interviews O001031YBM, p. 6 & O010920NS, p. 7).

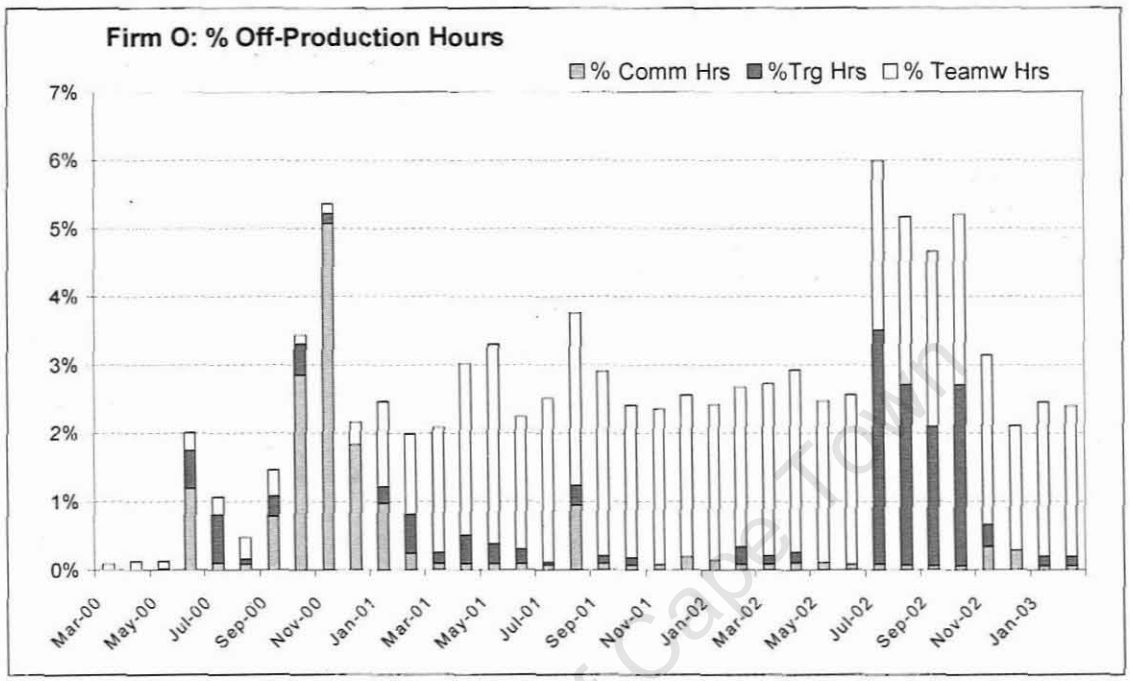

Figure 5: Firm O Hours off Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked

As can be seen from Figure 5, there was substantial communication and consultation with the shop floor employees at the end of 2000 before the shop floor team meetings started early in 2001. Throughout the research period, training on teamwork, problem-solving, 5S house-keeping, goal alignment and quality assurance took place, and from July to October 2002, many new employees received job skill training in anticipation of increased sales.

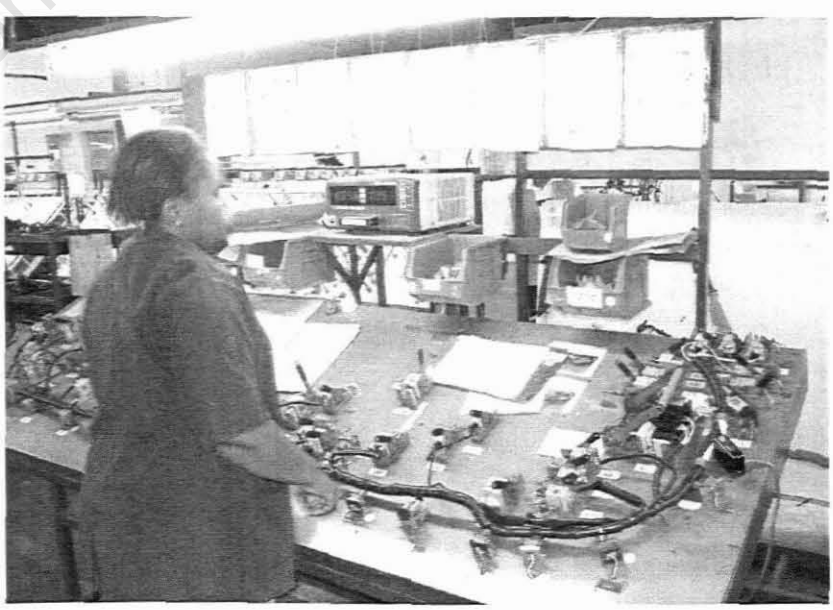

Figure 6: On-line Quality Assurance Test Bench at Firm O

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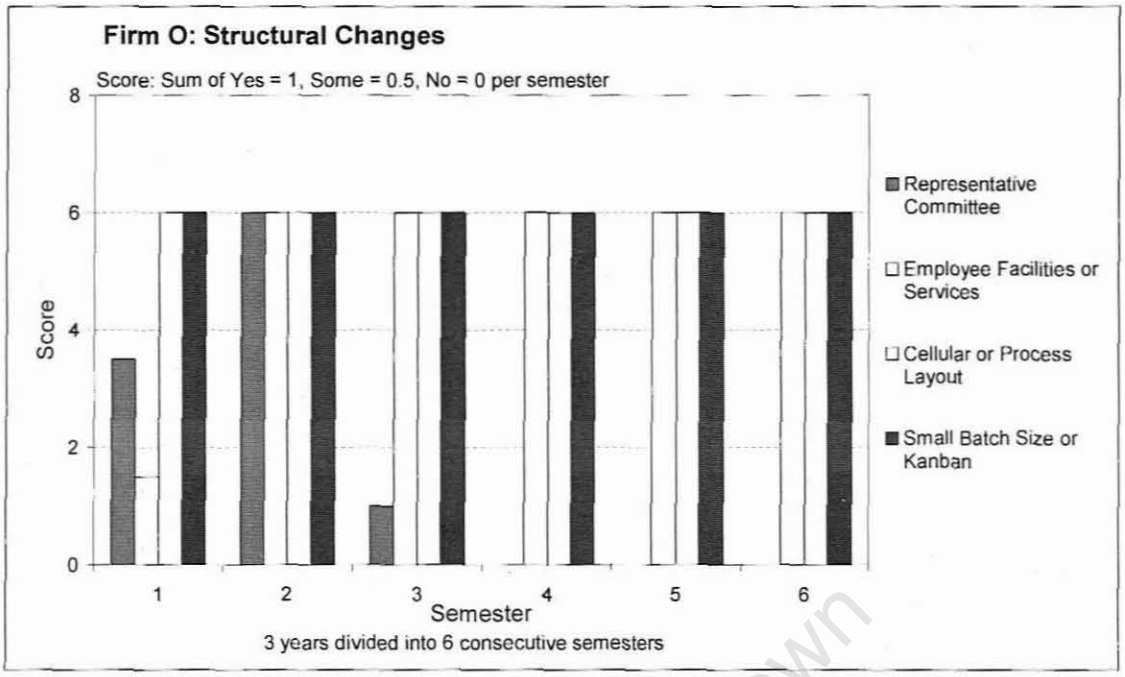

Figure 7: Firm O Structural Changes (Permanent Work System Changes)

Like some other firms participating in the WPC, Firm O's steering committee was also absorbed into the permanent cross-functional meeting of team leaders and line management as after the initial programme implementation issues had been dealt with, it was left with little to do. The firm had a cellular layout and Kanban system before the research started, although the firm did build stock briefly in the middle of 2001 in anticipation of disruptions when some production capacity was moved to its other plant (Interview H010920NS, p. 4).

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Figure 8: JIT Despatch (left) and Kanban Racks (right) at Firm O

Throughout the programme implementation period, top management support was unequivocal, with the operations director said to "always talk Workplace Challenge, so for him it's eat, drink, smoke, you know, that kind of thing" (Interview O010920NS, p. 11). Managers acted as meeting facilitators, and in addition to a quality manager, the firm also appointed a full-time lean manufacturing manager (Interview O030221JC, p. 1). In March 2001, five of the firm's managers went on an industrial study tour to Japan, where seeing the TPS in action reportedly made a big impact (Interview O010920NS, p. 1). The shop floor team meetings and higher level cross-functional team meetings became entrenched in the way the firm operated (Interview O020711NS, p. 3). Overall, this led to significant buy-in by the shop floor employees into the programme (Interview O020711RK, p. 1 & O030221JC, p. 5).

Figure 9: Team Meeting Area at Firm O

However, the programme implementation also suffered from disruptions. The move of the crimping facility to the other plant made training difficult (Interview O010920NS, p. 4) and the implementation of employee suggestions declined when the shop floor layout changed to allow for new product introductions and when new employees, unfamiliar with process improvement, joined the firm (Interview O020711-RK, p. 1).

Performance Outcome Trends

These graphs represent the intermediate (WIP & absenteeism) and operational (productivity and quality) performance outcomes at Firm O over the research period.

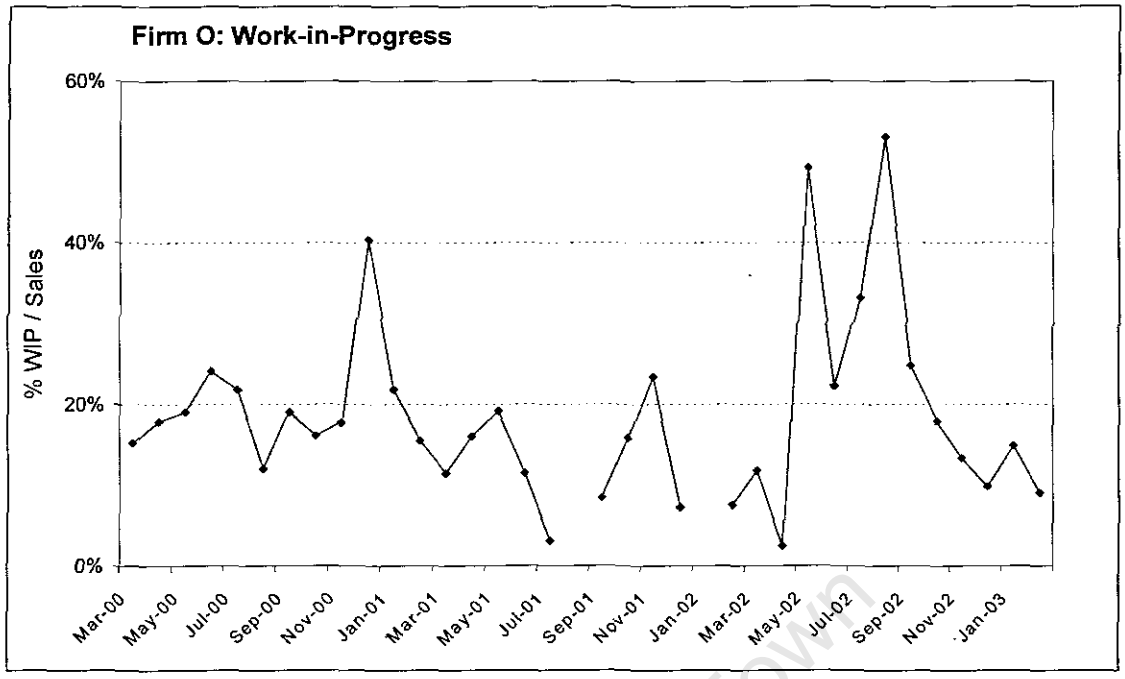

Figure 10: Firm O Work-in-Progress as a Percentage of Sales

No explanation is available for the temporary increase in WIP during 2002. However, it seems to have returned to previous levels by early 2003.

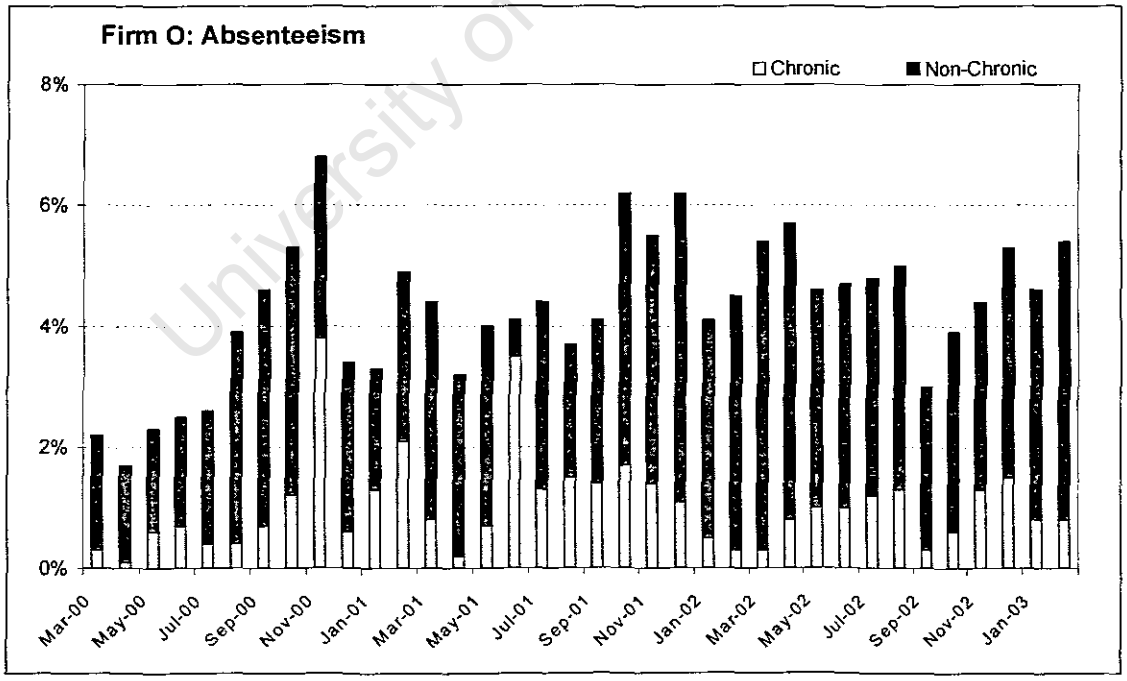

Figure 11: Firm O Absenteeism

Firm O separated employees absent for lengthy periods due to maternity or long convalescences from those who were absent for short periods. It is not known whether

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the low absenteeism at the outset of the research period was temporary. The non-chronic absenteeism appears to be on a slightly worsening trend.

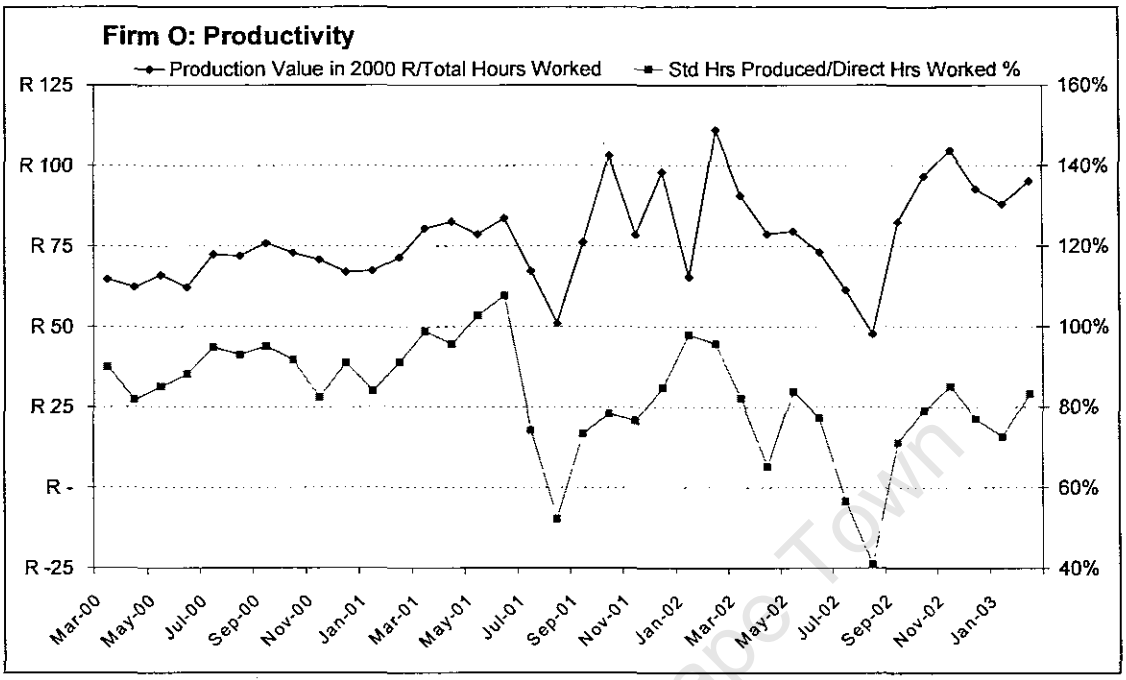

Figure 12: Firm O Productivity

As the largest firm researched and being subject to a corporate reporting requirement, Firm O had quite a sophisticated monthly performance reporting system. There was therefore no basis for questioning the reliability of the two available productivity indicators. As they are indicated to be approximately similar, but show opposing trends of improvement and deterioration, probably the best way of reconciling the differences was to interpret the productivity performance as "level", as reported in Appendix 4.13.

In Figure 13 below, "external ppm" refers to defects identified at Firm O's largest customer, Toyota, whereas "internal ppm" refers to defects found on Toyota products before they left Firm O's factory. The trend of external ppm shows a substantial improvement, although as the internal ppm measure does not decline, this may be due to vigilant quality assurance in Firm O's plant rather than to improved process capability. A "substantial improvement" in quality performance was reported in Appendix 4.13 as the external defect measure shows that the problem encountered in July 2002 did not materially affect the customer and the internal defect measure shows that recovery was under way.

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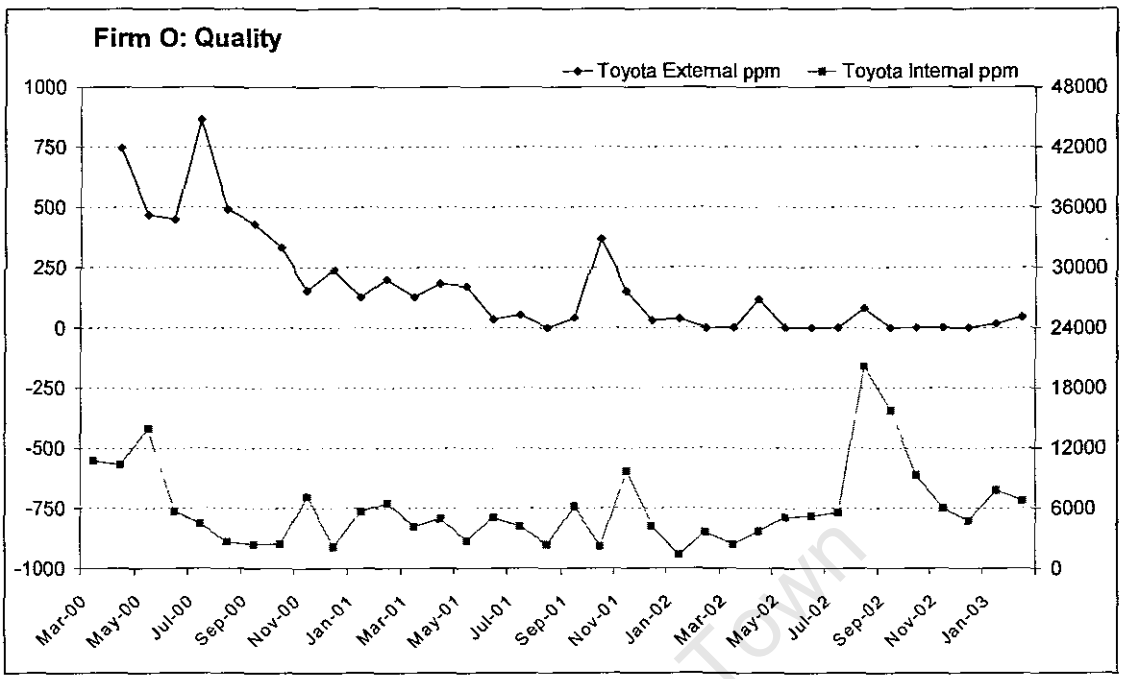

Figure 13: Quality

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Summary and Interpretation of Case Findings

Firm O exhibited many of the programme implementation characteristics associated with effective implementation. Circumstances such as

- the repetitive nature of the process;
- familiarity within the car manufacturing sector with TBWO;
- technical support from its major customer/parent corporation; and
- the foundation laid by the firm's initiatives prior to the WPC project,

and practices during programme implementation such as

- management commitment to the programme;
- staff development (e.g., the Japan study tour);
- extensive communication and consultation with employees;
- appointment of lean manager and permanent training facilitators;
- shop floor layout changes to improve process flow;
- sophisticated quality management;
- emphasis on process improvement projects; and
- institutionalization of TBWO practices

made for effective programme implementation.

However, the programme implementation suffered from

- disruption from the moving of production capacity to another plant;
- the August 2001 strike at auto-assemblers;
- decline of the Bright Ideas suggestion implementation scheme;
- the introduction of new product lines;
- the influx of new staff to meet increase in demand;
- turnover of training staff; and
- below average proportion of time off production of 2.63% for TBWO supporting activities.

The performance outcome on productivity became more variable from mid 2001 and cannot conclusively be classified as either an improvement or a deterioration because of conflicting trends from two performance indicators. However, quality performance showed a clear improving trend. The management regarded the TBWO in the plant as an important reason why they were able to weather the organisational disruptions relatively well (Interview O020711RK, p. 3), but the disruptions also seem to have affected productivity performance negatively.

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Appendix 4.7: Firm E Case

Background

Firm E was a small footwear producer, mostly of fashionable ladies shoes, located in Durban. It was a family business, and at the time of the research, it was managed by the daughter of the original owner, who had taken over after her father went into semi-retirement. Average sales were R183,531 per month, and it had an average of 30 employees over the research period. Market conditions in the footwear sector were very difficult over the research period, and the firm closed down early in 2002. Therefore, data for only 24 months are available for this firm.

Firm Profile

The following graphs provide an indication of how the firm's profile changed over the research period.

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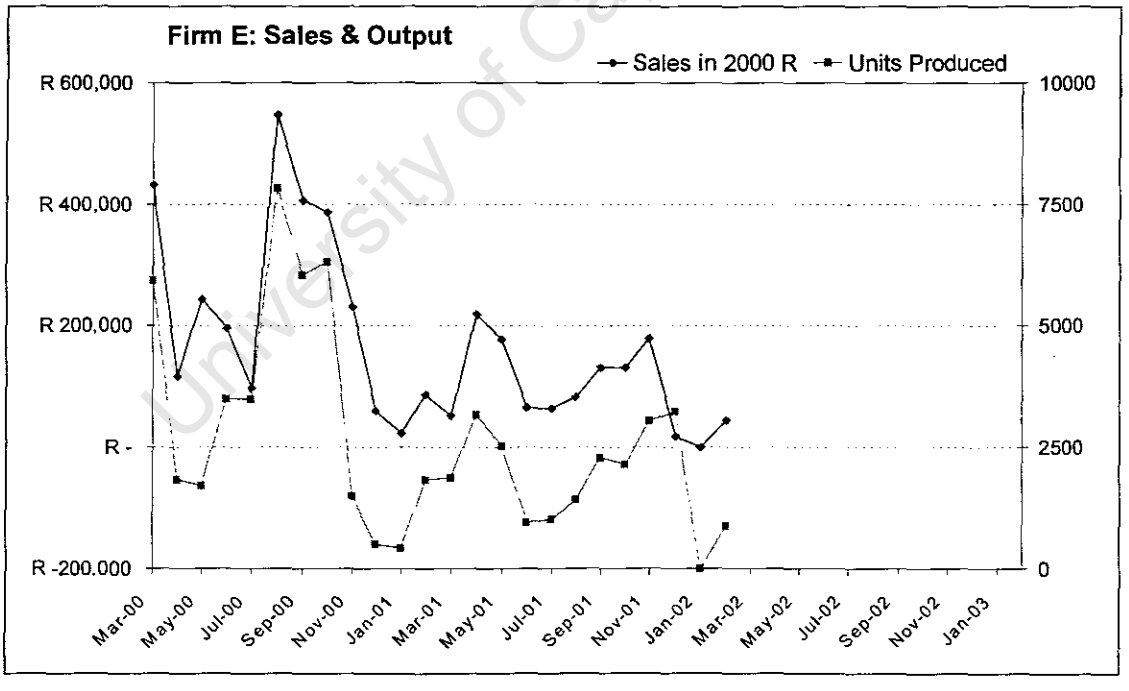

Figure 1: Firm E Sales (Discounted against firm's price increases to Rand in 2000) & Output

The decline in the firm's sales and output is evident from Figure 1. This was primarily due to price competition from shoes imported from the East. The firm's agent was replaced in September 2001, but this did not arrest the decline in sales (Interview

E010913KA, p. 13). Another strategy that the firm opted for to deal with the situation was to improve internal operations through participation in the WPC.

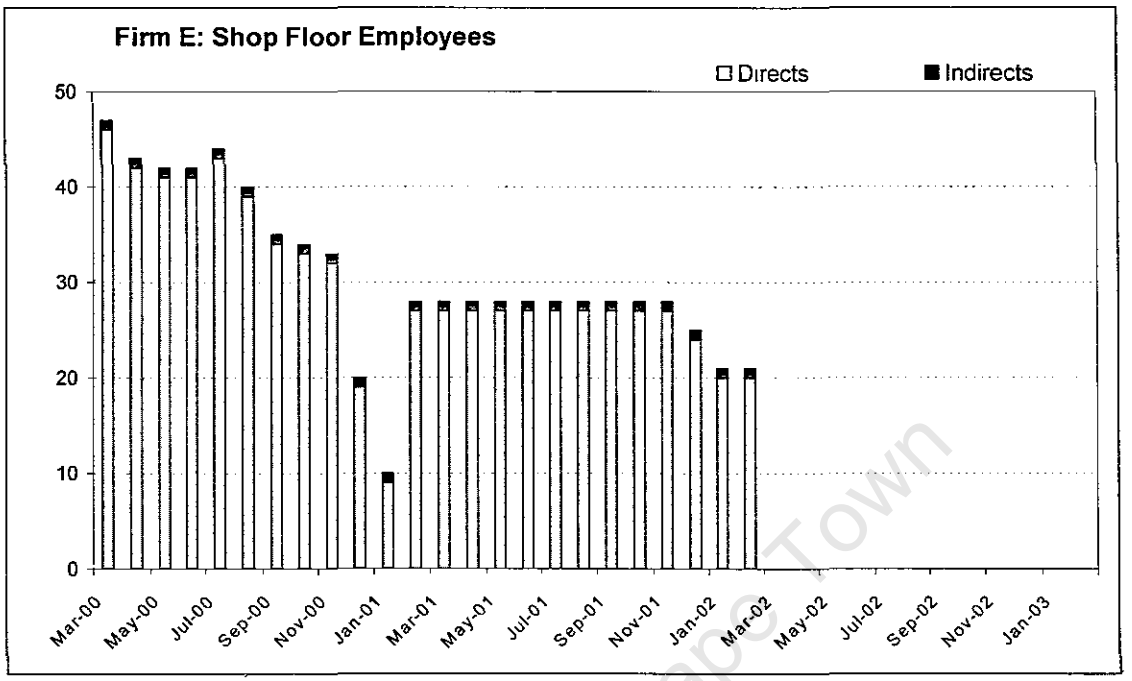

Figure 2: Firm E Shop Floor Employees (Excluding Management)

The decline in employment (Figure 2) and hours worked (Figure 3) is commensurate with the firm's decline in sales.

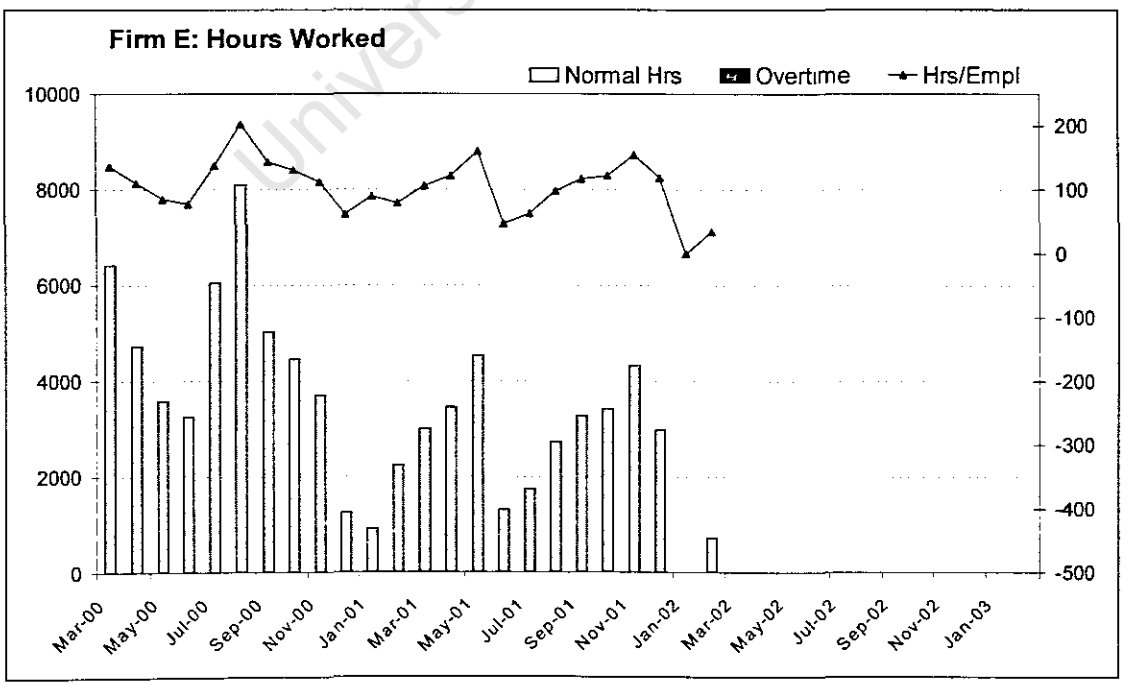

Figure 3: Firm E Hours Worked

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Implementation of TBWO Programme

Firm E's TBWO programme started in July, 2000 with training for the employees in basic business principles. It was followed up with training to prepare the team leaders for the organisational changes that were to follow later in 2000 (Interview E001030KA, p. 1). From February to August, 2001, an experienced footwear industry consultant planned and implemented substantial changes to the shop floor layout to improve process flow, introduce one-piece production, and improve quality management and other operational systems. He spent a lot of time on the shop floor implementing and training the employees in the new way of working (Interview, E010307KA, p. 2).

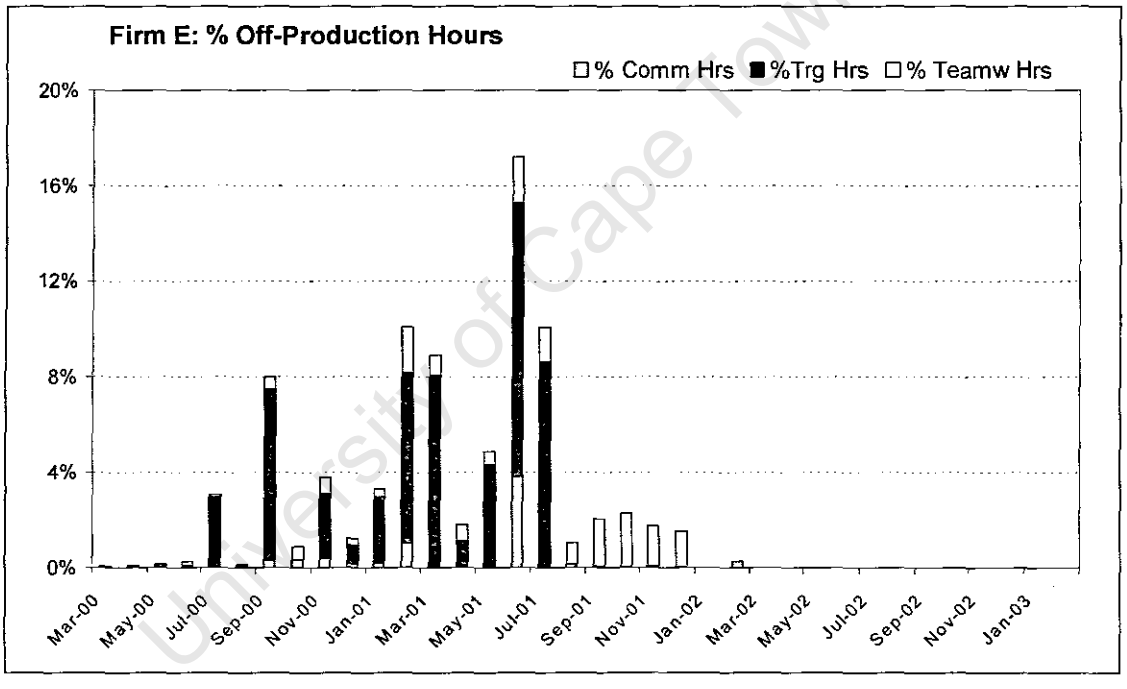

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Figure 4: Firm E Hours off Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked.

Comparison of Figures 3 & 4 shows how, during a short time in July, 2001, training was stepped up to put the employees' idle time to good use (Interview E010913KA, p. 7). Because of the small size of the firm, communication with employees took place informally. While regular daily meetings were held with team leaders, the shop floor teams did not meet formally as issues were dealt with between other tasks.

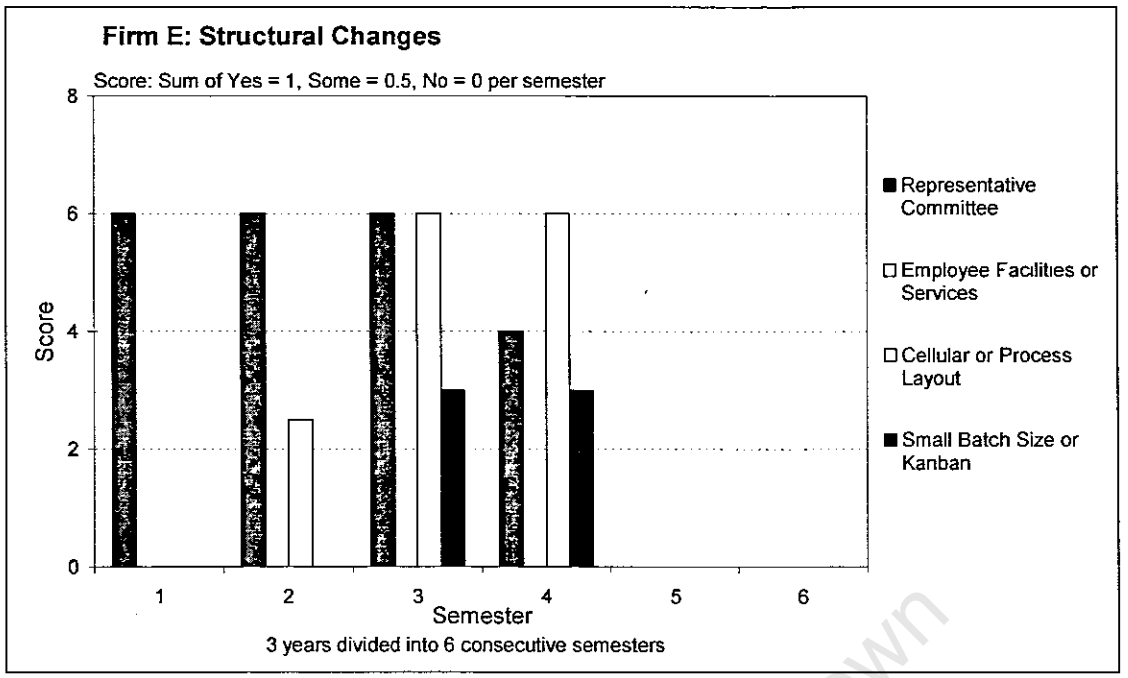

Figure 5: Firm E Structural Changes (Permanent Work System Changes)

Figure 5 reflects the introduction of a "ring" system (which is the terminology used for cellular manufacturing in the footwear industry) and production of one piece at a time in lots synchronised with the order book (Interview E E010913KA, p. 1). After these process changes were made, the firm's TBWO programme went into consolidation mode.

However, there were problems with material supplies and quality of workmanship, which caused the firm's deliveries of Christmas orders to be late, which, in turn, caused cash-flow problems (Interview E020305YP, p. 2). In March 2002, the firm resorted to stopping its own production and outsourcing to avoid cost overruns. By this time, it was apparent that employees at the firm were quite badly demoralized as they did not improve their performance in an attempt to stave off the outsourcing (Interview E020305YP, p. 4). By April 2002, operations ceased completely and the firm faced closure (Interview E020422, p. 1).

Performance Outcome Trends

These graphs report the intermediate (WIP & absenteeism) and operational (productivity and quality) performance outcomes at Firm E over the research period.

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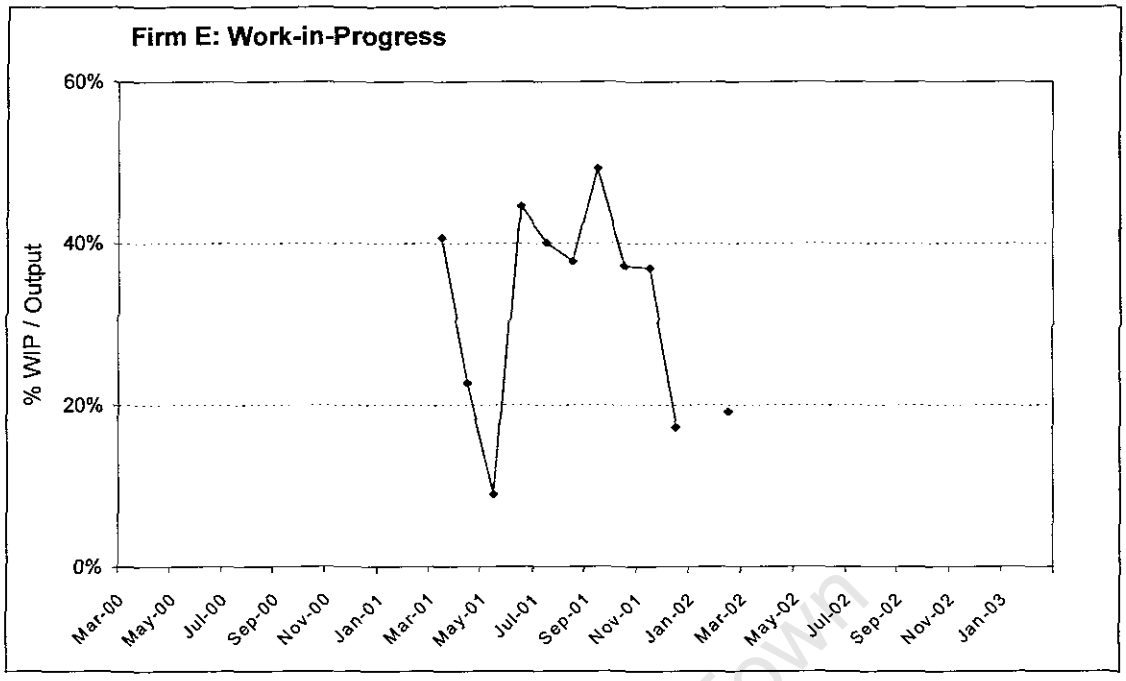

Figure 6: Firm E Work-in-Progress as a Percentage of Output

Firm E started measuring WIP as one of the performance measures implemented as part of its TBWO programme. However, as Figure 6 shows, too little data was collected to determine a trend on this measure.

No absenteeism figures were available for the firm due to the flexible nature of its employment practices.

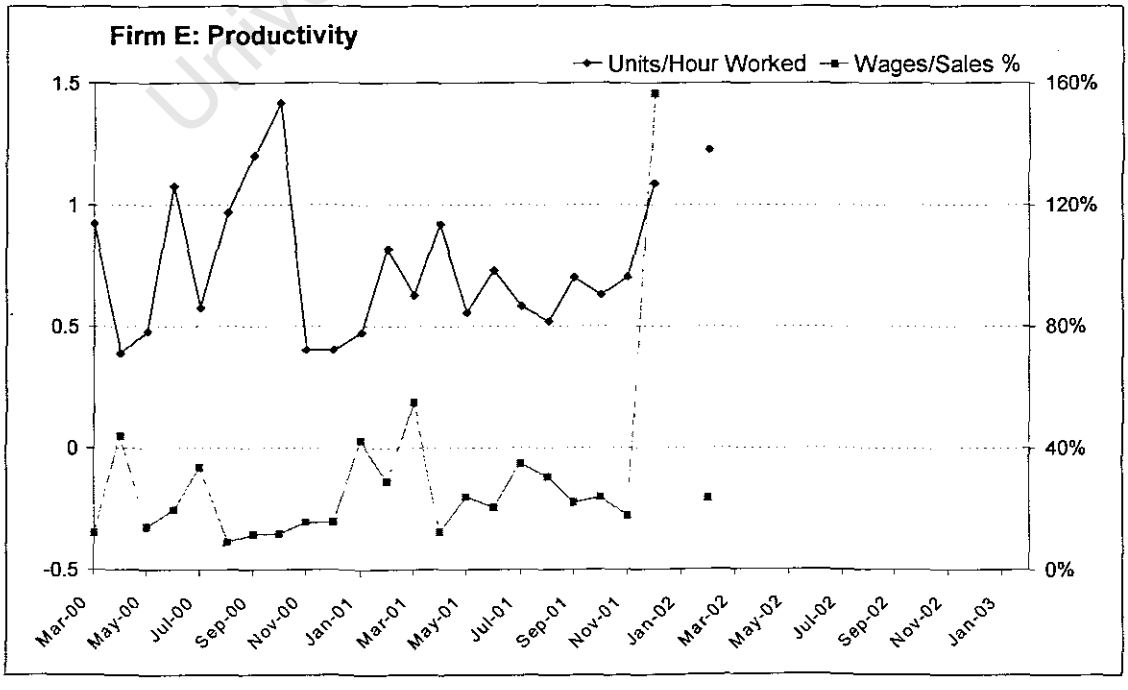

Figure 7: Firm E Productivity

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The firm's productivity performance appeared to remain at more or less the same level, apart from some anomalous data prior to ceasing production before the firm was liquidated. It was classified as having "level" performance in Appendix 4.13.

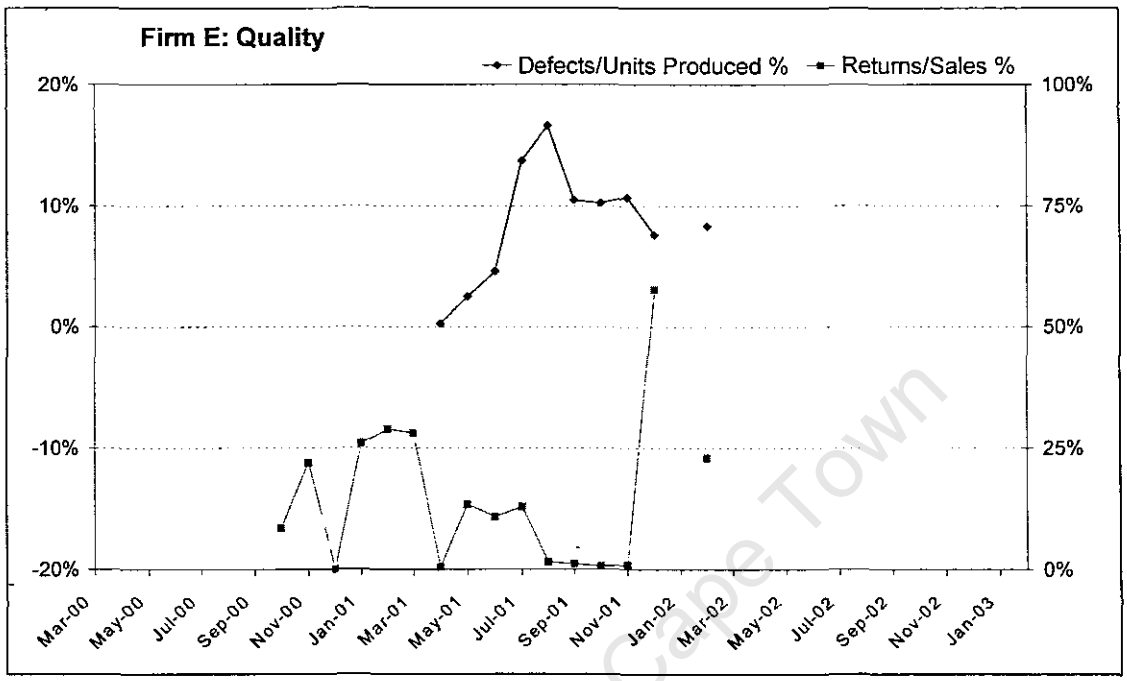

Figure 8: Firm E Quality

No assessment is possible with the available quality data as the data series is too short. The data is also likely to be unreliable due to teething problems during the start-up of quality data collection. Therefore no assessment was made of the firm's quality performance for Appendix 4.13.

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Summary and Interpretation of Case Findings

At 3.60%, the percentage of off-production time to support TBWO activities by Firm E was slightly above average. While the management of the firm were enthusiastic about their TBWO programme and implemented substantial process changes, the firm's difficult circumstances overshadowed the programme. Being a very small firm, the limited available resources seems to have been consumed by the organisational disruption which goes with short-time due to poor demand, rather than being invested in effective implementation of its TBWO programme. It appears that the workforce was also demoralized by chronic job insecurity, which may have undermined their willingness to put in the effort to make the workplace changes deliver improved performance.

Productivity did not improve, and although the quantitative quality data is inconclusive, the fact that quality problems were reported by management throughout the research indicates that quality performance also did not improve. This case also shows that TBWO is unlikely to be an effective strategy to counter market conditions that are fundamentally not viable.

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Appendix 4.8: Firm X Case

Background

Firm X was an engineering firm specializing in stainless steel metal fabrication. They undertook two types of work: design and fabrication of large turnkey installations for industries such as food processing, wine production and pharmaceutical manufacture; and one-off or batch production of parts and components for other intermediate producers. The average number of shop floor employees over the research period was 54 and the firm's average sales figure was R1,53m p.m. The firm was established a few years before the WPC project, when the fabrication department of a bottling equipment producer split off from what then became one of its major customers. It is located in an industrial area in Paarl, a town about 100km from Cape Town.

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The firm was led by a dynamic young managing director, who played a leading role in establishing the firm. Although a relatively small firm, most of the employees were technically well qualified and the firm had a particular strength in the area of design and project management. Figure 1 shows the layout of the shop floor as a typical engineering shop with the various machining centres located around a central aisle. Raw materials came in from the laser cutter (off the picture below right), went through the required machining processes to finish at the far end of the aisle (top right) and back out to Despatch, to the right of the picture.

Figure 1: Firm X Shop Floor Layout

Firm Profile

The following graphs provide an indication of how the firm's profile changed over the research period.

Figure 2 shows that employment at Firm X increased from just under 40 shop floor employees to about 60, over the 3-year research period. The employees were mostly skilled artisans as the work entailed quite diverse engineering and fabrication, which was mostly done by hand because of the non-repetitive project-type work being undertaken by the firm.

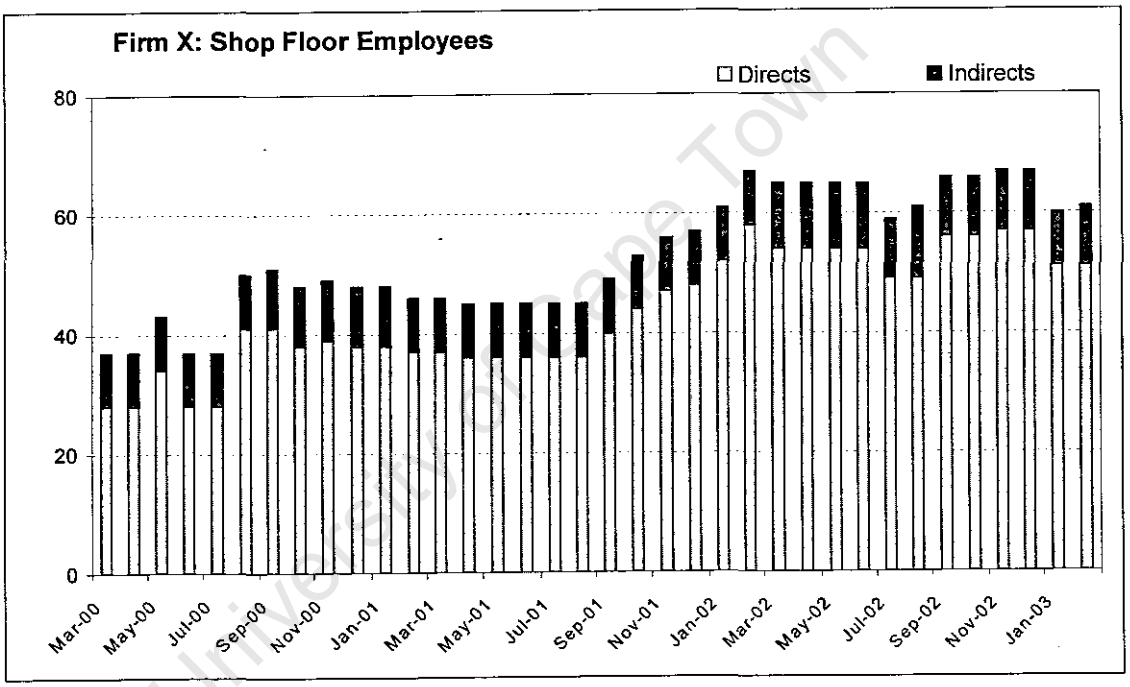

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Figure 2: Firm X Shop Floor Employees (Excluding Management)

The total hours worked at the firm increased in line with the increase in employment. Therefore, hours worked per employee did not increase substantially, except for late in 2002, when a lot of overtime was worked to complete a big project.

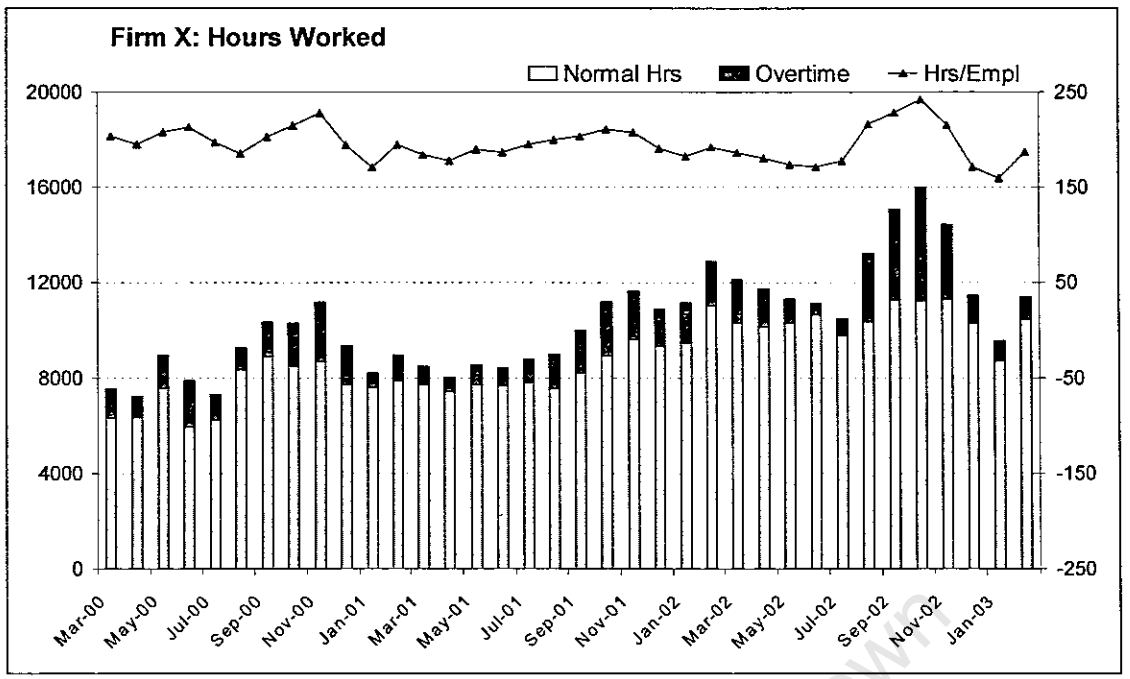

Figure 3: Firm X Hours Worked

Figure 4 shows a substantial increase in the sales of the firm over the research period although it fluctuated quite a lot due to the lumpy nature of project work.

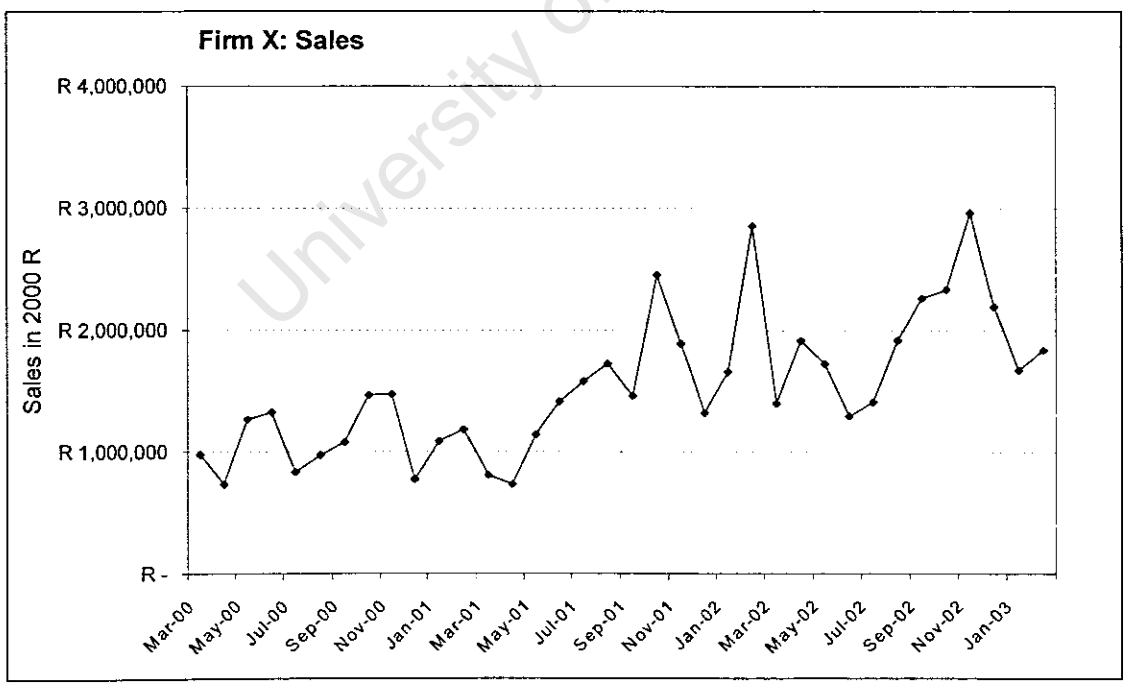

Figure 4: Firm X Sales (Discounted against firm's price increases to Rand in 2000)

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Implementation of TBWO Programme

The following graphs provide an indication of the activities undertaken by the firm to implement TBWO.

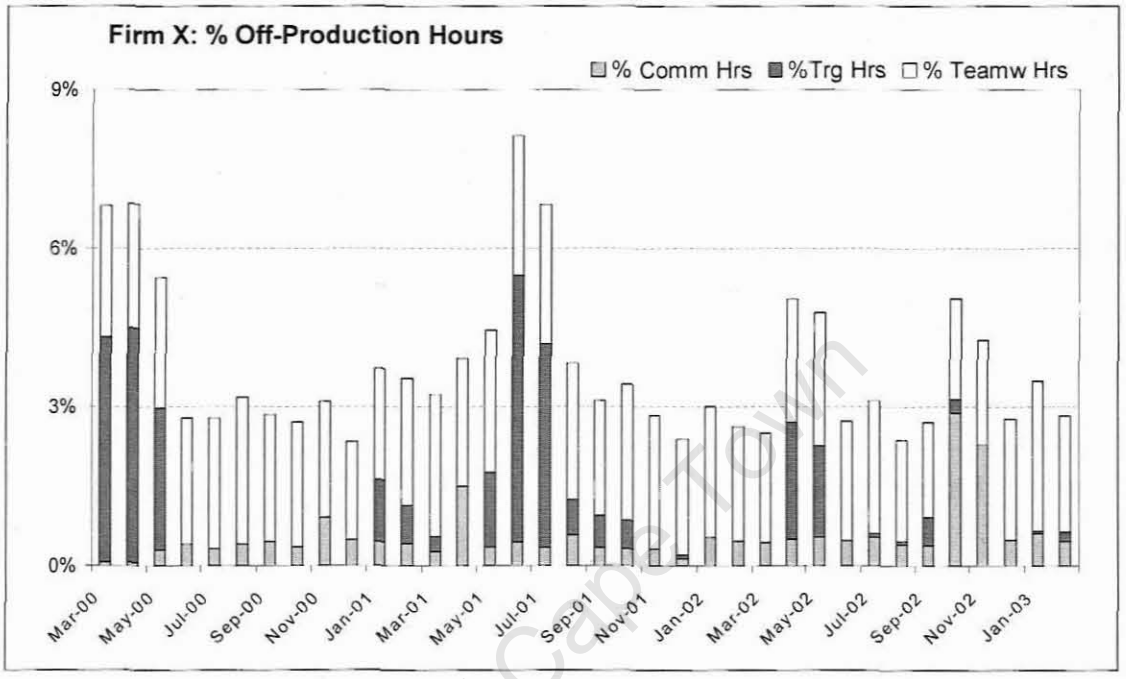

Figure 5: Firm X Hours off Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked.

Firm X undertook a fair amount of training at different times of the programme implementation, as shown in Figure 5. The firm had an unusual communication/teamwork meeting arrangement in that the shop floor teams met at the start of each working day around the central notice board on the shop floor, where the production manager briefed all shop floor employees on issues of the day. Then the team met for 10-15 minutes before starting the day's work (Interview X000114AV, p. 21/2). The MD and the WPC consultant drafted a meeting agenda and trained the teams to run the meetings (Interview X000114AV, p. 23) and also provided conflict resolution support (Interview X000114AV, p. 13). However, I was told that later

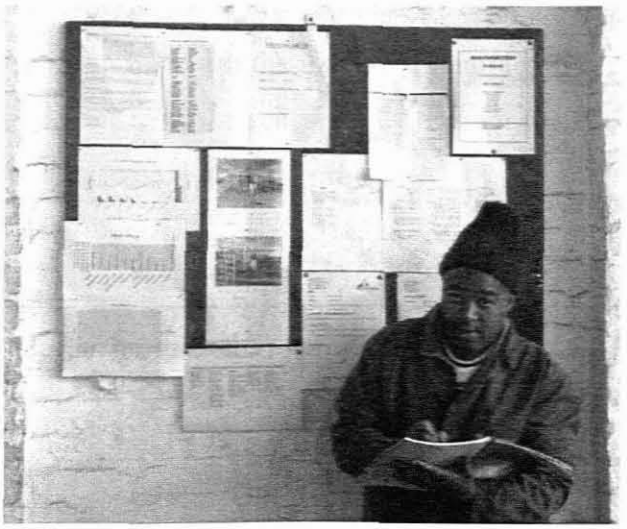

Figure 6: The Central Notice Board

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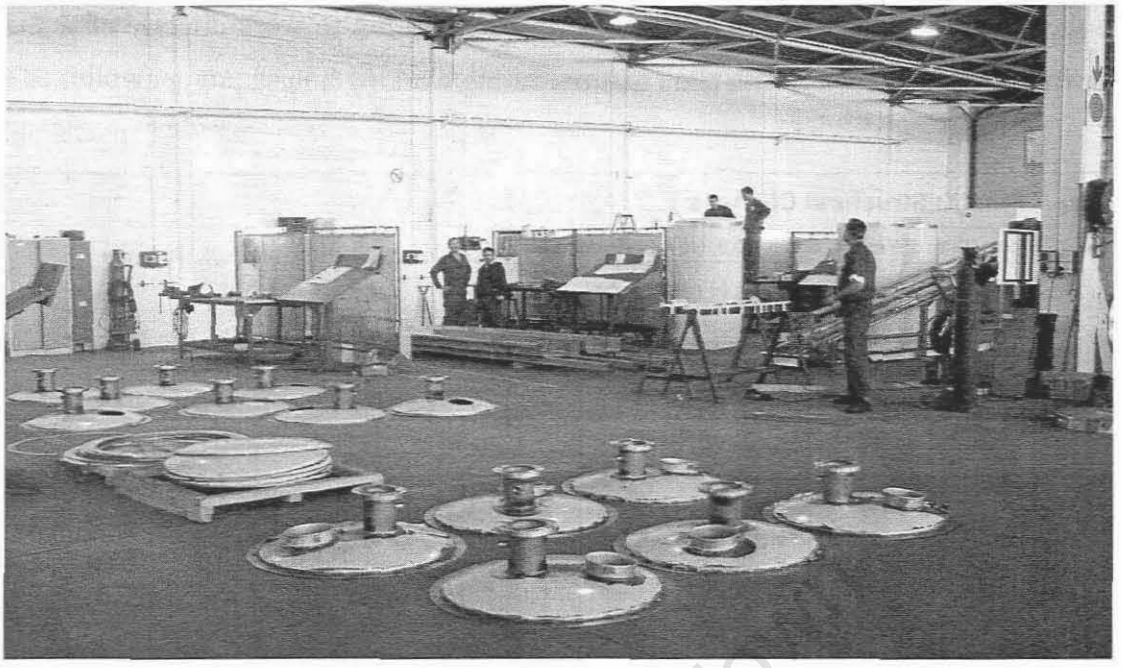

Figure 8: Project Fabrication Area at Firm X

One of the first issues that was identified was that the projects needed to be separated from jobbing as they were impeding the flow of product through the process. Cliques had also formed around the status of certain projects and customers so the need to restructure the work organisation and HR department were also addressed (Interview X000114AV, p. 6/7). An employee representative committee was established, which later became the WPC steering committee. Transformation was also addressed by making an "affirmative action" promotion of one of the senior artisans, whose potential was identified after an extensive process of evaluation (Interview X000114AV, p. 10).

As the firm was more advanced in its preparation for the WPC, there was some frustration while it had to wait for some of the other firms in the sector to start (Interview X030415AV, p. 5). However, once the WPC consultant was appointed, major changes were made,

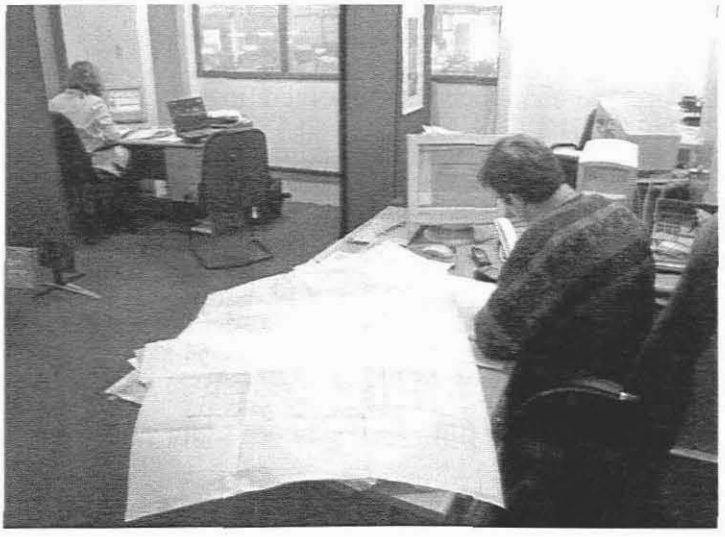

Figure 9: Firm X Design Office

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and by the middle of 2000, HR, sales and production planning were restructured and each department was given its office space (Interview X000114AV, p. 17). An attitude survey was conducted and a worker representative committee was established to improve communication between the shop floor and management. The MD reported that "Their whole attitude to the firm, their seniors and management changed... and it had the greatest impact on the firm's effectiveness and productivity. It's about quality, communication and respect for one another" (Interview X000114AV, p. 18/9).

The work organisation was based on groups of employees working together in departments, their team leaders forming a second-tier team together with line management and a third-tier team involving senior management. As the firm had to cope with significant volume fluctuations, a high degree of flexibility to work overtime was required from employees. The new TBWO structure was used to communicate these needs, and other information such as financial measures with the employees, and was regarded as an important reason why employee relations improved (Interview X020213AV, p. 13). Towards the end of 2001, work pressure precluded regular meetings of the employee representative committee, and early in 2002, employee relations improved to the extent that employee issues were incorporated into the regular management committee meetings.

Figure 10: Employee Representative Committee Meeting

By end of 2000, new job descriptions were in place, and during 2001, two projects received priority attention. The one was a skills development project to upgrade the interpretation of drawings and basic technical calculations skills, for which a technical design trainer was contracted (Interview X010214AV, p. 2). The other was a new incentive system. A previous system paid out "production" bonuses for several years,

in the programme implementation the teams started going to work directly after the general briefing and dealt with team matters during working hours.

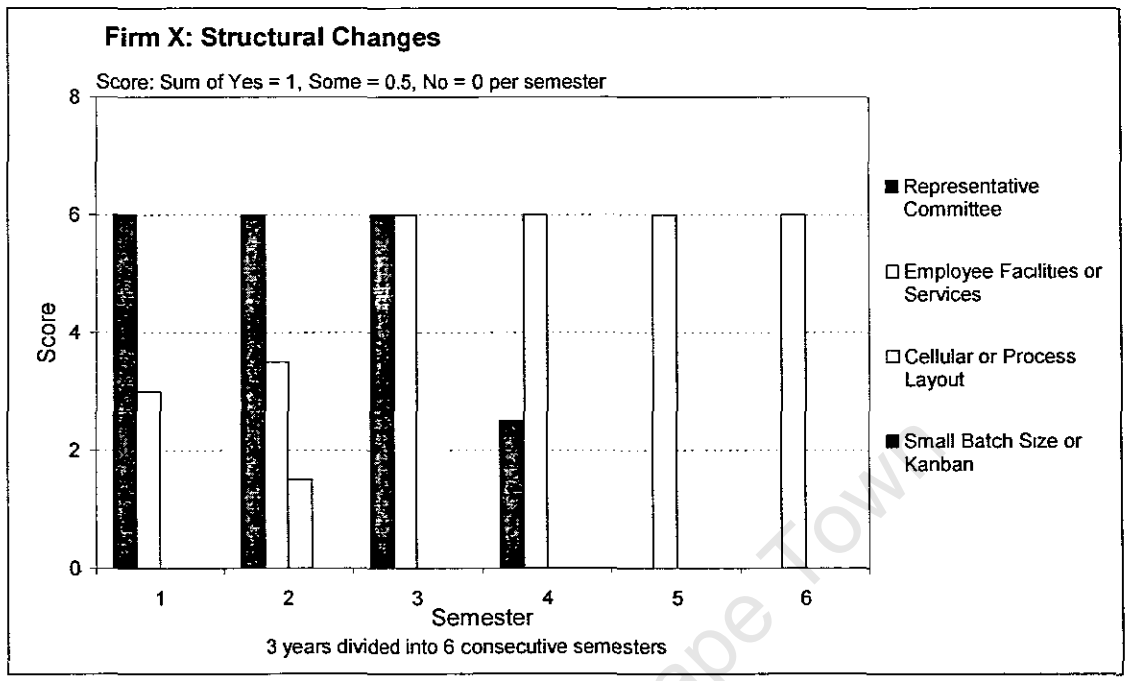

Figure 7: Firm X Structural Changes (Permanent Work System Changes)

Figure 7 shows that the representative committee was dissolved about halfway through the research period, but this should not be interpreted as a reversal of TBWO practices implemented as it became superfluous due to the good working relationship between employees and management. The layout change in the second semester refers to moving the despatch and storage areas to improve flow through the process. As the firm was an engineering shop, reduction of batch size was not applicable. The firm did a major upgrade to its employee canteen to the extent that management also use it.

Before the firm became involved in the WPC, it was already implementing five projects that were decided on in a strategic review in 1999. These projects were integration of its financial management systems, improving its IT systems to enable paperless adminstration, particularly in the design office, improving production planning and costing, customer orientation, identifying training needs, and improving communication with employees (Interview X000114AV, pp. 1-2). The WPC was seen as complementary to the last objective and was launced in the firm in September 2000 (Interview X000114AV, p. 3).

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but in the preceding 2 years, there were no payouts. After much discussion around a new performance measurement system, it was decided to implement a team-based incentive system based on production and profit measures (Interview X010906AV, p. 10), and the new system was put into effect from August 2001. As almost all errors, production as well as administrative errors, such as incorrect quotes, required a credit note to be issued, it was decided to use credit notes issued as a defect indicator. (Interview X010906AV, p. 3). Initially, the employees made bonuses quite easily; then, the targets were adjusted, and in 2002, they did not get bonuses regularly. However, by early 2003, the firm's profitability had improved to the extent that bonuses were paid out again (Interview X030415AV, p. 6/7).

Despite difficult market conditions (another stainless steel products firm that participated in the same WPC cluster closed down during the research period), Firm X managed to improve sales over the research period (see Figure 4) because of projects for overseas clients (Interview X020213AV, p. 26). It placed pressure on production capacity, and early in 2002, the MD was concerned that "we are working long hours, but we are putting out too little. We must look at our work methods...is what you are doing now really necessary?" (Interview X020213AV, p. 3). An illustration of how thoroughly management approached process improvement is that even the telephonist's work was analysed and quality standards, such as answering the telephone within three rings, were set (Interview X020213AV, p. 32).

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However, there were also some setbacks. The "affirmative action" appointment did not work out, and after counselling, the appointee returned to his former position by choice (Interview X020213AV, p. 5). An effort was also made to introduce multi-skilling by training artisans to do their welding, but it resulted in serious quality problems and was abandoned (Interview X020213AV, p. 12). There was some unhappiness about the fact that the WPC consultant appeared to be implementing some of the systems developed for Firm X at a rival firm that had also participated in the project (Interview X020213AV, p. 14).

In my final interview with the MD, he attributed the improved labour to sales ratio (which was a very significant driver of costs in their business) and reduced scrap-to-sales ratio directly to the TBWO programme implemented as result of the firm's

participation in the WPC (Interview X030415AV, p. 6). And, true to the way he had been driving renewal in the firm, he went on to say that their next objective was to gain the new 2000 version of ISO9000 accreditation (Interview X030415AV, p. 10).

Performance Outcome Trends

These graphs report the intermediate (WIP & absenteeism) and operational (productivity and quality) performance outcomes at Firm X over the research period.

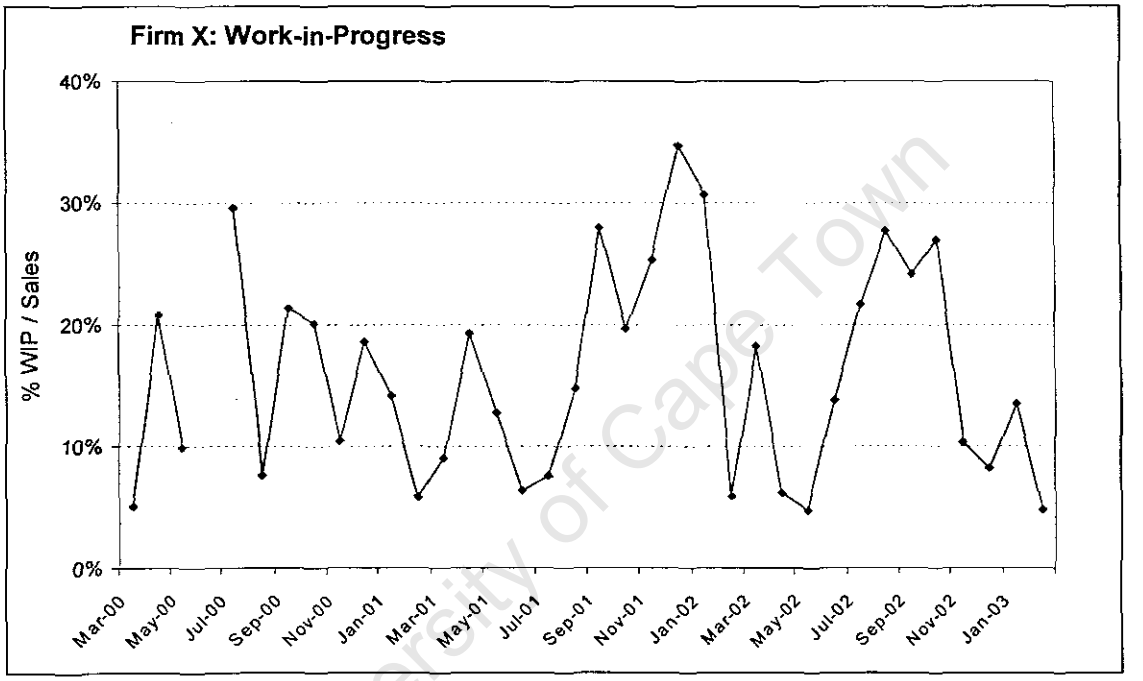

Figure 11: Firm X Work-in-Progress as a Percentage of Sales

WIP was difficult to control in Firm X due to the build-up of WIP during big projects, as can be seen from Figure 11. However if the increase in WIP due to the big projects at the end of 2001/early 2002 and the end of 2002 are eliminated, it appears as if the base WIP may have been reduced over the years.

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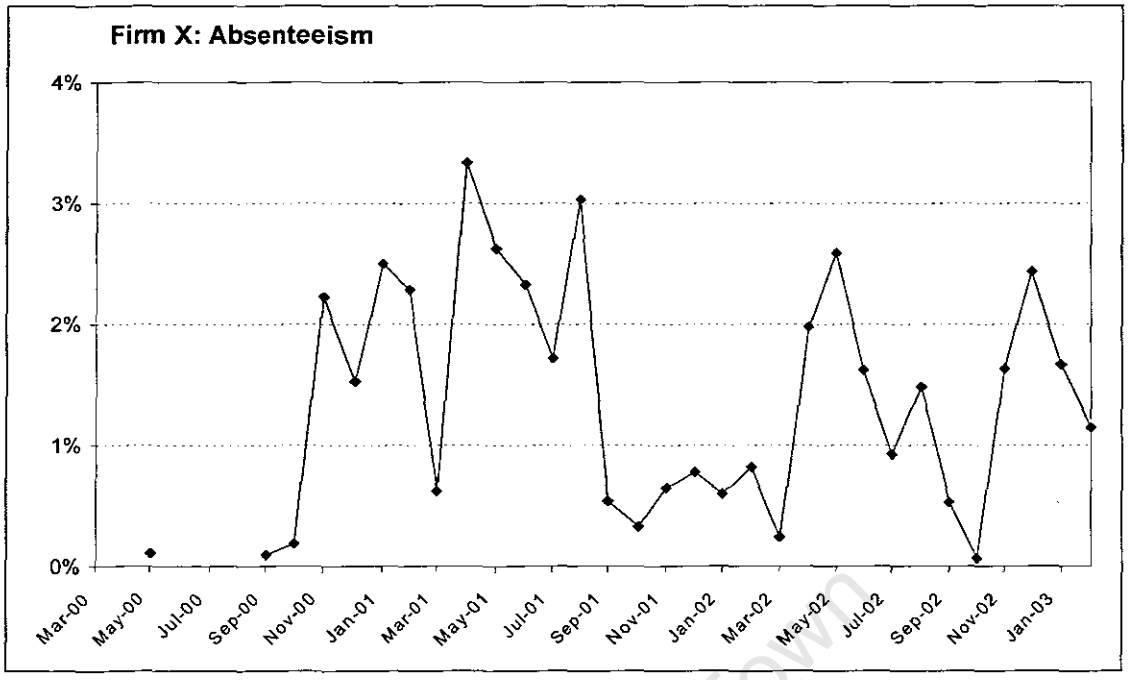

Figure 12: Firm X Absenteeism

Figure 12 shows that absenteeism, while fluctuating quite substantially, has improved marginally. At an average of 1.4% over the research period, the absenteeism at Firm X was the lowest of all the firms researched.

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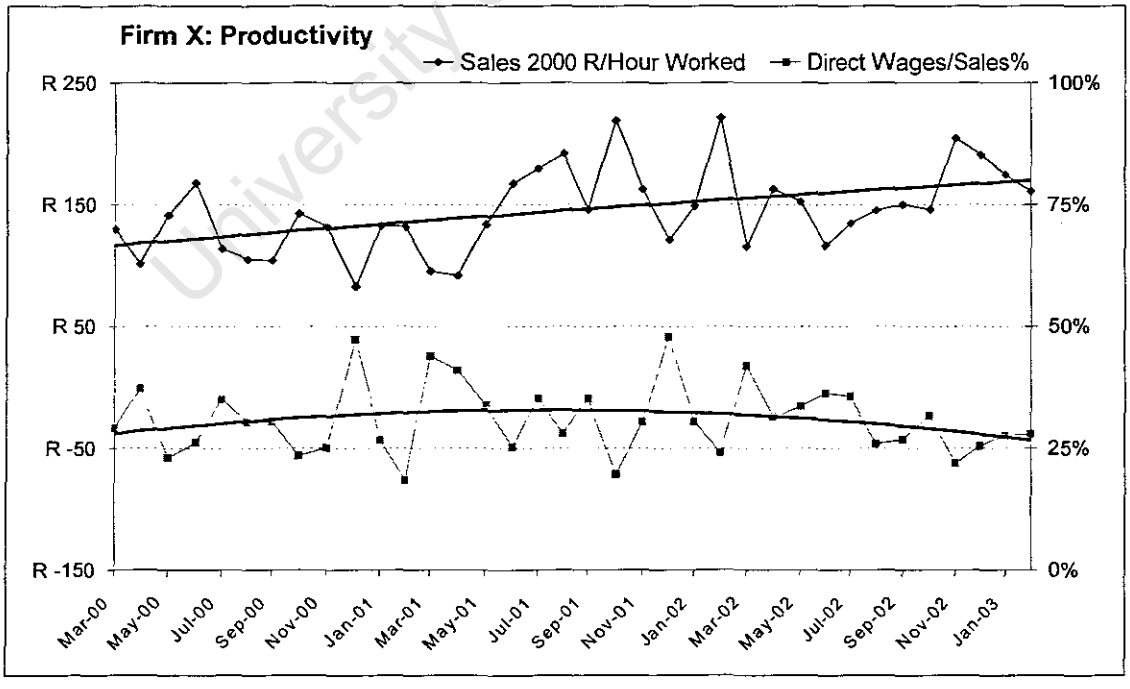

Figure 13: Firm X Productivity (Trend Lines added)

Unfortunately, no standard measure of physical output was possible at Firm X due to the variety of products manufactured. Thus, the firm's sales figure, discounted to

Rand in 2000, was used as a measure of output against hours worked. The sales figure used when calculating direct wages as a percentage of sales was not discounted as it was calculated using Rand values in the same month. These measures do have the disadvantage of being affected by changes in sales margin, but I was told that the margin used for quoting did not change over the research period. As both available measures showed long-term improvement over the research period, it was assessed as a "moderate improvement" of productivity, as reported in Appendix 4.13.

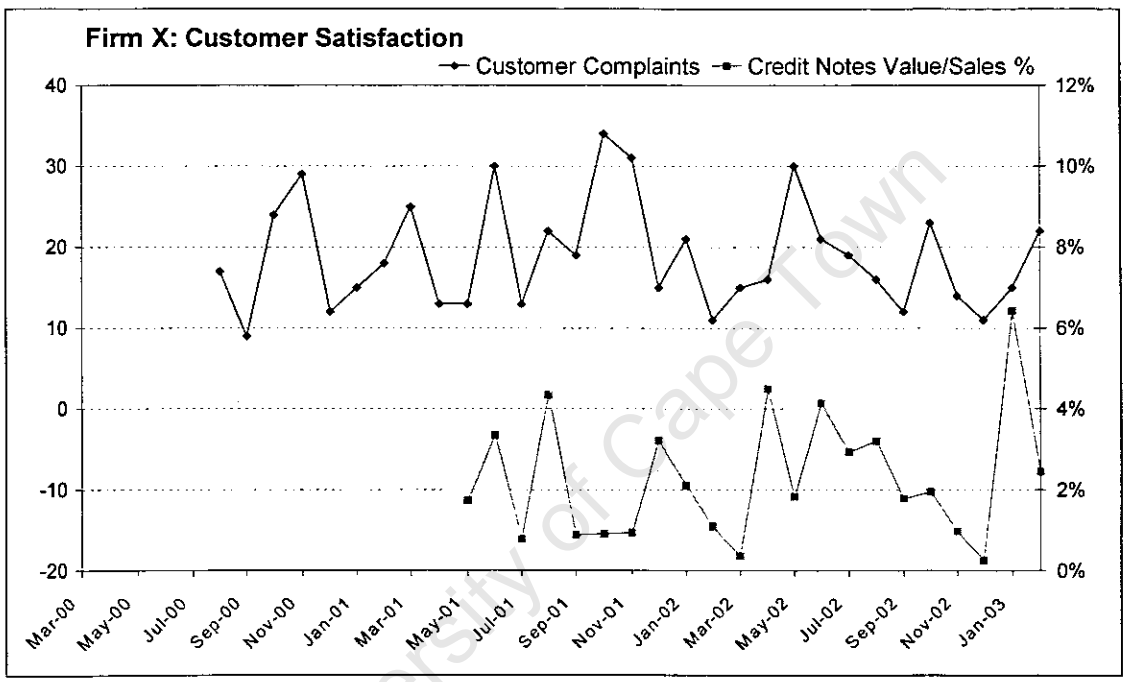

Figure 14: Firm X Quality

As the product process of Firm X was not repetitive, a measure of quality related to unit output was not possible. The firm used "number of customer complaints" and "value of credit notes written" as proxy measures of quality. Both measures remained at more or less the same level although with quite a lot of variability. It was therefore assessed as a "level" trend, as reported in Appendix 4.13.

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Summary and Interpretation of Case Findings

Due to the non-repetitive nature of Firm X's production process, implementation of TBWO practices did not follow the typical pattern. The process layout was functional rather than cellular, and the team work arrangements were also unconventional. However, the firm made substantial efforts to implement improved communication

and consultation practices, establish representative structures, upgrade staff facilities, and intensify training and spent 3.77% of paid time in support of TBWO activities.

Reliable interpretation of the performance measures at Firm X was also difficult due to the product flexibility. However, given the consistent findings on the two available productivity measures and the qualitative information from the managing director, it is fair to conclude that the introduction of TBWO at Firm X had a positive impact on its performance.

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Appendix 4.9: Firm S Case

Background

Firm S was an auto-component manufacturer that fabricated metal parts such as bumpers, fenders, fuel tanks, roll bars and bull bars for utility vehicles and trucks, mostly in mild and stainless steel. The average number of shop floor employees over the research period was 115 and the firm's average sales were R2,016m Rand per month. The firm was founded in 1997, when it split off from the parent company which undertook heavy engineering projects for the mining and construction industries. The parent company was a family-owned business, and the owner took an active interest in the affairs of Firm S. It was located in Pine-town, an industrial area in the Durban metropolitan area, in premises adjacent to the parent company, with which it shared administrative functions.

Figure 1: Fuel Tank Production at Firm S

Firm Profile

The following graphs provide an indication of how the firm's profile changed over the research period.

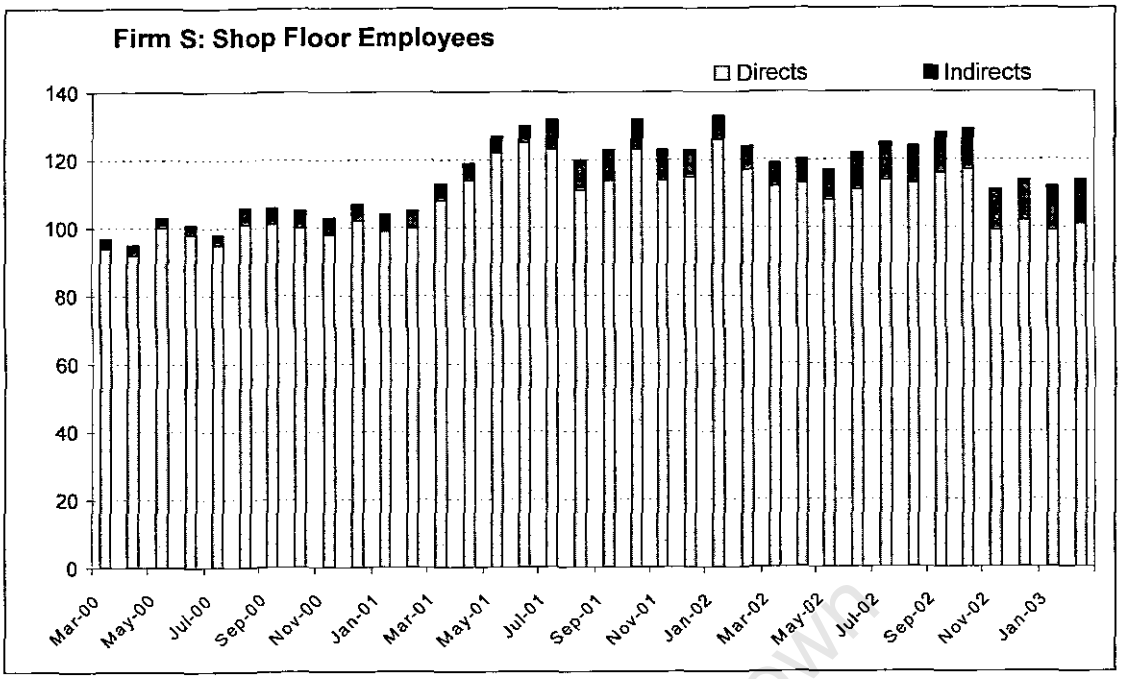

Figure 2: Firm S Shop Floor Employees (Excluding Management)

Employment at Firm S increased during the first half of 2001 but was reduced towards the end of 2002 due to the need to reduce costs at the firm.

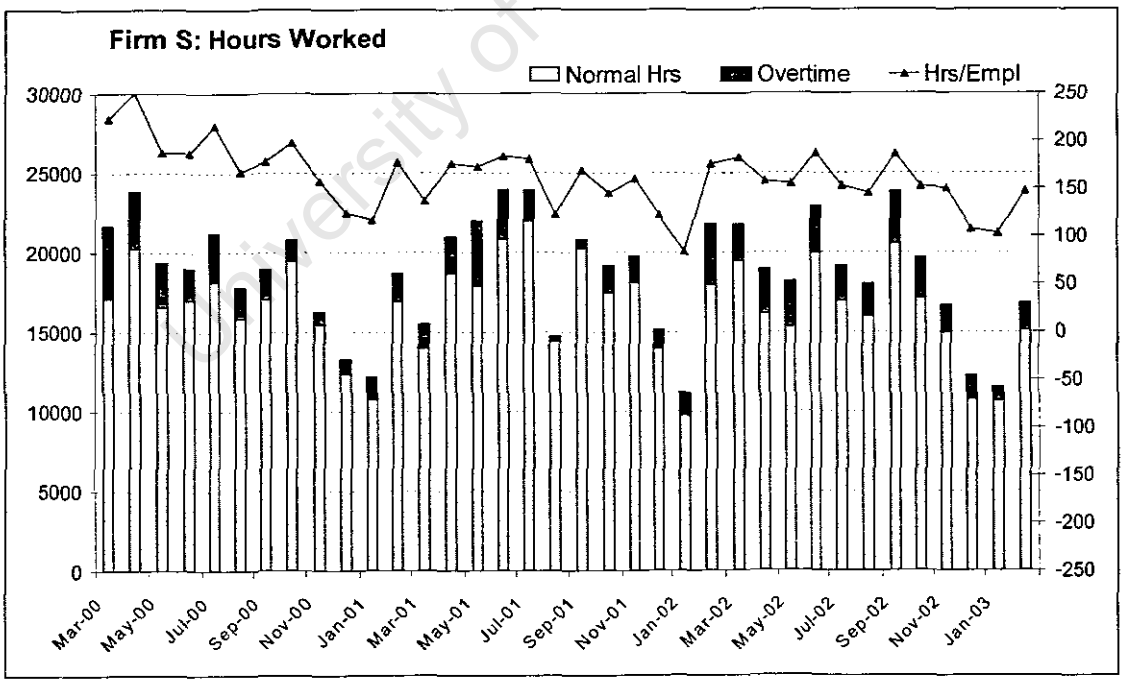

Figure 3: Firm S Hours Worked

As more people were employed at Firm S, the hours worked per employee declined slightly, as shown in Figure 3. Seasonal fluctuations in work hours are also clearly evident.

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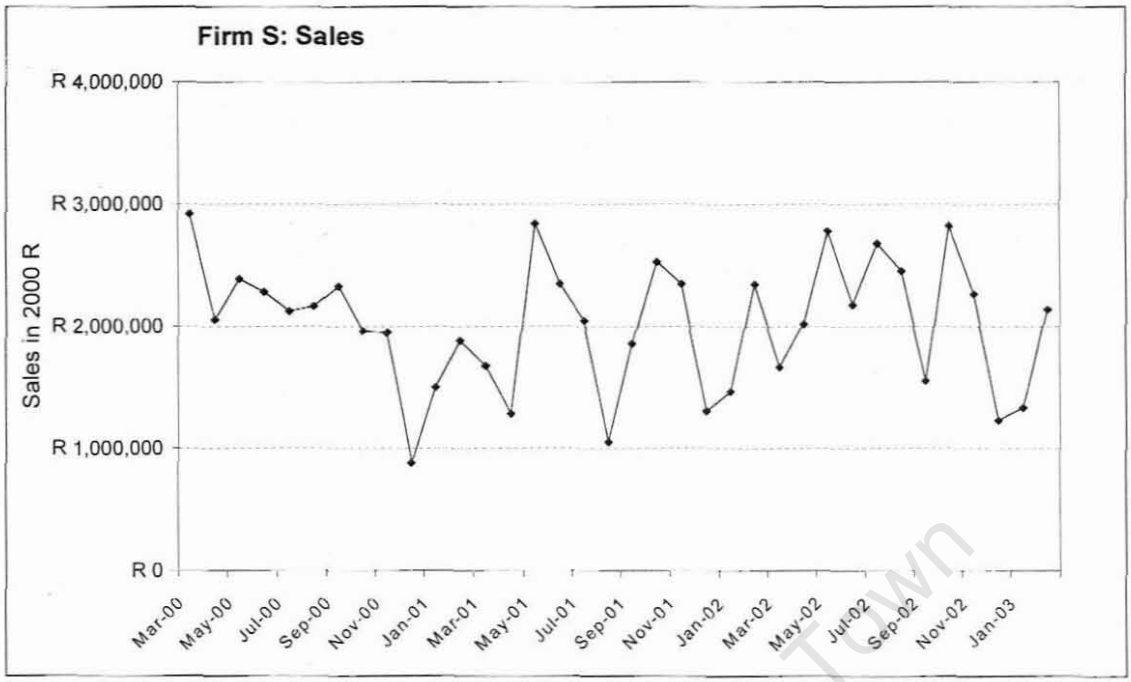

Figure 4: Firm S Sales (Discounted against firm's price increases to Rand in 2000)

Figure 4 shows that the firm's sales remained at much the same level throughout the research period, although they fluctuated quite substantially. This was mostly due to erratic demand from new customers, the effect of a strike at car assemblers, and a substantial increase in the cost of raw materials.

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Implementation of TBWO Programme

The firm's WPC steering committee appointed CD (a consultancy used by a number of other firms participating in the WPC) as its consultant for the WPC early in 2000 (Interview S010309JV, p. 18) and followed the standard CD process of re-structuring the shop floor into "mini-

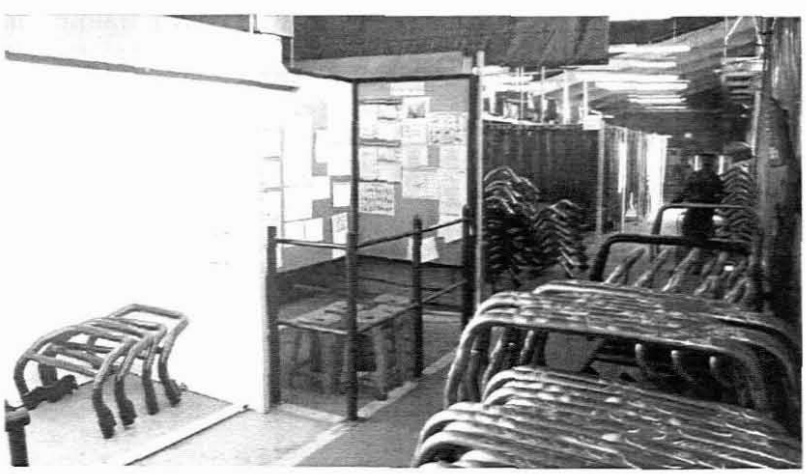

Figure 5: Level 1 Team Meeting Area in Pipe Production Area

business" teams, which were trained using a series of training workbooks developed by CD. Early in this process, team meeting areas were set up for each "Level 1" team, with laminated chart templates onto which the teams could record their performance measures in five key performance areas: quality, cost, flexibility, morale, and safety, as illustrated in Figure 5.

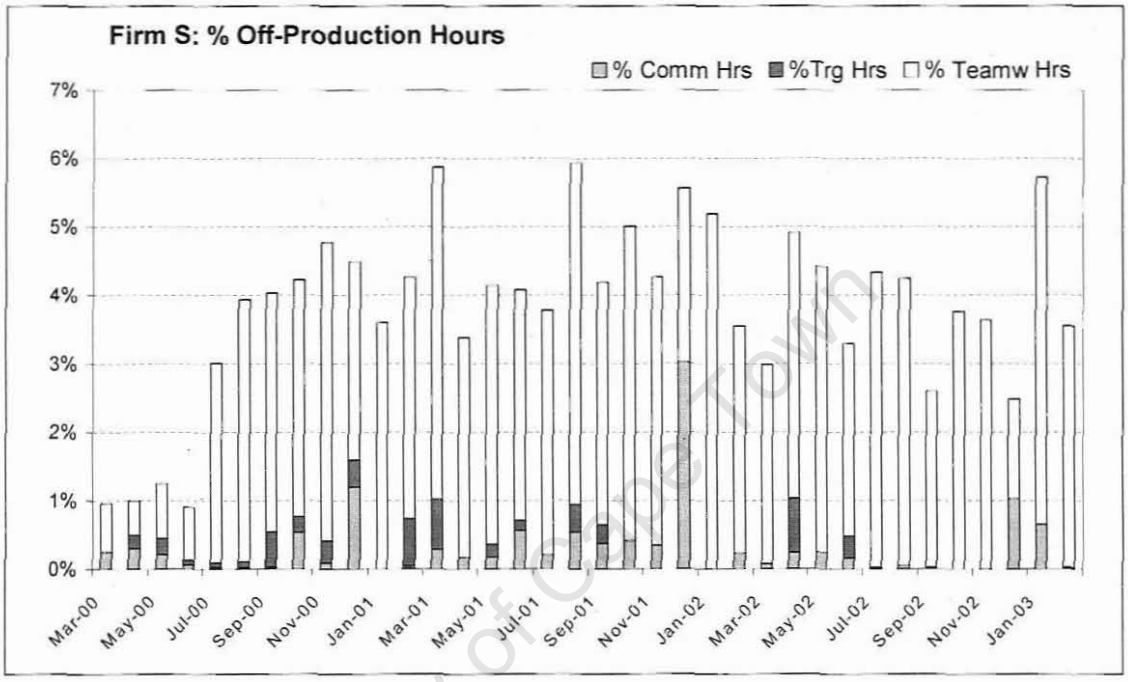

Figure 6: Firm S Paid Hours off Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked.

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Figure 6 shows the substantial amount of time shop floor employees spent on team work. The training started with intensive MDWT training for management and team leaders in July 2000. Thereafter, the work organisation was progressively restructured by constituting teams, installing their team meeting area, doing the first training module on teamwork, and starting the team audits whereby team shop floor practices were regularly checked against defined

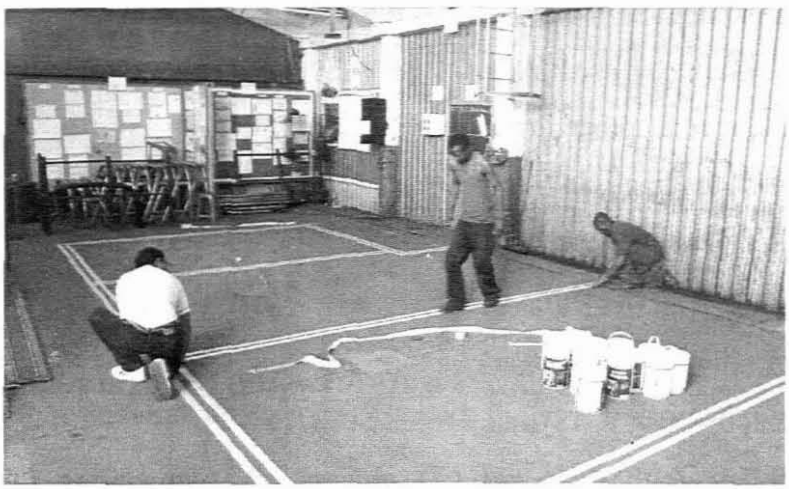

Figure 7: New Team Area being Measured Out

standards. By Septem-ber 2000, this was substantially completed, and from October 2000, teams were encouraged to implement improvement suggestions that did not involve significant disruption to their production schedule (Interview S010309JV, p. 19-23).

During the first year of the programme, new ablution blocks were put in, to avoid long walks to the toilet, as well as additional showers to accommodate the late shift (Interview S030208GJ, p. 7). Level 2 meetings involving all team leaders and first-line managers were also introduced. In 2001, the training programme continued with modules such as 5S housekeeping and problem-solving, and the launch of Kaikaku (systemic changes aimed at "performance breakthrough") projects. In May 2001, a night shift was introduced because of increased sales. Towards the end of the year, the emphasis of the programme changed to consolidation of the work organisation changes, and discussions on a profit-sharing scheme commenced (Interview S010914JV, p. 33).

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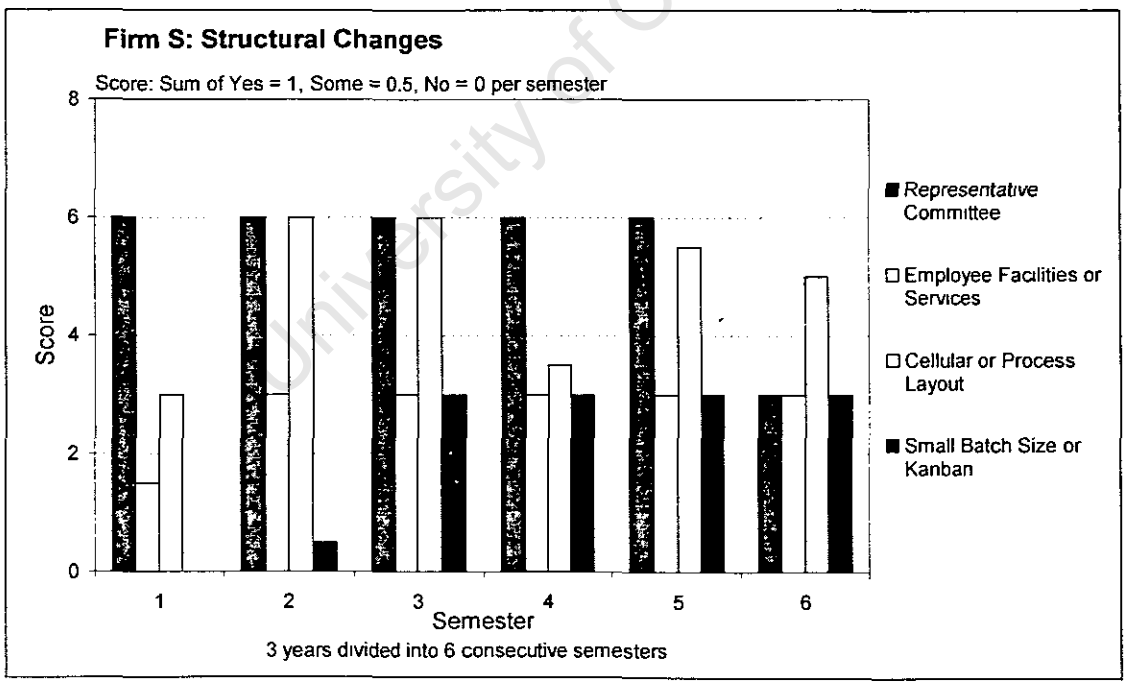

Figure 8: Firm S Structural Changes (Permanent Work System Changes)

By March 2002, the training had been completed, and the leadership (Level 3) team addressed "soft" issues of leadership style and devolving responsibilities in the operation (Interview S020712JV, p. 1). Changes were made throughout the business

in administration and production scheduling, where a simple manual scheduling system helped enhance flexibility and reduce lead time (Interview S010309JV, p. 35).

Figure 8 above shows that Firm S implemented all of the structural changes recorded for this research, to a greater or lesser extent. Like some of the other firms, their steering/representative committee had little to do after the initial organisational change issues had been dealt with. The reduction in implementation of cells was due more to setbacks with implementation rather than to reverting to traditional work organisation, and towards the end of the research period, the firm starting paying attention to reduction of WIP, although a *Kanban* system was not implemented.

Figure 9: Level 2 Team Leader Meeting

In June 2002, the firm received a very high score for team-work in an international quality audit (Interview S020712JV, p. 13). The MD considered the new "world-class" approach to organising production as important in gaining new customers when a truck assembler out-sourced its metal component fabrication to Firm S because of its improved service levels (Interview S010309JV, p. 38/9). Firm S also secured an export order from a high-profile European sports car manufacturer (Interview S010914JV, p. 32).

The MD of the firm was an enthusiastic supporter of the WPC and chaired the auto-component sector steering committee. He drove the initiative actively within the firm, did some of the shop floor training himself and, in interviews, talked about devolving responsibility to shop floor employees (Interview S010309JV, p. 2/3). The engineering and quality managers in the firm were also hands-on people, and generally it was quite a challenge for them to stand back to give the shop floor people

room to take charge although, in principle, they all supported devolved decision-making.

During the TBWO programme's implementation, the firm's environment became very difficult to work in. One of its major customers cut order releases by half in March 2001, only to double them the next month to try to catch up lost production, and a 4-week strike at the vehicle assemblers caused further disruption to the production schedule (Interview S020313JV, p. 1). In the second half of 2001, the firm faced a serious threat to its margin because raw material process had increased substantially, while the auto-assemblers were not allowing price increases (Interview S020712JV, p. 10). By January 2003, the firm was making a loss, and "crisis management" was diverting attention away from supporting the teams (Interview S030207JV, p. 1/2). The new export line also encountered quality problems (Interview S030208GJ, p. 1).

When it became known that the firm's owner had blamed teamwork for some of the firm's problems, this affected morale negatively (Interview S030207JV, p. 3). The firm's accounting system had to be restructured to keep track more accurately of costs in the mini-businesses. Then, the union representatives who had received a lot of training were voted out and replaced by less accommodating representatives shortly before the research period ended in March 2003 (Interview S030207JV, p. 10).

An indication that the programme was not being sustained was that the recording of the number of suggestions implemented per month was not kept up. Figure 10 is a photograph of the Level 3 summary table, taken in February 2003, which shows that it was last filled in in September 2002. Despite the setbacks hindering the implementation of the TBWO programme at Firm S, the

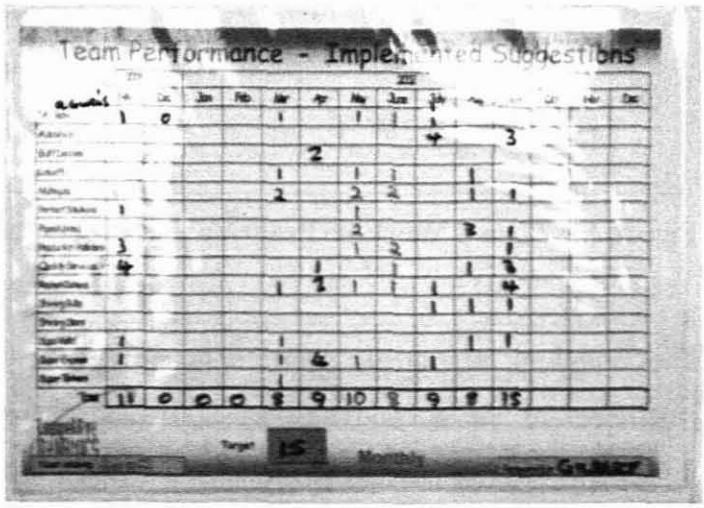

Figure 10: Incomplete Recording of Team Suggestions Implemented

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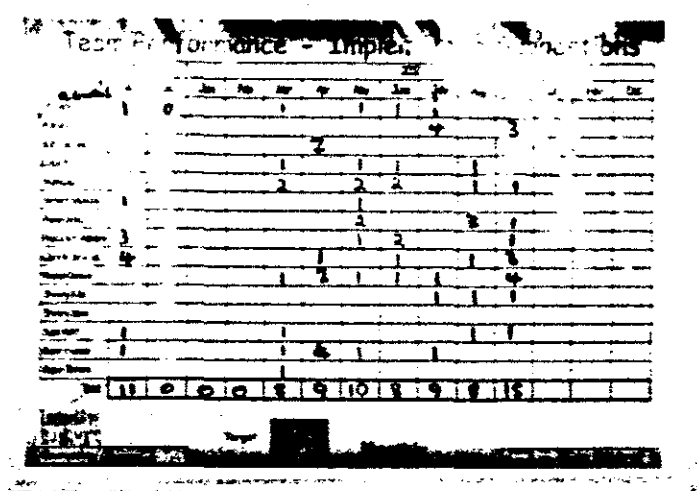

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firm's MD remained positive about the programme and he said that the teams helped management to cope better with the environmental instability (Interview S020313JV, p. 3). He remained committed to the programme and went on to say that "at the heart of it all, participative management, getting people involved, improving their skill-base, providing them with the opportunity within a structured framework, ja, nothing has changed" (Interview S020313JV, p. 9).

However, the consultant working with Firm S noted that the MD and other senior managers had very strong personalities and they sometimes issued directives which contradicted the effort to build the decision-making capacity of the teams and their leaders. This was addressed later in the programme, and the consultant was impressed with how seriously senior management took cognisance of the consequences of their management style (Interview CD020716DF, p. 15).

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Performance Outcome Trends

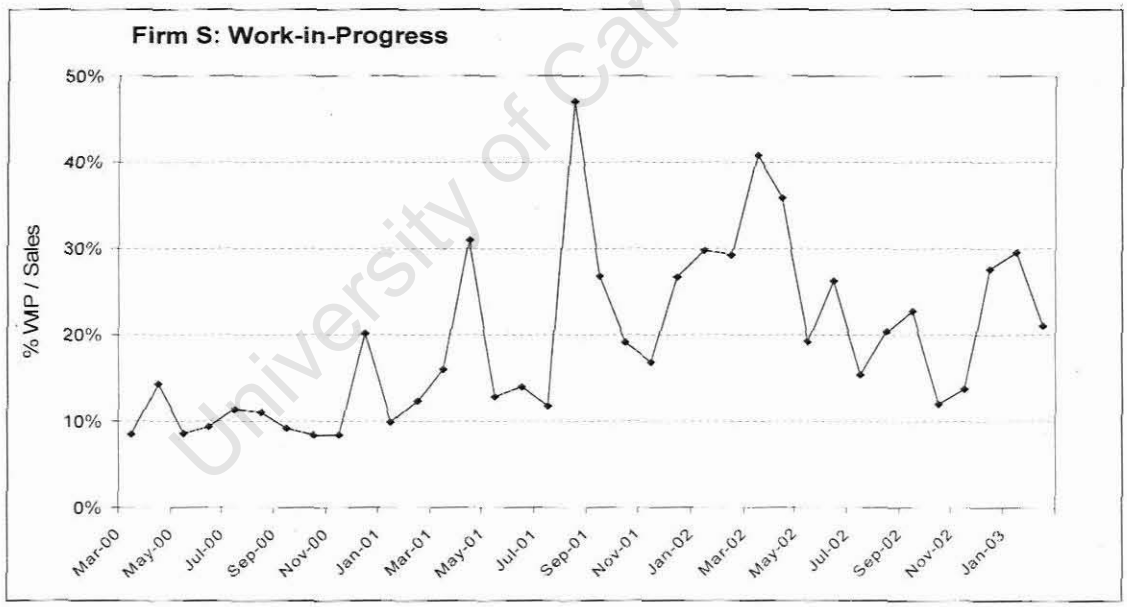

Figure 11: Firm S Work-in-Progress as a Percentage of Sales

The firm took a strategic decision to build stock through a strike at their major customers in the second half of 2001 and thereafter tried to smooth demand fluctuations with higher stock levels to avoid disruptions to the production schedule. So, Figure 11 reflects an increase in WIP progress although, strictly speaking, some of it was finished goods for which they did not have a separate inventory category.

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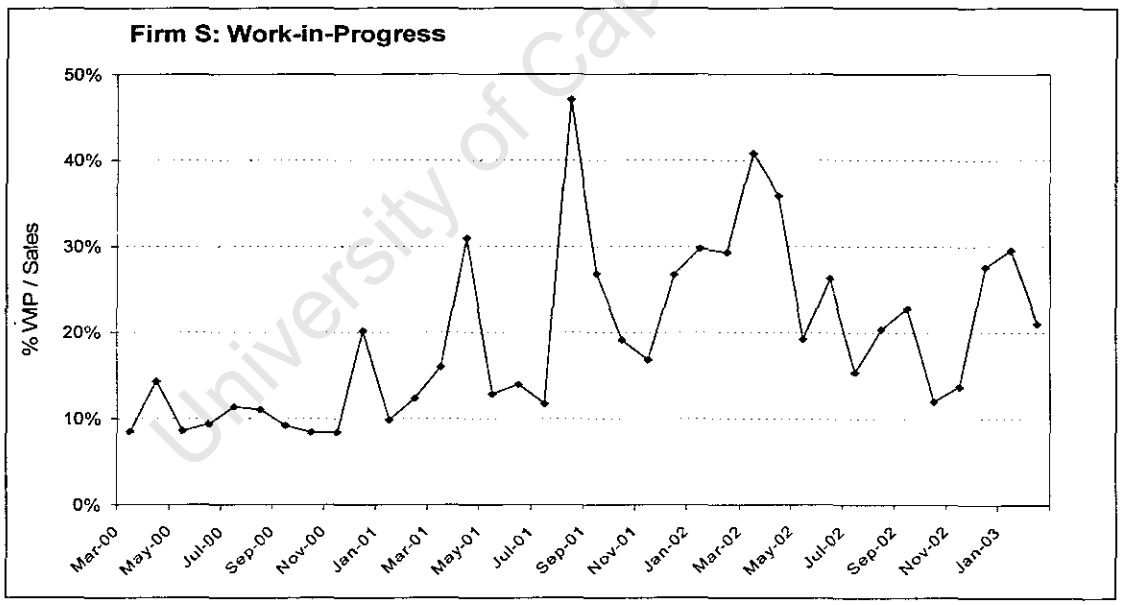

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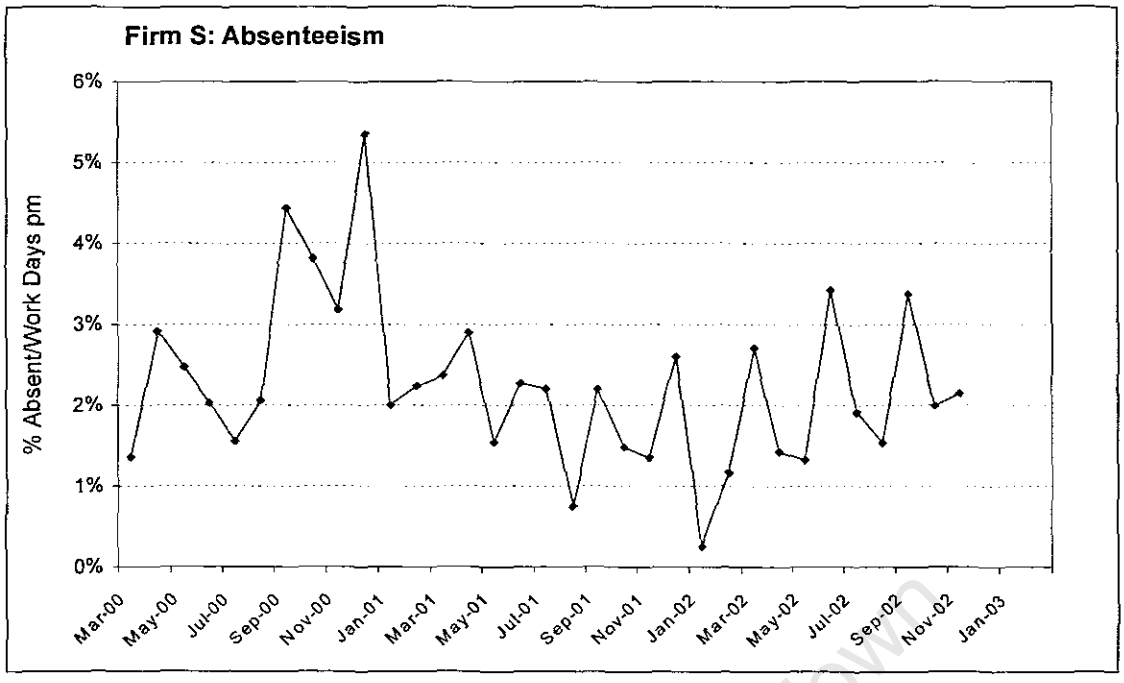

Figure 12: Firm S Absenteeism

These absenteeism figures come from information collected for an incentive scheme specifically aimed at reducing absenteeism. It was discontinued at the end of 2002 as it was considered not to be particularly effective.

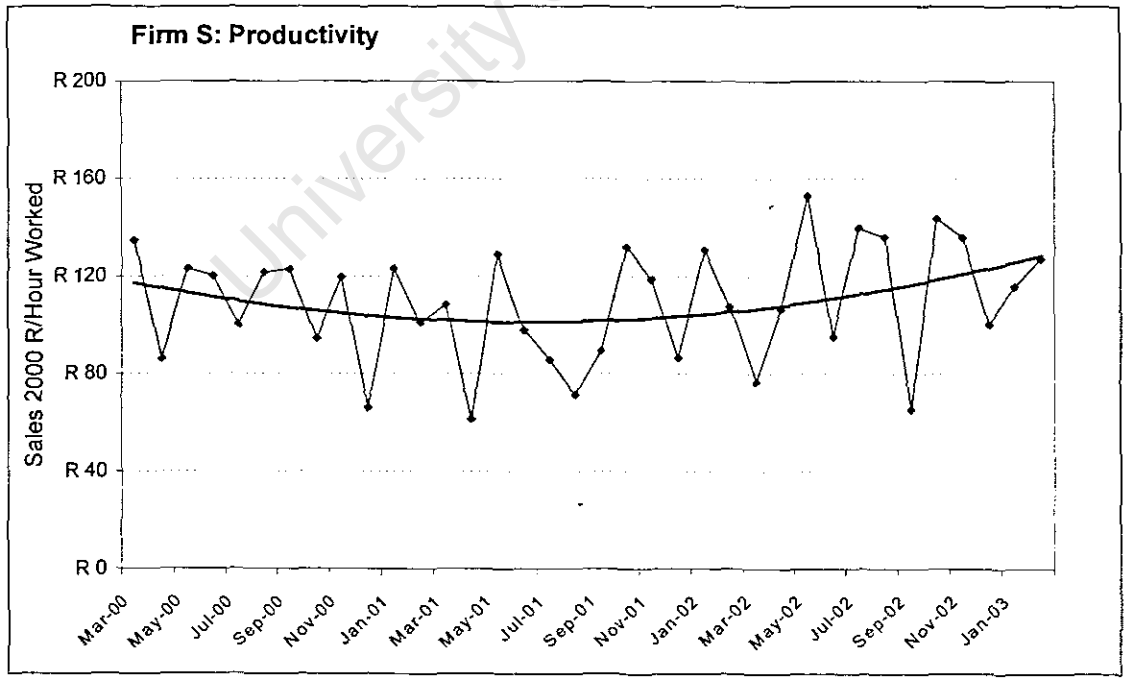

Figure 13: Firm S Productivity (Trend Line added)

For the purpose of the findings reported in Appendix 4.13, the productivity performance of Firm S was assessed as a "slight improvement" because of the

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improving trend towards the end of the research period. This is probably a conservative assessment as the firm's margins were under serious pressure towards the end of the research period.

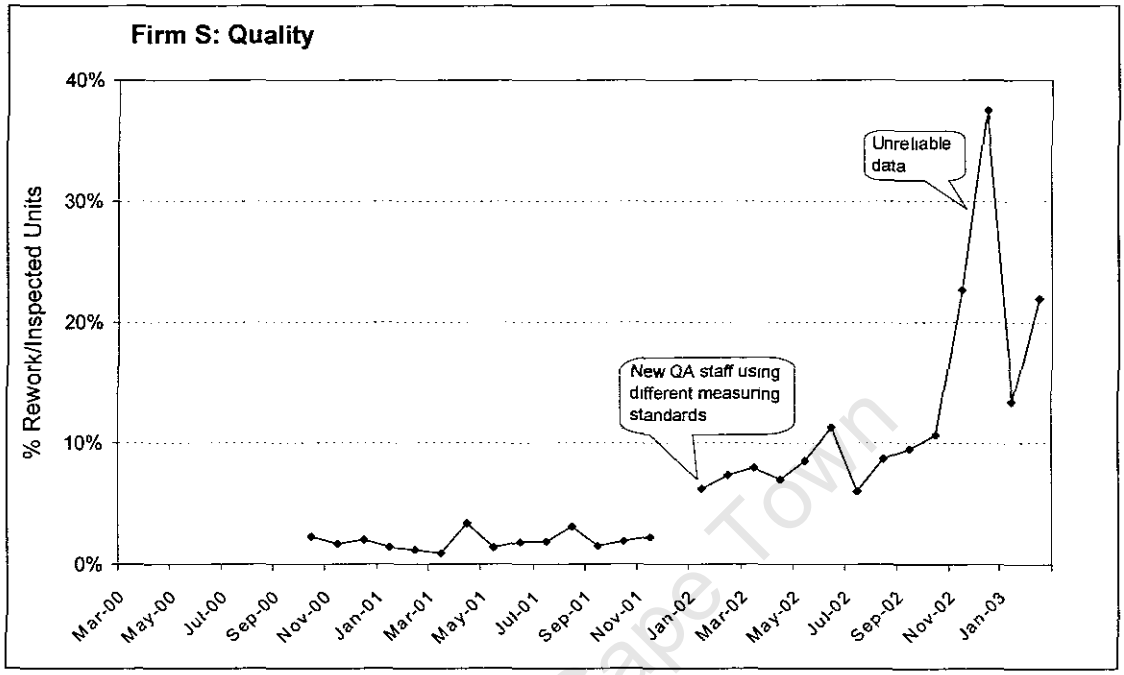

Figure 14: Firm S Quality

For the purpose of the findings reported in Appendix 4.13, the quality performance of Firm S was assessed as a "moderate deterioration" because of the deteriorating trend towards the end of the research period. However, this finding is not reliable due to the inconsistent measures used when there was change in QA staff.

Summary and Interpretation of Case Findings

Over the research period, the off-production hours of Firm S averaged 3.81%, which placed the firm 5th highest of the firms researched, which was above the average of 3.27% for all the firms researched. The management of Firm S were somewhat disappointed with the performance outcomes after having promoted and implemented the firm's programme with an almost religious fervour. However, considering that the firm undertook substantial product development and took on new customers in difficult circumstances, caused by a major strike and steep raw material price increases, a more realistic assessment might be that they did well to perform as well as they did under the circumstances.

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Appendix 4.10: Firm Y Case

Background

Firm Y was a metal-spring and wire-products manufacturer. It served mostly the automotive and domestic appliance manufacturers but also a variety of smaller markets such as those making chicken coops for the agricultural market. The open-plan factory was divided into a number of process-based "focus factories", such as those involved in wire-forming, induction welding, casting, bending, and powder coating. It was a second-generation, family-owned business, located in a well-established industrial area in Pietermaritzburg, Kwazulu-Natal. Firm Y employed an average of 65 shop floor people, and the average nominal value of production was R816 387 per month over the research period.

Firm Profile

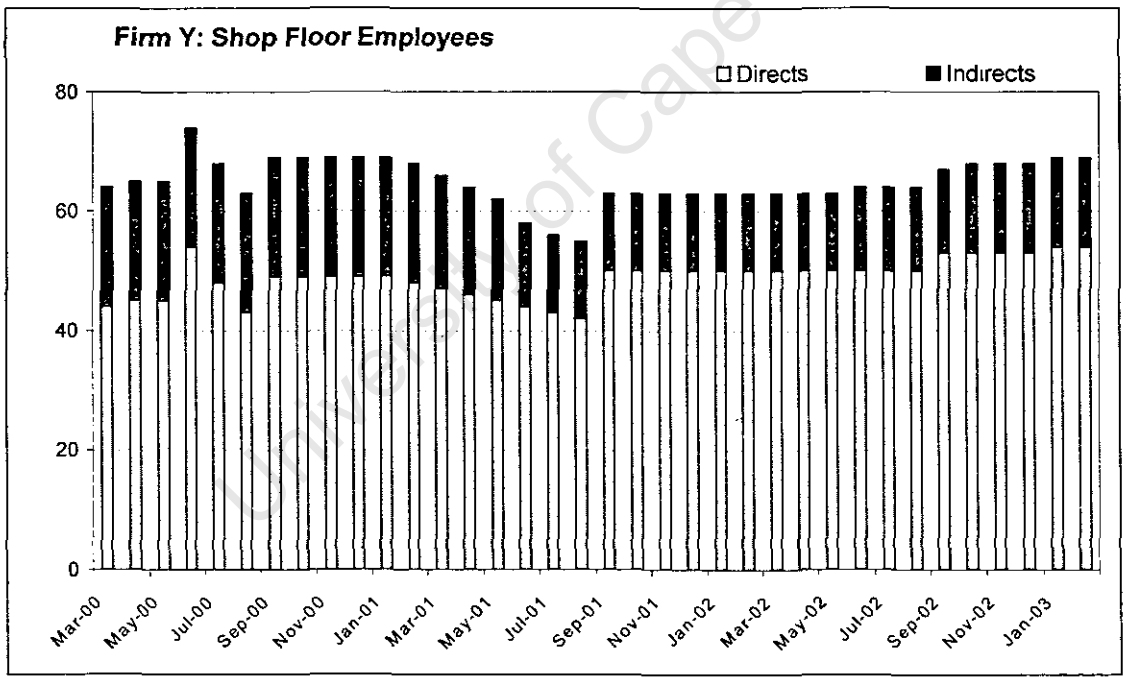

Figure 1: Firm Y Shop Floor Employees (Excluding Management)

Employment at Firm Y remained relatively stable over the research period, although Figure 1 shows that the ratio of indirect to direct shop floor employees declined. The hours worked at Firm Y increased from 136 hours per employee in the first year of research through 165 hours per employee in the second year to 205 hours per employee in the third year. Figure 2, below, also shows that overtime, as a proportion of total hours worked, increased.

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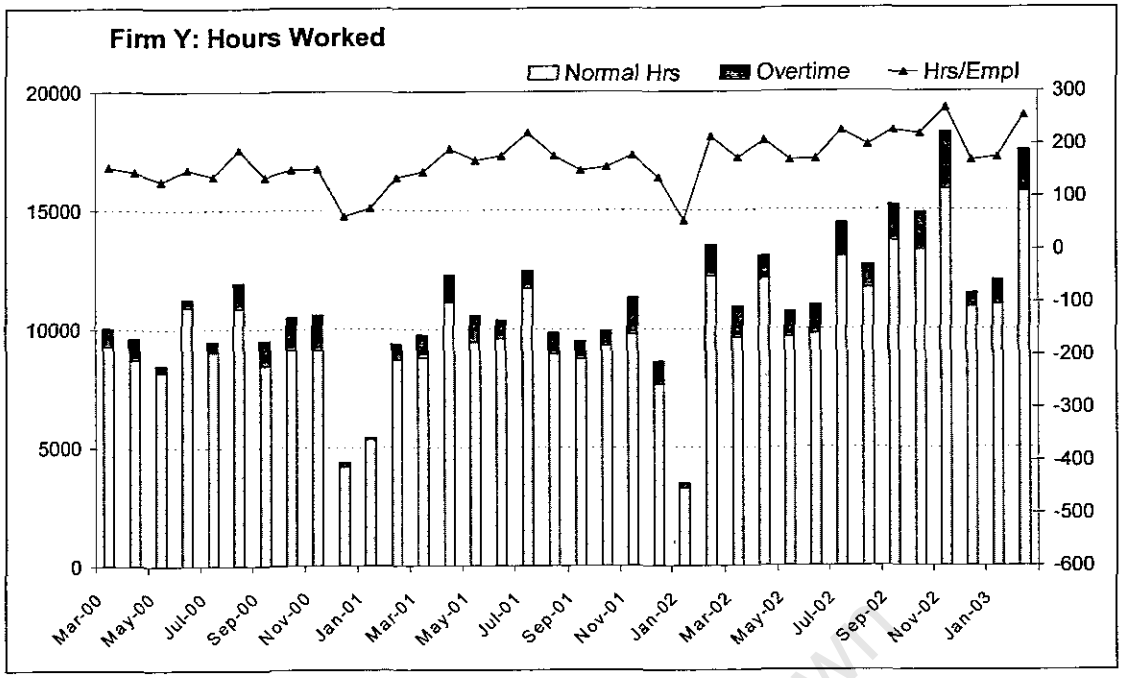

Figure 2: Firm Y Hours Worked

Figure 3 shows that, apart from seasonal variations, the output of Firm Y remained at more or less the same levels. There appears to have been a slight shift towards more production of spring steel relative to mild steel (wire) products. However, this trend may have been reversed as the firm secured a long-term order to manufacture car seat frames for Volkswagen SA in September 2002 (Interview Y020710BA, p. 7).

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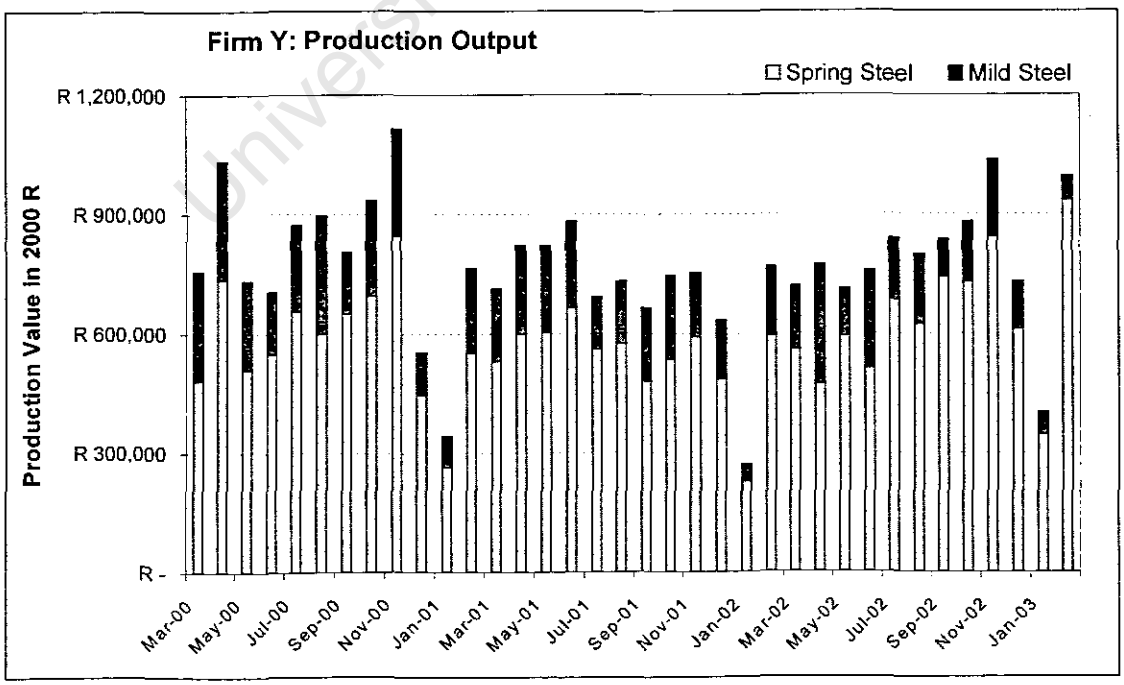

Figure 3: Firm Y Production Value (Discounted against firm's price increases to Rand in 2000)

Implementation of TBWO Programme

Firm Y's TBWO programme started with a 1-day workshop by the WPC consultants on the "mini-business" teamwork approach for 18 managers and prospective team leaders at an off-site venue in June 2000. As the firm had already committed to the initiative, the workshop participants also made suggestions for improvement projects that were done prior to implementation of shop floor teams in July 2000 (Interview, Y010313BA, p. 8). Teamwork training for team leaders, who then trained team members, followed in August, and by September 2000, the team members also completed 5S housekeeping training. By the end of the year, each team meeting area was supplied with performance measurement graphs and other visual management aids, and the firm also became only the third company in South Africa to achieve TS16949 accreditation (a quality standard used in the automotive industry) (Interview, Y010313BA, p. 9). Figure 4 shows the high level of training in 2000 and the start of shop floor team meetings in October 2000.

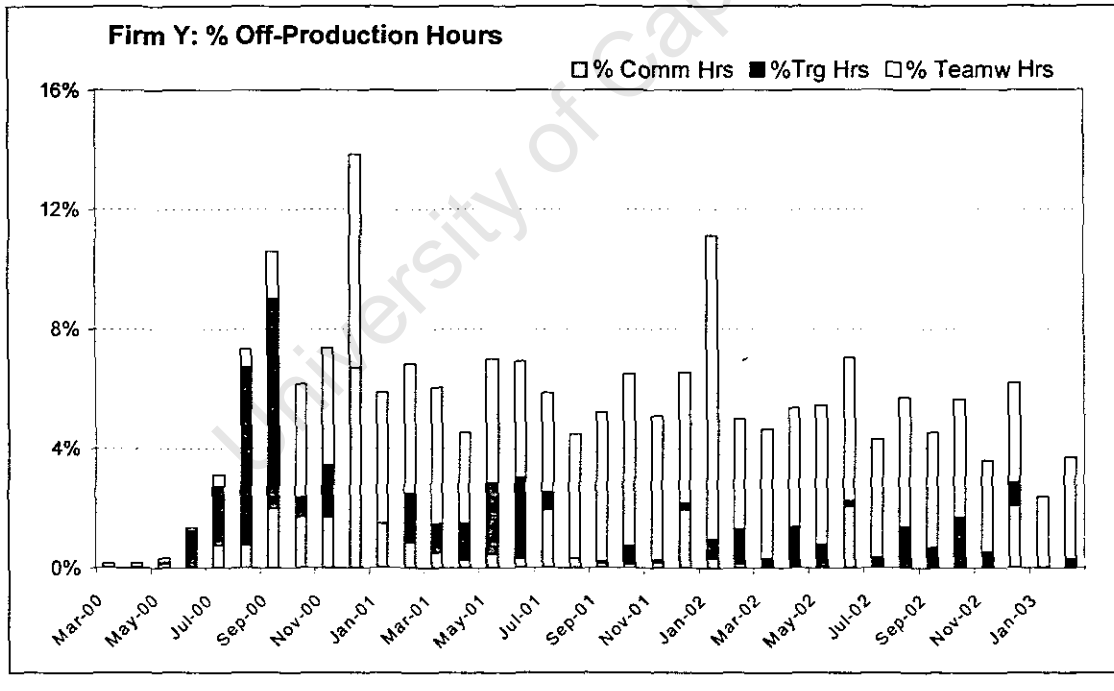

Figure 4: Firm Y Hours off Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked.

On the last day of business in 2000, the firm shut down production and cleared the shop floor, and all the employees were involved in team report-back presentations on progress in the implementation of their TBWO programme. The production director also commented on the ease with which the firm started up in 2001 after the annual

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vacations because the team meetings took place from the first day (Interview, Y010313BA, p. 11). During the course of the next 2 years, further training, particularly on problem solving and process improvement, took place and company-wide progress reviews were held at 6-month intervals (see Figure 4).

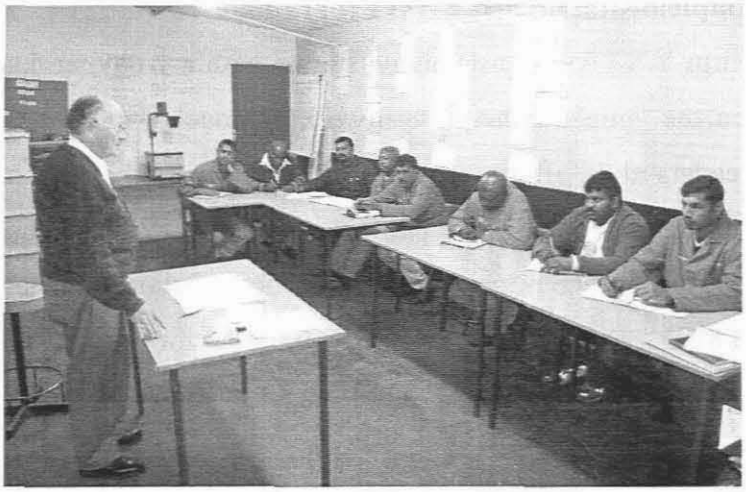

Figure 5: Training by Production Director at Firm Y

The firm undertook several *Kaikaku* projects; for instance, the seat frame production process changed several times during the research. In February 2000, during a best operating practice workshop, conducted at Firm Y as part of the orientation phase of the WPC project, the seat frame output was improved from 39 to 85 frames per day by improving the jig and placement of the wire parts. Output then improved to 135 frames per day by tilting the jig at about 45 degrees, which enabled welding from one position because the need to move to the other side of the jig had been eliminated. A new welding helmet, with an automatic darkening visor, improved output to 180 frames per day. The VWSA contract to supply seat frames prompted the firm to put in place a dedicated seat frame production cell, as shown in Figure 6.

Figure 6: Seat Frame Cell with Movable Work Trolleys at Firm Y

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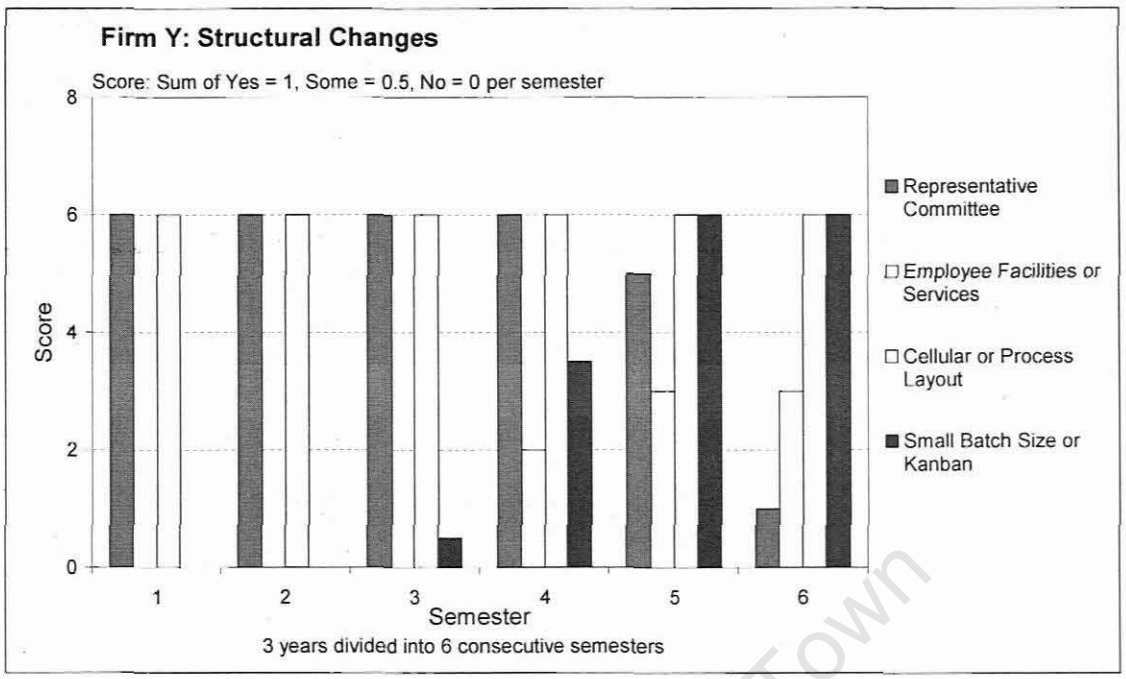

Figure 7: Firm Y Structural Changes (Permanent Work System Changes)

Firm Y's steering committee was absorbed into the team leaders' meeting, and therefore Figure 7 reflects the cessation of the steering committee's activities. The staff facilities were only attended to towards the end of the research period, when they were painted. The plant was laid out as a set of focussed factories, based on different production requirements from the outset of the research. These formed the basis for the shop floor teams and interacted with one another as internal customers. From 2001, *Kanban* systems were also progressively introduced in the factory (Interview Y020307BA, p. 3).

The firm's managers took a personal interest in the functioning of the shop floor teams and often attended their meetings in the role of team facilitators (Interview Y010313BA, p. 3). The internal customer relationship between teams was established early in the programme and initially led to conflict between teams over delivery and quality expectations. However, after some conflict resolution input by management, team leaders started accommodating other teams, for instance, by "lending" them labour (Interview Y010313BA, p. 5). By March 2003, the team leaders were managing cost variances of jobs against budget. The production director was very pleased about the fact that the level at which a cost variance triggered an investigation could be reduced from R2000 in 2001 to R300 in 2002 (Interview Y020307BA, p. 6).

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Teams were given access to workshop resources to make process improvements and, as can be seen in Figure 8, about 850 shop floor suggestions p.a. were implemented.

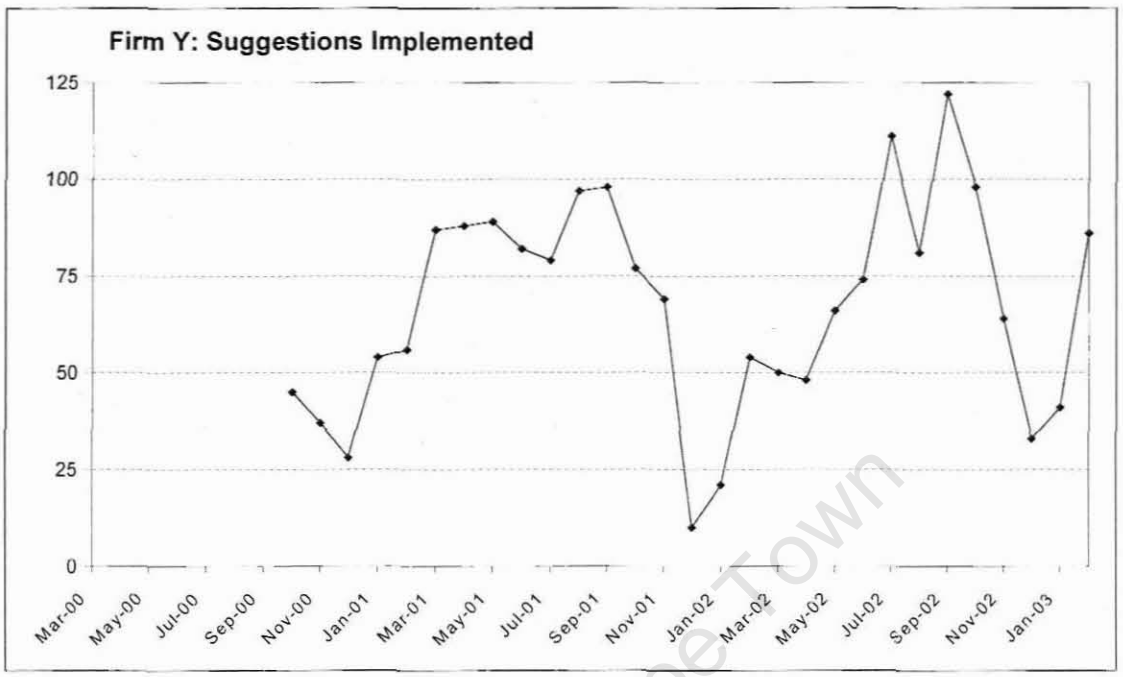

Figure 8: Suggestions Implemented at Firm Y

In November 2001, the production manager resigned, and he was not replaced. Instead, the team leaders took over his responsibilities (see Figure 9) and their pay was adjusted accordingly (Interview Y020307BA, p. 10). When the production director retired at the end of 2002, the original production manager returned to the firm and continued the arrangement (Interview Y030218JB, p. 1). The increased responsibilities of the team leaders might explain the decline in indirect employees shown in Figure 1.

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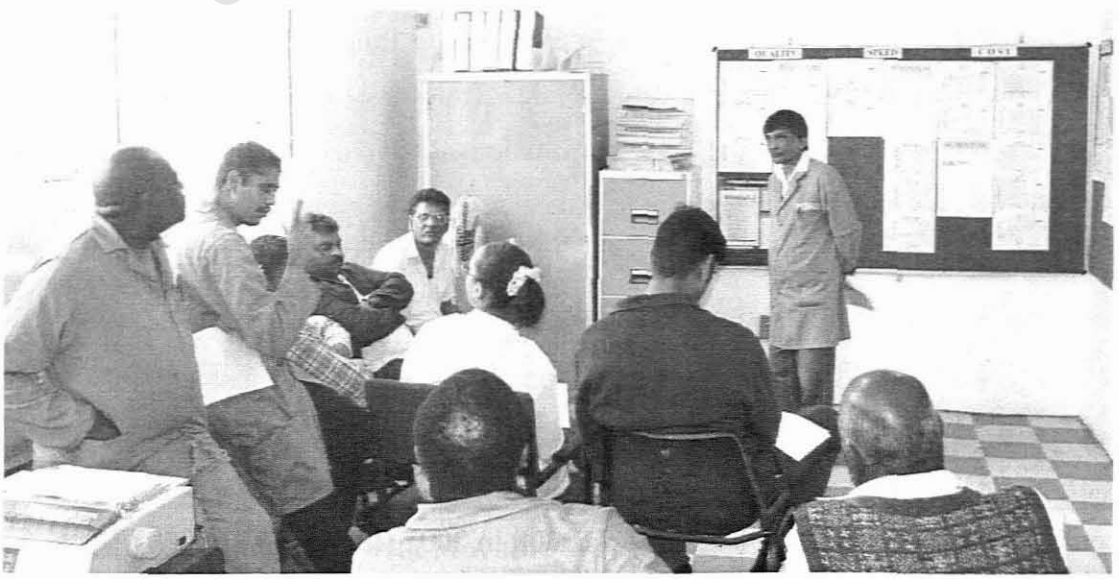

Figure 9: Team Leader Meeting without Production Manager at Firm Y

In July 2002, the production director said that the shop floor teams had "slid back and become complacent" with things like quality control and improvement suggestions. He conducted some internal audits of the teams himself, and this resulted in an increase in non-conformance reports (NCRs) (Interview Y020710BA, p. 1). However, he also said that shop floor morale was "absolutely tremendous" and that absenteeism had improved (Interview Y020710BA, p. 10). The firm was a finalist in a national productivity award, and he attributed much of its success, in terms of gaining quality accreditations and new customers, directly to the TBWO programme that it had implemented (Interview Y020307BA, p. 3).

Figure 10: Tidy Shop Floor at Firm Y

After the original production director had settled in upon his return, he also raised the problem of sustaining the programme early in 2003. He expressed concern that "our trends have been going in the opposite way to what we should be doing" (Interview Y030218JB, p. 5). He thought that some of the performance measures needed updating and that the firm's skills requirements had become more sophisticated. In an attempt to address these requirements, he was writing standard operating procedures and also intended recruiting new employees who had completed their high school education. The workshop had become a constraint on the implementation of suggestions, so he promoted a shop floor employee with fitting and turning experience to permanently work on process improvements (Interview Y030218JB, p. 3).

However, the firm was doing well financially. In the 2002/3 financial year, turnover was up 30% year-on-year and the firm had recovered from a loss-making situation a few years earlier. The managing director attributed much of the new business to the TBWO programme and called it "one of the best sales tools we've ever had" (Interview Y020424RR, p. 7).

Performance Outcome Trends

These graphs depict the intermediate (WIP & absenteeism) and operational (productivity and quality) performance outcomes at Firm Y over the research period.

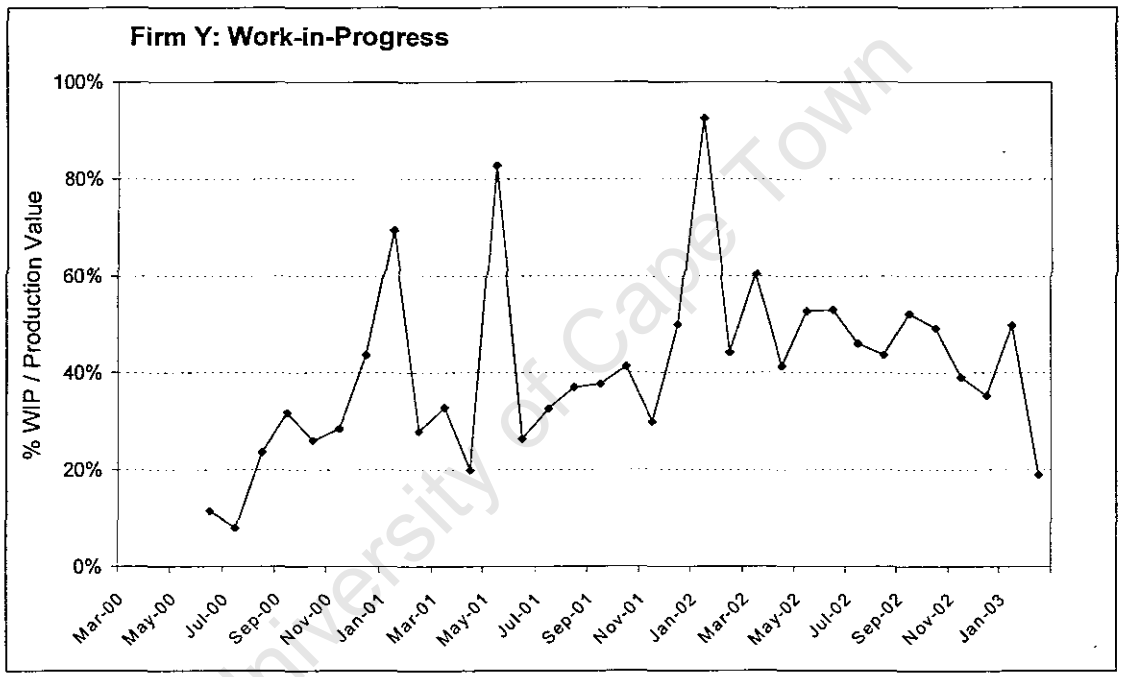

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Figure 11: Firm Y Work-in-Progress as a Percentage of Production Value

In March 2001, the production director commented that the firm's WIP had been drastically reduced because when the annual stock-take was done at the end of February, there was so little WIP to count that it took much less time than in previous years (Interview Y010313BA, p. 15). While this appears to have been the case again in 2002, the reduction was merely a correction in an upward spike in WIP levels, which was probably a consequence of the annual shutdown. Figure 11 shows that the basic trend in 2000 and 2001 was increasing, although that was reversed in 2002.

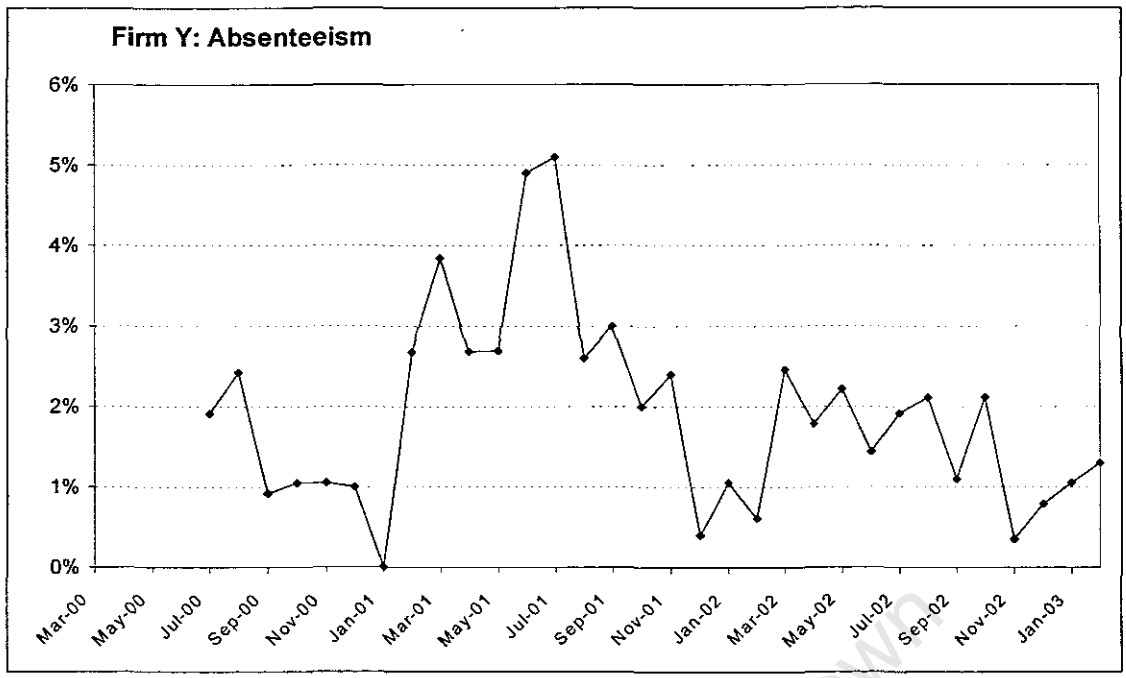

Figure 12: Firm Y Absenteeism

The firm's management repeatedly spoke about the improved morale and participation by the shop floor employees (Interviews Y010313BA, p. 2; Y020424RR, p. 8; Y030218JB, p. 1). This is corroborated by the absenteeism data shown in Figure 12 as Firm Y was one of the few firms researched in which absenteeism improved.

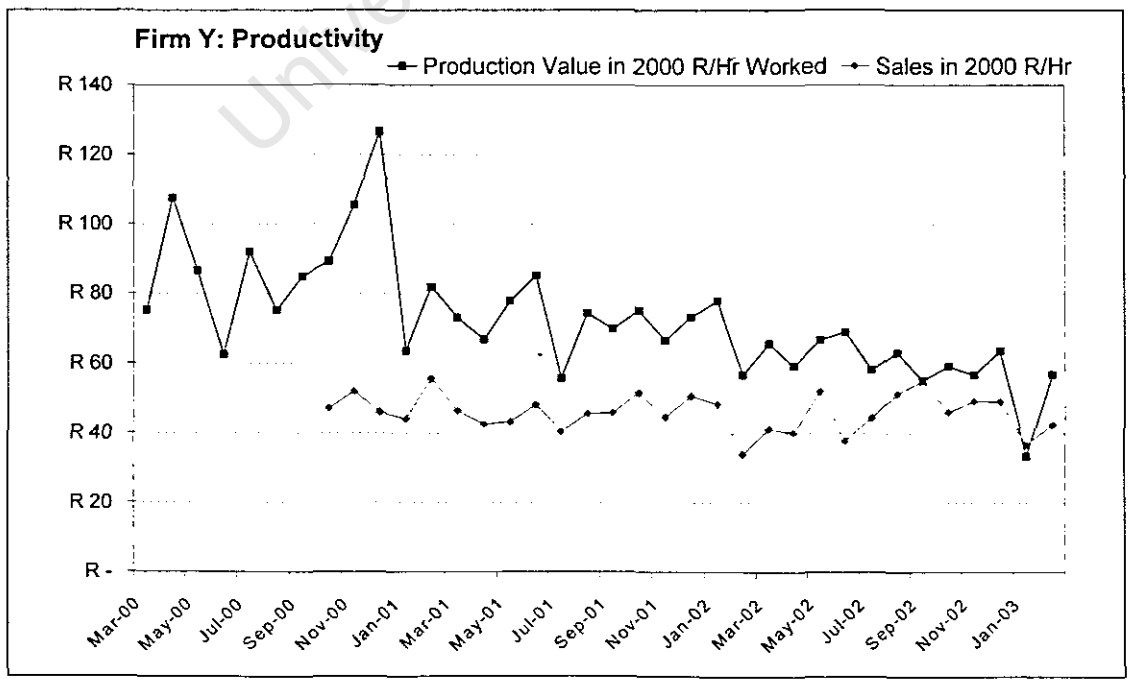

Figure 13: Firm Y Productivity

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The data in Figure 13 has been discounted against the firm's price increases and weighted according to mild- and spring-steel output as a proportion of production value. Sales per hour worked remained more or less level over the research period, and production value per hour worked showed a steady decline over the research period. The latter indicator was the preferred measure as it was closer to operational performance. Therefore, the productivity performance for Firm Y was classified as a "moderate deterioration" in Appendix 4.13.

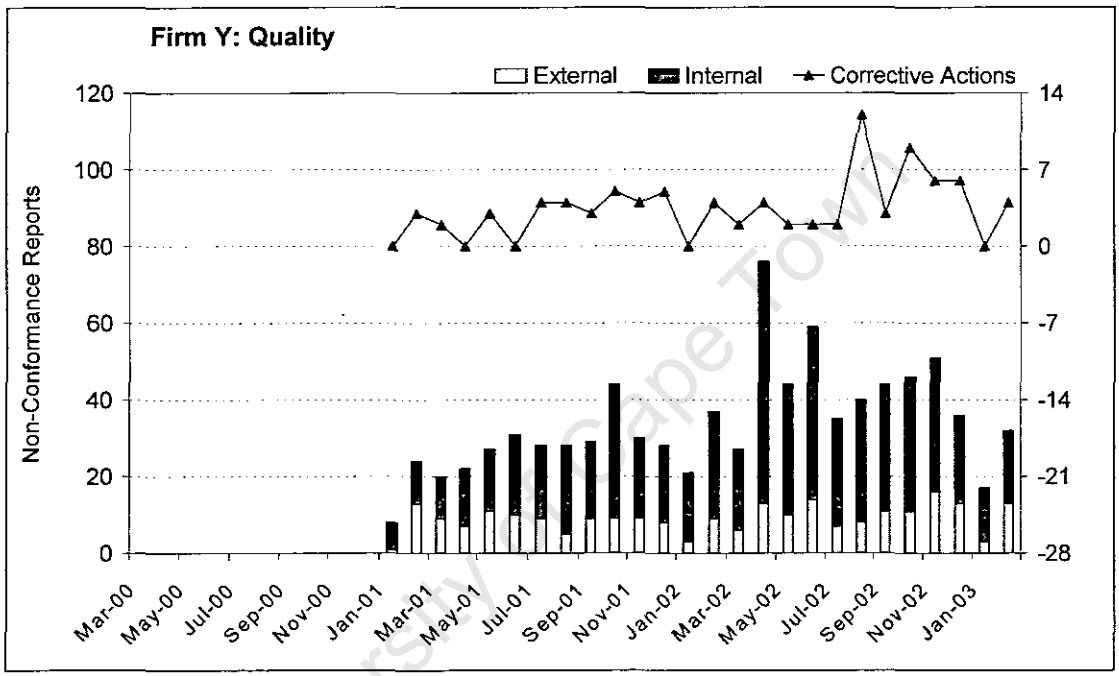

Figure 14: Firm Y Quality (Non-Conformance Reports)

Firm Y's quality data has to be interpreted with two considerations in mind. After the production director raised awareness of quality standards in mid-2002, the internal NCRs and subsequent corrective actions increased. While this reflects room for improvement in underlying process capability, it is positive in the sense that the data in Figure 14 shows improved quality control.

The other consideration to keep in mind when interpreting Firm Y's quality performance is that it manufactures high volumes of small products, which can impact substantially on a measure such as parts per million (ppm) if a whole batch is defective. Therefore, the data in Figure 15 is highly variable. Defects in the hands of the firm's customers appear to have improved, but defects inside the factory appear

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not to have improved. Therefore, quality performance for Firm Y was classified as a "slight deterioration" in Appendix 4.13.

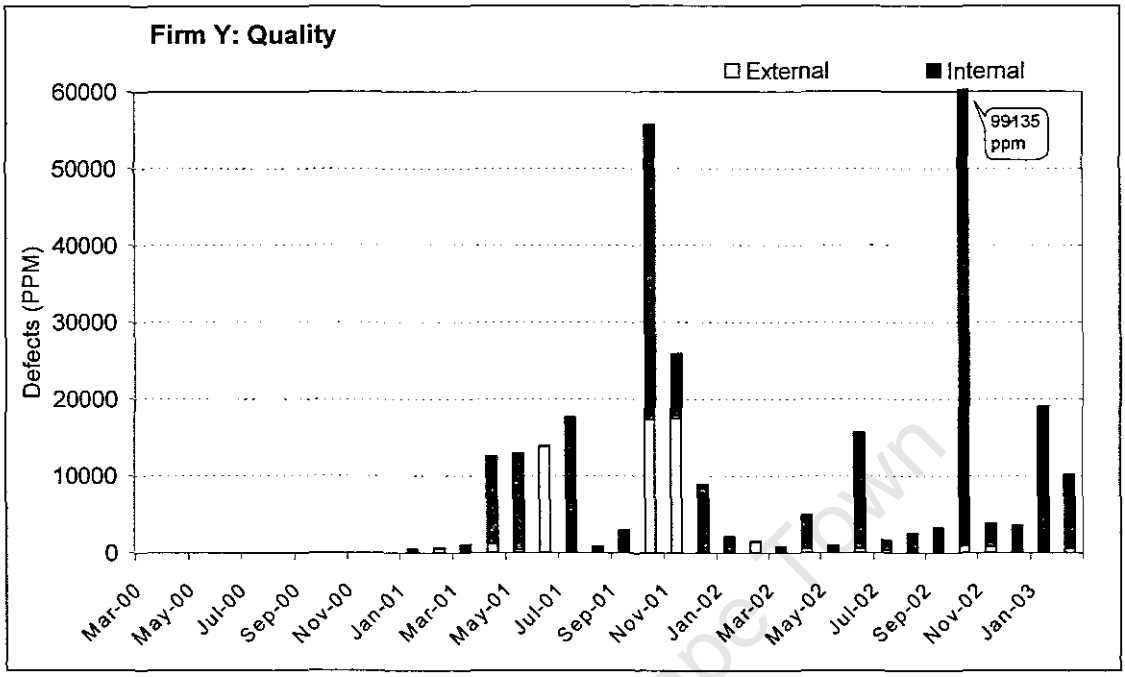

Figure 15: Firm Y Quality (Defects ppm)

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Summary and Interpretation of Case Findings

Off-production time in support of TBWO activities at Firm Y was on average 5.44% of total time worked, well above the average of 3.27% for all the firms researched. As related above, Firm Y implemented many practices in support of its TBWO programme. The fact that it was one of the few firms from which data was available on the number of suggestions implemented reflects the extent of its implementation effort.

The declining productivity and quality performance for Firm Y is therefore not consistent with the hypotheses in this research. It is also not consistent with the qualitative data reported by the management; in particular, the production director reported substantial cost savings when the teams were given responsibility for controlling their expenses. Also, the firm's overall financial performance improved over the research period.

There are several possible explanations for this contradiction:

- The preferred measure of operational performance used for this research may have been a poor or incorrect reflection of actual performance in this case as the product values used to calculate the value of production output may have introduced distortions into the data.
- Cost reduction was not one of the performance measures collected in this research because it is not always due to improved operational performance. However, it is possible that where management have a cost reduction focus (as was reported by the management of Firm Y) material cost reductions could have been substituted for labour productivity improvement.
- Firm Y undertook a lot of product development during the research period, which resulted in an increase in confirmed orders towards the end of the research period. The firm may have curtailed productivity improvement during the research and the potential improved performance of the firm may only be realised once production volumes increase.
- Firm Y's TBWO programme started from scratch and was aggressively implemented. Possibly the trade-off due to the amount of time and effort spent on programme implementation reduced productivity.
- The management at Firm Y emphasised the human resource aspects, such as employee morale and participation, of the programme. As the available research shows that the link between employee satisfaction and improved job performance is weak (see section 2.6.4.2), there may have been too much reliance on the HR aspect of TBWO at Firm Y.

The finding at Firm Y therefore is open to interpretation. Strictly on the basis of the available quantitative data, the finding is that Firm Y's performance declined after it made significant efforts to implement TBWO. However, this finding is contradicted by the qualitative data.

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Appendix 4.11: Firm U Case

Background

Firm U was a third-generation, family-owned clothing manufacturing plant in Landsdowne, Cape Town. It employed an average of 231 shop floor employees and produced garments with a nominal value of R4.5m per month over the period of the research. The factory was a relatively new purpose-built facility, located in an area with numerous skilled clothing machinists. It produced mostly children's clothes for a single large retail group with a reputation for high quality everyday wear and with which they had built up a close working relationship over many years.

An important difference between this case and the others researched was that quantitative data for this firm was available for the 3 years prior to the period that data was collected for most of the other firms. Therefore, the data series for Firm U is over 72 months.

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Firm Profile

The following graphs provide an indication of how the firm's profile changed over the research period.

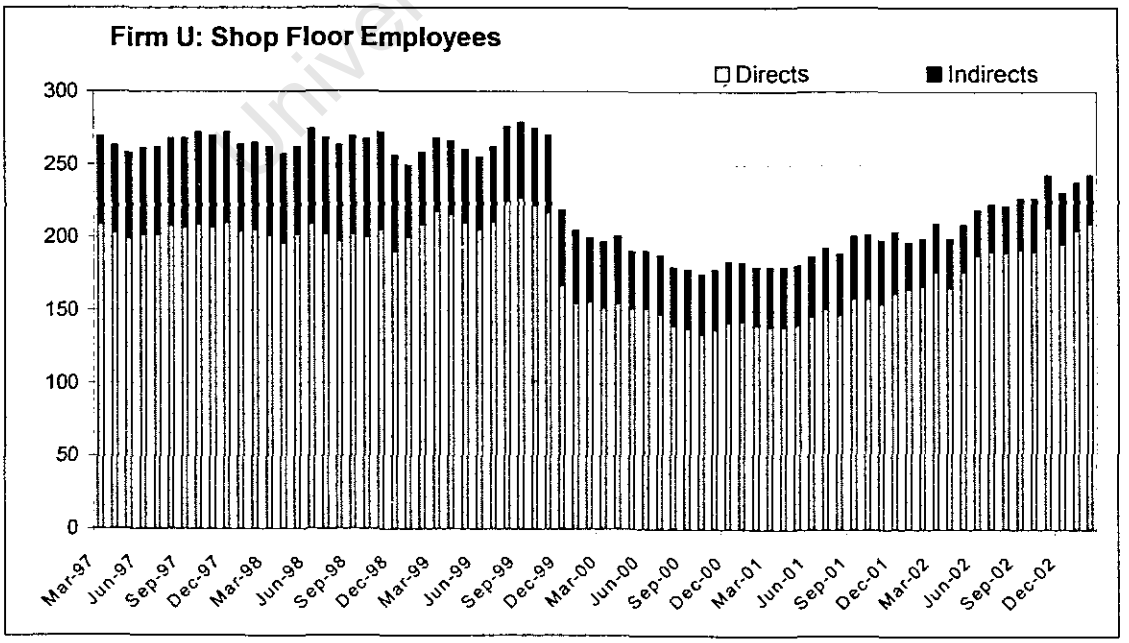

Figure 1: Firm U Shop Floor Employees (Excluding Management)

In 1999, Firm U lost a lot of business to firms in regions of the country where the *industry agreement on wage rates was lower or not applicable* (Interview U010510DA&HC, p. 8). Figure 1 shows the resulting retrenchment of late 1999 after production for the summer peak demand season was completed. While Firm U survived relatively well, the closure of several clothing producers in the Western Cape during the research period was evidence of the difficult market conditions in which they operated.

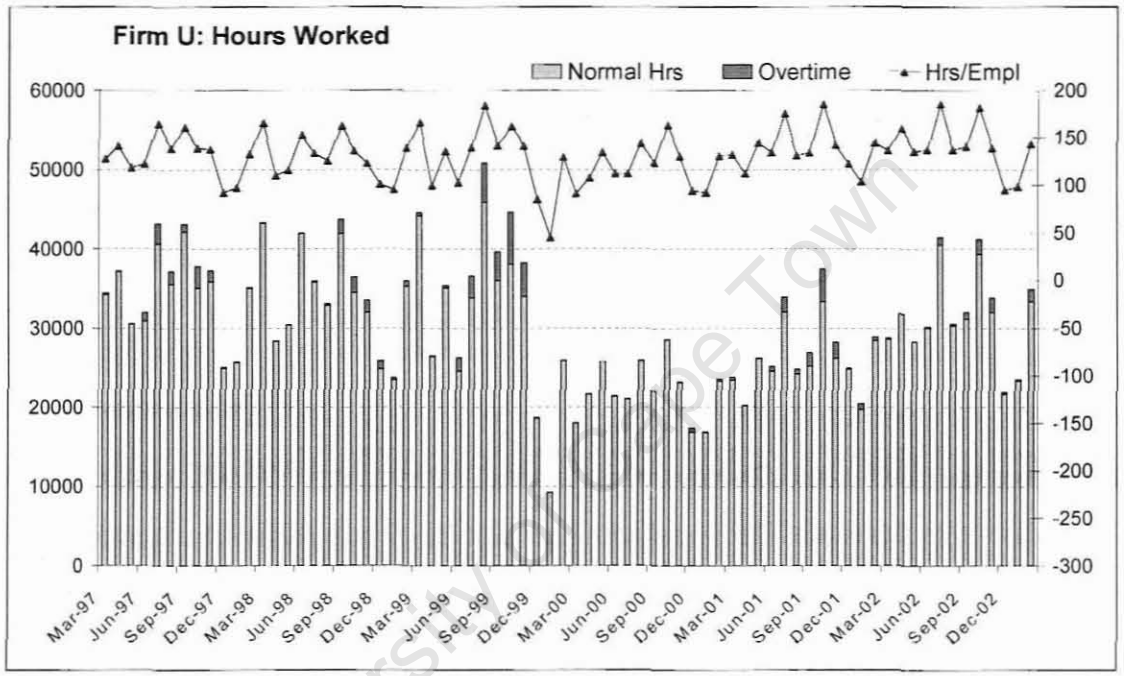

Figure 2: Firm U Hours Worked

Figure 2 shows that the loss of business mentioned earlier impacted briefly on the average hours worked per shop floor employee but recovered to the long-term average soon after.

Figure 3, below, shows the drop in output early in 2000, after the retrenchments. Thereafter, physical output in terms of units produced recovers to previous levels. However, it is apparent from the rise in value of output at the same time that higher value items were being produced. This resulted from changes in customer preferences for higher value-added clothing, not only from branded merchandise but also from garments with higher work content, such as items with cargo pockets and more elaborate trimmings.

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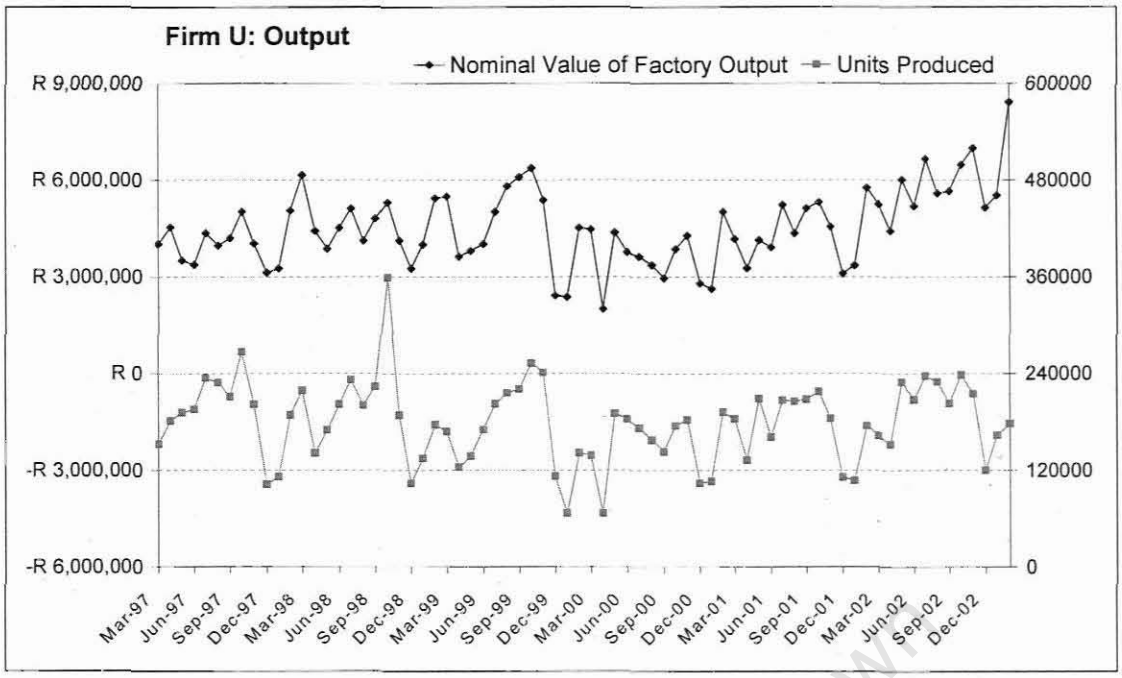

Figure 3: Firm U Nominal Value of Output and Units Produced

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Implementation of TBWO Programme

The mainstay of Firm U's TBWO programme was the incremental conversion of its progressive bundle production lines (see Figure 4) to cellular manufacturing (also known as modular production in the clothing industry; see Figure 5) over several years from June 1998 until all the lines had been replaced by September 2002 (see Figure 16). The production manager had seen the modular production system in

Figure 4: Progressive Bundle Straight Line at Firm U

operation when he visited clothing firms in the United Kingdom several years earlier and took the opportunity to start introducing the new form of work organisation after the factory moved to new premises (Interview U010510DA&HC, p. 1).

Figure 5: U-shaped Modular/Cellular Production at Firm U

In 1998, the Clothing Industry Training Board also conducted a modular production training project which demonstrated this form of work organisation to local clothing producers (Lomofsky, 1999, p. 81). Firm U employed a newly graduated production manager from the local technical college to facilitate the introduction of the modules at the firm. As the unionised workforce was somewhat resistant to the new way of working, modular production was initiated with volunteers, although eventually all the machinists were re-organised into modules (Interview U020904DA, p. 3).

Figure 7 below shows that the greater part of the firm's off-production time was spent on training, a large proportion of which was skills training as in clothing

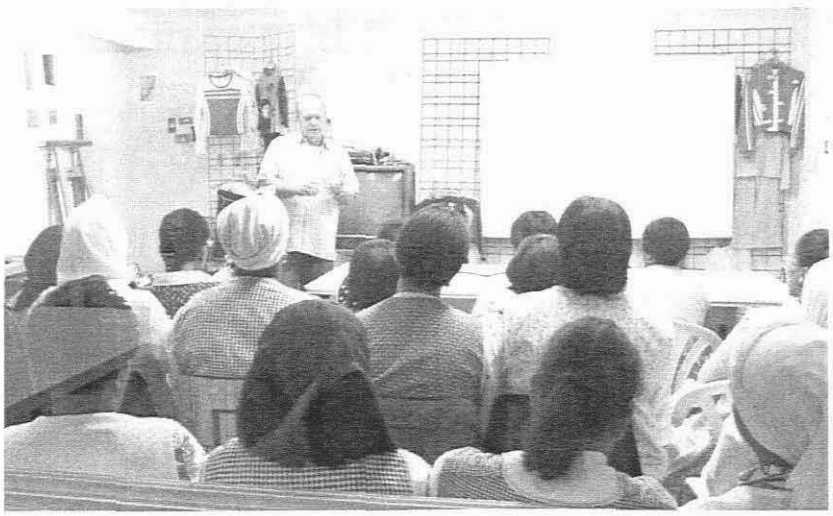

Figure 6: Training by the Production Manager at Firm U

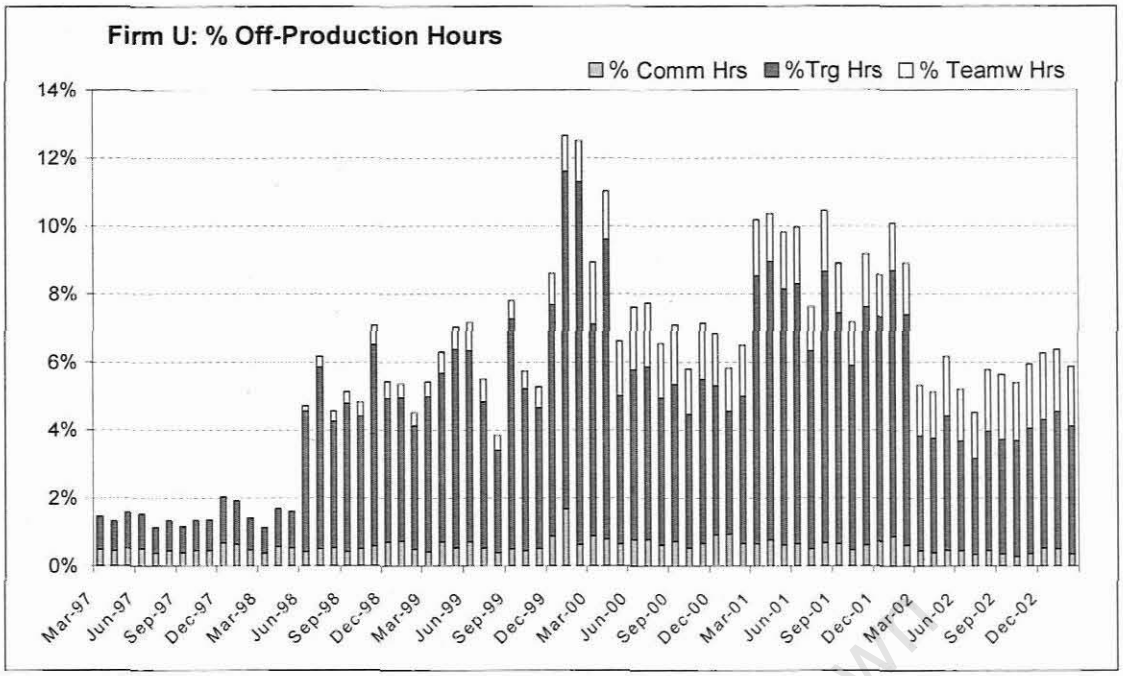

Figure 7: Firm U Hours off Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked.

manufacture, it is critical for the shop floor employees to maintain high levels of machining skills. When each module started up, teams received training in how to run it, and for several years, each modular team was also taken off-site for team-building, in which inter-personal and working relationships were addressed. It is also possible to see, in Figure 7, how team meetings became a larger proportion of off-production time as more modules started up.

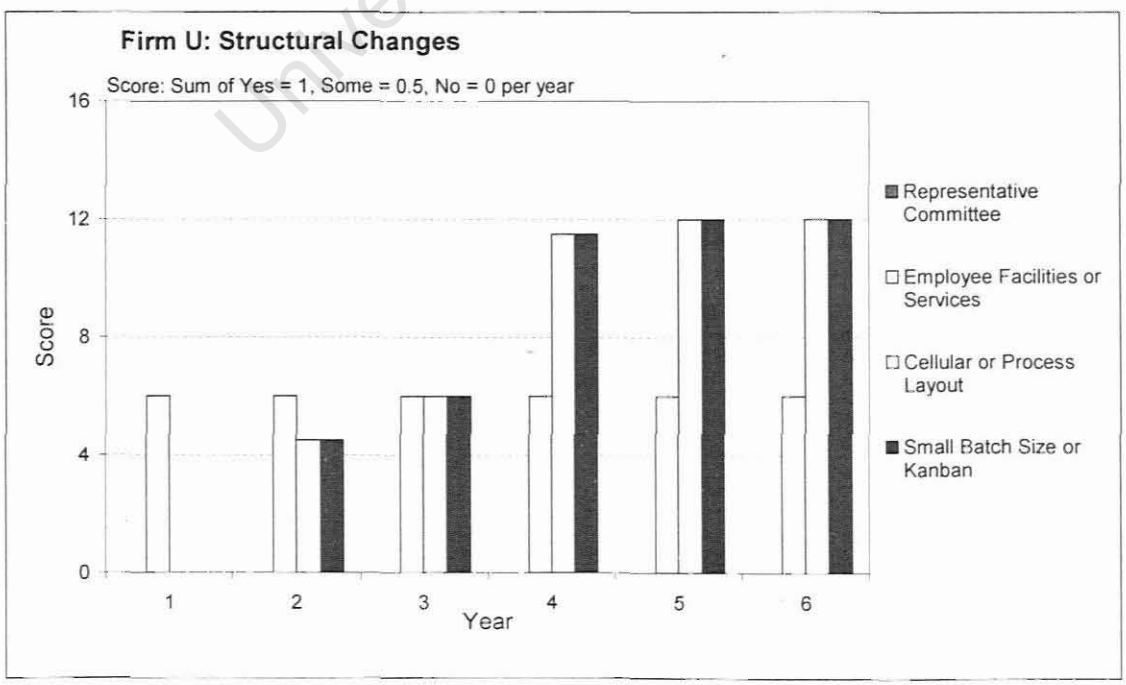

Figure 8: Firm U Structural Changes (Permanent Work System Changes)

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Figure 8 shows that, apart from the conversion to a modular work organisation and regular meetings of the steering committee, not much else was done in terms of structural changes. Before the switch to modular production, the firm had an incentive system which paid out a bonus from 63% efficiency to a maximum of 100%. This system was changed for the modules to start at 75% efficiency for the daily production of the module, with no upper limit. Initially, it was regarded as a management ploy to apply pressure on the workforce, but after some modules repeatedly reached 100%, a new level of performance became part of the mindset of the shop floor employees at the firm (Interview U010510DA&HC, p. 6). By February 2001 this had spread to all the people still working on the lines, and all the machinists were rewarded with Kentucky Fried Chicken at the end of the month (Interview U010510DA, p. 7).

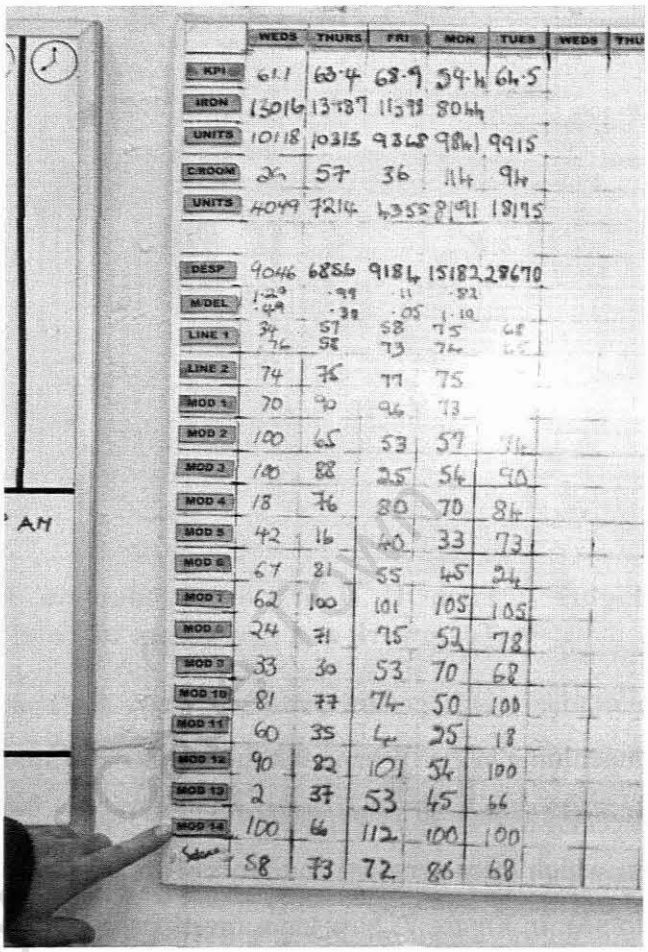

Figure 9: Daily Performance Board at Firm U

Figure 10: Downtime on Module at Firm U

To encourage the teams to take greater responsibility, the teams' efficiency targets were not adjusted for absent team members and downtime due to machine breakdowns. However, access to mechanics to fix breakdowns became an issue (Interview U030227MS, p. 11), and in 2002, the firm trained some machinists to do

minor maintenance themselves. (Interview U030430DA, p. 1). As more modules became operational, the module set-ups for garment style changes became a problem due to a shortage of available machines. Previously, all machines would be in production all the time; however, within the modules, some machines were idle at times, causing a reduction in effective capacity. So, at the end of 2002, the firm invested R1.3m in new machines to improve its flexibility to change garment styles (Interview U030430DA, p. 1).

Figure 11: Team & Facilitator discussing Module Set-up

As Firm U's customer required high quality standards, a quality management system was in place (see Figure 12). The firm had a handyman to make up work aids; however, there was no actively managed process improvement system and suggestions from the shop floor employees were implemented on an ad hoc basis.

Figure 12: Quality Inspection and Feedback to Module at Firm U

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Performance Outcome Trends

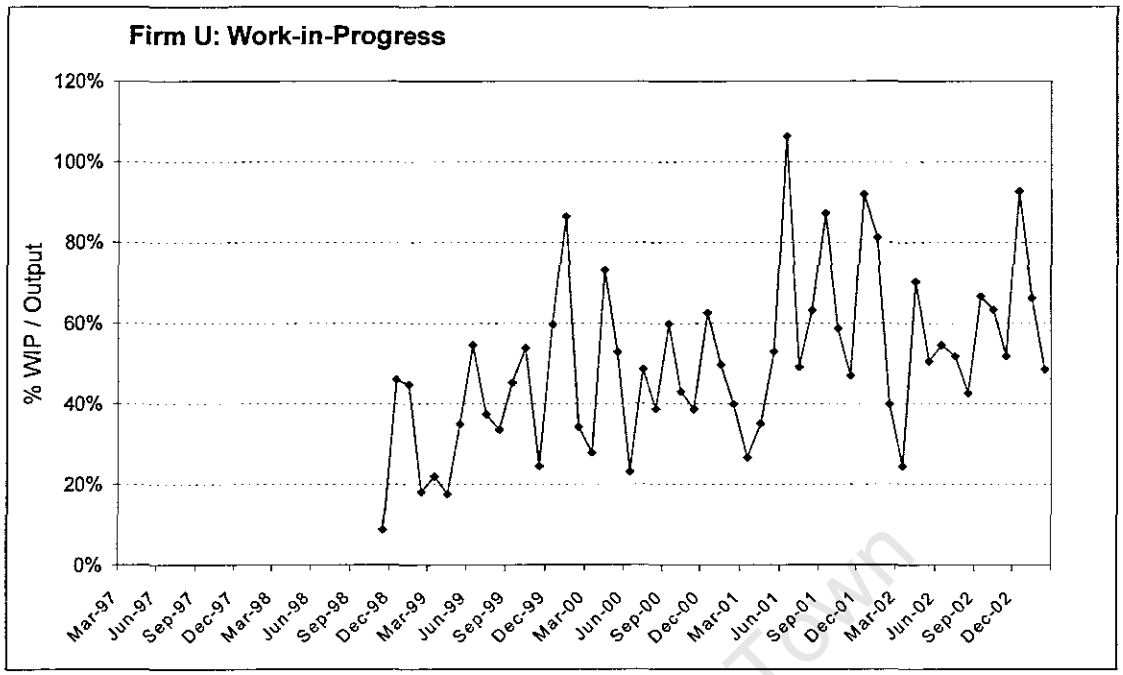

Figure 13: Firm U Work-in-Progress as a Percentage of Sales

Contrary to the expectations for a modular production system, Figure 13 shows that WIP did not reduce over the period for which data is available.

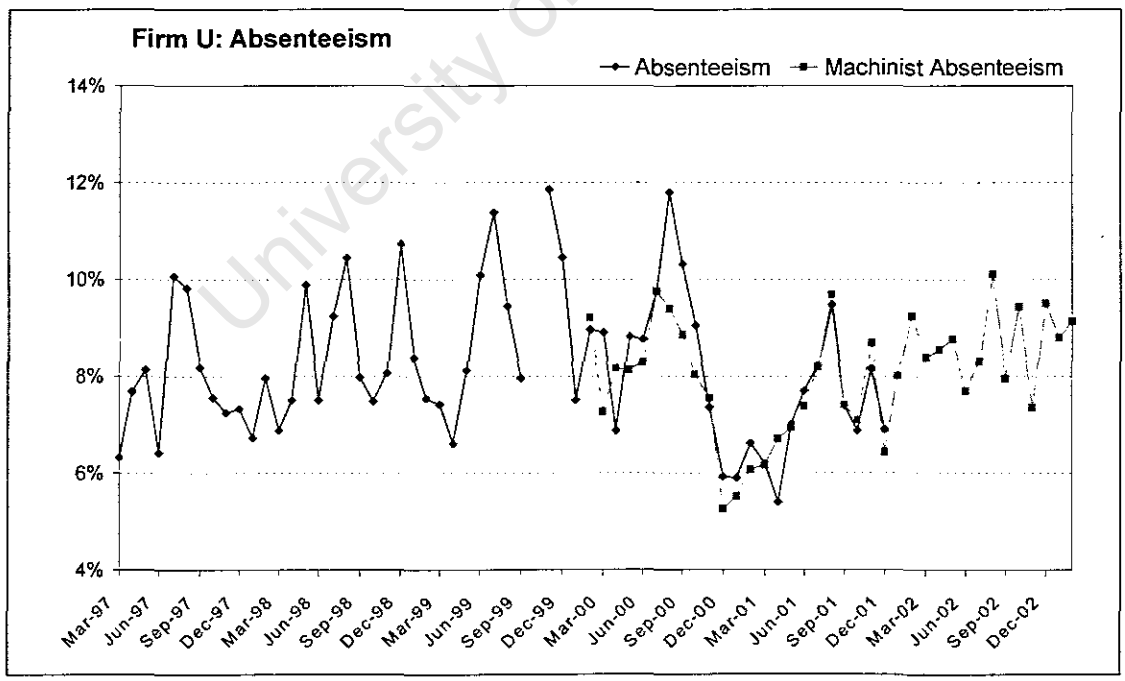

Figure 14: Firm U Absenteeism

The firm changed the way it measured absenteeism from general to machinist-specific absenteeism, but in Figure 14, the overlapping portion of the two data series indicates

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that the measures are comparable. This data does not indicate any substantial change in the level of absenteeism.

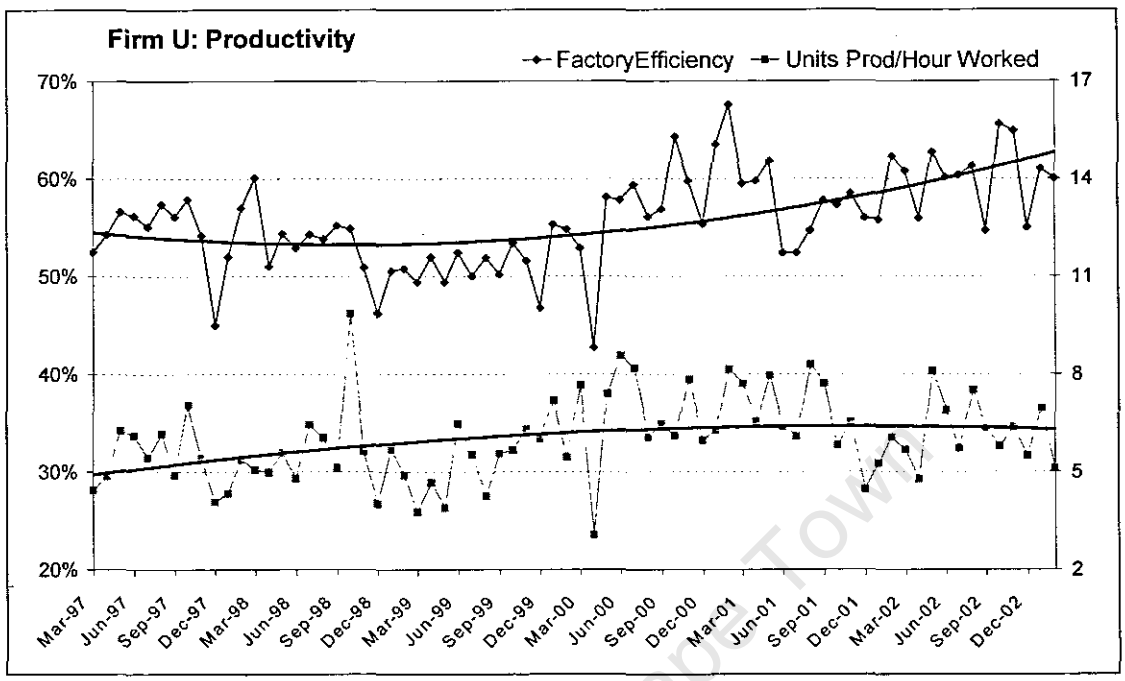

Figure 15: Firm U Productivity (trend lines added)

Although productivity per unit did not appear to improve, as mentioned earlier, the work content per garment increased and therefore factory efficiency is a more reliable indicator of this measure.

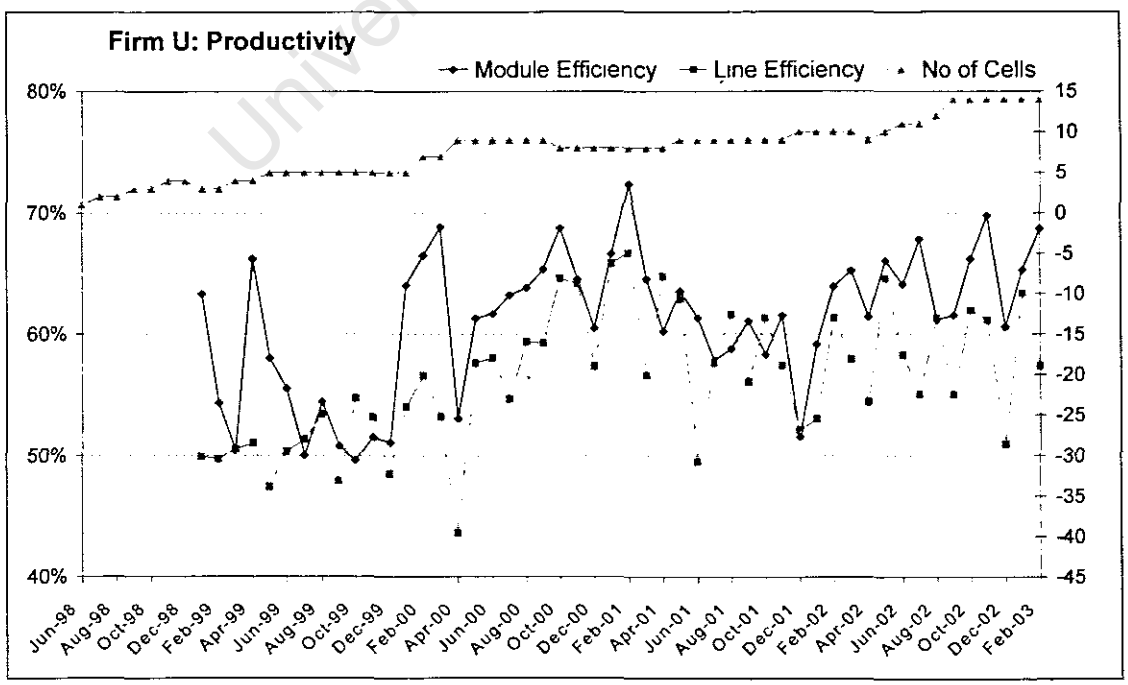

Figure 16: Line vs. Module Productivity at Firm U

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Further corroboration of the superior performance of modular production is provided by the comparison between the performances of the lines with those of the modules. Over the period for which data is available, the lines averaged 56.4% efficiency, whereas the modules were at 61.1% efficiency on average, as is apparent from the graphs in Figure 16. Productivity was therefore classified as "moderately improved" in Appendix 4.13.

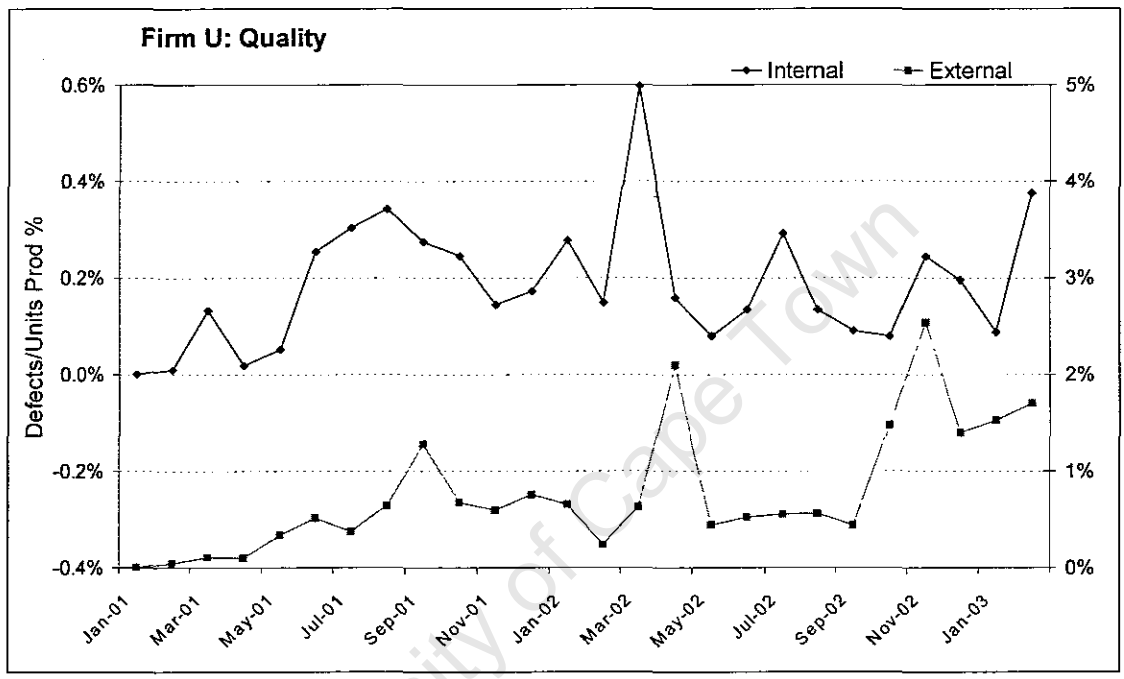

Figure 17: Firm U Quality

Two quality indicators were available over the last 2 years of the research. The internal quality indicator is more reliable because the external quality was a measure of supplier (e.g., fabric faults) and sub-contractor (e.g., printing of transfers) quality. The quality performance was classified as "level" for the purpose of Appendix 4.13.

Summary and Interpretation of Case Findings

Despite difficult market conditions, Firm U progressively implemented cellular manufacturing until all the traditional lines on its shop floor were replaced. It was one of only two of the firms in this study that had commenced their TBWO programme prior to the research period. At 5.89% off-production time, it ranked second highest for time spent on TBWO activities. The firm's implementation programme relied mostly on the new layout, training of operators in basic teamwork and conflict

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resolution skills, and quality control, rather than on process improvement and disciplined shop floor best practice.

While quality performance remained at much the same level as before, productivity of the manufacturing cells were demonstrably better than that of the traditional lines.

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Appendix 4.12: Firm N Case

Background

Firm N was a sintered metal product manufacturer that produced mostly auto-components. The average number of shop floor employees over the research period was 99 and the firm's average monthly value of production was R1,468m. Until 1997, the firm was part of a South African industrial corporation with a traditional autocratic management style. The firm was sold to the current international parent corporation because it was making a loss at the time. The international parent was also focussed on producing sintered products and gave the local management a free hand to make management decisions, provided they remained within budgeted parameters. The firm was located in an industrial area in Cape Town.

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Firm Profile

The following graphs provide an indication of how the firm's profile changed over the research period.

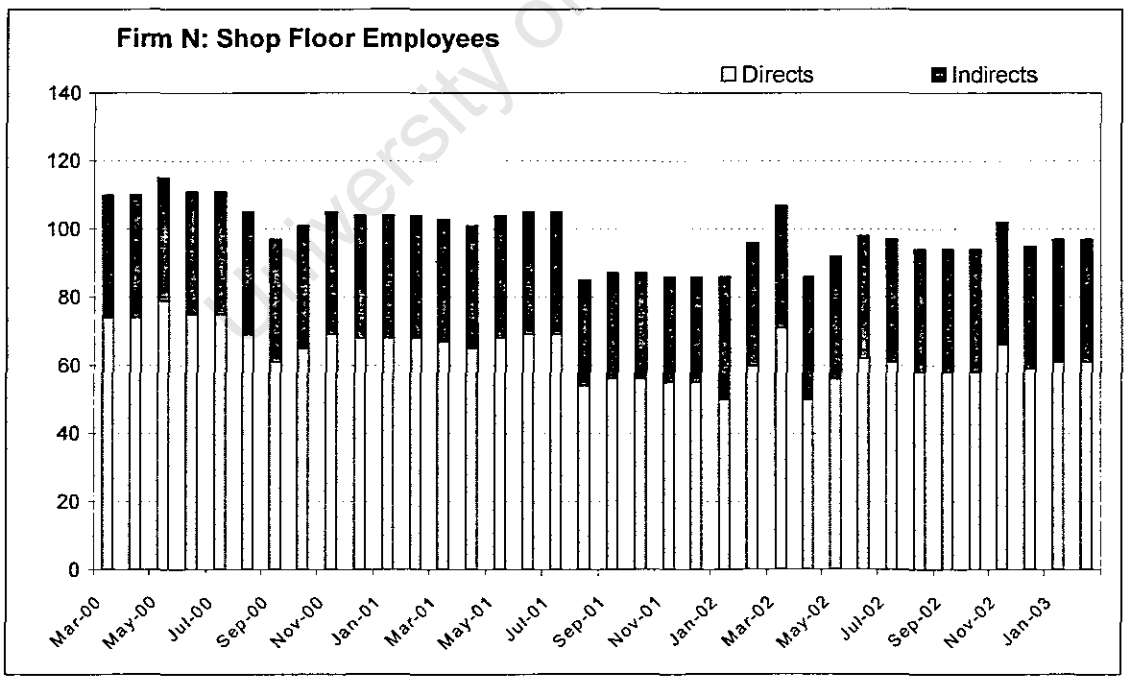

Figure 1: Firm N Shop Floor Employees (Excluding Management)

The reduction in number of employees in the middle of 2001 came as result of an increase in productivity, which is fully explained later in this case.

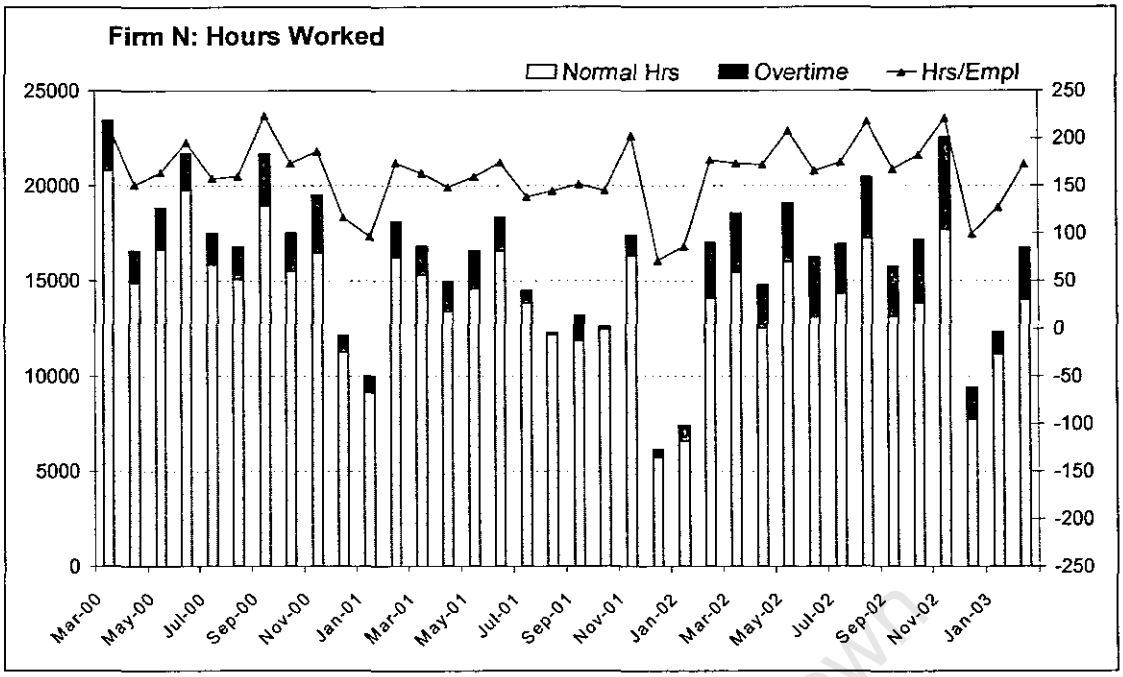

Figure 2: Firm N Hours Worked

The reduction in hours worked in December and January every year, shown in Figure 2, was due to the annual shutdown over the Christmas period.

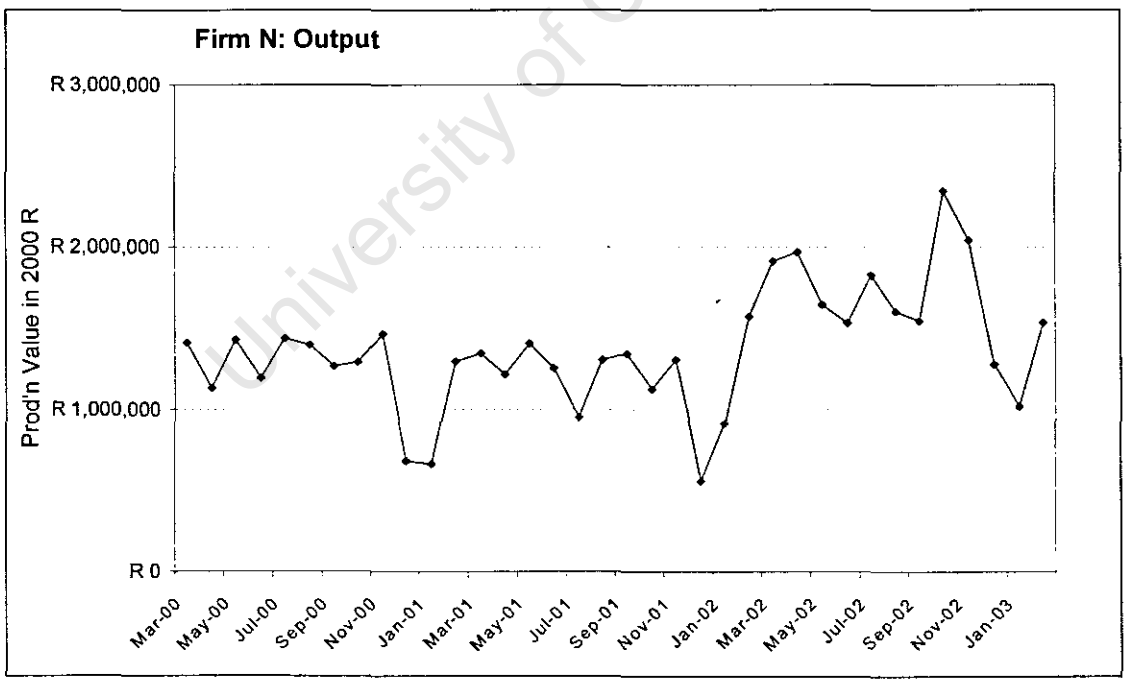

Figure 3: Firm N Value of Production Output (Discounted against Firm's Price increases to Rand in 2000)

The output of Firm N, reported in Figure 3, is closely related to the firm's sales as it operated on a JIT basis with its major customers. Firm N's major customers were first-tier auto-component suppliers to vehicle assemblers, and that market was

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growing well in South Africa over the research period. Towards the end of the research period, the firm was increasingly being asked to become involved in new product development with its local customers (Interview N020805EA, p. 14), gained new customers (Interview N020805EA, p. 15), and also started to pick up export orders from its parent company (Interview N020805EA, p. 25).

Implementation of TBWO Programme

At the time of the firm's sale, the general manager was replaced with the firm's technical director, who had long been in disagreement with the autocratic management style used in the firm. After reading the book *Lean Production* by Womack and Jones (1996), he and the production manager were keen to try out the approach in the factory. Their major customer supported them by making available training materials for a TQM programme. They built a training room at the back of the factory and trained all the employees themselves for 4 days, in groups of 16, during 1998 (Interview N010216EA, p. 1).

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Figure 4: The Blue Cell at Firm N

The sintering process entails pressing metal powder into shapes, baking it in a sintering furnace, pressing it again, and then drilling holes, tapping threads or doing other finishing processes. While the initial training took place, the batch and queue process was converted to a cellular layout. As this required making 2.5 meter-deep

pits and foundations for the pressing machines, it involved substantial planning and resource commitment. However, it paid off fairly quickly, with lead-time reductions from 6 weeks to 4 hours and a work-in-progress reduction of 90% (Interview N010216EA, p. 3). Right from start, "EI meetings" were held in which each cell met for an hour per week to do process improvement projects, and a cross-functional team called the SLIM committee (the acronym means "clever" in the local language) was also formed, where the EI facilitators met with the heads of service departments to iron out obstacles to implementing suggestions (Interview N010216EA, p. 4). However, in 1999, the EI meetings started to become "gripe sessions" and the initiative started to "fizzle out" (Interview N010216EA, p. 3).

Then the general manager heard of the WPC and saw it as an opportunity to revive the programme. In January 2000, it was re-launched under the auspices of the WPC and the firm restructured its existing consultative structures into a WPC steering committee. A WPC consultant was appointed and she facilitated a strategic planning session in August 2000, during which management and 22 shop floor employees developed a common vision for the firm (Interview N010216EA, p. 7).

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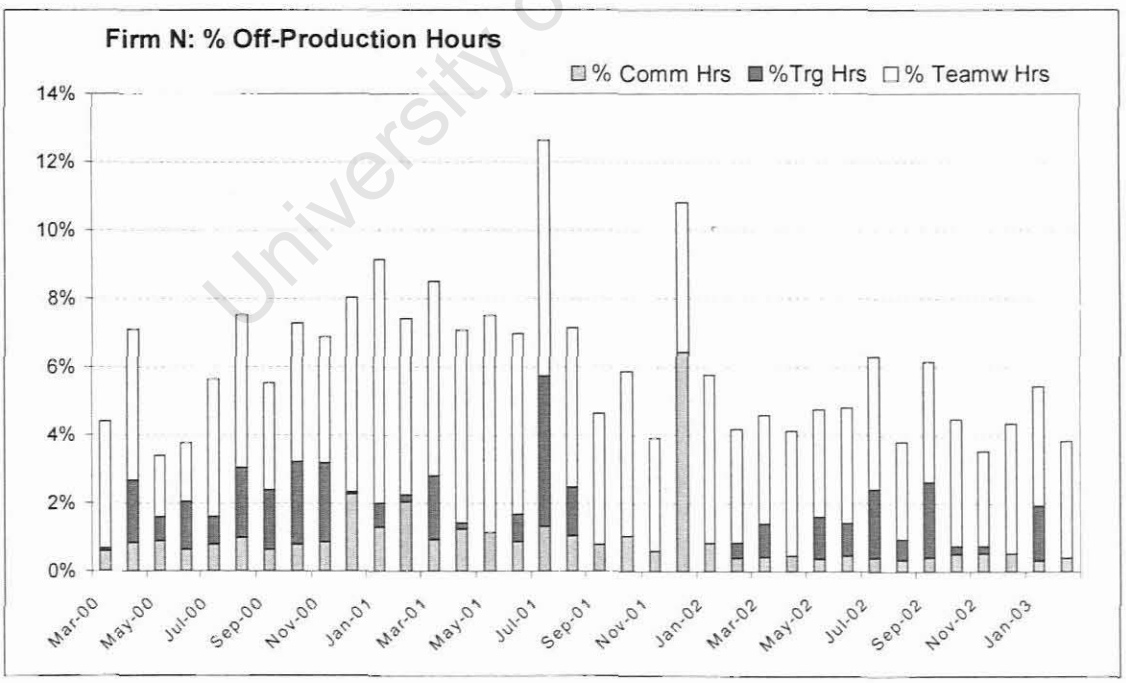

Figure 5: Firm N Hours off Production for Communication, Training or Teamwork as a Percentage of Total Hours Worked.

Figure 5 shows that despite having started the TBWO initiative well before the WPC project, Firm N still spent a high percentage of shop floor employee paid time on

TBWO practices over the research period. At an average of 6.03%, this was the highest of all the firms researched.

As the major structural changes, such as converting the shop floor layout and organizing into teams, had taken place before the WPC, the focus during the WPC was on training team leaders in meeting management, conflict resolution, and other leadership skills; technical skills training to improve reading of drawings and taking of measurements; and teamwork in the cells. The WPC consultant spent a large part of her time on improving the employees' skills at doing process improvement projects at the weekly EI meetings until August 2001 (Interview N020212EA, p. 14), using the 8D-TOPS (8 Disciplines for Team Orientated Problem-Solving) method (Interview N010216EA, p. 6). Each team was expected to complete at least three improvement projects per year, and a "quality stage" was built in the factory, where teams presented their projects to the whole workforce. They distinguished between "corrective action" and "continuous improvement" to make clear the difference between maintaining and improving performance (Interview N010216EA, p. 6). Each cell was also given a small budget and a purchasing book so that they had full autonomy to make small process improvements (Interview N010216EA, p. 12).

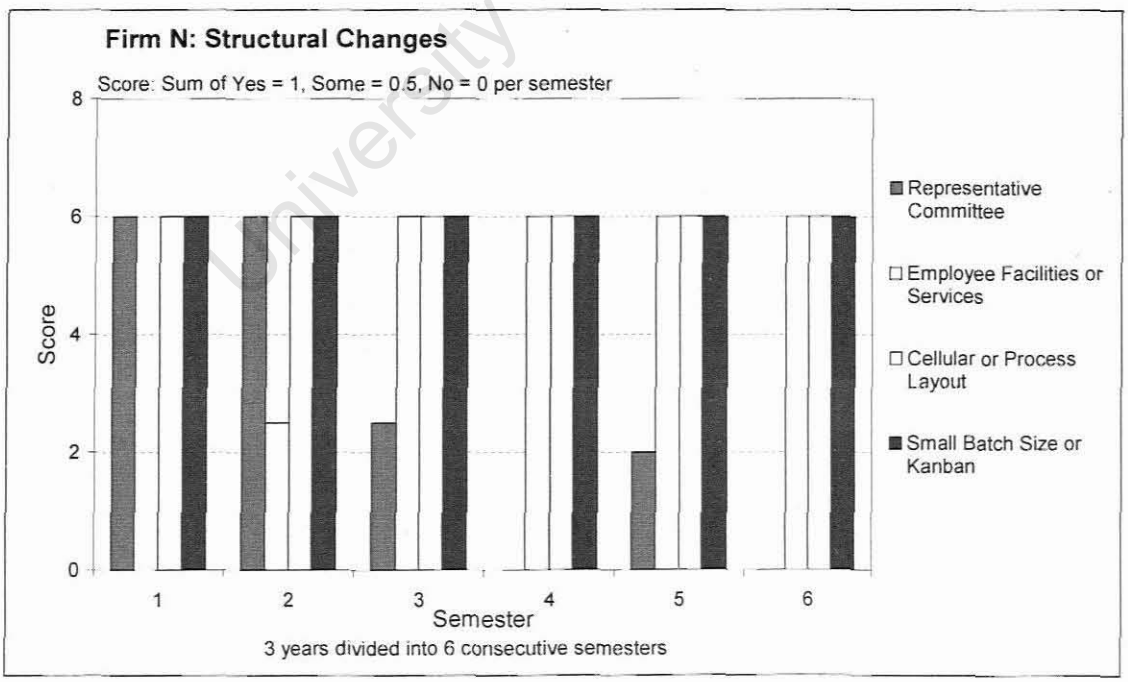

Figure 6: Firm N Structural Changes (Permanent Work System Changes)

Figure 6 shows that the firm had a cellular layout and also operated on a system of small production batches throughout the data collection period. The representative

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committee did not meet in the 4th semester for the reasons explained below, and after briefly starting up again early in 2002, was found to be superfluous and was absorbed into other communication/consultation structures at the firm. In March 2001, the staff canteen was upgraded so that weekly meetings with employees could be held there.

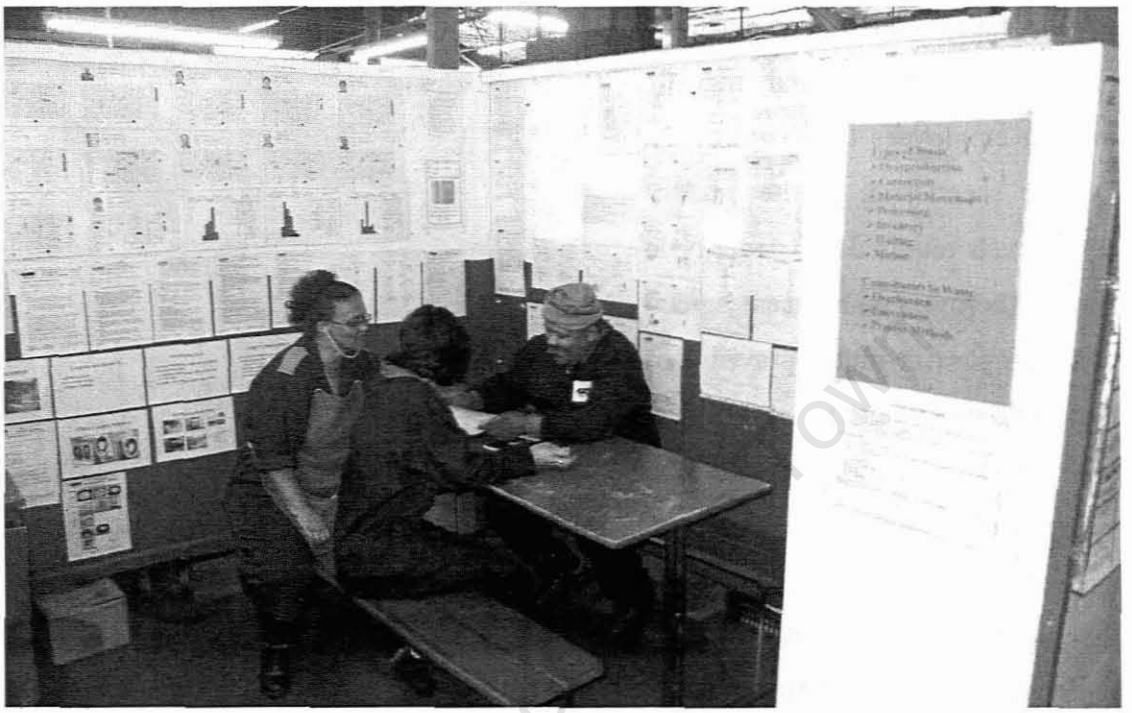

Figure 7: Green Cell Team Area at Firm N

The firm also had an incentive system, which went through several incarnations during the research period. Initially, there were two schemes. The teams were rewarded with a fixed bonus for achieving certification as cells (Interview N010216EA, p. 8) and a company-wide profit sharing scheme, based on 10 key performance measures, paid out every 3 months (Interview N010216EA, p. 9). The incentive scheme was agreed upon after lengthy consultations with the steering committee, but the production manager reported that the system was not well received, not least because it did not pay out regularly because of employees not reaching the targets set (Interview N010216EA, p. 10).

Then, in August 2001, the firm faced a crisis. After recovering from the poor performance of previous years, the firm had been making a profit. A sudden downturn in orders in the middle of 2001 prompted management to initiate consultations with the employee representatives about working short-time to cut costs. The employee

representatives returned from consulting the workforce with a proposal to discharge the contract workers (see Figure 1), deploy some of the indirect employees to direct production, stop all non-production related meetings and training (see Figure 5), and make the production targets with only the permanent employees (see Figure 11). Despite scepticism, as the productivity levels required had never been reached before, management agreed to the proposal, with the proviso that the employees would return to short-time if it did not work. Not only was the projected loss for August 2001 averted but the firm ended up making a "sizable profit" for the month (Interview N020212, p. 2).

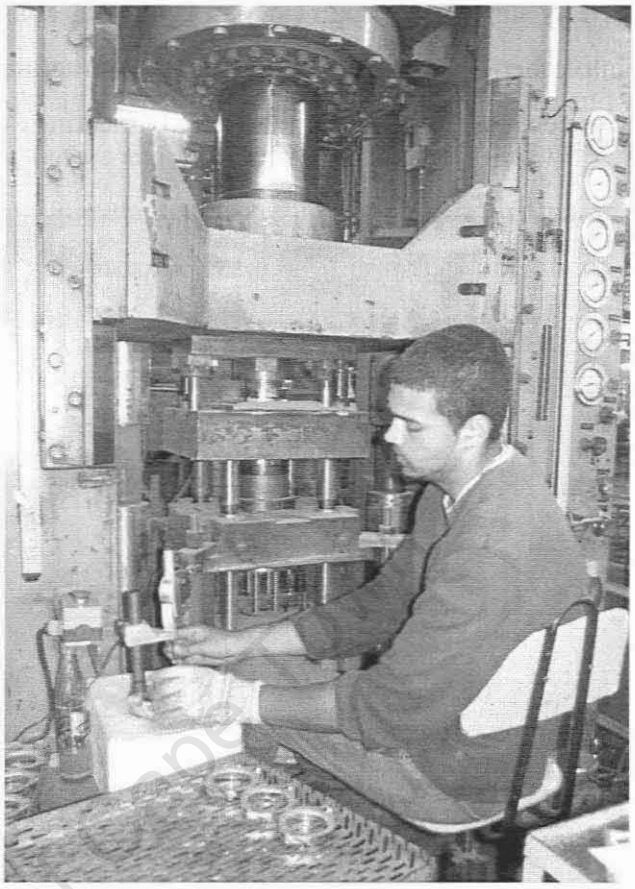

Figure 8: On-line Quality Control at Firm N

After the remarkable turnaround, the employee representatives approached management for a reward, and the incentive scheme was changed to one based on paying out 25% of the firm's profit over the budget negotiated with the shareholders. Half the bonus was paid out at the end of the each month, and the other half was put into a kitty in case of shortfalls in future months. However, for the rest of 2001, the firm made profits every month except for October 2001, and the balance in the kitty was paid out at the end of the year (Interview N020212, p. 3). The factory was still performing well at the end of the research period in February 2003 after the second annual payout of the balance in the kitty at the end of 2002 (Interview N030325EA, p. 1). The production manager thought that "part of the reason the plan worked was not only because people put in the effort but because the systems were now there to accommodate them" (Interview N020212, p. 4).

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Performance Outcome Trends

These graphs report the intermediate (WIP & absenteeism) and operational (productivity and quality) performance outcomes at Firm N over the research period.

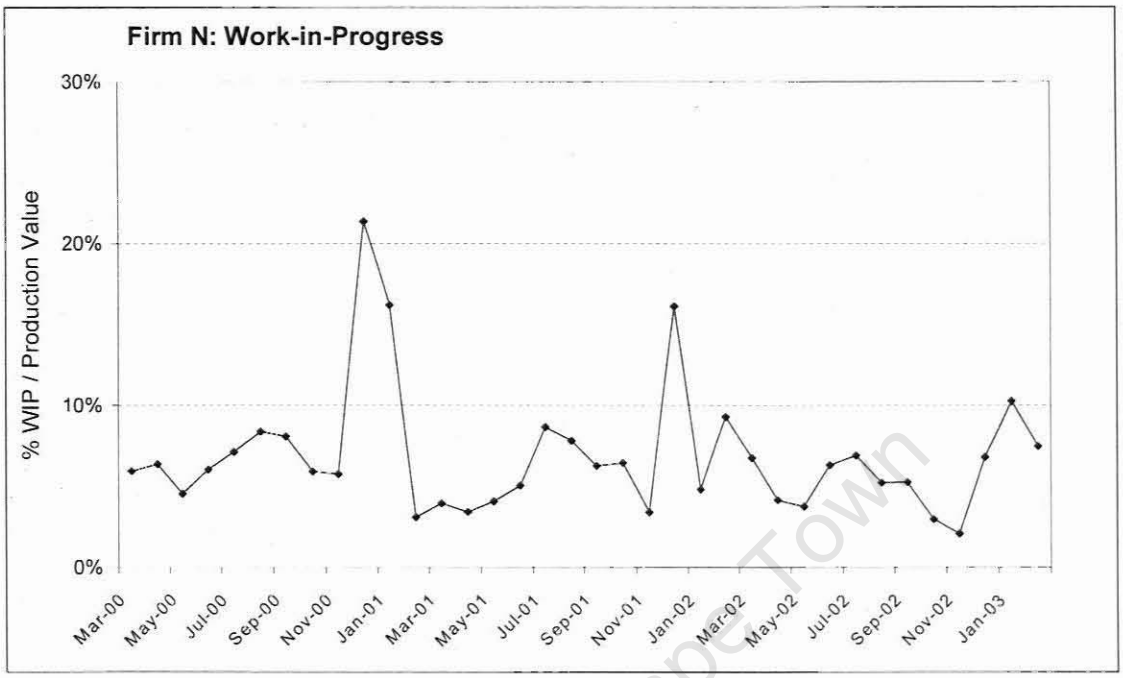

Figure 9: Firm N Work-in-Progress as a Percentage of Production Value

Other than short-lived increases in work-in-progress during the annual shut-downs in December and January, Figure 9 shows that Firm N maintained the same level of WIP over the research period despite an increase in production output (see Figure 3).

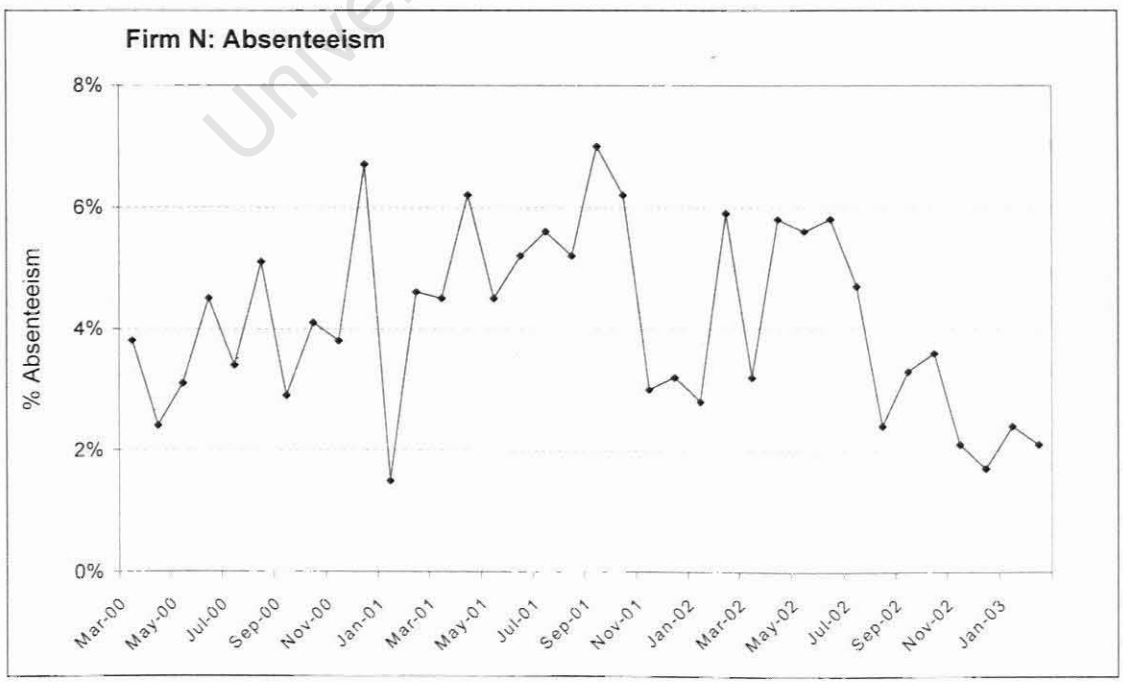

Figure 10: Firm N Absenteeism

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Figure 10 shows that since the productivity turnaround in the middle of 2001, absenteeism appears to have been on a downward trend.

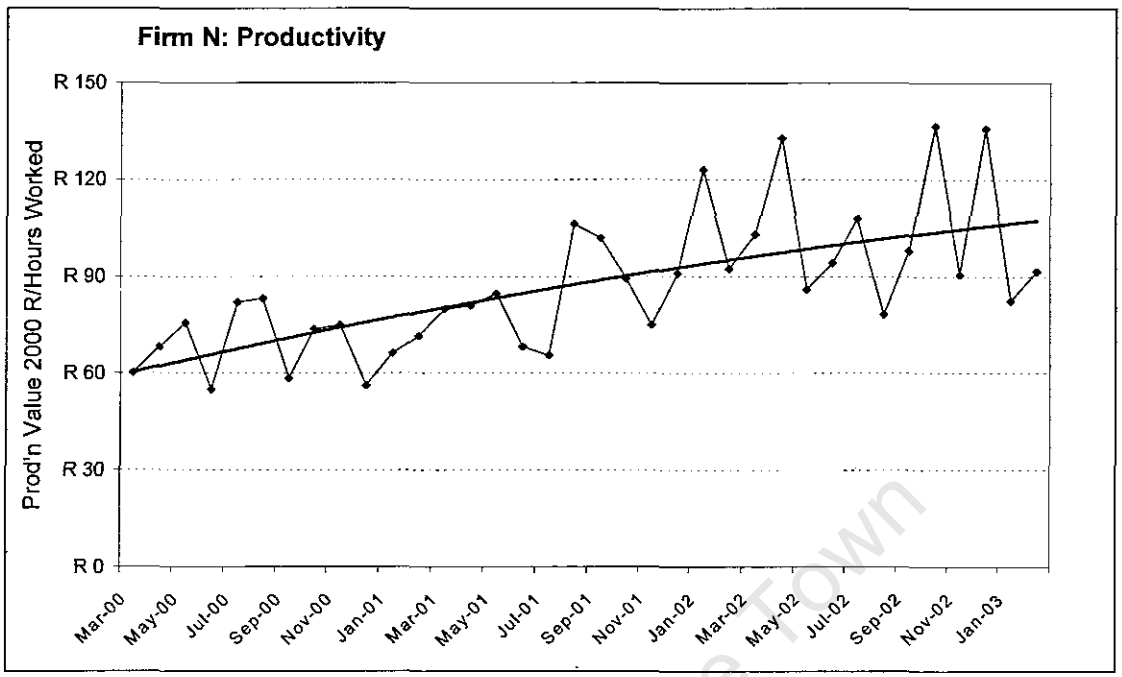

Figure 11: Firm N Productivity (2nd Order Polynomial Trend Line added)

While the trend line in Figure 11 appears to show a more or less consistent rate of improvement in productivity, closer inspection shows that it had shifted to a sustained higher level after the step change in performance in the middle of 2001. Therefore, a "substantial improvement" in productivity performance is reported in Appendix 4.13 for Firm N.

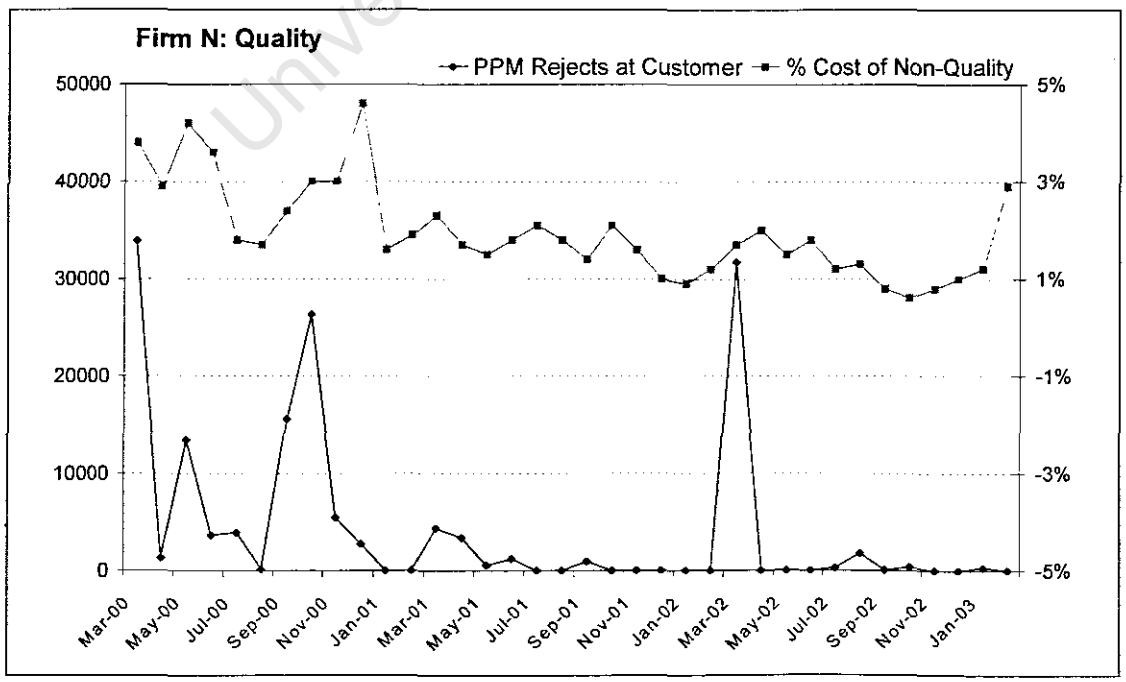

Figure 12: Firm N Quality

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Both measures of quality performance shown in Figure 12 show that, apart from isolated incidents, there has been a sharp decrease in Firm N's defect rate and cost of quality. This is reported in Appendix 4.13 as a "substantial improvement" in Firm N's quality performance.

Summary and Interpretation of Case Findings

Firm N stands out as the firm among the firms researched that did most to implement TBWO practices:

- It is the firm with the highest percentage, 6.23%, of off-production time dedicated to the three indicator implementation activities: communication and consultation, training, and teamwork over the research period.
- It started its TBWO programme several years before the WPC by making a substantial effort to change the shop floor layout to cellular production.
- It sustained communication and consultation with shop floor employees in several ways throughout the programme.
- Firm N placed the highest emphasis on process improvement by shop floor employees of the 12 firms researched, supported the shop floor employees with targeted process improvement training and facilitation of team meetings, and put in place the resources to rapidly implement their recommendations.

The industrial sector in which the firm operated grew well over the implementation period, but when it experienced a slump in demand in 2001, a substantial performance improvement took place. This can be attributed to the capability of its operational systems and employee skills that had been built up but not realized until a triggering event took place. Before this event, the firm's incentive system was not very successful due to its complexity, but afterwards it was simplified and it played an important role in sustaining its performance.

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Appendix 4.13: Summary of Performance Outcome Classifications

(Note: These classifications are based on the detailed information reported in each case.)

Firm	Productivity	Quality
R	**Slight Improvement** is indicated by trend of both indicators. % Wages/Sales is less reliable because it is an accounting measure.	**Level Performance** is indicated by trend although it is a proxy measure.
G	**Moderate Deterioration** by both indicators, especially towards end of period, although efficiency is less reliable before January 2000.	**Moderate Improvement followed by Moderate Deterioration** indicated by trend of % Defects /Units produced. % Rejects/Units produced is a not a reliable indicator because units were scrapped for a wide variety of reasons.
C	**Moderate Deterioration** is consistently indicated by trend.	**Moderate Deterioration** is consistently indicated by trend.
J	**Slight Deterioration** Efficiency measure is not reliable. Units produced/hours worked, although variable, is level for most of period with deterioration only towards end.	**Moderate Deterioration** Although deterioration is slight for most of period, it becomes significantly worse towards end.
K	**Slight Deterioration** Improvement towards end of period militates against classification as moderate deterioration.	**Moderate Improvement** is indicated by trend. Deterioration towards end appears to be reversing.
O	**Level Performance** probably reconciles difference of two equally reliable measures.	**Substantial Improvement** indicated by trend over most of the period. Recovery from specific problem towards end was under way.
E	**Level Performance** indicated by trend over period. Last months' figures anomalous due to firm closure.	No assessment possible due to unreliable data and short data series.
X	**Moderate Improvement** indicated by most reliable trend over period.	**Level Performance** is indicated by trend although it is a proxy measure.
S	**Slight Improvement** indicated by consistent trend over period.	**Moderate Deterioration** probable if account is taken of exaggerating effect of unreliable measurement by new staff.

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Firm	Productivity	Quality
Y	**Moderate Deterioration** indicated by most reliable trend over period.	**Slight Deterioration** probably indicated, but measure is highly variable.
U	**Moderate Improvement** indicated by both trends over a long period.	**Level Performance** is indicated by more reliable measure over last 2 years.
N	**Substantial Improvement** consistently indicated by trend.	**Substantial Improvement** consistently indicated by trend.

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